NASA SP–7037 (272)
December 1991

RONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
SCIENTIFIC & TECHNICAL INFORMATION

NASA SP–7037 (272)
December 1991

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Program
Washington, DC 1991

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 719 reports, journal articles, and other documents originally announced in November 1991 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N91-29139 — N91-31077
IAA (A-10000 Series)	A91-48445 — A91-52998

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 1991 will be published in early 1992.

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

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Category 01 Aeronautics (General) 887

Category 02 Aerodynamics 891
Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

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

Category 04 Aircraft Communications and Navigation 910
Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

Category 05 Aircraft Design, Testing and Performance 920
Includes aircraft simulation technology.

Category 06 Aircraft Instrumentation 930
Includes cockpit and cabin display devices; and flight instruments.

Category 07 Aircraft Propulsion and Power 936
Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

Category 08 Aircraft Stability and Control 942
Includes aircraft handling qualities; piloting; flight controls; and autopilots.

Category 09 Research and Support Facilities (Air) 955
Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

Category 10 Astronautics 961
Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and *spacecraft propulsion and power.*

Category 11 Chemistry and Materials 962
Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

Category 12 Engineering 968
Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

Category 13 Geosciences 983
Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

Category 14 Life Sciences N.A.
Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

Category 15 Mathematical and Computer Sciences 983
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.

Category 16 Physics 989
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

Category 17 Social Sciences 991
Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

Category 18 Space Sciences N.A.
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

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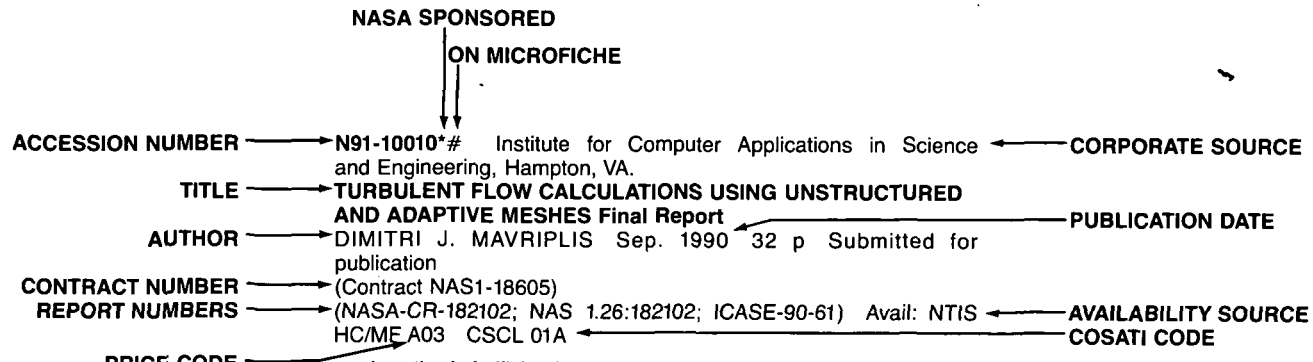
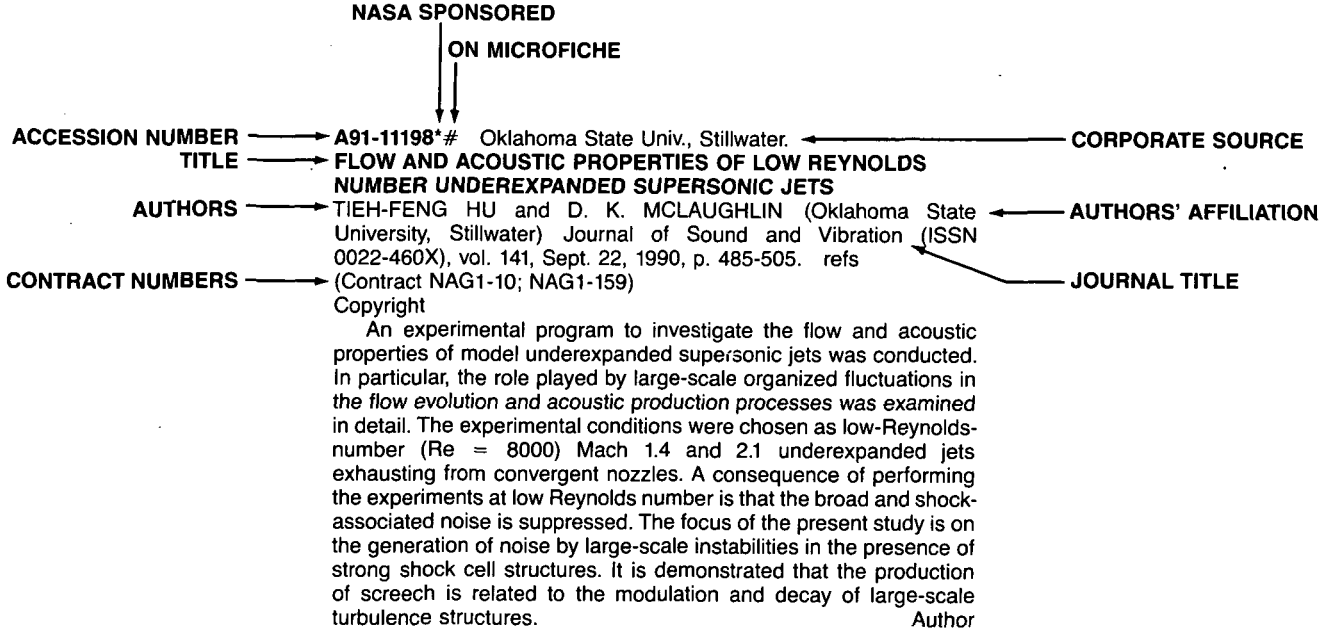
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 272)

DECEMBER 1991

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AERONAUTICS (GENERAL)

A91-48596* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TIRE/RUNWAY FRICTION INTERFACE
THOMAS J. YAGER (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. refs
(SAE PAPER 901912) Copyright

An overview is given of NASA Langley's tire/runway pavement interface studies. The National Tire Modeling Program, evaluation of new tire and landing gear designs, tire wear and friction tests, and tire hydroplaning studies are examined. The Aircraft Landing Dynamics Facility is described along with some ground friction measuring vehicles. The major goals and scope of several joint FAA/NASA programs are identified together with current status and plans. C.D.

A91-48602
AIRCRAFT CERTIFICATION - HIRF PROTECTION REQUIREMENTS FOR CIVIL AIRCRAFT SYSTEMS
JAMES J. TREACY (FAA, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 13 p.
(SAE PAPER 901918) Copyright

Pursuant to a request by the FAA, the SAE is developing a technical basis for protecting electrical and electronic systems on civil aircraft from high intensity radiated field (HIRF) effects generated by external sources. The SAE's AE-4R Subcommittee will identify the HIRF environment, recommend test and analysis methods for demonstrating that aircraft systems are protected, and identify HIRF-resistant aircraft and systems designs. Until new regulations are issued in view of AE-4R recommendations, the FAA and the European Joint Airworthiness Authority will continue to issue special requirements for aircraft protection from HIRF. O.C.

A91-48605 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA'S HIGH SPEED RESEARCH PROGRAM - AN INTRODUCTION AND STATUS REPORT
HOWARD L. WESOKY (NASA, Lewis Research Center, Cleveland, OH), MICHAEL J. PRATHER (NASA, Goddard Institute for Space Studies, New York), and GERALD G. KAYTEN (NASA, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 26 p. refs
(SAE PAPER 901923) Copyright

NASA's High Speed Research Program (HSRP) gives attention to the potential environmental effects of a next-generation SST in three areas of concern: atmospheric pollution, airport community noise, and sonic boom. Research has accordingly been undertaken in such fields as the validation of ozone depletion predictions, the feasibility a 90-percent NO(x) emissions reduction to minimize ozone-layer impacts, economically viable compliance with FAR 36 Stage 3 airport community noise levels, and the comparative advantages of efficient subsonic flight over land masses or low-sonic-boom-optimized configurations. Interim HSRP milestones for 1991 and 1992 are noted. O.C.

A91-48615
ADVANCED COMPOSITE USE EXPERIENCES - THE BASIS FOR FUTURE APPLICATIONS
JOHN D. WARNER (Boeing Commercial Airplane Group, Seattle, WA) and ALAN G. MILLER SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 21 p.
(SAE PAPER 901938) Copyright

Opportunities for the application of composites to commercial jet transports are addressed. The major obstacles that must be overome to permit continued and expanded applications are discussed. These include: overcoming the 'black aluminum' mentality, shimming, protection against lightning strikes and high-intensity radiation fields, reduction of raw material costs, cost-effective tooling, automation, simplified shimming, inspection, product maintenance, and resolution of workplace and environmental issues. C.D.

A91-48618
TRAINING SYSTEM REQUIREMENTS - A TRAINING SYSTEM DEVELOPER'S VIEWPOINT
JOHN R. IMHOF, CHARLES K. FITSCHEN (IIT Research Institute, Dayton, OH), and MICHAEL COOVER (Eagle Technology, Inc., Dayton, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 27 p.
(SAE PAPER 901945) Copyright

This paper discusses the general Joint Primary Aircraft Training System (JPATS) Concept Study, which is the first step in the analysis and definition of the Primary Aircraft Training System (PATS) portion of the USAF Specialized Undergraduate Pilot Training. The study provides a top-down look at the system requirements for the PATS aircraft and for the accompanying ground-based training system. C.D.

A91-48620
POSSIBLE HARDWARE SOLUTIONS FOR FUTURE PILOT TRAINING
JOSEPH J. BINDER (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p.
(SAE PAPER 901948) Copyright

In the decade of the nineties, a complete revamping of USAF pilot training will occur which will see Specialized Undergraduate Pilot Training (SUPT) become a reality. This paper reviews the SUPT concept and other upcoming changes in pilot training. Some of the hardware requirements for future pilot training are addressed, emphasizing the need to replace the current T-37 trainer aircraft. C.D.

A91-48624
JOINT LIVE FIRE AND LIVE FIRE PROGRAMS
RALPH W. LAUZZE, II (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p.
(SAE PAPER 901952) Copyright

The procedures and results of the Joint Live Fire and Live Fire Test programs are discussed. Particular attention is given to results pertaining to aircraft fuel ingestion and hydraulic fuel fires. C.D.

A91-48632* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ADVANCED TRANSPORT OPERATING SYSTEMS PROGRAM
JOHN J. WHITE (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901969) Copyright

NASA-Langley's Advanced Transport Operating Systems Program employs a heavily instrumented, B 737-100 as its Transport Systems Research Vehicle (TRSV). The TRSV has been used during the demonstration trials of the Time Reference Scanning Beam Microwave Landing System (TRSB MLS), the '4D flight-management' concept, ATC data links, and airborne windshear sensors. The credibility obtainable from successful flight test experiments is often a critical factor in the granting of substantial commitments for commercial implementation by the FAA and industry. In the case of the TRSB MLS, flight test demonstrations were decisive to its selection as the standard landing system by the ICAO. O.C.

A91-48651
BACK TO THE FUTURE OF THE PERSONAL AVIATION
STEVEN C. CROW (Arizona, University, Tucson) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 29 p. refs
(SAE PAPER 901990) Copyright

The status of personal aviation is reviewed with particular attention given to specifications for a personal aviation system with a reasonable chance of attracting 100-thousand buyers annually. These specifications include price, liability, performance, control, convenience, safety, and environmental impact. Personal aviation represents a three-level system, comprising the Global Posiotioning system for navigation, an infrastructure called Skyways, and modular conveyances called Starcars that function as automobiles and airplanes. O.G.

A91-48670
DEVELOPMENT AND CERTIFICATION OF A COMPOSITE AIRFRAME
RICHARD WONG (Beech Aircraft Co., Wichita, KS) Society of Manufacturing Engineers, Conference on Composites in Manufacturing, 10th, Anaheim, CA, Jan. 7-10, 1991. 14 p. refs
(SME PAPER EM91-108) Copyright

The choice of an all-composite primary structure in an aircraft such as the Starship is driven by weight-saving, corrosion-prevention, compound-curved aerodynamic contour, and fatigue-insensitivity considerations. The present account of this aircraft's structural design gives attention to the methods by which the qualification criteria of FAA part 23 regulations were met. These qualification efforts extended to materials, environmental conditions-definition, laminate structures validation, NASTRAN structural analysis, and damage tolerance characteristics. FAA certification was demonstrated by this process to be obtainable within reasonable cost/schedule frameworks. O.C.

A91-48672
COMPOSITE SUPPORTABILITY
E. A. WESTERMAN (Boeing Military Airplanes, Seattle, WA) Society of Manufacturing Engineers, Conference on Composites in Manufacturing, 10th, Anaheim, CA, Jan. 7-10, 1991. 9 p.
(SME PAPER EM91-114) Copyright

The roles of composite materials in aircraft support and associated problems are discussed. The skills and training required of personnel who handle composites are summarized, and current practices in the repair of composites are examined. Improvements that need to be made in these practices are addressed. C.D.

A91-48794
OPTIMIZED DEFINITION OF AERONAUTICAL MATERIALS [DEFINITION OPTIMISEE DES MATERIAUX AERONAUTIQUES]
A. FERRAN (Aerospatiale, Departement Conception Generale, Toulouse, France) Materiaux et Techniques (ISSN 0032-6895), vol. 79, May-June 1991, p. 5-10. In French.
Copyright

A review is presented of the evolutionary changes that have taken place over the past 15 years in the field of aeronautical materials. Attention is directed to changes in the context of material definition, qualification of materials for aircraft certification, and the continuing endeavor to find the best return on investment for new material structures. It is indicated that the separation between the various commercial and technical functions in the area of aeronautical materials is tending to diminish, with the material function becoming multidisciplinary within the manufacturing organizations. R.E.P.

A91-49115
THE INTRODUCTION OF TITANIUM SUPERPLASTICALLY FORMED AND SUPERPLASTICALLY FORMED/DIFFUSION BONDED COMPONENTS INTO SERVICE ON AIRBUS AIRCRAFT
MARTIN H. MANSBRIDGE (British Aerospace, PLC, Airbus Div., Filton, England) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 224-236. refs
Copyright

The titanium alloy (typically, Ti-6Al-4V) SPF and SPF/DB structural components which have been designed and manufactured for use by Airbus aircraft thus far have demonstrated significant cost and weight savings. Attention is given to the quality-assurance procedures developed for these processing tasks. All the original SPF tool cavities developed have performed as desired and remain in regular use. O.C.

A91-49152
INSERVICE EXPERIENCE AND MAINTENANCE OF ADVANCED COMPOSITE STRUCTURES IN AIRLINE SERVICE
DONALD JOYNES (Boeing Commercial Airplane Group, Seattle, WA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 1131-1145.
Copyright

The first generation of advanced composite carbon and aramid fiber reinforced production components were introduced into the Boeing commercial airplane fleet in the early eighties. An assessment is made of the reported in-service incidents to the carbon fiber composite control surfaces and the resulting implications. The impact on the commercial airlines of the new composite components and their maintenance requirements, some unforeseen problems associated with their introduction, and the resolution by Boeing of these problems are discussed. Some observations deduced from the in-service experience with these first generation components are also presented. It is concluded that the first generation of composite components have successfully proven that carbon fiber is a viable structural material and that the components met their design objectives. Author

A91-49159
PAINT STRIPPING IN THE AEROSPACE INDUSTRY
KATY WOLF (Institute for Research and Technical Assistance, Los Angeles, CA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 1264-1270.
Copyright

Methods available for paint stripping of aerospace structures and other industrial equipment are discussed. Special attention is

given to the following alternatives: methylene chloride-based chemical strippers, cryogenic striping, plastic media blasting, sodium bicarbonate stripping, and not painting at all. I.S.

A91-49858
IMPLEMENTATION OF NEW TECHNOLOGY - A BOEING PERSPECTIVE
CHET EKSTRAND (Boeing Commercial Airplanes, Seattle, WA) IN: Managing the modern cockpit; Proceedings of the 3rd Human Error Avoidance Techniques Conference, Dallas, TX, Dec. 4, 5, 1990. Warrendale, PA, Society of Automotive Engineers, Inc., 1990, p. 7-13.
(SAE PAPER 902341) Copyright

The last decade has seen the introduction of many high-technology airplanes into the air transportation system. These high-tech airplanes have typically brought flight decks with highly integrated Flight Management Systems and a host of challenges in terms of effectively utilizing the new technologies. Training is the area that offers the greatest potential for improvement in how the high-tech flight deck is operated. A system for definition of knowledge/skill development levels, training medium allocation, cognitive task definition, and knowledge/skill maintenance interval analysis, are some of the enhancements proposed in this paper. Author

A91-51247
NEAR-NET-SHAPE PRODUCTION TECHNIQUES IN AIRCRAFT CONSTRUCTION - INNOVATIVE PRODUCTION METHODS REDUCE COSTS AND ENHANCE COMPETITIVENESS
New-Tech News (ISSN 0935-2694), no. 2, 1991, p. 13-15.
Copyright

The most important near-net-shape structural component-manufacturing methods in the aerospace industry are SPF-DB and incremental forgoing. The present evaluation of their development status notes that SPF-DB can yield cost and weight reductions of up to 50 and 35 percent, respectively, in Ti alloy components. Numerical superplastic deformation process simulations are capable of yielding critical insights into workpiece shape, tool design, wall-thickness distribution and optimum process control. Measured wall-thickness distributions have been found to deviate by only 10 percent from predicted values. O.C.

A91-51673
DESIGN BUREAU DEVELOPS NEW ENGINES FOR MIKOYAN MIG-29, MILITARY TRAINER
JEFFREY M. LENOROVITZ Aviation Week and Space Technology (ISSN 0005-2175), vol. 135, Sept. 16, 1991, p. 65.
Copyright

A thrust growth of about 20 percent is planned for the uprated version of the 18,260 lb thrust rated (with afterburner) RD-33 engine that presently powers the MiG-29 fighter. The growth powerplant will have a new fan for increased airflow, and it may incorporate materials that would allow the turbine inlet temperature to be increased from the current level of 1,670 K. Design of a military trainer engine that will incorporate a single-stage high-pressure turbine and a two-stage low-pressure turbine is under way. The compressor will have one centrifugal stage, while the number of axial stages is still undetermined. Pressure ratio for the powerplant will be about 20, and airflow is to be approximately 28 kg/sec with a turbine inlet temperature of about 1,600 K. R.E.P.

A91-52714
GLIDERS. AIRPLANES [PLANERY. SAMOLETY]
OLEG K. ANTONOV Kiev, Izdatel'stvo Naukova Dumka, 1990, 505 p. In Russian. refs
Copyright

The book contains a collection of papers written by O.K. Antonov, a renowned Soviet aircraft designer, over a period of 60 years and covering various aspects of the design, construction, and operation of gliders and propeller-driven and jet aircraft. The discussion of gliders includes simple glider models, determination of the aerodynamic characteristics of gliders, the theory of glider flight, and glider designs. Papers on aircraft cover such topics as aircraft engine designs, flight safety, performance of transport aircraft, and problems of quality, reliability, and durability. V.L.

A91-52829
THE FUTURE OF AIRCRAFT DESIGN
MARK A. BURGESS (Boeing Advanced Systems, Defense and Space Group, Seattle, WA) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 22-25, 51.
Copyright

Answers to questions regarding the future of aircraft design and the work of aerospace professionals in the next few decades are presented. The importance of computers and special programs for the development of advanced methods to solve extremely complicated problems and the effect that computer technology will have on future aircraft design are outlined with various examples. The paradox is pointed out that future new technology aircraft will be designed by the least experienced work force since before WW II, and it is noted that this work force will try to meet demanding requirements under severe cost-reduction pressure. It is concluded that unless industry and academia join forces to come to grips with this situation, it seems likely that the aerospace industry will be plagued by cost overruns, schedule slippages, and performance deficiencies. V.I.

A91-52830
AIRCRAFT DESIGN - WHERE DOES IT STAND?
JAN ROSKAM (Kansas, University, Lawrence) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 26-29.
Copyright

A detailed description of the different phases of aircraft design is presented; questions on unresolved issues with regard to design methodology are posed; and an overview on some of the major design mistakes made during the past ten years is given. From the comparison between design and other professions it is concluded that there is neither an archival aircraft design journal nor a source of academic funding for design research activities at universities. It is pointed out that the great majority of conceptual designers do not have doctorates and have little motivation to pursue an academic career. The importance of designers understanding future customer needs is stressed, since design decisions are driven by those needs and new technological developments. The validation of these developments before their incorporation into production hardware is a major factor in the design decision-making process. V.I.

A91-52832
WHAT LIES AHEAD FOR AIR TRANSPORTATION?
IRVIN R. LUCAS, III (GE Aircraft Engines, Cincinnati, OH), JOSEPH WINDISCH (Port Authority of New York and New Jersey, New York), MARIAN THOMPSON (British Aerospace, PLC, London, England), GARY G. NELSON, OSCAR L. MORGENSTERN (Mitre Corp., Bedford, MA), and RICHARD DUNCAN (AIAA, Washington, DC) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 36-43.
Copyright

An overview is presented of the problems, challenges and issues that confront the airline industry today, and possible directions for the future. Consideration is given to the industry manufacturer's perspective in forecasting, controlling air traffic, how fatigue and corrosion affect aging aircraft, and the aging of jet engines. It is indicated that the problems facing the airlines are the results of many factors including deregulation, losses created by weakened demand and increased costs, the Persian Gulf War, the rising debt from buy-outs and aircraft acquisitions, and an overburdened air traffic control system. R.E.P.

A91-52836* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GENERAL AVIATION - TRANSPORTATION IN TRANSITION
JOSEPH W. STICKLE (NASA, Langley Research Center, Hampton, VA), BRUCE J. HOLMES (AIAA, Washington, DC), and ROBERT

J. STEWART Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 56-58.
Copyright

An overview is presented of the current status of general aviation and some of the problems that it faces. Of some 220,000 active general aviation aircraft in the U.S., 195,000 are piston engine powered single- or twin-engine aircraft, that conflict with the large high-speed commercial jet transports throughout the operating spectrum. The access to airport conflict shows that the limiting factor is not airspace or airport size, but rather airway structures and airport systems that have failed to keep pace with demand. Design and development of an aircraft that can routinely fly a 150 mph approach, achieve rapid but controlled deceleration to touchdown speed, and turn off at an early exit is required. GPS satellites could provide precision approach capability to all airports and runways for commercial and general aviation aircraft. R.E.P.

A91-52948
CONCEPTUAL DESIGN OF A STARCAR
STEVEN C. CROW (Arizona, University, Tucson) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 27 p. refs
(SAE PAPER 911021) Copyright

Design concepts for Starcars, transformer vehicles that function as automobiles or airplanes, are reported. A Starcar is a composition of three components: passenger module, road module, and sky module. The Starcar examples considered include a radio-controlled GPS platform about 30 inches long and a Dodge Caravan equipped with a GPS sensor, central processor, radio modem data link, and step-motor controls. Conceptual design details including engine type, materials, performance and weight are enumerated. V.I.

A91-52950
ON THE FEASIBILITY OF SMALL, TRANSCONTINENTAL COMMUTER AIRCRAFT
JAN ROSKAM and KYLE WETZEL (Kansas, University, Lawrence) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 20 p. refs
(SAE PAPER 911023) Copyright

An evaluation is made of the possibility of long-range commuter-sized commercial aircraft operations, in order to obviate stops at major hubs in routes between medium-sized coastal cities on the U.S. mainland. Attention is given to recent advancements in aerodynamic and propulsion system design methodologies which may facilitate the profitable development of such aircraft. A critical design feature of the configuration considered is the mid-wing torque-box-type carry-around structure, which must be validated by a comparative weight analysis relative to a conventional low wing. O.C.

A91-52954
AIRCRAFT ENGINE FUEL FEED AND TRANSFER COMPONENT PRESSURE DEFINITIONS
SAE Aerospace Information Report, AIR 1749, Feb. 13, 1991, 4 p.
(SAE AIR 1749) Copyright

Conventional pressure terms are identified which relate to fuel feed, refueling, and transfer components of aircraft engines. The pressure terms described in the listing include static, operating, rated-inlet, rated-discharge, maximum transient, and case-drain/body pressures. Also defined are proof, back, surge, burst, and cracking pressures, and pressure loss is defined. Other pressure definitions include reseat, absolute, gage, dynamic, total, head, and barometric pressures. Although it is assumed that for these definitions the isothermal, liquid fluid in consideration is fuel, it is noted that referee fluid can be substituted for fuel. References for the definitions given are listed for the fuel systems, pumps, and the hydraulic and pneumatic components. C.C.S.

A91-52957
MAINTENANCE OF GROUND SUPPORT EQUIPMENT
SAE Aerospace information Report, AIR 4286, Nov. 29, 1990, 8 p.
(SAE AIR 4286) Copyright

A methodology is outlined which encompasses the acquisition, maintenance, and disposal of ground-support equipment and is intended to promote safe, serviceable equipment. Maintenance during the acquisition process includes setting specifications, standardizing equipment, evaluating available equipment, and training and provisioning during purchasing phases. The maintenance period is found to require the establishment of maintenance practices such as inspection, quality audits, and defined equipment categories. Other important considerations for maintenance are unscheduled maintenance, human resources, facilities, equipment and special tools, cost controls, and management-information systems. Important factors related to equipment disposal are set forth with respect to the replacement decision and equipment rebuild. C.C.S.

A91-52965
AIRCRAFT GROUND AIR CONDITIONING SERVICE CONNECTION
SAE Aerospace Standard, AS 4262, Feb. 12, 1991, 7 p.
(SAE AS 4262) Copyright

An aerospace standard is presented for interface configurations of air conditioning (AC) service connections for commercial transport aircraft including clearances for AC hose couplings. The standard applies to a connection comprising a slotted ring and integral locking pads and a second connection made up of a flanged tube with external locking lugs. The durability, maintainability, and repairability of the connections are assessed, and it is found that the connections can be replaced in about one man-hour. Extensive graphic descriptions of the connections are given, and established uniform requirements are established for accessibility, access doors, and materials. The standards are an integral component of ARP4084 and the U.S. Military Standard MS33562 for the standardization of locations and types of such connections. C.C.S.

N91-29139# National Aeronautical Establishment, Ottawa (Ontario).
COMMONWEALTH ADVISORY AERONAUTICAL RESEARCH COUNCIL. FIRST CANADIAN NEWSLETTER ON SYSTEMS, 1989
JOHN B. CROLL Jul. 1989 45 p
(NAE-LTR-FR-108; CTN-91-60083) Copyright Avail: NTIS HC/MF A03

The Commonwealth Advisory Aeronautical Research Council (CAARC) exists to encourage and coordinate aeronautical research among four member countries: Australia, Canada, India and the United Kingdom. The five fields of colaboration within CAARC are aerodynamics, human engineering, propulsion, structures and systems. The field of systems includes display systems including night visioning systems, direct voice input/output systems, control technology (parameter estimation and mathematical modelling), integrayed flight control, satellite based systems, integrated navigation systems, and simulators. Brief descriptions are given of current Canadian research and development efforts relating to these areas. Reports are presented which were provided by universities, industry, and government agencies involved in aerospace systems research. A list of contributors and of Canadian companies involved in the manufacture of avionics and electronics products related to the selected systems topics is included.
CISTI

N91-29140# National Aeronautical Establishment, Ottawa (Ontario).
FLIGHT RESEARCH LABORATORY. INSTITUTE FOR AEROSPACE RESEARCH Annual Progress Report, April 1989 - March 1990
Jun. 1990 163 p
(CTN-91-60105) Copyright Avail: NTIS HC/MF A08

A summary is presented of progress in the research project of the Flight Research Laboratory (formerly the National

Aeronautical Establishment) of the National Research Council of Canada, with a brief indication of plans for continuing and new projects. Flight Research Lab facilities include a fleet of five research aircraft, including a Twin Otter aircraft instrumented for atmospheric research, a Bell 205A airborne simulator used to simulate control systems in helicopters and other aircraft, a Convair 580 multipurpose flying laboratory, a T-33 platform for use in microgravity studies, and a Falcon 20 jet which was recently added to the research fleet. This aircraft is currently being prepared for applications in the areas of microgravity research, microwave landing system studies and atmospheric sensing. The Flight Recorder Playback Centre provides a facility for playback of cockpit flight recorders, flight data recorders, air traffic control tapes, and video tape recorders. The Speech Research Centre is equipped to study voice I/O technology and to support aircraft crash investigations on the research program of the Flight Research Laboratory. Most research is carried out as joint projects with collaborators from industry, universities and cooperating government agencies. CISTI

N91-29141# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
INTERNATIONAL AVIATION (SELECTED ARTICLES)
25 Apr. 1991 71 p Transl. into ENGLISH from Guoji Hangkong (Peoples Rep. of China), no. 6, 1989 p 7-27
(AD-A237175; FTD-ID(RS)T-0533-90) Avail: NTIS HC/MF A04 CSCL 01/1

Translations are presented of articles from Chinese publication. Some topics of discussion are as follows: China's Developing Flight Test Research Center; Civilian Aircraft Flight Testing Technology; The BW-1 Longitudinal Variable Stability Aircraft; Experiments to Measure Flight Test Vibration and Flutter; by Guan Peifang; Thirty Years of Powerplant Flight Test Research; The Test Flight Center's Flight Simulation Devices; Aircraft Engine Environmental and Ingestion Testing; Test Flight Technology for Aviation Electronics Equipment; Flight Testing of Ejection Seat Systems, Remote Sensing for Aerial Photography; Feilundi TRANSLITERATION Produces an Optical Communications Installation for Helicopters; Flight Testing Aircraft Fire Control, Special Equipment and Electronic and Automatic Control System. GRA

N91-29142# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
INTERNATIONAL AVIATION (SELECTED ARTICLES)
19 Mar. 1991 21 p Transl. into ENGLISH from Guoji Hangkong (Peoples Rep. of China), no. 314, Apr. 1989 p 52-56
(AD-A237232; FTD-ID(RS)T-0691-90) Avail: NTIS HC/MF A03 CSCL 01/3

Airborne Equipment and Systems are discussed. The following topics are included: (1) Model 10 Series Aerodynamic-Panel Emergency Escape Parachute, and (2) China-Made Liquid Cooling Vest for Pilots. GRA

N91-29143# Pennsylvania State Univ., University Park. Applied Research Lab.
TRANSLATION OF AIRFOIL TRAILING EDGE NOISE ARTICLE FROM REVUE D'ACOUSTIQUE
R. C. MARBOE and R. M. WEYER 25 Jun. 1991 31 p Transl. into ENGLISH from Revue d'Acoustique (France), no. 73, 1985 p 3
(Contract N00039-88-C-0051)
(AD-A237811; PSU-ARL-TM-91-120) Avail: NTIS HC/MF A03 CSCL 01/1

The paper Bruit d'un profil dans un e'coulement, by P. Garcia and P. Gerard, has been translated into English. The paper originally was published in Revue d'Acoustique, No 73, 1985 2/2 by Office National d'Etudes et de Recherches Aerospatiales (ONERA). The work, Airfoil noise in air flow, describes measurements of the wave number spectrum of the turbulent boundary layer induced pressure field in the vicinity of the airfoil trailing edge. An estimate of radiated noise using modifications to the theories of Howe and Hogdson is made. The paper is significant because of the good agreement between the measurements of Brooks and Hogdson (1980) and a predicted radiated noise level based on a measured trailing edge fluctuating pressure wave number spectrum with measured far field radiated noise. An effect of array element separation distance on measured convection velocity is also shown. GRA

N91-30075# Executive Resource Associates, Inc., Arlington, VA.
GENERAL AVIATION PILOT AND AIRCRAFT ACTIVITY SURVEY Triannual Summary Report, 1990
1991 111 p *Prepared in cooperation with Adsystech, Inc.*, Silver Spring, MD
(Contract DTFA01-88-Y-01026)
(AD-A236497) Avail: NTIS HC/MF A06 CSCL 01/2

This report provides a summary and analysis of the data collected in the 1990 General Aviation Pilot and Aircraft Activity Survey. The survey was conducted at a random sample of general aviation airports across the nation during the months of June, July, August, and September 1990 by the Federal Aviation Administration with the assistance of the Civil Air Patrol. The survey data provides information regarding the magnitude and characteristics of general aviation including: type and source of weather information services, trip Length in time and distance, and pilot age and certification. Estimates are made of total 1990 general aviation operations, fuel consumption and aircraft miles flown. GRA

N91-30076 Loughborough Univ. of Technology (England). Dept. of Transport Technology.
A REVIEW OF UK AVIATION POLICY
ROBERT CAVES Jul. 1991 47 p
(TT-9107; ISBN-0-904947-34-3) Copyright Avail: Issuing Activity

This is a short review of UK aviation policy which concentrates more on strategic than operational issues. It is concluded that, where it is possible to consider the industry's and the consumer's interest in isolation, there are few areas where policy needs to be improved. The present policy framework involves Dept. of Transportation and other branches of government in decisions in these areas: new runway location and bilateral negotiations. It is suggested that a more open forum is needed for the consideration of such issues as the role of airports in regional and national development; the balance between growth in traffic and damage to the environment; the advantages of competition compared with the costs of providing the infrastructure to give it free expression; the integration of all modes of transport; community goals for longer distance transport; the integration of UK and the European Economic Community policy with respect to non-EEC nations; and methods of monitoring monopolies. Author

02

AERODYNAMICS

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

A91-48541
NAVIER-STOKES COMPUTATIONS OF TRANSITION TO TURBULENT FLOW AROUND AIRFOILS
SHEN C. LEE and CHANG R. CHEN (Missouri-Rolla, University, Rolla) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. refs
(SAE PAPER 901808) Copyright

Numerical solutions of the Reynolds-averaged Navier-Stokes equations were obtained with the two-equation k-epsilon turbulence model. Considering the low-Reynolds-number effect in the closed vicinity of a solid boundary, a stream function and vorticity method was developed to consider both the laminar and turbulent stresses throughout the two-dimensional, incompressible flowfield of any arbitrary geometry. At a low Reynolds number (Re = 30), the

initially imposed disturbances around an airfoil are damped out; the flow is laminar. At a moderately high Reynolds number (Re = 1000), instability of laminar flow is obtained by exhibiting cyclic patterns in the stream function and vorticity distributions. Nevertheless, only laminar stress occurs in the entire flowfield. At a higher Reynolds number (Re = 10 to the 6th), turbulent stress, which is about three orders of magnitude larger than the laminar stress, occurs at a certain distance downstream of the leading edge and in the wake region. The location, where the turbulent stress begins to increase is considered as the point of transition. Author

A91-48542* Lockheed Engineering and Sciences Co., Hampton, VA.
BOUNDARY-LAYER STABILITY ANALYSIS OF FLIGHT-MEASURED TRANSITION DATA
CLIFFORD J. OBARA (Lockheed Engineering and Sciences Co., Hampton, VA), PAUL M. H. W. VIJGEN (High Technology Corp., Hampton, VA), CYNTHIA C. LEE (NASA, Langley Research Center, Hampton, VA), and MICHAEL S. WUSK (Analytical Services and Materials, Inc., Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p. refs
(Contract NAS1-19000; NAS1-18240; NAS1-18599)
(SAE PAPER 901809) Copyright

Correlation of in-flight boundary-layer transition experiments with linear boundary-layer stability theory contributes both to the validation of the numerical methods as well as the analysis of the measured transition process. Transition results obtained in a recent flight experiment, in which the extent of laminar flow and the transition process on the wing of a business-jet fitted with an instrumented glove section were determined, are analyzed. The experiment was conducted at freestream Mach numbers from 0.55 to 0.82, chord Reynolds numbers from 10 to 20 x 10 to the 6th, and leading-edge sweep angles 17 deg to 20 deg. The growth of both Tollmien-Schlichting and crossflow instabilities are predicted using the e exp n method for several flight conditions and the calculated n-factors at transition onset are correlated. Comparison of the measured dominant boundary-layer disturbance frequencies and the predicted unstable frequencies shows fair agreement for several of the flight conditions studied. Author

A91-48544
NUMERICAL SOLUTIONS FOR AXISYMMETRIC BODIES OF REVOLUTION IN PITCHING OSCILLATORY MOTION
M. H. LIN and M. J. SHEU (National Tsing Hua University, Hsinchu, Republic of China) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901811) Copyright

A numerical method is developed to analyze the flow around an axisymmetric ogive-cylinder and an ellipsoid-cylinder bodies undergoing harmonic pitching motion in an uniform air free stream. The pressure distributions along the lengthwise and over the circumference of the body are calculated with fineness ratio of 3:1 at mean angle of incidence 0 deg and 5 deg. Results are presented for a range of frequency parameters and various mean angles of incidence in order to show the influence of the frequency parameter and the mean angle of incidence on the aerodynamic properties. Author

A91-48545
NUMERICAL ANALYSIS OF COMPRESSIBLE FLOW AROUND THREE-DIMENSIONAL FIN-BODY COMBINATION
OHYUN RHO, WON W. KIM, CHONG A. KIM, and DONG H. LEE (Seoul National University, Republic of Korea) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. Research supported by Ministry of Science and Technology of the Republic of Korea. refs
(SAE PAPER 901812) Copyright

The existing two-dimensional Euler code is extended to the three-dimensional flow problem in which the transonic flow around the double fin-body combinations was analyzed. Ni's two-dimensional formulas are extended to the three-dimensional case and applied to the supersonic flow calculation over the double fin-body combinations. The numerical results have proved to be very accurate in predicting the pressure distribution and capturing the shock. The code extended to the three-dimensional flow analysis in the paper can be consequently used to estimate the aerodynamic characteristics of the complicated body. Author

A91-48566* Eidetics International, Inc., Torrance, CA.
FOREBODY VORTEX CONTROL AS A COMPLEMENT TO THRUST VECTORING
G. N. MALCOLM and T. T. NG (Eidetics International, Inc., Torrance, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 31 p. refs
(Contract NAS2-13155; F33615-86-C-3623)
(SAE PAPER 901851) Copyright

The desire to enhance the controllability of fighter aircraft at high angles of attack, particularly yaw control, has fostered an interest in both vectored thrust and active control of forebody vortices. This paper reviews several methods of forebody vortex control that have been investigated with water and wind tunnel tests of both generic and actual fighter configurations. The methods investigated include pneumatic or blowing techniques using surface-mounted jets and slots, surface suction, variable-height deployable strakes, and rotatable tip strakes. Flow visualization, and force and moment measurements have shown that all of the methods are effective in manipulating the forebody vortices over a wide range of angles of attack and sideslip, primarily through control over flow separation on the surface of the forebody. All are most effective when applied near the forebody tip. The advantages and limitations of the various methods are reviewed. Author

A91-48567
NON-LINEAR AEROELASTIC PREDICTIONS FOR TRANSPORT AIRCRAFT
T. W. PURCELL, C. J. BORLAND, and E. N. TINOCO (Boeing Co., Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p. refs
(SAE PAPER 901852) Copyright

A loosely coupled method for aeroelastic predictions of aircraft configurations is shown. This method couples an advanced structural analysis method with a CFD aerodynamics code in a modular fashion. This method can use almost any CFD code, so a validation of several such codes is shown to establish regions of validity for each code. Results from potential codes, an Euler code, and a Navier-Stokes code are shown in comparison with experiment. Viscous effects are included in most cases through a coupled boundary-layer solver or a turbulence model as appropriate. Author

A91-48568
COMPUTATIONAL ANALYSIS OF THE EXTERNAL FLOWFIELD ABOUT A FIGHTER CONFIGURATION
G. A. MILLER and S. AGRAWAL (McDonnell Aircraft Co., Saint Louis, MO) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. refs
(SAE PAPER 901854) Copyright

A study intended to demonstrate the usefulness of computational fluid dynamics (CFD) methods in analyzing fighter aircraft aerodynamics is presented. The external flowfield about a fighter configuration was analyzed to evaluate an Euler solver and a hybrid combination of an Euler solver and a panel method. The Euler code is found to provide good estimates for the incremental effects of aileron deflections using both wing-alone and wing fuselage modeling. It is concluded that the addition of the fuselage to the wing-alone model improves estimates of the effects of leading edge and trailing edge flap deflections. A hybrid combination of the tails from a subsonic panel method provides good estimates of trimmed drag changes for small flap/aileron deflections. O.G.

A91-48569
EFFICIENT EULER ANALYSIS OF TRANSONIC FLOW AROUND ADVANCED TURBO-PROP

DONG-HO LEE, OH-HYUN RHO, and CHANG-JOO KIM (Seoul National University, Republic of Korea) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. Research supported by Korea Science and Engineering Foundation. refs
(SAE PAPER 901855) Copyright

A fast explicit multigrid scheme has been extended to 3D steady transonic flows around an eight bladed SR-3 turbo-prop. The predicted power requirement is found to be sensitive to the artificial viscosity coefficient. Nonlinear artificial dissipation is considered to be more reasonable, but artificial viscosity coefficients need careful determination. The multigrid scheme under consideration reduced computational time about 60 percent. O.G.

A91-48570
INTERNAL AND EXTERNAL FLOW SIMULATION USING MULTIZONE EULER/NAVIER-STOKES AERODYNAMIC METHODS
S. W. SINGER and E. A. MATTSON (Lockheed Aeronautical Systems Co., Burbank, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. Research supported by Lockheed Aeronautical Systems Co. refs
(SAE PAPER 901856) Copyright

A computational method based on a cell-centered, finite-volume spatial discretization and explicit time-stepping algorithm for solving the Euler and Navier-Stokes equations is used to simulate inviscid and viscous flow about configurations including a diverging nozzle, a 74 degree delta wing, and a Mach 6 Waverider. Solutions are obtained using patched multizone grids with both matching and different grid densities across zonal interfaces and are correlated with analytical solutions and experimental data. The computational results increase the confidence in applying Euler and Navier-Stokes solvers to the more complex mixed internal/external flows associated with complete aircraft configurations. Author

A91-48571
AIRPLANE - UNSTRUCTURED-MESH APPLICATIONS
JOHN C. VASSBERG, KATHLEEN B. DAILEY, and DOUGLAS M. FRIEDMAN (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 22 p. Research supported by Douglas Aircraft Co. refs
(SAE PAPER 901857) Copyright

Recent developments in the AIRPLANE program are discussed, focusing on the unstructured-mesh Euler method capable of solving the inviscid transonic flow about complex 3D aircraft configurations. Geometric capabilities of the method are illustrated with solutions about simple, semicomplex, and extremely complex aerodynamic configurations. Particular attention is given to computational resources and manpower requirements benchmarked for the ONERA-M6 wing and a generic MDC Tri-Jet transport. The computers under consideration in this survey include CONVEX, CRAY, Hitachi, and IBM. O.G.

A91-48610* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PROSPECTS FOR DRAG PREDICTION USING COMPUTATIONAL FLUID DYNAMICS
THOMAS W. ROBERTS (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 19 p. refs
(SAE PAPER 901932) Copyright

An account is given of CFD methods deemed likely to yield aerodynamic drag prediction improvements. Improvements in drag prediction are noted to largely proceed from improvements in viscous-layer resolution. Geometric modeling and grid generation are acknowledged to be major pacing items, and may be more important than turbulence modeling. The use of upwind differencing has led to improved solution accuracy due to the nature of the artificial viscosity in cases involving shocks and nonphysical dissipation across viscous layers. Multiblock algorithms will allow more complex geometries to be treated. O.C.

A91-48611* Stanford Univ., CA.
THE COMPUTATION OF INDUCED DRAG WITH NONPLANAR AND DEFORMED WAKES
ILAN KROO (Stanford University, CA) and STEPHEN SMITH (NASA, Ames Research Center, Moffett Field, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. Previously announced in STAR as N91-24106. refs
(SAE PAPER 901933) Copyright

The classical calculation of inviscid drag, based on far field flow properties, is re-examined with particular attention to the nonlinear effects of wake roll-up. Based on a detailed look at nonlinear, inviscid flow theory, the paper concludes that many of the classical, linear results are more general than might have been expected. Departures from the linear theory are identified and design implications are discussed. Results include the following: wake deformation has little effect on the induced drag of a single element wing, but introduces first order corrections to the induced drag of a multi-element lifting system. Far field Trefftz-plane analysis may be used to estimate the induced drag of lifting systems, even when wake roll-up is considered, but numerical difficulties arise. The implications of several other approximations made in lifting line theory are evaluated by comparison with more refined analyses. Author

A91-48612
INDUCED DRAG OF A SIMPLE WING FROM WAKE MEASUREMENTS
GUENTER W. BRUNE and PAUL W. BOGATAJ (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p. refs
(SAE PAPER 901934) Copyright

Detailed flow surveys in the wake of a rectangular wing of aspect ratio six are described, which provide measurements of induced drag, profile drag, and lift. The investigation was conducted at 0.18 Mach number and 1.27 million chord Reynolds number employing a single five-hole probe for the measurement of total pressure and all three components of wake velocity. A comparison of wake data with balance data and wing theory demonstrates the excellent accuracy of low-speed wake measurements. Furthermore, the wake survey technique is shown to have good data repeatability and to accurately predict drag increments due to model modifications such as vortex generators. Spanwise distributions of induced drag, profile drag, and lift obtained from wake measurements are also presented. Author

A91-48613 California Univ., Davis.
CALCULATION AND MEASUREMENT OF INDUCED DRAG AT LOW SPEEDS
C. P. VAN DAM, KOOROSH NIKFETRAT (California, University, Davis), P. M. H. W. VIJGEN (High Technology Corp., Hampton, VA), and C. M. FREMAUX (George Washington University, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p. refs
(Contract NCA2-397; NCC1-47; NAS1-18240)
(SAE PAPER 901935) Copyright

An overview is presented of the calculation and the measurement of induced drag with emphasis on moderate-to-high aspect ratio wings with vortex shedding restricted to the trailing-edge. The discussion concentrates on farfield techniques and is limited to low Mach number, steady flows in the absence of active systems such as surface blowing and propulsion. The calculation techniques are applied to three-dimensional flowfield solutions obtained with potential and Euler codes. The effect of wake rollup on the induced drag is discussed. Also, induced drag measurements using wake-survey techniques are reviewed.
Author

A91-48614* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
WINGTIP VORTEX TURBINE INVESTIGATION FOR VORTEX ENERGY RECOVERY

WILLIAM K. ABEYOUNIS, JAMES C. PATTERSON, JR., H. P. STOUGH, III (NASA, Langley Research Center, Hampton, VA), ALFRED J. WUNSCHEL (USAF, Wright-Patterson AFB, OH), and PATRICK D. CURRAN (Sundstrand Aviation, Rockford, IL) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901936) Copyright

A flight test investigation has been conducted to determine the performance of wingtip vortex turbines and their effect on aircraft performance. The turbines were designed to recover part of the large energy loss (induced drag) caused by the wingtip vortex. The turbine, driven by the vortex flow, reduces the strength of the vortex, resulting in an associated induced drag reduction. A four-blade turbine was mounted on each wingtip of a single-engine, T-tail, general aviation airplane. Two sets of turbine blades were tested, one with a 15' twist (washin) and one with no twist. Th power recovered by the turbine and the installed drag increment were measured. A trade-off between turbine power and induced drag reduction was found to be a function of turbine blade incidence angle. This test has demonstrated that the wingtip vortex turbine is an attractive alternate, as well as an emergency, power source. Author

A91-48641* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT EXPERIMENTS STUDYING THE GROWTH OF THE DISTURBANCES IN THE LAMINAR BOUNDARY LAYER
CYNTHIA C. LEE (NASA, Langley Research Center, Hampton, VA), MICHAEL S. WUSK (Analytical Services and Materials, Inc., Hampton, VA), and CLIFFORD J. OBARA (Lockheed Engineering and Sciences Co., Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 21 p. refs
(SAE PAPER 901979) Copyright

Results are presented from flight experiments conducted on a gloved aircraft wing surface, incorporating closely-spaced flush-mounted and streamwise-located instrumentation for instability frequencies and pressure distributions, which studied the growth of disturbances in the laminar boundary layer. Mach numbers up to 0.81 were encountered in order to obtain compressible-condition measurements; this exploration therefore encompassed chord Reynolds number conditions of the order of 10-20 million, as well as the introduction of sweep via sideslip maneuvers, and the effects of cloud particles. O.C.

A91-48649
APPLICATION OF FAVORABLE AERODYNAMIC INTERFERENCE TO SUPERSONIC AIRPLANE DESIGN
ROBERT M. KULFAN (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 21 p. refs
(SAE PAPER 901988) Copyright

There is a significant potential for improvements in cruise aerodynamic efficiency of supersonic aircraft through improved design methodology, friction drag reduction, innovative design and the use of favorable interference concepts. The use of favorable aerodynamics concepts such as supersonic biplanes, ring wing, parasol wing and caret wings for the design of a small supersonic aircraft is discussed. The parasol wing concept is shown to offer the greatest potential for improvements in lift/drag ratio relative to a conventional design. However, the best aerodynamic concept is very dependent on the design Mach number, and on the airplane component size relationships. Optimized nacelle installations for a High Speed Civil Transport, HSCT, have aerodynamic interference effects similar to the parasol wing concept. Author

A91-48652
APPLICATION OF VERY THICK BLC AIRFOILS TO A FLYING WING TYPE TRANSPORT AIRCRAFT
HARVEY R. CHAPLIN (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901992) Copyright

A boundary-layer control-incorporating V-planform 'flying wing' transport aircraft configuration is presented and its prospective performance gains relative to conventional configurations are discussed. The very thick airfoils employed are found to have only minimal aerodynamic penalties and substantial structural weight, payload volume and payload arrangement advantages. Attention is given to critical Mach number, cruise performance, and takeoff/landing performance behavior. O.C.

A91-48653* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SUPERSONIC AERODYNAMIC CHARACTERISTICS OF A MANEUVERING CANARD-CONTROLLED MISSILE WITH FIXED AND FREE-ROLLING TAIL FINS
A. B. BLAIR, JR. (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901993) Copyright

Wind tunnel investigations were conducted on a generic cruciform canard-controlled missile configuration. The model featured fixed or free-rolling tail-fin afterbodies to provide an expanded aerodynamic data base with particular emphasis on alleviating large induced rolling moments and/or for providing canard roll control throughout the entire test angle-of-attack range. The tests were conducted in the NASA Langley Unitary Plan Wind Tunnel at Mach numbers from 2.50 to 3.50 at a constant Reynolds number per foot of 2.00 x 10 to the 6th. Selected test results are presented to show the effects of a fixed or free-rolling tail-fin afterbody on the static longitudinal and lateral-directional aerodynamic characteristics of a canard-controlled missile with pitch, yaw, and roll control at model roll angles of 0 deg and 45 deg. Author

A91-48816* Toledo Univ., OH.
SEMIANALYTICAL TECHNIQUE FOR SENSITIVITY ANALYSIS OF UNSTEADY AERODYNAMIC COMPUTATIONS
DURBHA V. MURTHY (Toledo, University, OH) and KRISHNA R. V. KAZA (NASA, Lewis Research Center, Cleveland, OH) (Structures, Structural Dynamics, and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988, Technical Papers. Part 3, p. 1307-1316) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 481-488. Previously cited in issue 12, p. 1820, Accession no. A88-32314. refs
Copyright

A91-48817* Notre Dame Univ., IN.
SEPARATED FLOWFIELD ON A SLENDER WING UNDERGOING TRANSIENT PITCHING MOTIONS
S. A. THOMPSON, S. M. BATILL, and R. C. NELSON (Notre Dame, University, IN) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 489-495. Research sponsored by University of Notre Dame. Previously cited in issue 09, p. 1274, Accession no. A89-25169. refs
(Contract NAG1-727)
Copyright

A91-48819
UNSTEADY FLOW ABOUT POROUS CAMBERED SHELLS
TURGUT SARPKAYA and PAUL J. LINDSEY (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 502-508. Research supported by U.S. Navy. Previously cited in issue 06, p. 813, Accession no. A90-19791. refs

A91-48820
PREDICTION OF UNSTEADY PRESSURE AND VELOCITY OVER A ROTORCRAFT IN FORWARD FLIGHT
N. M. KOMERATH, D. M. MAVRIS, and S. G. LIOU (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 509-516. Previously cited in

issue 18, p. 2756, Accession no. A89-42072. refs
(Contract DAAL03-88-K-0070)
Copyright

A91-48821* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLIGHT TESTS OF EXTERNAL MODIFICATIONS USED TO REDUCE BLUNT BASE DRAG
SHERYLL G. POWERS (NASA, Flight Research Center, Edwards, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 517-525. Previously cited in issue 16, p. 2597, Accession no. A88-40763. refs
Copyright

A91-48822
TWO METHODS FOR CALCULATING THE VELOCITIES INDUCED BY A CONSTANT DIAMETER FAR-WAKE
D. H. WOOD (Newcastle, University, Australia) and C. MEYER Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 526-531. Research supported by Australian Research Council. refs
Copyright

This paper describes two methods for calculating the velocities induced by the constant diameter helical vortices that occur in the far-wakes of helicopter rotors in hover or vertical flight, propellers, and horizontal-axis wind turbine. The velocities involve infinite integrals which, in general, cannot be integrated analytically. In the first method, each integral is evaluated numerically up to a finite limit and the remaining integral is approximated by an analytical function. The integrand of each function, or 'remainder', is found by summation over all of the vortices shed at the same radius. Numerical experiments show the remainders have a computational efficiency similar to those derived previously. The main features of the present remainders are simplicity and versatility. Furthermore, the remainders can replace numerical integration in some special cases. In the second method, the range of integration is made finite by transforming the integrand into one containing an infinite sum. The sum is approximated using the Euler-Maclaurin formula, and the resulting integral is evaluated numerically. The method is more cumbersome than the first but is robust, very accurate, and should be particularly useful at small vortex pitch. Author

A91-48823
ANALYTICAL AND COMPUTATIONAL STUDY OF UNSTEADY SHOCK MOTION ON HYPERSONIC FOREBODIES
MARK J. LEWIS, YVETTE SURLINE, and JOHN D. ANDERSON, JR. (Maryland, University, College Park) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 532-539. Research supported by Charles Stark Draper Laboratory, Inc. Previously cited in issue 10, p. 1435, Accession no. A90-26962. refs
Copyright

A91-48824
TWO COMPLEMENTARY APPROACHES TO ESTIMATE DOWNWASH LAG EFFECTS FROM FLIGHT DATA
RAVINDRA V. JATEGAONKAR and GIRIJA GOPALRATNAM (DLR, Brunswick, Federal Republic of Germany) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 540-542. refs
Copyright

The problem of accounting for downwash lag effects in flight data-based aircraft parameter estimation is discussed in view of a parameter-estimation program that can handle both linear and nonlinear system models. Attention is given to the possibility of using the linearized approach to separately estimate the two pitch-damping derivatives from flight tests with larger aircraft which possess limited roll-angle capabilities. O.C.

A91-48837* VRA, Inc., Blacksburg, VA.
COMPARISON OF HYPERSONIC EXPERIMENTS AND PNS PREDICTIONS. I - AEROTHERMODYNAMICS. II - AERODYNAMICS
BILAL A. BHUTTA and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 28, July-Aug. 1991, p. 376-393. refs
(Contract NAS3-25450)
(AIAA PAPER 90-3068) Copyright

A 3D parabolized Navier-Stokes (PNS) technique is examined in terms of applications to equilibrium-air and perfect-gas hypersonic flows at different Mach numbers and angles of attack. The method renders sublayer approximation unnecessary, and treats axis-normal coupling effects first followed by a shock solution and a corrector step. Predictions of hypersonic flowfields over several blunt conical configurations are found to agree with established wind-tunnel and flight data, although those for the Dhawan-Narasimha (1958) transition model vary from the experimental data. The PNS technique is also applied to predictions of wall-pressure distributions and force and moment data, and the results agree with experimental values. The PNS method allows the calculation of a wide variety of configurations with only a slight increase over traditional computing times. C.C.S.

A91-48935
TRANSONIC VISCOUS-INVISCID INTERACTION BY A FINITE ELEMENT METHOD
M. M. HAFEZ (California, University, Davis), W. G. HABASHI (Concordia University, Montreal, Canada), and S. M. PRZYBYTKOWSKI (Pratt and Whitney Canada, Longueuil) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 13, July 20, 1991, p. 309-319. Research supported by Pratt and Whitney Canada. refs
(Contract NSERC-OGPIN-013)
Copyright

A method is outlined for solving two-dimensional transonic viscous flow problems, in which the velocity vector is split into the gradient of a potential and a rotational component. The approach takes advantage of the fact that for high-Reynolds-number flows the viscous terms of the Navier-Stokes equations are important only in a thin shear layer and therefore solution of the full equations may not be needed everywhere. Most of the flow can be considered inviscid and, neglecting the entropy and vorticity effects, a potential model is a good approximation in the flow core. The rotational part of the flow can then be calculated by solution of the potential, streamfunction and vorticity transport equations. Implementation of the no-slip and no-penetration boundary conditions at the walls provides a simple mechanism for the interaction between the viscous and inviscid solutions and no extra coupling procedures are needed. Results are presented for turbulent transonic internal choked flows. Author

A91-48968* Toledo Univ., OH.
NUMERICAL SIMULATION OF SHROUDED PROPELLERS
ABDOLLAH A. AFJEH (Toledo, University, OH) IN: Heat Transfer and Fluid Mechanics Institute, 32nd, Sacramento, CA, June 6, 7, 1991, Proceedings. Sacramento, CA, California State University, 1991, p. 345-362. Research supported by NASA and Ohio Aerospace Institute. refs
Copyright

A numerical model was developed for the evaluation of the performance characteristics of a shrouded propeller. Using this model, a computational study was carried out to investigate the feasibility of improving the aerodynamic performance of a propeller by encasing it in a shroud. The propeller blade was modeled by a segmented bound vortex positioned along the span of the blade at its quarter-chord-line. The shroud was modeled by a number of discrete vortex rings. Due to the mutual dependence of shroud and propeller vortex strengths and the propeller vortex wake an iterative scheme was employed. Three shroud configurations were considered: a cylindrical and two conical shrouds. The computed performance of the shrouded propeller was compared with that of a free propeller of identical propeller geometry. The numerical results indicated that the cylindrical shroud outperformed the conical shroud configurations for the cases considered. Furthermore, when compared to the free propeller performance, the cylindrical shroud showed a considerable performance

enhancement over the free propeller. However, the improvements were found to decrease with an increase in the advance ratio and to virtually diminish at advance ratios of about 2.5. Author

A91-49065
FINITE ANALYTIC SOLUTION OF TURBULENT FLOW FIELD THROUGH CASCADE OF AIRFOIL
DIAO XU and GUOCHUAN WU (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 139-143. In Chinese. refs

The finite analytic method is used in the present study to calculate the turbulent flow field described with Navier-Stokes equations in body-fitted curvilinear coordinate system. The finite analytic method invokes the analytic solution of governing partial differential equations in formulating the algebraic equations that relates a nodal value in an element to its neighboring nodal values. The major feature of the finite analytic method is its ability to simulate automatically the upwind influence of neighboring nodal values according to direction and magnitude of convection. It is shown that the finite analytic method has good numerical stability and accuracy. The turbulent flow fields through a two-dimensional channel and a cascade of airfoil are numerically simulated by using finite analytic method in the present study. The k-epsilon turbulence model and wall function method are also employed. The agreement of numerical solution with experimental data is quite good. Author

A91-49179
THE LOADING CAPABILITY OF AXIAL FLOW COMPRESSOR WITH WIDE CHORD ROTOR BLADE
YOH KAKEHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 449, 1991, p. 303-313. In Japanese. refs

This paper shows an improved performance of a five-stage axial flow compressor and a two-stage fan applying a wide chord blade in some of their rotor stages. The estimation procedure of maximum loading capability on the wide chord rotor blade is also described, based on the analogy between a compressor rotor blade and a diffuser passage. A procedure for estimating the maximum pressure rise potential and the minimum flow rate boundary was formulated on the basis of mean-line parameters, such that it can be used during the preliminary design early phase in the planning. A good agreement is demonstrated between the predicted and tested stall pressure and stall flow rate limits for the wide chord compressor and fan. Author

A91-49238
HEAT TRANSFER MEASUREMENTS ON A BICONIC IN HYPERVELOCITY NITROGEN FLOW
S. L. GAI (University College, Canberra, Australia), T. CAIN, and W. S. JOE (Australian National University, Canberra, Australia) Aeronautical Journal (ISSN 0001-9240), vol. 95, June-July 1991, p. 187-193. Research supported by Australian Research Grants Scheme. refs
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Heat transfer rates on a straight biconic, an attractive configuration for an aeroassisted orbital transfer vehicle, were made in the ANU T3 shock tunnel at various angles of attack and a stagnation enthalpy of 26 MJ/kg, equivalent to a flight speed of 7.2 km/s. The heat transfer database at this higher enthalpy has been compared with the data obtained on the same model in hypersonic and hypervelocity facilities elsewhere. The nonequilibrium flow effects on the model have been discussed in terms of the Hornung reaction rate parameter Omega. Author

A91-49402
LONGITUDINAL VORTEX STRUCTURES AND HEAT TRANSFER IN THE REATTACHMENT REGION OF A SUPERSONIC TURBULENT BOUNDARY LAYER [PRODOL'NYE VIKHREVYE STRUKTURY I TEPLOOBMEN V OBLASTI PRISOEDINENIIA SVERKHZVUKOVOGO TURBULENTNOGO POGRANICHNOGO SLOIA]
E. G. ZAULICHNYI and V. M. TROFIMOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Mar.-Apr. 1991, p. 66-72. In Russian. refs
Copyright

Results of an experimental study of the three-dimensional features of flow and heat transfer associated with Taylor-Goertler vortices are reported. A new second wall layer of longitudinal structures is discovered whose generation mechanism is not related to the Taylor-Goertler vortices. Details of the experimental procedure are described. V.L.

A91-49404
CALCULATION OF FLOW PAST A SPHERICALLY BLUNTED CONE FOR DIFFERENT FLOW REGIMES IN A SHOCK LAYER AND SURFACE GAS INJECTION [RASCHET OBTEKANIIA SFERICHESKI ZATUPLENNOGO KONUSA PRI RAZLICHNYKH REZHIMAKH TECHENIIA V UDARNOM SLOE I VDUVE GAZA S POVERKHNOSTI]
A. V. BUREEV and V. I. ZINCHENKO PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Mar.-Apr. 1991, p. 100-106. In Russian. refs
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Axisymmetric supersonic flow past a spherically blunted cone is investigated analytically for Reynolds numbers corresponding to different flow regimes. In particular, attention is given to the effect of surface injection of varying intensity and injected gas distribution along the spherical bluntness generatrix on the characteristics of heat and mass transfer. The results obtained are compared with experimental data. V.L.

A91-49506
A THREE-DIMENSIONAL BOUNDARY LAYER ON A FLAT DELTA WING UNDER CONDITIONS OF MODERATE INTERACTION WITH HYPERSONIC FLOW [TREKHMERNYI POGRANICHNYI SLOI NA PLOSKOM TREUGOL'NOM KRYLE NA REZHIME UMERENNOGO VZAIMODEISTVIIA S GIPERZVUKOVYM POTOKOM]
G. N. DUDIN Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1991, p. 110-116. In Russian. refs
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Results of a calculation of a three-dimensional boundary layer on a flat delta wing of finite span are presented for the case of the moderate interaction of the wing with an external hypersonic flow. The effect of the value of the hypersonic interaction parameter on gas flow in the boundary layer and on the aerodynamic characteristics is discussed. The discussion is illustrated by a specific example. V.L.

A91-49511
FLOW BLOCKING DURING MODEL TESTING IN THE POROUS WORKING SECTION OF A WIND TUNNEL FOR FREESTREAM MACH APPROACHING 1 [BLOKIROVKA POTOKA PRI ISPYTANIIAKH MODELEI V PERFORIROVANNOI RABOCHEI CHASTI AERODINAMICHESKOI TRUBY PRI FREESTREAM M APPROACHING 1]
V. M. NEILAND and N. N. KHOZIAENKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1991, p. 151-157. In Russian. refs
Copyright

Flow blocking in the porous test section of a wind tunnel associated with the finite length of the porous walls is investigated analytically and experimentally. Flow blocking is shown to be possible in the case of finite-length porous walls when the degree of porosity is small. A method for determining the parameters of the unperturbed incoming flow in wind tunnels with low-porosity walls is recommended. V.L.

A91-49513
UNSTEADY AERODYNAMIC INTERACTION OF TWO ANNULAR ROWS OF WEAKLY LOADED BLADES ROTATING RELATIVE TO EACH OTHER IN SUBSONIC FLOW [NESTATSIONARNOE AERODINAMICHESKOE VZAIMODEISTVIE DVUKH KOL'TSEVYKH LOPATOCHNYKH VENTSOV TONKIKH SLABONAGRUZHENNYKH LOPATOK PRI IKH VRASHCHENII DRUG OTNOSITEL'NO DRUGA V DOZVUKOVOM POTOKE]
K. S. REENT Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1991, p. 165-174. In Russian. refs
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A91-49514
A STUDY OF SUPERSONIC FLOW PAST BODIES AT LOW ALTITUDES WITH ALLOWANCE FOR RADIATION [ISSLEDOVANIE SVERKHZVUKOVOGO OBTEKANIIA TEL NA MALYKH VYSOTAKH S UCHETOM IZLUCHENIIA]
E. Z. APSHTEIN, V. I. SAKHAROV, and A. V. SHEVOROSHKIN Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1991, p. 182-184. In Russian. refs
Copyright

The radiant heat transfer associated with the motion of bodies in the earth atmosphere is investigated in the case of low altitudes (0-40 km), i.e., for high gas densities and optically thick shock layers. In particular, calculations are carried out for flight velocities of 12-15 km/s over a wide range of body dimensions (i.e., optical thickness of the shock layer). Distributions of relative radiant heat fluxes are presented for ellipsoids of revolution with different axis ratios. V.L.

A91-50301
A NUMERICAL CALCULATION OF THE TWO-DIMENSIONAL NOZZLE JET
JINSHAN PAN, XINYUE WANG, and WENZHENG FAN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, May 1991, p. 135-140. In Chinese. refs

This paper calculates the properties of 2D nozzle jet by applying the 'scaling method'. That is, the properties of the nonaxisymmetric jet can be obtained from the properties of an axisymmetric jet, after scaling by an appropriate scaling factor. The numerical results obtained by this method are in good agreement with the experimental data. A comparison of the total temperature distributions between axisymmetric nozzle jet and 2D nozzle jet is made. Author

A91-50331
EFFECTS OF FREESTREAM TURBULENCE ON THE PERFORMANCE CHARACTERISTICS OF AN AIRFOIL
JON A. HOFFMANN (California Polytechnic State University, San Luis Obispo) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1353, 1354. Abridged. Previously cited in issue 21, p. 3286, Accession no. A90-45867. refs
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A91-50332* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF VORTEX CORE DISTORTION ON BLADE-VORTEX INTERACTION
D. J. LEE and C. A. SMITH (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1355-1362. Previously cited in issue 19, p. 2940, Accession no. A87-44916. refs
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A91-50333
THIN-LAYER FULL NAVIER-STOKES SIMULATIONS OVER A SUPERSONIC DELTA WING
W. P. WEBSTER and JOSEPH S. SHANG (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1363-1369. Previously cited in issue 10, p. 1435, Accession no. A90-26968. refs

A91-50339
MOVING SURFACE BOUNDARY-LAYER CONTROL - STUDIES WITH BLUFF BODIES AND APPLICATION
V. J. MODI, M. S. U. K. FERNANDO (British Columbia, University, Vancouver, Canada), and T. YOKOMIZO (Kanto Gakuin University, Kanazawa, Japan) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1400-1406. Research supported by Science Council of British Columbia. Previously cited in issue 06, p. 756, Accession no. A90-19781. refs
(Contract NSERC-A-2181)
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A91-50342
EXPERIMENTAL INVESTIGATION OF A SUPERSONIC SHEAR LAYER WITH SLOT INJECTION OF HELIUM
F. T. KWOK, P. L. ANDREW, W. F. NG, and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1426-1435. Research supported by Johns Hopkins University. Previously cited in issue 08, p. 1100, Accession no. A90-22162. refs
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A91-50346* Florida State Univ., Tallahassee.
SPECTRAL METHODS FOR THE EULER EQUATIONS - THE BLUNT BODY PROBLEM REVISITED
DAVID A. KOPRIVA (Florida State University, Tallahassee), THOMAS A. ZANG, and M. Y. HUSSAINI (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1458-1462. refs
(Contract NAG1-862; DE-FC05-85ER-25000; NAS1-18605)
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The present use of the Chebyshev spectral collocation method, in conjunction with shock-fitting, to solve the blunt-body problem gives attention to the boundary and the shock-acceleration equations. The crux of these procedures is the use of the characteristic compatibility relations to compute the body pressure and shock velocity. It is shown that converged solutions are obtainable without artificial smoothing, and that spectral accuracy is achieved. O.C.

A91-50347* United Technologies Research Center, East Hartford, CT.
GUST RESPONSE ANALYSIS FOR CASCADES OPERATING IN NONUNIFORM MEAN FLOWS
KENNETH C. HALL and JOSEPH M. VERDON (United Technologies Research Center, East Hartford, CT) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1463-1471. Previously announced in STAR as N90-18415. refs
(Contract NAS3-25425)
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The linearized unsteady aerodynamic response of a cascade of airfoils subjected to entropic, vortical, and acoustic gusts is analyzed. Field equations for the first-order unsteady perturbation flow are obtained by linearizing the full time-dependent mass, momentum, and energy conservation equations about a nonlinear, isentropic, and irrotational mean or steady flow. A splitting technique is then used to decompose the unsteady velocity field into irrotational and rotational parts leading to field equations for the unsteady entropy, rotational velocity, and irrotational velocity fluctuations that are coupled only sequentially. The entropic and rotational velocity fluctuations can be described in terms of the mean-flow drift and stream functions which can be computed numerically. The irrotational unsteady velocity is described by an inhomogeneous linearized potential equation which contains a source term that depends on the rotational velocity field. This equation is solved via a finite difference technique. Results are presented to indicate the status of the numerical solution procedure and to demonstrate the impact of blade geometry and mean blade loading on the aerodynamic response of cascades to vortical gust

excitations. The analysis described leads to very efficient predictions of cascade unsteady aerodynamics phenomena making it useful for turbomachinery aeroelastic and aeroacoustic design applications. Author

A91-50358
COMMENT ON 'INDUCED DRAG BASED ON LEADING-EDGE SUCTION FOR A HELICOPTER IN FORWARD FLIGHT'
J. G. LEISHMAN (Maryland, University, College Park) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1532, 1533; Authors' Reply, p. 1534, 1535. refs
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A91-50668* Analytical Services and Materials, Inc., Hampton, VA.
NONPARALLEL INSTABILITY OF SUPERSONIC AND HYPERSONIC BOUNDARY LAYERS
NABIL M. EL-HADY (Analytical Services and Materials, Inc., Hampton, VA) Physics of Fluids A (ISSN 0899-8213), vol. 3, Sept. 1991, p. 2164-2178. Previously announced in STAR as N91-22085. refs
(Contract NAS1-18599)
Copyright

Multiple scaling technique is used to examine the nonparallel instability of supersonic and hypersonic boundary-layer flows to three-dimensional (first mode) and two-dimensional (second mode) disturbances. The method is applied to the flat plate boundary layer for a range of Mach numbers from 0 to 10. Growth rates of disturbances are calculated based on three different criteria: following the maximum of the mass-flow disturbance, using an integral of the disturbance kinetic energy, and using the integral of the square of the mass-flow amplitude. By following the maximum of the mass-flow disturbance, the calculated nonparallel growth rates are in good quantitative agreement with the experimental results at Mach number 4.5. Author

A91-50776
DEVELOPMENT OF METHODS FOR OPTIMIZING TURBINE CASCADES [RAZVITIE METODOV OPTIMIZATSII RESHETOK TURBINNYKH PROFILEI]
A. F. SLITENKO Akademiia Nauk SSSR, Izvestiia, Energetika i Transport (ISSN 0002-3310), May-June 1991, p. 144-150. In Russian. refs
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A method is presented for the multicriterial optimization of turbine cascades with allowance for various parametric and functional constraints. It is shown that the optimization procedure proposed here makes it possible to produce essentially laminar cascades with minimal loss coefficients and minimal heat transfer to the blade surface. V.L.

A91-50842
A HEAD SECTION OF A GIVEN VOLUME WITH OPTIMAL WAVE RESISTANCE IN THE APPROXIMATION OF NEWTON'S LAW OF RESISTANCE [GOLOVNAIA CHAST' ZADANNOGO OB'EMA, OPTIMAL'NAIA PO VOLNOVOMU SOPROTIVLENIIU V PRIBLIZHENII ZAKONA SOPROTIVLENIIA N'IUTONA]
A. N. KRAIKO Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 55, May-June 1991, p. 382-388. In Russian. refs
Copyright

The paper is concerned with the profiling of the head section of a plane or axisymmetric body which has a minimum wave resistance for a given volume in accordance with Newton's law of resistance. In this formulation, the solution of the problem is shown to depend on the dimensionless volume. Details of the solution procedure are presented. V.L.

A91-50990* Akron Univ., OH.
REAL-TIME SIMULATION OF SUPERSONIC INLETS
F. MOSSAYEBI, T. T. HARTLEY, J. A. DE ABREU-GARCIA (Akron, University, OH), and S. R. PANSINO (Youngstown State University, OH) IN: IEEE International Conference on Systems Engineering, 2nd, Pittsburgh, PA, Aug. 9-11, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 288-291. refs
(Contract NAG3-904)
Copyright

A previously published real-time simulation algorithm, the matrix stability region placement (MSRP) method, is used to simulate a small perturbation model of the NASA Lewis Mach 2.5 40-60 mixed compression inlet. The model is representative of high-speed internal flow propulsion systems which can be approximated as quasi-one-dimensional flows. The resulting system of equations, which is stiff, is also simulated by the second-order Adam-Bashforth method. It is shown that the MSRP method can be used to simulate small perturbation models of high-speed internal flow propulsion systems in real time. I.E.

A91-51013
A UNIFIED UNSTEADY LIFTING-LINE THEORY
JEAN-LUC GUERMOND and ANTOINE SELLIER (Bassin d'Essais des Carenes, Paris, France) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 229, Aug. 1991, p. 427-451. Research supported by Marine Nationale. refs
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A lifting-line theory for wings of large aspect ratio at unsteady conditions is developed on the basis of the integral equation formulation of the problem, described by Kida and Miyai (1978). In this theory, the wing may be curved or inclined to the flow, and the asymptotic expansion is uniformly valid with respect to the frequency. A numerical study is carried out using this theory, and the results are compared with literature data. I.S.

A91-51295
COMPUTATION OF A TRANSONIC AIRFOIL FLOW CONSIDERING VISCOUS EFFECTS AND THIN SEPARATED REGIONS
V. E. KOVALEV (Tsentral'nyi Aerogidrodinamicheskii Institut, Zhukovski, USSR) and O. V. KARAS La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 1, 1991, p. 1-15. refs
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A direct-inverse method is proposed for computing a laminar or turbulent compressible 3D boundary layer that uses a finite-difference type technique of the predictor-corrector type, according to the Keller scheme. A method is then presented for calculating a transonic flow around a wing, including viscous effects and thin separated regions, based on semiinverse coupling. Examples of applications are discussed, including cases where the flow separates on the upper surface near the trailing edge, or near the shock root. Author

A91-51297
VORTEX-AIRFOIL INTERACTION BY NUMERICAL SOLUTION OF UNSTEADY NAVIER-STOKES EQUATIONS
TA P. LOC (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences pour l'Ingenieur, Orsay; ONERA, Chatillon, France) and B. CABRIT (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences pour l'Ingenieur, Orsay, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 1, 1991, p. 31-42. refs
(Contract DRET-88-047)
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This paper proposes a numerical study of the interaction of a viscous vortex with an NACA 0012 airfoil. The mathematical model is based on the unsteady incompressible Navier-Stokes equations. The vorticity and stream function formulation of the Navier-Stokes equations is considered. The discretized equations are solved by the numerical method developed at LIMSI and using fourth-order hermitian relations. Results are given for Reynolds numbers of 5,000 and 20,000. The influence of the position, area and intensity of the vortex on the airfoil aerodynamic coefficients is analyzed. Author

A91-51557
A NUMERICAL CALCULATION OF A RAREFIED GAS FLOW AT LOW MACH NUMBERS
KYOJI YAMAMOTO (Okayama University, Japan) IN: Workshop on Space Fluid Dynamics and Related Problems, Kurashiki, Japan, Nov. 22, 23, 1989, Proceedings. Fukuoka, Japan, Kyushu University, 1990, p. 42-47. refs

A method of analyzing a rarefied gas flow past a two dimensional body of an arbitrary shape when the rarefaction is not too high and when the Mach number is small is examined. The main flow around the body is treated by the Oseen-Stokes equation, while the flow in the kinetic region adjacent to the body surface whose thickness is of the order of the mean free path is analyzed by the linearized B-G-K equation. Both solutions matched each other at the outer edge of the kinetic region. As an example of the present analysis, the flows past a circular and elliptic cylinder are considered. Author

A91-51559
SUPERSONIC OPPOSING JETS
SHIGEKI TANAKA (Toyobo Co., Ltd., Research Center, Otsu, Japan), KOJI TESHIMA (Kyoto University of Education, Japan), and MICHIO NISHIDA (Kyushu University, Fukuoka, Japan) IN: Workshop on Space Fluid Dynamics and Related Problems, Kurashiki, Japan, Nov. 22, 23, 1989, Proceedings. Fukuoka, Japan, Kyushu University, 1990, p. 58-67. refs

The flow field resulting from a sonic nose jet exhausting counter to a supersonic free stream of a Mach number of 3 was visualized by means of a laser induced fluorescence method. The experiments were conducted for various values of the ratio of counter jet total pressure to free-stream total pressure. The ratio of body diameter to jet exit diameter was taken to be 0.2 and 0.4. The results show that the structure of the opposing jets are significantly affected not only by the ratio of jet total pressure to free stream total pressure but also by the ratio of body diameter to jet exit diameter. It was also observed that at the low pressure ratios, there exists an unstable flow regime. Simple analysis is applied to the prediction of the position of the free stream shock and Mach disk and compared with the experimental result. The comparison shows a good agreement. Author

A91-51612
DESIGN PROBLEMS OF THREE-DIMENSIONAL CONTRACTIONS
YAOXI SU, CHAOQIANG LIN, and LIU HONG (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, July 1991, p. 245-252. In Chinese. refs

Three-dimensional contraction design of wind tunnels is studied using numerical analysis of the incompressible flow in rectangular contractions for three types of commonly used wall contours. Two design criteria generally used for axisymmetric contractions, i.e., (1) no separation on nozzle walls and (2) nonuniformity at exit cross sections lower than 2 percent, are reviewed and applied to three-dimensional contractions. It is found that a contour with matched cubic curves, when optimized, gives the most satisfactory results, while a contour with a Witozinsky curve gives the worst results because of a serious adverse pressure gradient near the entrance. It is also shown that cross section similarity is of no real value in three-dimensional contraction design practice. C.D.

A91-51844
NUMERICAL SIMULATION OF THE CHANGE IN THE SUPERSONIC FLOW PAST A BODY PRODUCED BY SWITCHING ON A NEARBY HEAT SOURCE
T. V. BAZHENOVA, V. N. LIAKHOV, and S. M. KHARITONOV (AN SSSR, Moscow, USSR) IN: Dynamics of detonations and explosions: Explosion phenomena; International Colloquium on Dynamics of Explosions and Reactive Systems, 12th, Ann Arbor, MI, July 23-28, 1989, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 233-243. refs
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Numerical simulation is used to investigate the changes in parameters on the surface of a spherical body and the drag coefficient when a heat source is placed on the symmetry axis in front of or behind the body. The nonstationary motion of the medium is modeled by difference analogs of the Euler gasdynamics equation represented in a spherical coordinate system with independent variables. The numerical simulation is carried out in two stages. First, using arbitrary initial conditions, the field of the parameters in the initial flow around the body is found to be without a heating source. Then the source is switched on and the flow rearranged. At both stages a stationary state is obtained. With time a hot-gas-filled corridor forms in the wake behind the source; as a result, the stagnation pressure in the flow falls, as does the coefficient. C.A.B.

A91-51867
EXPERIMENTAL INVESTIGATION OF THE UNSTEADY FLOW BEHIND SCREENS AND HONEYCOMBS
LUNXI XIA, CESAR FARELL (Minnesota, University, Minneapolis), and P. KAVANAGH (Iowa State University of Science and Technology, Ames) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 367-376. refs
(Contract NSF CEE-84-10532; NSF ECE-86-13554)
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The use of honeycombs, screens, or combinations of the two in controlling turbulence is examined by determining the turbulence characteristics of the control configurations themselves. The flows from the experimental apparatus are monitored for turbulence intensity and power spectral density at different mean velocities and downstream distances, and the resulting flowfields are divided into zones relating to flow characteristics. It is shown that organized motion (vortex shedding or shear layer instability) is responsible for the turbulence, and the honeycomb/screen combination with zero-distance separation reduces turbulence most effectively. C.C.S.

A91-52187
TRANSONIC AIRFOIL ANALYSIS BASED ON THE INTERACTION OF EULER AND INTEGRAL BOUNDARY-LAYER EQUATION
HANLONG CAI and FENG LI (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A221-A227. In Chinese. refs

A method based on viscous/inviscid interactions is used to calculate the transonic flows over airfoils. The two-dimensional inviscid region is computed by solving the Euler equations using LU-ADI algorithm. The boundary layer is solved by employing a standard two-dimensional integral momentum and kinetic energy shape parameter equations, in conjunction with the inverse integral technique based on the velocity profiles of the separated turbulent boundary layer. The viscous/inviscid interaction is achieved using the surface transpiration velocity model. Transonic viscous/inviscid interacting flows over airfoils with a small separated region are calculated and compared with the experimental data. The results in this paper show that this viscous/inviscid interaction method can provide more agreeable results as compared with experiments, and applied to analyze the separated flows over airfoils. Author

A91-52189
AN AF3 ALGORITHM FOR THE CALCULATION OF TRANSONIC NONCONSERVATIVE FULL POTENTIAL FLOWS OVER WINGS OR WING/BODY COMBINATIONS
HONGQUAN CHEN and MINGKE HUANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A234-A240. In Chinese. refs

A computer code has been developed for analyzing the transonic flow over wings or wing/body combinations using a nonconservative full potential equation according to Baker's highly efficient finite difference algorithm. A detailed, fully implicit AF3 approximate factorization iteration scheme, is constructed in a

body-fitted C-H grid. The parts of the transonic solution in the program can provide the analyses not only for flow past wings but also for the calculation of transonic flows over wing/body combinations due to the utilization of a tensor form for the nonconservative full potential equation in an arbitrary curved coordinate system. Author

A91-52200
DERIVATION OF THE TWO DIMENSIONAL TRANSONIC TIME LINEARIZED INTEGRAL EQUATION
JICHAO SU and LIYI WU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A316-A320. In Chinese. refs

An alternative approach to the time linearized integral equations is proposed, and the far-field characteristics of two-dimensional transonic unsteady flow are analyzed. The order of the unsteady flow quantities in the far field is lower than that in the steady flow, and the differentiation does not increase the orders of the magnitude of the far-field quantities. Finally, an analytical expression for the far field is presented. Author

A91-52207
THE INVESTIGATION OF THE DRAG FORCE OF THE RIGID HOLLOW HEMISPHERICAL PARACHUTE MODELS IN THE STARTING FLOW
MINXUAN ZHOU (Hongguang Aero-Dropping Equipment Factory, Nanjing, People's Republic of China) and QIXIANG LIAN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B217-B222. In Chinese. refs

The drag of hollow hemispherical parachute models is measured by a one-component strain gauge balance, while the flow field is investigated by the hydrogen bubble technique. Based on the measures and the theoretical analysis, the relationship between the ratio of maximum drag F(max) to force F(a) caused by added mass during uniform accelerations and nondimensional parameter U(max) exp 2/ad is obtained. In addition, the flowfield phenomena related to maximum drag is studied. The experiments will be helpful to realize the internal relation between the dynamic stability of parachute and the opening shock. Author

A91-52208
COMPRESSIBLE LAMINAL AND TURBULENT BOUNDARY-LAYER COMPUTATIONS FOR THE THREE-DIMENSIONAL WING
QIN E and FENGWEI LI (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B223-B230. In Chinese. refs

Based on three-dimensional, time-dependent momentum and mean-flow kinetic energy integral equations for compressible boundary layers in nonorthogonal curvilinear coordinates, the existing algorithm for 2D, compressible, laminal and turbulent integral equations is extended to solve the boundary-layer problem over finite swept wings. The equations are solved by using the four-step Runge-Kutta scheme with local time marching to accelerate the convergence. The stability and covergence of the numerical scheme is analyzed, and the effect of the cross flow dissipation integral upon the calculation are examined. Numerical results of steady, compressible, laminal and turbulent boundary layers over the finite swept wing show to be satisfactory. Author

A91-52276
CONSISTENT RATIONAL-FUNCTION APPROXIMATION FOR UNSTEADY AERODYNAMICS
W. EVERSMAN (Missouri-Rolla, University, Rolla) and A. TEWARI Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 545-552. Research supported by McDonnell Aircraft Co. refs
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An improved method is developed for the approximation of generalized, unsteady aerodynamic forces by a rational transfer function in the Laplace domain. Whereas the previous methods produce an ill-conditioned eigenvalue problem when the optimized values of two or more poles of the transfer function are close to one another, the present scheme accounts for such frequent cases consistently. Also, the new method results in a large reduction in the computational cost of an optimized aerodynamic rational approximation when compared with the previous procedures for a given accuracy. These improvements are due to the use of higher order poles (as against the simple poles of conventional methods), without increasing the total number of aerodynamic states of the system, and they make the method applicable to routine transient response calculations. The method employs a nongradient optimizing process for the selection of the nonlinear parameters of the transfer function. Approximations are presented for the three-dimensional, subsonic aerodynamics of a high aspect ratio wing. Author

A91-52280
HYBRID DOUBLET LATTICE/DOUBLET POINT METHOD FOR LIFTING SURFACES IN SUBSONIC FLOW
WALTER EVERSMAN (Missouri-Rolla, University, Rolla) and DALE M. PITT (McDonnell Aircraft Co., Saint Louis, MO) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 572-578. Previously cited in issue 12, p. 1776, Accession no. A89-30799. refs
Copyright

A91-52284
FURTHER STUDIES OF HARMONIC GRADIENT METHOD FOR SUPERSONIC AEROELASTIC APPLICATIONS
D. D. LIU (Arizona State University, Tempe), P. C. CHEN (Zona Technology, Inc., Mesa, AZ), A. S. POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA), and D. K. JAMES (European Forum on Aeroelasticity and Structural Dynamics, Aachen, Federal Republic of Germany, Apr. 17-19, 1989, Proceedings, p. 605-620) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 598-605. Previously cited in issue 14, p. 2123, Accession no. A90-33410. refs
Copyright

A91-52285* Michigan Univ., Ann Arbor.
OSCILLATION OF HIGH-ALTITUDE BALLOONS
WILLIAM J. ANDERSON (Michigan, University, Ann Arbor) and ISRAEL TABACK (Bionetics Corp., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 606-608. Research supported by NASA. refs
Copyright

The Vaisala-Brunt frequencies of atmospheric waves lie sufficiently near He-filled balloon buoyancy oscillation frequencies to cause a near-resonance condition, especially in the 11.6-24.4 km altitude range. This excitation will hold for such balloons irrespective of size and payload variations due to the independence of balloon buoyant frequencies from size. Vertical perturbations of approximately 5-min period should accordingly be anticipated by balloon flight-control system designers. O.C.

A91-52304
ESTIMATES OF OXIDES OF NITROGEN FORMED IN A SCRAMJET INLET
L. M. CHIAPPETTA and J. J. SANGIOVANNI (United Technologies Research Center, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 678-683. Previously cited in issue 09, p. 1274, Accession no. A89-25172. refs
Copyright

A91-52315* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATION OF AN EFFICIENT HYBRID SCHEME FOR AEROELASTIC ANALYSIS OF ADVANCED PROPELLERS
R. SRIVASTAVA, D. L. HUFF (NASA, Lewis Research Center, Cleveland, OH), LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta), and T. S. R. REDDY (NASA, Lewis Research Center, Cleveland; Toledo, University, OH) Journal of Propulsion

and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 767-775. Previously cited in issue 08, p. 1099, Accession no. A90-22153. refs
(Contract NAG3-730)

A91-52316
HOT WIRE MEASUREMENTS DOWNSTREAM OF A PROPFAN
T. G. TILLMAN and J. C. SIMONICH (United Technologies Research Center, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 776-783. Research supported by United Technologies Corp. Previously cited in issue 20, p. 3084, Accession no. A89-47027. refs

A91-52318
ADAPTIVE GRID EMBEDDING NAVIER-STOKES TECHNIQUE FOR CASCADE FLOWS
ROGER L. DAVIS and JOHN F. DANNENHOFFER, III (United Technologies Research Center, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 792-799. Research supported by United Technologies Corp. Previously cited in issue 09, p. 1274, Accession no. A89-25179. refs

A91-52319
UNSTEADY AERODYNAMIC ANALYSIS OF DUCTED FANS
MARC H. WILLIAMS (Purdue University, West Lafayette, IN), JINSOO CHO (Belcan Technologies, Inc., Indianapolis, IN), and WILLIAM N. DALTON (General Motors Corp., Indianapolis, IN) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 800-804. refs

A steady and unsteady aerodynamic analysis of ducted fans has been developed using a frequency domain panel method based on three-dimensional linear compressible lifting surface theory. The duct is assumed to be a finite-length right-circular cylinder concentric with the rotor. Both the duct and rotor blades are modeled by simple harmonic rotating doublet sheets. The model spans a single reference passage with the influence of the rest of the configuration included by symmetry. Results for the steady state performance characteristics of a ducted rotor are compared with an Euler calculation. The effect of the duct on the unsteady aerodynamic forces induced by blade vibration is examined, and comparisons are made with two-dimensional unsteady cascade theory. Finally, it is shown that the duct has an adverse effect on the aeroelastic stability of the rotor. Author

A91-52655
A STUDY OF THE TRANSITION FROM SUPERCRITICAL TO SUBCRITICAL VISCOUS-NONVISCOUS INTERACTION IN THE WAKE OF A PLATE [ISSLEDOVANIE PEREKHODA OT ZAKRITICHESKOGO K DOKRITICHESKOMU REZHIMU VIAZKO-NEVIAZKOGO VZAIMODEISTVIIA V SLEDE ZA PLASTINOI]
A. A. KOVALENKO and I. I. LIPATOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1991, p. 72-78. In Russian. refs

The problem of hypersonic flow near a plate of zero thickness and in the symmetrical wake behind the plate is investigated analytically assuming a strong viscous-nonviscous interaction. When the pressure in the wake is specified above a certain value, a solution is obtained which may be considered discontinuous. Such a discontinuity is accompanied by a change in the type of interaction from supercritical to subcritical, with a gradual change in the pressure to the specified value. It is noted, however, that this 'discontinuity' is not a conventional gasdynamic discontinuity since the wake flow is essentially two-dimensional. V.L.

A91-52695
AN ITERATION-MARCHING SCHEME FOR CALCULATING FLOW PAST THREE-DIMENSIONAL SURFACES AT LOW SUPERSONIC VELOCITIES [ITERATSIONNO-MARSHEVAIA SKHEMA DLIA RASCHETA OBTEKANIIA TREKHMERNYKH POVERKHNOSTEI PRI MALYKH SVERKHZVUKOVYKH SKOROSTIAKH]
IU. B. LIFSHITS and V. S. SAKOVICH Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 31, July 1991, p. 1051-1065. In Russian. refs

The boundary value problem for a full potential equation, modeling flow of a gas past a body at a low supersonic velocity, is approximated by a system of differential-difference problems in planes normal to the flow. Finite differences are used to substitute for the potential derivatives in the longitudinal direction only. In the transverse planes, a projection-grid scheme is used for equation discretization. As a result, an iteration scheme can be applied whereby an iteration represents a marching pass downstream, with consecutive solution of boundary value problems in the transverse planes. For a supersonic longitudinal velocity throughout the flow, a solution is obtained in a single iteration. V.L.

A91-52791
PANEL-METHOD CORRECTIONS FOR HALF-MODEL WIND-TUNNEL INTERFERENCE
WENYING GU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W7-1 to W7-7. refs

Using sparse pressure distribution data measured near the wall, various interpolations are made, and Hess panel method (distributing source and doublet singularities over the half-model surface) is extended to calculate the velocity distribution at any field point so that the boundary values of the solution are provided. After compressibility transformation, the interior Dirichlet problem is solved by the double-layer potential method. Applying the irrotationally condition, completing the spline differentiation for the discrete solution of the space Dirichlet problem and the longitudinal adaptive quadrature, angle-of-attack correction and sideslip-angle correction are obtained by means of the transverse velocity distribution over the upstream reference plane. The compressibility effect is also included for calculating the far-field velocity distribution of the half-model. Author

A91-52799
A METHOD OF CALCULATING THE FACTORS OF GROUND EFFECT AND WALL INTERFERENCE AT HIGH LIFT COEFFICIENT
MINGYAN CHEN (Nanjing Aeronautical Institute, People's Repubic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W16-1 to W16-7. refs

This paper describes a method of calculating the factors of ground effect and wall interference at high lift coefficient with consideration of the effect of wake relocation. The results of the calculation show that the vortex wakes behind the wing at high lift coefficients deflect down and roll up, having a marked influence on downwash at tail location. On the other hand, the factors of ground effect and wall interference greatly change with various tail locations as well as lift coefficient. In this case the corrections for test data result in errors especially for pitching moment by using the routine method. The present method can be used to predict the downwash field at tail location and correct the test data at high lift coefficients. Author

A91-52802
ANALYSIS OF SIDEWALL INFLUENCE ON AIRFOIL AND HALF-MODEL TESTING AND THE THEORY OF BOUNDARY LAYER CONTROL
Y. X. SU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W19-1 to W19-5. refs

An effort is made to develop a general mathematical model for sidewall effects on airfoil and half-model testing, as well as a theory of surface suction-induced boundary-layer control (BLC) for the elimination of sidewall effects. The viscous-inviscid interaction model is valid for general 3D flows. Attention is given to the advantages and disadvantages of suction BLC in realistic engineering applications. O.C.

A91-52806
TRANSONIC WIND TUNNEL WALL INTERFERENCE CORRECTIONS OF SEMISPAN WING DATA
SHUJIE WANG (Harbin Aerodynamics Research Institute, People's Republic of China) Chinese Aeronautics and Astronautics Establishment and Northwestern Polytechnical University, International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Paper . 8 p. refs

Analytical computations are presented which are relevant to the Wall Interference Assessment and Correction (WIAC) project being developed in cooperation with NASA. A nonlinear code for 3D WIAC is applied to a semispan wing with a streamwise profile equivalent to that of the NACA-0012, and the corrections for the Mach number and angle of attack are based on the pressure distributions of an equivalent model. In-tunnel pressure distributions are calculated by using the measured pressure distributions at the tunnel walls as outer boundary conditions. The wall-interference correction procedure with the WIAC code introduces some errors because it is simplified. However, rereduced experimental data is found to agree with the results of a Navier-Stokes code suggesting the utility of the independent free-air checks. C.C.S.

A91-52921
NUMERICAL AND ANALYTICAL STUDY OF TRANSVERSE SUPERSONIC FLOW OVER A FLAT CONE
D. L. BOOK (U.S. Navy, Naval Research Laboratory, Washington, DC), S. EIDELMAN, I. LOTTATI, and X. YANG (Science Applications International Corp., McLean, VA) Shock Waves (ISSN 0938-1287), vol. 1, Aug. 1991, p. 197-203. Research supported by DNA and U.S. Navy. refs
Copyright

Quasi-steady supersonic flow over a flat cone on a plane surface is studied. A formula is derived for the angle through which the flow lines turn at the cone. The results are used to justify the use of two-dimensional simulations of the flow. Peak pressures and total impulses are obtained numerically for various cone angles. Author

A91-52926
A COMPUTATIONAL MODEL FOR THE ANALYSIS OF FINITE WINGS IN POTENTIAL FLOW
ROBERTO ROSATI and MICHAEL PAPADAKIS (Wichita State University, KS) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 16 p. refs
(SAE PAPER 910990) Copyright

A Non-Planar Vortex Lattice Method (VLM) has been combined with a Two-Dimensional Surface Panel Method for computing the aerodynamic characteristics of finite wings in incompressible inviscid flow. This numerical model can be applied to wings with thickness and arbitrary planform, and requires very little computing time when compared to Three-Dimensional Surface Panel Methods currently in use. The formulation of the present method is described in detail, and results from its application to three wing configurations are presented. The results obtained using the present method are compared with results obtained using the VSAERO code and with experimental data. Good correlation is demonstrated in all cases. Author

A91-52927
A VORTEX LATTICE MODEL FOR DELTA WINGS WITH BURSTING
BARNES W. MCCORMICK (Pennsylvania State University, University Park) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 20 p. refs
(SAE PAPER 910991) Copyright

The prediction of the nonlinear behavior of delta wings at moderately high angles of attack and low speeds is considered. A vortex-lattice model is used to determine the circulatory lift and the leading-edge suction force. The vortex lift is calculated from the suction force assuming that the leading edge vortices have not burst. The circulatory and vortex lift are corrected for vortex bursting and flow separation using a semiempirical approach to estimate the burst locations of the leading edge vortices. O.G.

A91-52928
TVD FORMULATIONS OF THE 2D NAVIER-STOKES EQUATIONS FOR AIRFOIL ANALYSIS
S. REDDY, S. KLAUSMEYER, X. LIU, and M. PAPADAKIS (Wichita State University, KS) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 18 p. refs
(SAE PAPER 910992) Copyright

The application of total variation diminishing (TVD) implicit and explicit schemes to transonic flow around airfoils is presented. Several upwind and symmetric TVD flux limiters from the Non-MUSCL family are examined and compared with Jameson's nonlinear artifical dissipation model. Inviscid results indicate that TVD schemes reduce shock smearing while practically eliminating numerical oscillations. Analytical results are presented for a NACA 0012 airfoil for various transonic flow conditions using TVD formulations of the 2D Navier-Stokes equations. Comparison of computed results with experimental data show good agreement. Author

A91-52933* Purdue Univ., West Lafayette, IN.
EXPERIMENTAL RESULTS OF A PROPELLER/WING INTERACTION STUDY
ROBERT T. JOHNSON, JOHN P. SULLIVAN (Purdue University, West Lafayette, IN), and DAVID P. WITKOWSKI (Boeing Commercial Airplanes, Seattle, WA) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 12 p. Research supported by NASA. refs
(SAE PAPER 910998) Copyright

Steady state measurements have been performed on a propellar and a wing in a tractor configuration, to investigate the consequences of mutual interference on overall performance. For certain geometries wing lift is found to be enhanced, and wing drag to be decreased. The unsteady nature of the propeller-wing aerodynamic interaction has been studied using flow visualization. Results obtained indicate that the tip vortex is severed at the wing leading edge, the severed tip vortex filaments shear in a spanwise direction relative to one another, and these displaced filaments deform to reconnect at the trailing edge. O.G.

A91-52947
AERODYNAMIC PERFORMANCE OF WING-BODY CONFIGURATIONS AND THE FLYING WING
E. TORENBEEK (Delft University of Technology, Netherlands) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 8 p. refs
(SAE PAPER 911019) Copyright

An elementary analysis has been made of generic wing-body configurations with variable volume allotment in wing and body, for constant total useful volume, including the all-wing configuration. These aircraft were compared on the basis of the Lift-to-Drag (L/D) ratio, for specified flight conditions. In addition the parameter ML/D for constant corrected thrust has been optimized, resulting

in certain combinations of altitude and speed for maximum specific range (if corrected TSFC = constant). Finally, the effect of volume allotment on L/D for given engine size was studied. It has been found that in many cases optimum volume allotments indicate that wing-body combinations are to be favored. Only in the case of relatively low Mach numbers and high-altitude flight the flying wing outperforms conventional aircraft, but it will generally require larger engines. Author

N91-29144# National Aeronautical Establishment, Ottawa (Ontario). Unsteady Aerodynamics Lab.
SUBSONIC AERODYNAMIC COEFFICIENTS OF THE SDM AT ANGLES OF ATTACK UP TO 90 DEG
X. Z. HUANG and M. E. BEYERS Jan. 1990 55 p
(NAE-LTR-UA-93; CTN-91-60006) Copyright Avail: NTIS HC/MF A04

Static aerodynamic coefficients were obtained for the Standard Dynamics Model (SDM), a generic fighter aircraft model, at angles of attack up to 90 deg. Effects of sideslip angle, wind speed and sting diameter were investigated under conditions of very low wall interference. The aerodynamic characteristics of the SDM are consistent with asymmetrical vortex shedding becoming dominant at angles of attack between 26 and 53 deg, and asymmetrical vortex breakdown occurring on the wing at higher angles of attack between 53 and 69 deg. The lateral-directional coefficients exhibited nonlinear dependence on angle of sideslip as well as angle of attack. The variations with angle of sideslip of the longitudinal aerodymanic and rolling moment coefficients are asymmetrical at angle of attack equals 36 deg. There was no distinct effect of velocity/Reynolds number for wind speeds between 69 and 100 m/s. Sting diameter effects were negligible at low angles of attack. Small but measurable effects of sting diameter on the side-force and moment coefficients were observed in angles of attack between 28 and 63 deg. Author (CISTI)

N91-29145# National Aeronautical Lab., Bangalore (India).
PERFORMANCE OF AN AIRFOIL AT LOW REYNOLDS NUMBER
PREMALATHA and P. RAMAMOORTHY Mar. 1991 83 p
(NAL-PD-CF-9102) Avail: NTIS HC/MF A05

A new airfoil performance software was developed by combining two independent codes. The first one is based on Theodorsen's thick airfoil theory, and the second is a boundary layer code based on the integral method. The lift and pitching moment coefficients are obtained by Theodorsen's theory, suitably modified for the viscous effects. The comparison between this code and the NCSU code and experiments for a few low drag airfoils show good correlation. Hence, the code has great potential for further development. Author

N91-29146# National Aeronautical Lab., Bangalore (India).
AEROWING - THE SOFTWARE FOR AERODYNAMIC ANALYSIS OF A LARGE ASPECT-RATIO FINITE WING AT LOW SPEEDS
P. RAMAMOORTHY and B. K. PREMAGEETHA Mar. 1991 17 p
(NAL-PD-CF-9101) Avail: NTIS HC/MF A03

An existing computer software package for the determination of lift, drag, and pitching moment of the finite wing is ported onto PS 386/387 system and validated against known examples. This software, is presently designated as AEROWING and is used to obtain the loads on the wing of an remotely piloted vehicle. The results prove that the software can provide a tool for the wing analysis and design. Author

N91-29149# Department of the Navy, Washington, DC.
STABILIZED SQUARE PARACHUTE Patent Application
CARL CALIANNO, inventor (to Navy) 19 Apr. 1990 13 p
(AD-D014946; US-PATENT-APPL-SN-518619) Avail: NTIS HC/MF A03 CSCL 01/1

This invention relates generally to aerodynamic decelerators and more particularly to the aerodynamic stabilization of parachutes having square canopies. When dropping a store such as a sonobuoy into the ocean from a high altitude it is necessary to assure proper orientation upon impact. This requires the use of a parachute which has high drag to slow the store's descent and stability to minimize its oscillations. Parachute instability, caused by destabilizing aerodynamic side forces on the canopy, is translated to the store through the parachute's suspension lines, causing the store to oscillate, adversely affecting impact orientation. An air-deployed payload which has a video camera mounted therein for transmission during air descent also requires a parachute with high drag efficiency and extreme stability to prevent oscillation of the payload during descent. GRA

N91-30078# Illinois Univ., Chicago. Dept. of Mechanical Engineering.
INTERFEROMETRIC TOMOGRAPHY OF HIGH-SPEED AERODYNAMIC FLOWS Final Report
SOYOUNG S. CHA 31 Aug. 1990 11 p
(Contract DAAL03-87-K-0098)
(AD-A229319; ARO-25014.8-EG) Avail: NTIS HC/MF A03 CSCL 20/4

Tomographic visualization of 3-D flow fields from multidirectional interferometric data has various advantages in its noninvasiveness and relatively high resolution and instantaneous capture of gross fields. The technique, however, encounters ill-posed problems: i.e., incompleted projection, limited angular scanning, and insufficient nonuniform data. Three typical methods were developed for accurately reconstructing flow fields from severely limited data. First, a general method termed the complementary field method (CFM) was developed in order to treat the all ill-posed problems in a unified manner. This iterative method can be combined with any direct reconstruction techniques. A special approach, which employs the CFM, was formulated for discontinuous shock reconstruction arising in aerodynamics. Second, direct reconstruction techniques based on continuous local basis functions were developed. These techniques, utilizing higher order approximation, demonstrate better reconstruction of continuous fields. Third, a variable grid technique was develop to reflect intrinsic spatial resolution information contained in interferometric data. Test results demonstrate substantial error reduction when the CFM and an appropriate developed technique are coupled. GRA

N91-30079# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
AN EXPERIMENTAL INVESTIGATION OF THE FLOW PAST AN IDEALIZED WING-BODY JUNCTION Final Report, 1 Jun. 1985 - 31 May 1990
WILLIAM J. DEVENPORT and ROGER L. SIMPSON Jul. 1990 516 p
(Contract N00014-87-K-0421)
(AD-A229602; VPI-AOE-172) Avail: NTIS HC/MF A22 CSCL 20/4

Velocity measurements, pressure measurements and surface oil-flow visualizations, performed in the flow past an idealized wing-body junction, are presented. The junction consists of a cylindrical wing mounted normal to a flat surface on which an otherwise two-dimensional turbulent boundary is growing. The velocity measurements were made over a detailed grid using hot-wires and a three-component laser Doppler anemometer. At most locations all components of mean velocity and the Reynolds stress tensor were measured. These data clearly reveal, for the first time, the turbulence structure of the horseshoe vortex and the surrounding flow. The purpose of this report is to present the data in a form suitable for use by other researchers, especially those wishing to compute this flow. GRA

N91-30080*# AEDAR Corp., Landover, MD.
CONTROL OF HELICOPTER ROTORBLADE AERODYNAMICS
JAMES A. FABUNMI Washington NASA Jul. 1991 50 p
(Contract NAS2-13095)
(NASA-CR-4350; A-91030; NAS 1.26:4350) Avail: NTIS HC/MF A03 CSCL 01/1

The results of a feasibility study of a method for controlling

the aerodynamics of helicopter rotorblades using stacks of piezoelectric ceramic plates are presented. A resonant mechanism is proposed for the amplification of the displacements produced by the stack. This motion is then converted into linear displacement for the actuation of the servoflap of the blades. A design which emulates the actuation of the servoflap on the Kaman SH-2F is used to demonstrate the fact that such a system can be designed to produce the necessary forces and velocities needed to control the aerodynamics of the rotorblades of such a helicopter. Estimates of the electrical power requirements are also presented. A Small Business Innovation Research (SBIR) Phase 2 Program is suggested, whereby a bench-top prototype of the device can be built and tested. A collaborative effort between AEDAR Corporation and Kaman Aerospace Corporation is anticipated for future effort on this project. Author

N91-30087 Georgia Inst. of Tech., Atlanta.
DYNAMIC STALL OF CIRCULATION CONTROL AIRFOILS Ph.D. Thesis
GEORGE D. SHREWSBURY 1990 171 p Previously announced as A90-19923
Avail: Univ. Microfilms Order No. DA9115397

Lift modulation is required for rotorcraft applications since the retreating blade will always produce less lift due to the reduced dynamic pressure. A numerical study was made to evaluate the dynamic stall characteristics of an oscillating circulation control airfoil. An analysis procedure was used which provided an efficient solution to the 2-D, time accurate Navier-Stokes equations. This procedure includes the effects of compressibility and can provide solutions for regions which contain turbulent, separated flow. The computational code also implemented an eddy viscosity turbulence model which was modified to account for curved wall jets and the associated free shear layer. The results of the study indicate that circulation control may be a useful concept to effectively modulate the lift for rotorcraft applications. If the circulatory lift was not restored by the time the pitching cycle is completed, the lift cannot be the same as the starting value, and the hysteresis loop will bifurcate into a bimodal, two lobed characteristic. Dissert. Abstr.

N91-30088*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
EXTENSION OF MULTIGRID METHODOLOGY TO SUPERSONIC/HYPERSONIC 3-D VISCOUS FLOWS Final Report
VEER N. VATSA, ELI TURKEL, and J. S. ABOLHASSANI (Computer Sciences Corp., Hampton, VA.) Aug. 1991 25 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187612; NAS 1.26:187612; ICASE-IR-91-66) Avail: NTIS HC/MF A03 CSCL 01/1

A multigrid acceleration technique developed for solving 3-D Navier-Stokes equations for subsonic/transonic flows was extended to supersonic/hypersonic flows. An explicit multistage Runge-Kutta type of time stepping scheme is used as the basic algorithm in conjunction with the multigrid scheme. Solutions were obtained for a blunt conical frustum at Mach 6 to demonstrate the applicability of the multigrid scheme to high speed flows. Computations were performed for a generic High Speed Civil Transport configuration designed to cruise at Mach 3. These solutions show both the efficiency and accuracy of the present scheme for computing high speed viscous flows over configurations of practical interest. Author

N91-30090*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
UNSTRUCTURED-GRID METHODS DEVELOPMENT: LESSONS LE ARNED
JOHN T. BATINA Aug. 1991 8 p Presented at the 4th International Symposium on Computational Fluid Dynamics, Davis, CA, 9-12 Sep. 1991
(NASA-TM-104137; NAS 1.15:104137) Avail: NTIS HC/MF A02 CSCL 01/1

The development is summarized of unstructured grid methods for the solution of the equations of fluid flow and some of the lessons learned are shared. The 3-D Euler equations are solved, including spatial discretizations, temporal discretizations, and boundary conditions. An example calculation with an upwind implicit method using a CFL (Courant Friedricks Lewy) number of infinity is presented for the Boeing 747 aircraft. The results obtained in less than one hour of CPU time on a Cray-2 computer, thus demonstrating the speed and robustness of the present capability. Author

N91-30093*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
MULTIGRID FOR HYPERSONIC VISCOUS TWO- AND THREE-DIMENSIONAL FLOWS Final Report
E. TURKEL, R. C. SWANSON, V. N. VATSA, and J. A. WHITE (Analytical Services and Materials, Inc., Hampton, VA.) Jul. 1991 24 p Previously announced in IAA as A91-40746 Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187603; NAS 1.26:187603; ICASE-91-57) Avail: NTIS HC/MF A03 CSCL 01/1

The use of a multigrid method with central differencing to solve the Navier-Stokes equations for hypersonic flows is considered. The time dependent form of the equations is integrated with an explicit Runge-Kutta scheme accelerated by local time stepping and implicit residual smoothing. Variable coefficients are developed for the implicit process that removes the diffusion limit on the time step, producing significant improvement in convergence. A numerical dissipation formulation that provides good shock capturing capability for hypersonic flows is presented. This formulation is shown to be a crucial aspect of the multigrid method. Solutions are given for two-dimensional viscous flow over a NACA 0012 airfoil and three-dimensional flow over a blunt biconic. Author

N91-30095*# California Polytechnic State Univ., San Luis Obispo.
THE POWER INDUCED EFFECTS MODULE: A FORTRAN CODE WHICH ESTIMATES LIFT INCREMENTS DUE TO POWER INDUCED EFFECTS FOR V/STOL FLIGHT Report, 1 Jan. 1990 - 30 Sep. 1991
DORAL R. SANDLIN and KIPP E. HOWARD Jul. 1991 297 p (Contract NCC2-664)
(NASA-CR-188081; NAS 1.26:188081) Avail: NTIS HC/MF A13 CSCL 01/1

A user friendly FORTRAN code that can be used for preliminary design of V/STOL aircraft is described. The program estimates lift increments, due to power induced effects, encountered by aircraft in V/STOL flight. These lift increments are calculated using empirical relations developed from wind tunnel tests and are due to suckdown, fountain, ground vortex, jet wake, and the reaction control system. The code can be used as a preliminary design tool along with NASA Ames' Aircraft Synthesis design code or as a stand-alone program for V/STOL aircraft designers. The Power Induced Effects (PIE) module was validated using experimental data and data computed from lift increment routines. Results are presented for many flat plate models along with the McDonnell Aircraft Company's MFVT (mixed flow vectored thrust) V/STOL preliminary design and a 15 percent scale model of the YAV-8B Harrier V/STOL aircraft. Trends and magnitudes of lift increments versus aircraft height above the ground were predicted well by the PIE module. The code also provided good predictions of the magnitudes of lift increments versus aircraft forward velocity. More experimental results are needed to determine how well the code predicts lift increments as they vary with jet deflection angle and angle of attack. The FORTRAN code is provided in the appendix. M.G.

N91-30098*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FULL-SCALE SEMISPAN TESTS OF A BUSINESS-JET WING WITH A NATURAL LAMINAR FLOW AIRFOIL
DAVID E. HAHNE and FRANK L. JORDAN, JR. Sep. 1991

52 p
(NASA-TP-3133; L-16905; NAS 1.60:3133) Avail: NTIS HC/MF A04 CSCL 01/1

A full-scale semispan model was investigated to evaluate and document the low-speed, high-lift characteristics of a business-jet class wing that utilized the HSNLF(1)-0213 airfoil section and a single-slotted flap system. Also, boundary-layer transition effects were examined, a segmented leading-edge droop for improved stall/spin resistance was studied, and two roll-controlled devices were evaluated. The wind-tunnel investigation showed that deployment of single-slotted, trailing-edge flap was effective in providing substantial increments in lift required for takeoff and landing performance. Fixed-transition studies to investigate premature tripping of the boundary layer indicated no adverse effects in lift and pitching-moment characteristics for either the cruise or landing configuration. The full-scale results also suggested the need to further optimize the leading-edge droop design that was developed in the subscale tests. Author

N91-30099# Aeritalia S.p.A., Turin (Italy). Defence Aircraft Group.

AERODYNAMIC ANALYSIS OF THE FLOW CHARACTERISTICS OF A DELTA-CANARD CONFIGURATION

A. FERRETTI and A. SALVATORE 1990 12 p Presented at the 17th Congresso Internaz. ICAS 1990, Stockholm, Sweden, 9-14 Sep. 1990 Previously announced in IAA as A91-24472
(ETN-91-99774) Avail: NTIS HC/MF A03

A complete cycle of aerodynamic analysis of the local flow characteristics on a delta canard aircraft configuration is performed through the examination of wind tunnel and flight data covering subsonic-transonic and supersonic regimes. A pressure plotting wind tunnel model scale 1:13, is tested in different entries in wind tunnels. Flow characteristics are investigated in the whole Mach alpha range of interest, analyzing development of vortex flow on the wing surface and the effects of canard on it. Key aerocharacteristics, like trailing edge pressure and minimum pressure coefficient on the wing, are identified and correlated to the insurgance of peculiar flow structures obtaining a prediction criterion from attached to vortex flow. The availability of inflight pressure measurement over the flying surfaces of BAe E.A.P. demonstrator aircraft allows for comparison of wind tunnel versus flight data. The effects of varying the Reynolds number are evaluated. A comparison of the experimental results with computational estimates is carried out in order to assess the reliability of the theoretical methods in predicting complex three dimensional flow fields. ESA

N91-30100# Aeritalia S.p.A., Turin (Italy). Defence Aircraft Group.

INVISCID CALCULATIONS BY AN UPWIND FINITE ELEMENT METHOD OF HYPERSONIC FLOWS OVER A DOUBLE (SIMPLE) ELLIPSE

V. SELMIN and L. FORMAGGIA 1990 17 p Presented at the Conference on Flows for Reentry Vehicles, Antibes, France, 22-25 Jan. 1990
(ETN-91-99776) Avail: NTIS HC/MF A03

The quest of better designed reentry vehicles has caused the development of more sophisticated solution algorithms which take into account the complex chemical phenomena associated with high speed flows. As a result of that, the number of variables involved and the complexity of the equations has increased considerably. In this context, the optimization of the number of mesh points required for a given solution accuracy is of paramount importance. Unstructured grids are considered best suited to handle large variations of grid size, putting more points exactly where needed and allowing a straightforward implementation of adaptive strategies. An unstructured grid approach is therefore chosen. An inviscid flow solver able to operate on such grids is developed. The solver employs an hybrid finite volume/finite element algorithm and some upwind concepts reformulated in the context of unstructured triangular grids. The upwind decomposition of the fluxes provides a way for combining accurate and robust schemes, able to cope effectively with very strong shock phenomena. ESA

N91-30102# Aeritalia S.p.A., Turin (Italy). Defence Aircraft Group.

SIMULATION OF HYPERSONIC FLOWS ON UNSTRUCTURED GRIDS

V. SELMIN and L. FORMAGGIA 1990 4 p Presented at Congress on Computation Mechanics, Stuttgart, Fed. Republic of Germany, 27-31 Aug. 1990
(ETN-91-99778) Avail: NTIS HC/MF A01

The study of high speed flows is receiving attention by aerospace industries in connection with the design of high supersonic transport aircrafts and reentry vehicles. The development of effective numerical solvers is of particular interest due to the difficulties and high costs associated with experimental work at this flow regime. High speed flow is characterized by the importance of forms of energy which are normally neglected at lower speed, namely the excitation of vibrational degrees of freedom, dissociation and ionization. The solution algorithm must take into account, to some degree, all or some of these mechanisms of energy transfer. In addition, the flow solution normally presents strong shocks and shock interactions. The code must be able to capture those features without spurious oscillations. Simulation systems taking all these factors into consideration are presented. ESA

N91-30103# Aeritalia S.p.A., Turin (Italy). Defence Aircraft Group.

NUMERICAL SIMULATION OF VISCOUS TURBULENT FLOWS PAST AEROSPACE CONFIGURATIONS

NICOLA CERESOLA and SANDRA TARDITI 1990 18 p Presented at the Conference on Computing: Achievements, Problems, and Prospects, Capri, Italy, 3-7 Jun. 1990
(ETN-91-99779) Avail: NTIS HC/MF A03

A numerical code for the simulation of three dimensional viscous compressible flows is developed. The steady, thin layer Navier-Stokes equations are solved with a finite differences, implicit, approximate factorization method. A semi-implicit marching algorithm in one space direction is applied to ensure input/output efficiency on a vector computer. The code is applied to flows ranging from low subsonic to high supercritical regime past wing geometries; comparisons are made with available experimental data. Satisfactory results are obtained. ESA

N91-30104# European Space Agency, Paris (France).

A CONTRIBUTION TO THE NUMERICAL SIMULATION OF TRANSONIC FLOW AROUND A DELTA WING BY SOLVING THE NAVIER-STOKES EQUATIONS Ph.D. Thesis - Karlsruhe Univ.

ACHIM HILGENSTOCK (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.) May 1991 121 p Transl. into ENGLISH of Ein Beitrag zur Numerische Simulation der Transsonischen Stroemung um Einen Deltafluegel Durch Loesung der Navier-Stokes,schen Bewegungsgleichungen (Goettingen, Fed. Republic of Germany, DLR), Dec. 1989 99 p Original language document was announced as N91-10026
(ESA-TT-1225; DLR-FB-90-13; ETN-91-99805) Avail: NTIS HC/MF A06

Turbulent flow around a delta wing at incidence was simulated using a finite volume method. A brief explanation of the selection criteria for suitable computer grids and grid generation was set out. Numerical simulation is performed by means of a simple algebraic model for turbulence. On the basis of a delta wing with a sharp leading edge, the dependency of the numerical solution on the computer grids is discussed. The influence of the position of the transition line in respect of realistic wing/fuselage configuration is investigated. Numerical results are compared with experimental data. An interpretation of flow in the primary separation area is done. In the process, an explanation for the zone in the primary vortex which is observed by laser light sheet to be almost devoid of particles is performed. Mach number

distribution, and velocity, temperature, pressure and total pressure distributions are discussed by relating them to streamlines in the vortex area. ESA

N91-30105# European Space Agency, Paris (France).
WIND TUNNEL INVESTIGATIONS OF THE APPEARANCE OF SHOCKS IN THE WINDWARD REGION OF BODIES WITH CIRCULAR CROSS SECTION AT ANGLE OF ATTACK
HELMUT ESCH (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany, F.R.) May 1991 75 p Transl. into ENGLISH of Windskanaluntersuchungen zum Auftreten von Verdichtungsstoessen im Luvgebeit von Angestellten Kreiszylindrischen Ruempfen (Cologne, Fed. Republic of Germany, DLR), 15 Mar. 1990 63 p Original language document was announced as N91-10027
(ESA-TT-1226; DLR-FB-90-15; ETN-91-99806) Avail: NTIS HC/MF A04; Original German version available from DLR, WissenschaftlichesBerichtsw esen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 31 DM

The conditions causing the primary embedded shock to bend into the windward region of a circular cylinder at incidence are investigated by using Schlieren photographs, oil film patterns and measurements of surface pressure distribution. The critical crossflow Mach number range between 0.3 and 0.6 is covered by free stream Mach numbers between 1.25 and 2.5. The Reynolds numbers, based on body diameter, vary between 300,000 and 1,300,000. ESA

N91-30106# Aeritalia S.p.A., Turin (Italy).
COMPARISON OF SOLUTION OF VARIOUS EULER SOLVERS AND ONE NAVIER-STOKES SOLVER FOR THE FLOW ABOUT A SHARP-EDGED CROPPED DELTA WING
B. R. WILLIAMS, W. KORDULLA, M. BORSI, and H. W. M. HOEIJMAKERS (National Aerospace Lab., Amsterdam, Netherlands) 1991 6 p Sponsored by Ministry of Defence; Bundesministerium fuer Verteidigung; Italian Ministry of Defence; and Netherlands Agency for Aerospace Programs
(ETN-91-99508) Avail: NTIS HC/MF A02

For the flow about a sharp edged cropped 65 degree delta wing numerical solutions obtained with different Euler methods are compared with each other, with the numerical solution of a Reynolds averaged Navier-Stokes method and with experimental data. At the selected free stream Mach number of 0.85 and angle of attack of 10 degree the flow features a leading edge vortex, is transonic, but contains weak shocks only. The results of the Euler methods were obtained on one and the same C-H type of grid with close to 300,000 cells. This investigation indicates that for the test case considered there are, from a theoretical point of view, significant differences between results from different Euler methods, even if artificial dissipation is minimized. However, the correlation of the Euler solutions with experimental data shows much larger differences due to the failure to represent secondary separation in the Euler methods and is therefore unsatisfactory. The results of the Reynolds averaged Navier-Stokes method demonstrate an improved correlation of theory and experiment. ESA

N91-30107# Aeritalia S.p.A., Turin (Italy). Computational Fluid Dynamics.
VORTICAL FLOW SIMULATION BY USING STRUCTURED AND UNSTRUCTURED GRIDS
M. BORSI, L. FORMAGGIA, E. HETTENA, S. SANTILLAN, V. SELMIN, and S. TARDITI 1991 12 p
(ETN-91-99509) Avail: NTIS HC/MF A03

Two Euler equation solvers on finite volume formulations on structured and unstructured grids are applied to the simulation of transonic vortical flow around a delta wing body configuration. The mesh generation techniques are described, some details on the flow solvers are given, and a comparison between the methods is presented. ESA

03

AIR TRANSPORTATION AND SAFETY

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

A91-48575
AIRLINE FITNESS FOR DUTY
JERRY T. DENNIS SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. refs
(SAE PAPER 901872) Copyright

The use of risk management techniques as an adjunct to internal audit procedures is considered. The principles of risk management and its basic objective are reviewed, and management techniques oriented toward loss control and risk financing are outlined. Focus is placed on problem avoidance or elimination, rational acceptance of risk, separation in aviation, predictability, and duplication. The financial side of risk management including retention and transfer is analyzed, and management responsibility is outlined. It is recommended that all airlines should establish a professional safety manager and should support such flight safety functions as organization of accident prevention programs, collection/analysis/communication of safety information, technical and training safety coordination, and corporate emergency response procedures. V.T.

A91-48622
HOT SURFACE IGNITION AND AIRCRAFT SAFETY CRITERIA
ROBERT G. CLODFELTER (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 21 p. refs
(SAE PAPER 901950) Copyright

A recently completed experimental program to quantify minimum hot surface ignition temperatures for flammable fluids encountered in aircraft engine compartments is reviewed. A highly realistic test article composed of a segment of an F-100 engine was used to provide actual engine compartment (F-16) geometries and clutter. The hot surface was an air-heated bleed air duct. The effects of many variables were investigated including pressure, temperature, fluid impingement scenario, and ventilation velocity. The paper reviews some of the results of the program, presents some results from other related efforts, suggests a 'Safe Design Temperature', presents a 'probability of ignition' for various fluids as a function of surface temperature and outlines a methodology for hot surface hazard analysis. Author

A91-48623
AIRCRAFT FIRE DETECTION AND SUPPRESSION
THOMAS C. HILLMAN (Walter Kidde Aerospace, Inc., Wilson, NC) and WILLIAM R. KANE SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 23 p. refs
(SAE PAPER 901951) Copyright

A review of past and state-of-the-art aircraft fire/explosion detection and extinguishing components is presented. The lessons learned from previously fielded systems are briefly discussed so that they can be applied to the modern protection systems as they are implemented. Also, the operational features and characteristics of both fire and explosion protection components and equipment are identified and discussed so that trade studies based on these components strengths and weaknesses can be conducted. By appreciating these components strengths and limitations, a system definition which is optimized for the given application can result. The application of detection and suppression technologies to select aircraft environments is also discussed. Environments considered included: fire protection for engine powerplant compartments, fire and explosion protection for vulnerable dry bay compartments, explosion protection for aircraft fuel tanks, and fire protection for aircraft cargo bay compartments. Based on the parametric characteristics of the perceived hazard,

the protection systems and components, and the specific environment of the aircraft which requires protection, the definition and configuration of an optimized approach for protection can better be defined. Author

A91-48633
TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS II) TRANSITION PROGRAM
GARY P. GAMBARANI (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p.
(SAE PAPER 901970) Copyright

The TCAS II Transition Program (TTP) must assess the operational impact of a large number of TCAS II units on the existing ATC system. Recorded TCAS data will be correlated with pilot, controller, and observer comments and supporting ATC recorded data. Software developed to support the TTP will convert all airborne data tapes into a common format that can be used by other program participants to perform their studies. Attention shall be given to unsafe conditions and flight-path deviations. O.C.

A91-48648
MASTERING THE SYSTEMS - AIR TRAFFIC CONTROL AND WEATHER
RICHARD L. COLLINS New York, Macmillan Publishing Co., 1991, 271 p.
Copyright

The art of flying is discussed with emphasis on the role of air traffic control and weather factors. The discussion covers common misconceptions about aviation and the effects of weather, various VFR and IFR flying techniques, and recommendations for dealing with the weather and air traffic control. In particular, consideration is given to flight planning, the effects of steady and changing winds, the effects of ground speed and tail wind, approach, landing, and evaluation of the flight. V.L.

A91-48654
WINDSHEAR - OPTIMUM TRAJECTORY, HUMAN FACTORS AND MISCELLANEOUS INFORMATION
WILLIAM W. MELVIN (Air Line Pilots Association, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p. refs
(SAE PAPER 901995) Copyright

The present discussion of insights obtained to date on trajectory optimization for windshear conditions gives attention to human factors-related problems of information transfer between pilot and ground controllers and pilot and aircraft. Pilots should be given more information on the low-level jetstream, reversal effects, visual effects, and equipment limitations in wind shears. Wind shear level quantification is judged preferable to automated decisionmaking. O.C.

A91-48655
PROFESSIONAL STANDARDS, COCKPIT RESOURCE MANAGEMENT AND ACCIDENT PREVENTION
JAMES A. MCINTYRE SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 5 p. refs
(SAE PAPER 901996) Copyright

The similarities and differencies between Cockpit Resource Management (CRM) and Professional Standards Committees (PSC) are examined, and their relationship to each other in positively affecting flight safety is discussed. It is concluded that joint effort of CRM and PSC appears to offer some solutions for reducing the problems of human error in the cockpit, help prevent accidents, and enhance flight safety. O.G.

A91-48659
OPPORTUNITIES TO IMPROVE HELICOPTER COCKPIT DISPLAYS - A PILOT'S PERSPECTIVE
PAUL G. STRINGER (Essex Corp., Columbia, MA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. refs
(SAE PAPER 902002) Copyright

Human error remains as the major cause/factor identified in both civil and military helicopter accident reports. This paper identifies some opportunities for improving helicopter operational performance and reduce human error accidents based on critical event analysis of accident reports and associated operational requirements. Analysis identified areas where the pilot was overloaded and information available to the pilot was inadequate for the particular situation. These results suggest several areas where the task demands could be made more compatible with the pilot capabilities for improved performance, fewer errors, and timely decisions in critical situations. Two areas addressed are power/flight performance management and obstacle avoidance. This information can be useful in developing helicopter automation and electronic display systems that improve safety and mission reliability. Author

A91-48785
HUMAN PERFORMANCE AND SYSTEMS SAFETY CONSIDERATIONS IN AVIATION MISHAPS
ALAN E. DIEHL (USAF, Inspection and Safety Center, Norton AFB, CA) International Journal of Aviation Psychology (ISSN 1050-8414), vol. 1, no. 2, 1991, p. 97-106. refs
Copyright

This article provides an overview of (1) accident generation, (2) the ensuing investigation process, and (3) the types of prevention measures that will be employed to ultimately decrease the probability of similar mishaps. The stages of the accident-generation process include ubiquitous hazards which lead to occasional incidents that in turn result in less frequent accidents. Steps in the investigation process included fact finding, information analysis, and authority review. The use of comparison data sources and mishap data bases are important collateral-investigation activities. The basic classes of accident-prevention measures included environmental-hazard exposure limitations, equipment safety features and/or warning devices, and establishing procedural safeguards. Human factors problems are associated with 50 to 90 percent of all accidents, whereas system safety principles provide the logical framework for deciding which type of countermeasures to apply in ameliorating such problems. This article describes the interface between human factors and system-safety concepts and provides examples of successful accident-prevention programs. Author

A91-49184
AIRCRAFT CONTROL IN THE 21ST CENTURY - EXAMINATION OF THE ROLE OF THE FLIGHT CREW [GESTION DES AERONEFS AU XXIE SIECLE - EXAMEN DU ROLE DE L'EQUIPAGE]
ROBERT G. BULEY (Northwest Airlines, Inc., Minneapolis, MN) (Symposium International sur l'Aviation au XXIe Siecle, Paris, France, Nov. 14-16, 1990) Navigation (Paris) (ISSN 0028-1530), vol. 39, July 1991, p. 412-420. In French.
Copyright

Future prospects concerning the role of the flight crew in aircraft control from the preflight verification phase, through takeoff and flight, and finally in the landing phase are discussed. It is pointed out that successful design of the air transportation system depends to a large extent on the proper definition of the role of the human operator. It is explained that a philosophy of automation that supports the role of the human operator should optimize the unique qualities of both the human and the machine in order to assure the optimal level of system safety. The operator should be allowed to exercise a greater degree of 'inner loop' control of the system as a means of assuring an adequate degree of situational awareness. L.M.

A91-49208
MINIMIZING AIRCRAFT FIRE/EXPLOSION HAZARDS
Aerospace Engineering (ISSN 0736-2536), vol. 11, Aug. 1991, p. 9-11.
Copyright

A review is presented of the particular problems faced by designers of military combat aircraft in that they must integrate fire/explosion protection (for peacetime operations) with measures that are intended to defeat the combustion-related kill mechanisms of counterair threats. The combat aircraft protection problem is multiplied by its considerable design sensitivity to the parasitic weight that is added to counter the explosion and fire hazards and threats. Generally, explosion/fire protection has a significant impact on hardening/vulnerability activities, 'kill given a hit' probabilities, and resulting vulnerable areas. R.E.P.

A91-50628
WORK-RELATED AVIATION FATALITIES IN COLORADO 1982-1987
CHRIS J. WIANT (Tri-County Health Dept., Englewood, CO), SUSAN P. BAKER (Johns Hopkins University, Baltimore, MD), WILLIAM M. MARINE (Colorado, University, Denver), ROGER VANCIL, and SHARON M. KEEFER (Colorado Dept. of Health, Denver) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 62, Sept. 1991, p. 827-830. Research supported by PHS. refs
Copyright

On-the-job deaths related to aviation are the seventh leading cause of fatal occupational injury in the U.S. In Colorado, they comprise 37 percent of all air transport deaths. A review of all occupational aviation-related fatalities in Colorado during 1982-1987 identified 86 deaths. Data sources were death certificates, Workers' Compensation records, and National Transportation Safety Board reports. Of the fatalities, five involved commercial air service, 16 were military personnel, and 65 (76 percent) were associated with general aviation. Nonmilitary occupations included 21 pilots, five flight instructors, four crop sprayers, and three search and rescue workers or firefighters. There were 18 people going to or from work sites. The 15 weather cases, seven aircraft malfunctions, and four power transmission wire strikes were the most significant factors in two-thirds of the crashes of civilian aircraft. Even experienced pilots exercised poor judgement. The prominence of general aviation in work-related aviation fatalities indicates a need for greater attention to the safety of workers whose jobs entail flying. Author

A91-50930
BENEFITS TO AVIATION OF AUTOMATED AIR REPORTS
NEIL GORDON (World Meteorological Organization, Geneva, Switzerland) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 27-30. refs
Copyright

The elements and benefits of in-flight weather reports from aircraft are examined. The special characteristics of cruise-level wind and temperature information from aircraft are discussed, including the facts that observations are at a single level, are asynoptic, are concentrated on air routes, and have a high spatial resolution. Information on turbulence and icing is also addressed. C.D.

A91-50951
EVALUATION OF OCEANIC FLIGHT DECK WORKLOAD AND ERROR REDUCTIONS THROUGH THE USE OF DATA COMMUNICATIONS
RICHARD E. HEINRICH and RICHARD B. WANK (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 205-212. refs
Copyright

The use of oceanic data communications provides increased efficiencies to the flight deck for AOC/ATC communications. Through the use of automated and semi-automated systems supported by data link, the flight deck can achieve both workload and error reduction. Furthermore, data link can provide oceanic areas with improved error detection and tracking capabilities that can drastically improve the current system. The industry, with the onset of Satcom in the past year, has undertaken studies, rapid prototypes and trials that have further highlighted data link's potential and made oceanic data link a reality. Author

A91-52279* California State Univ., Long Beach.
FORTIFIED LEWICE WITH VISCOUS EFFECTS
TUNCER CEBECI, H. H. CHEN, and N. ALEMDAROGLU (California State University, Long Beach) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 564-571. Previously cited in issue 06, p. 762, Accession no. A90-20009. refs
(Contract NAG3-935)
Copyright

A91-52938
ARTIFICIAL AND NATURAL ICING CONDITIONS FLIGHT TESTS ON THE PIAGGIO P.180 AVANTI AIRCRAFT
PAOLO CINQUETTI and SERGIO MARTINI (Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa, Italy) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 12 p. refs
(SAE PAPER 911004) Copyright

An extensive development and certification test program carried out to meet the requirements for safe operations in ice conditions is described. The program encompasses preliminary evaluation in wind-tunnel tests, real flight in artificial icing conditions realized behind U.S. air tanker NKC-135, and natural ice tests performed in a wide range of atmospheric environments with a variety of average liquid water contents, cloud droplets median volume diameter and static temperature. The remarkable amount of data made it possible to accomplish power plant certification and assess all the ice protection systems with a high safety level. Some discrepances found between data in artificial and natural tests are discussed. O.G.

N91-29152# Idaho National Engineering Lab., Idaho Falls.
ENVIRONMENTAL ASSESSMENT FOR THE FAA EXPLOSIVE DETECTION SYSTEM INDEPENDENT VALIDATION AND VERIFICATION PROGRAM
May 1991 17 p Prepared in cooperation with Department of Energy, Idaho Falls, ID
(Contract DE-AC07-76ID-01570)
(DE91-013190; DOE/EA-0507) Avail: NTIS HC/MF A03

The urgent development, fabrication, and operation of advanced explosive detection systems are needed by the Federal Aviation Agency (FAA) to counteract potential terrorist threats. The Department of Energy (DOE) proposes to provide independent testing of such devices at the Idaho National Engineering Laboratory (INEL) to evaluate their effectiveness. Testing of explosive detection devices at the INEL would provide data from which explosive detection devices may be chosen for deployment by the FAA. The potential risks posed by the explosive handling and storage can be managed by safe administrative controls and proper training of personnel. The facility proposed for the action is in an isolated location and requires minimum renovations. Environmental impacts resulting from the proposed validation and verification tests would be minimal. DOE

N91-29154# Gates Learjet Corp., Wichita, KS.
AIRCRAFT ICING HANDBOOK, VOLUME 1 Final Report, Feb. 1985 - Mar. 1991
A. HEINRICH, RICHARD ROSS, GLEN ZUMWALT, JOHN PROVORSE, and VISWA PADMANABHAN Mar. 1991 393 p
(Contract DTFA03-85-C-00007)
(AD-A238039; DOT/FAA/CT-88/8-1-VOL-1) Avail: NTIS HC/MF A17 CSCL 01/3

The design and validation of adequate aircraft ice protection has evolved into a specialized and technically complex area were many engineering disciplines are involved; namely, aeronautical, electrical, mechanical, electronics, chemical simulations, mathematical modeling, airframe/engine systems design, atmospheric physics, and meteorology. Research advances in any one discipline have a direct effect on updating the procedural

technology used in the design and validation of ice protection configurations, equipment, and systems. Periodically the Federal Aviation Administration (FAA) provides documentation to assist regulatory certification teams and industry design engineers in standardizing testing and validating procedures. Examples of such documentation are Engineering Summary of Airframe Icing Technical Data, FAA Report No. ADS-4 dated December 1968, and Engineering Summary of Powerplant Icing Technical Data, FAA Report No. RD-77-76 dated July 1977. Although most of the information contained in these reports is still valid, some is outdated, and more usable information is now available through recent research and experience. Therefore, this work was directed towards developing an updated and more comprehensive combined version of Report ADS-4 and RD-77-76 that includes reference material on ground and airborne icing facilities, simulation procedures, and analytical techniques. This document represents all types and classes of aircraft and is intended as a working tool for GRA

N91-29155# Gates Learjet Corp., Wichita, KS.
AIRCRAFT ICING HANDBOOK, VOLUME 2 Final Report, Feb. 1985 - Mar. 1991
A. HEINRICH, RICHARD ROSS, GLEN ZUMWALT, JOHN PROVORSE, and VISWA PADMANABHAN Mar. 1991 604 p (Contract DTFA03-85-C-00007)
(AD-A238040; DOT/FAA/CT-88/8-2-VOL-2) Avail: NTIS HC/MF A99 CSCL 01/3

The design and validation of adequate aircraft ice protection has evolved into a specialized and technically complex area where many engineering disciplines are involved; namely, aeronautical, electrical, mechanical, electronics, chemical simulations, mathematical modeling, airframe/engine systems design, atmospheric physics, and meteorology. Research advances in any one discipline have a direct effect on updating the procedural technology used in the design and validation of ice protection configurations, equipment, and systems. Periodically the Federal Aviation Administration (FAA) provides documentation to assist regulatory certification teams and industry design engineers in standardizing testing and validating procedures. Examples of such documentation are Engineering Summary of Airframe Icing Technical Data, FAA Report No. ADS-4 dated December 1968, and Engineering Summary of Powerplant Icing Technical Data, FAA Report No. RD-77-76 dated July 1977. Although most of the information contained in these reports is still valid, some is outdated, and more usable information is now available through recent research and experience. Therefore, this work was directed towards developing an updated and more comprehensive combined version of Report ADS-4 adn RD-77-76 that includes reference material on ground and airborne icing facilities, simulation procedures, and analytical techniques. This document represents all types and classes of aircraft and is intended as a working too GRA

N91-29156# Gates Learjet Corp., Wichita, KS.
AIRCRAFT ICING HANDBOOK, VOLUME 3 Final Report, Feb. 1985 - Mar. 1991
A. HEINRICH, RICHARD ROSS, GLEN ZUMWALT, JOHN PROVORSE, and VISWA PADMANABHAN Mar. 1991 242 p (Contract DTFA03-85-C-00007)
(AD-A238041; DOT/FAA/CT-88/8-3-VOL-3) Avail: NTIS HC/MF A11 CSCL 01/3

The design and validation of adequate aircraft ice protection has evolved into a specialized and technical complex area where many engineering disciplines are involved; namely, aeronautical, electrical, mechanical, electronics, chemical simulations, mathematical modeling, airframe/engine systems design, atmospheric physics, and meteorology. Research advances in any one discipline have a direct effect on updating the procedural technology used in the design and validation of ice protection configurations, equipment, and systems. Periodically the Federal Aviation Administration (FAA) provides documentation to assist regulatory certification teams and industry design engineers in standardizing testing and validating procedures. Examples of such documentation are Engineering Summary of Airframe Icing Technical Data, FAA Report No. ADS-4 dated December 1968, and Engineering Summary of Powerplant Icing Technical Data, FAA Report No. RD-77-76 dated July 1977. Although most of the information contained in these reports is still valid, some is outdated, and more usable information is now available through recent research and experience. Therefore, this work was directed towards developing an updated and more comprehensive combined version of Report ADS-4 and RD-77-76 that includes reference material on ground and airborne icing facilities, simulation procedures, and analytical techniques. This document represents all types and classes of aircraft and is intended as a working tool for GRA

N91-29157# National Transportation Safety Board, Washington, DC. Bureau of Accident Investigation.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 1 OF 1989 ACCIDENTS
18 Dec. 1990 413 p
(PB90-916901; NTSB/AAB-90/01) Avail: NTIS HC/MF A18; Paper copy also avail.on Standing Order deposit account required (minimum deposit $100 US, Canada, and Mexico; all others $200) CSCL 01/3

Selected aircraft accident reports for both U.S and foreign aviation operations in 1989 are briefly reported. The approximately 200 accidents presented here represent a random selection. Facts, conditions, circumstances, and probable causes for each accident are given. Author

N91-30110 National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: RUNWAY COLLISION OF EASTERN AIRLINES BOEING 727, FLIGHT 111 AND EPPS AIR SERVICE BEECHCRAFT KING AIR A100, ATLANTA HARTSFIELD INTERNATIONAL AIRPORT, 18 JANUARY 1990
29 May 1991 101 p
(PB91-910403; NTSB/AAR-91/03) Avail: NTIS HC/MF A06 CSCL 01/3

The runway collision of an Eastern Airlines Boeing 727 with an Epps Air Service Beechcraft at the Hartsfield International Airport, Atlanta, GA, on January 8, 1990, is examined. The safety issues discussed are air traffic controller procedures, conspicuity of airplane lighting, the see and avoid concept, and equipment and systems to prevent runway incursions. Safety recommendations concerning these issues were made to the FAA. Author

N91-30111 Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
THE DYNAMIC PERFORMANCE OF A VARIETY OF SEAT CUSHION MATERIALS UNDER VERTICAL IMPACT LOADS
D. R. DAY Dec. 1988 151 p Sponsored by Department of National Defence
(DCIEM-88-TR-53; CTN-91-60207) Avail: NTIS HC A08

A series of twenty-nine impacts using the HyGe Crash Simulator at the Impact Studies Facility of the Defence and Civil Institute of Environmental Medicine (DCIEM) was performed in order to determine the effectiveness of a variety of seat cushion materials in preventing spinal injuries during high accelerative loading. These commonly occur during helicopter crashes with relatively large vertical velocity components, hard landings of Schweizer training gliders, and ejections from jet aircraft. Two simple wooden seats were mounted on the impact sled so as to simulate impacts in the vertical (bottom of seat pan to top) direction only, with a velocity change of 21 miles per hour, with a peak deceleration of 17 G. The results showed that none of the energy-absorbing cushions tested had any significant effect on the probable occurrence, of spinal injury. However, 2-inch, and thicker foam-rubber cushions increased the risk of spinal injury significantly, with the probable severity of the injury increasing as the thickness of the foam increased. Author (CISTI)

N91-30112 Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
CANADIAN AIRCREW FRESH WATER SURVIVAL 1952-1987
C. J. BROOKS Dec. 1988 24 p
(DCIEM-88-RR-51; CTN-91-60209) Avail: NTIS HC A03

This paper reviews all aircraft accidents from 1952 to 1987 involving Royal Canadian Air Force or Canadian Forces aircrew ditching, parachuting or ejecting into fresh water. In that period there have been a total of 42 accidents involving 105 personnel. The survival rate was 61 percent compared with a 57 percent survival rate in sea water accidents. All rescues were completed in under 12 hours. Aircrews had less than 1 minute warning in 81 percent of the accidents. There were fatalities in 53 percent of the short warning accidents. Seventeen types of aircraft were involved in the accidents. There was one case of clinical hypothermia and 5 cases in which the crew were very cold and survival was attributed principally to quick rescue. Difficulties have occurred in inflating life jackets and deploying the life raft. Otherwise there is little data on the performance of these items. Immersion suits were not worn in any accidents. In general the problems encountered in ditching in fresh water were the same as those encountered in ditching in sea water. CISTI

N91-30113# Federal Aviation Administration, Atlantic City, NJ.
EFFECTIVENESS OF WATER SPRAY WITHIN THE CABIN OVERHEAD AREA
TIMOTHY MARKER Aug. 1991 27 p
(DOT/FAA/CT-TN91/29) Avail: NTIS HC/MF A03

Four full-scale postcrash fire tests were conducted in a modified DC-10 fuselage to investigate the benefits, if any, of spraying water in the area above the cabin ceiling, known as the overhead. The tests were part of a 28-test series using a wide body fuselage to study the performance of an onboard cabin water spray system. The spray system uses low flow rate nozzles which produce a fine mist consisting of a range of water droplet diameters. The system being tested was a breadboard design for the purpose of demonstrating concept feasibility only. In order to better quantify the overhead spray performance, two areas of the cabin ceiling were removed: the area directly adjacent to the fire door, and an area in the forward section of the fuselage near the gas sampling stations. Temperature, smoke, heat, and gas concentrations were monitored at various locations throughout the fuselage. Test results showed little or no improvement in cabin conditions due to the overhead spray. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A91-48578
DIGITAL NETWORKS AND FIBER OPTIC INTERCONNECTION
MARK D. MENDENHALL (Raychem Corp., Menlo Park, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901876) Copyright

The paper examines existing and emerging data transmission paths with the technology requirements of the next-generation vehicles. MIL-STD-1553B governing the data bus most commonly used by aircraft is reviewed, and attention is focused on the reliability of 1553B systems, field repairs, cost, maintenance, and materials. Emphasis is placed on such a wide-bandwidth medium as fiber optics and its properties. The strength of multimode fiber before and after buffer removal, before and after termination, signal loss in a bent fiber-optic cable, alignment problems in fiber-optic terminations, and losses due to lateral and longitudinal alignments are analyzed. Fiber-optic connectors classified into such groups as crimp and cleave, pot and polish, and PELL (no polishing, no epoxy handling, no liquids, no lenses) are considered as well as the use of common sealing techniques for preventing losses. V.T.

A91-48581
A PROSPECTUS OF PILOT FACTORS IN DATA LINK AT THE FAA TECHNICAL CENTER
MICHAEL C. REYNOLDS (Midwest Systems Research, Inc., Dayton, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p. refs
(SAE PAPER 901884) Copyright

The Mode S data link proposed by the FAA as a new ATC capability is addressed. It is argued that a system-centered approach to developing this link is needed which examines the link's impact on all parts of the National Airspace System (NAS). Emphasis is given to the need for integrating the data link communications into the cockpit. C.D.

A91-48582* Douglas Aircraft Co., Inc., Long Beach, CA.
CONSIDERATIONS FOR THE RETROFIT OF DATA LINK
WILLIAM H. CORWIN and HUGO W. MCCAULEY (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p. Research supported by NASA. refs
(SAE PAPER 901886) Copyright

Human factors issues related to the retrofit of data link in commercial transport aircraft are discussed. Topics that must be considered for data link implementation include, the loss of the party line, (i.e., the availability to all aircraft of information transmitted on a common voice frequency), and the scheduling of information to the flight crew. This paper focuses primarily on the human factors issues related to retrofit of Mode S. Retrofits is a difficult task because panel space accessible to flight crew members is limited. As with all cockpit equipment, data link implementation will have to comply with Federal Aviation Regulation 25.1523, which requires the manufacturer to address the conspicuity and ease of use of the data link device, and to assess the impact on crew workload. Operational sequence diagrams are provided to illustrate a methodology that can be used to decompose the flight crew body channel utilization of candidate avionics configurations in order to optimize the pilot-vehicle interface. Author

A91-48583
DATA LINK COMMUNICATION BETWEEN CONTROLLERS AND PILOTS - STATE OF THE KNOWLEDGE
KAROL KERNS (Mitre Corp., Bedford, MA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. Research supported by FAA. refs
(SAE PAPER 901887) Copyright

Research on operational use of data link technology as a means of exchanging information between aircraft and ground-based facilities has been underway for well over a decade. From this work, potentially useful data exist that remain largely unexploited for purposes of operational development. This paper reviews the simulation literature on data link communication between controllers and pilots to synthesize a base of useful, generalizable knowledge. General effects of the data link technology on the volume, speed, and timing of Air Traffic Control communications are analyzed for their operational significance. The analytic framework depicts data link effectiveness as interdependent with operational context, procedures and applications, and human interface design. Current research leaves many questions unanswered but consistently indicates that the combination of voice and data link communication outperforms either medium used by itself. Issues are raised for research and implementation. Author

A91-48584* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT TESTS USING DATA LINK FOR AIR TRAFFIC CONTROL AND WEATHER INFORMATION EXCHANGE
CHARLES E. KNOX and CHARLES H. SCANLON (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology

Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 19 p. refs
(SAE PAPER 901888) Copyright

Message exchange for air traffic control (ATC) purposes via data link offers the potential benefits of increasing the airspace system safety and efficiency. This is accomplished by reducing communication errors and relieving the overloaded ATC radio frequencies, which hamper efficient message exchanges during peak traffic periods in many busy terminal areas. However, the many uses and advantages of data link create additional questions concerning the interface among the human-users and the cockpit and ground systems. A flight test was conducted in the NASA Langley B-737 airplane to contrast flight operations using current voice communications with the use of data link for transmitting both strategic and tactical ATC clearances during a typical commercial airline flight from takeoff to landing. Commercial airplane pilots were used as test subjects. Author

A91-48599
THE COUPLING OF HIGH INTENSITY RADIO FREQUENCY (HIRF) ENVIRONMENTS INTO AIRCRAFT
RODNEY A. PERALA (Electro Magnetic Applications, Inc., Lakewood, CO) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 27 p. refs
(SAE PAPER 901915) Copyright

In this paper the interaction of the High Intensity Radio Frequency (HIRF) environment with aircraft is described. This environment is assuming more importance because of the use of composite materials and low level semiconductor technology which performs critical functions. Experimental coupling results are presented and discussed for induced cable currents at low frequencies, and for internal fields at high frequencies. A major portion of the paper is used to describe numerical techniques which can be used to solve the coupling problem. Author

A91-48625
FLIGHT MANAGEMENT COMPUTER SYSTEM DATALINK INTERFACE CAPABILITIES
PETER J. HOWELLS and DONALD MOORE (Smiths Industries Aerospace and Defense Systems, Inc., Grand Rapids, MI) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. refs
(SAE PAPER 901954) Copyright

A new communications path has been developed which allows both an airline and Air Traffic Control (ATC) to send or receive flight information, via the air to ground datalink interface, to or from the Flight Management Computer System (FMCS). This interface allows an airline to preload an FMC with route, weight and wind information and allows ATC to load route changes such as alternate approach procedure information directly into the FMCS for the pilot to review. In addition, the automatic downlink feature of the FMCS can be used to report airplane position, current wind, etc. at predetermined times. This data can be used by the airline and ATC to track airplanes and to improve wind models for other airplanes. To ensure that the datalink interface of the FMCS can meet the requirements of different airlines as well as evolving ATC capabilities, an adaptable, table-driven system has been developed. Author

A91-48626
DEVELOPMENT OF APPLICATIONS FOR THE AIR GROUND DATA EXCHANGE USING MODE S DATA LINK - FAA PROGRAM STATUS
ALEXANDRA ARGYROPOULOS (Mitre Corp., McLean, VA) and HUGH MCLAURIN (FAA, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. refs
(SAE PAPER 901955) Copyright

The Mode S data link program developed by the FAA will provide the first data link service in the National Airspace System. This paper surveys the application currently considered for implementation via data link, including flight services ATC applications, tower applications, and surveillance applications. The various test beds are addressed, and the ground architecture to support the data link is described. The development status of the avionics and cockpit procedures is summarized. C.D.

A91-48627
AIRLINE DATA LINK AUTOMATION - PROGRESS AND ISSUES
PAUL R. RYAN (American Airlines, Inc., Dallas, TX) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p.
(SAE PAPER 901957) Copyright

To move passengers and cargo from one airport to another requires a large amount of coordination and the transfer of information between support groups. The commercial airlines have automated the transfer of information from voice and paper documents to the use of digital data and have been successful in improving the coordination necessary to provide the highest degree of service to the passangers. This paper looks at two separate flight segments that identify the old and new process of information transfer. The 2 segments also identify the need for the FAA Air Traffic System to use the data link process for better coordination of aircraft traffic movement. Both the airline and FAA data link processes are being designed around the concept of the Aeronautical Communications Network (ATN) which will provide data connectivity between all coordinators and provide for a more efficient system to move passengers and cargo between airports. Author

A91-48634
OPERATIONAL RESEARCH AND DEVELOPMENT - THE PROCESS LEADING TO A CHANGE IN AIR TRAFFIC CONTROL SEPARATION STANDARDS
JERRY BRADLEY (FAA, Washington, DC) and KIMBERLY T. JOYCE (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p. refs
(SAE PAPER 901971) Copyright

Evolution of the Vertical Separation Standards Program is briefly reviewed from the establishment of standards in 1958 to the development of ICAO guidance for reducing vertical separation from 2000 feet to 1000 feet above flight level 290 in 1990. Particular attention is given to the operational research and development program conducted by the Federal Aviation Administration from 1981 to 1990 for developing data concerning the technical feasibility of reducing the vertical separation standard. The Vertical Separation Standards program resulted in the recommendations presented in the Advanced Notice of Proposed Rule-Making. O.G.

A91-48639
DEVELOPING MONITORING REQUIREMENTS FOR REDUCED SEPARATION AIRSPACE
KIMBERLY T. JOYCE (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901977) Copyright

Fundamental changes in the minimum separation between aircraft require an assessment of system performance monitoring. In both the North Atlantic minimum navigation performance specification airspace and in a reduced vertical separation minimum airspace, monitoring requirements are essential for safe operation. With increasing traffic demand and advancements in communications, navigation, and surveillance systems, aircraft separation minimums will be reevaluated for airspace-utilization optimation. O.C.

A91-49637#
AN AUTOMATIC CARRIER LANDING SYSTEM UTILIZING AIRCRAFT SENSORS
JOHN L. CRASSIDIS and D. J. MOOK (New York, State University, Buffalo) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and

Astronautics, 1991, p. 595-605. refs
(AIAA PAPER 91-2666) Copyright

A closed-loop control system is developed and evaluated for use in automatic Carrier landings. The system is based on a new tracking filter which uses angle of attack and airspeed measurements from the airplane, in addition to the usual ship-based radar measurements. The filter dynamic model is based on actual flight dynamics, using the additional measurements, and thus achieves significant radar-noise sensitivity reduction by eliminating the existing dependence on numerical differentiation of the radar output. An additional feedback loop which blends aircraft model estimates with radar measurements is also added to the system. Nonlinear optimization techniques are used to determine a set of optical filter and control gains for the entire closed-loop system. A detailed digital computer simulation, verified with available flight data, indicates that the use of the flight-dynamics-based tracking filter and the addition of the feedback loop dramatically improve every measure of the performance of the system. Author

A91-49639#
EVALUATION OF THE FLYABILITY OF MLS CURVED APPROACHES FOR WIDE-BODY AIRCRAFT
LOUIS J. J. ERKELENS and JAN-HEIN VAN DRONKELAAR (National Aerospace Laboratory, Amsterdam, Netherlands) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 617-626. Research supported by FAA. refs
(AIAA PAPER 91-2668) Copyright

Curved-path MLS approaches are examined with respect to their flyability for wide-body aircraft as well as the minimum required length of the straight final segment by means of simulations. Special attention is given to the performance and operational acceptance of manually flown curved approaches. Included in the evaluation are four curved approach paths consisting of a 90-degree curved segment and two straight segments. The length of the last segment is varied, and an MLS equivalent of a specific visual approach is employed for the simulation. Wind and visual conditions are varied up to and including limiting conditions, and data are collected for 320 approaches. It is determined that wide-body aircraft can fly the curved paths within certain constraints and with crews that are minimally familiarized with the paths. The minimum length for the final straight segment (2.0 NM under Cat II weather minima) and the subjective evaluations from the crews demonstrate that the curved paths can be preferable under certain conditions. C.C.S.

A91-49640#
A SHORT FINAL APPROACH PERFORMANCE EVALUATION TECHNIQUE
VINCENT WALTON, LEONARD ANDERSON, MUNIR ORGUN, TZE SIU, and SEAN FLANNIGAN (Boeing Co., Seattle, WA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 627-634. refs
(AIAA PAPER 91-2669)

A statistical method is developed for use in establishing performance boundaries for transport aircraft making automatic short final approach and landing on ILS-equipped runways. The method is based on current procedures for landing performance evaluation using a six degree-of-freedom Monte Carlo simulation. Such computer simulations accurately model aircraft dynamics and control system functions, and model random and deterministic components of winds and radio beacon performance. The short final approach evaluation method is applied to both automatic localizer capture at the edge of the ILS beam, and delayed capture for aircraft turning on to the beam centerline. Author

A91-49646*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PASSIVE OBSTACLE LOCATION FOR ROTORCRAFT GUIDANCE
P. K. A. MENON, G. B. CHATTERJI, and B. SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 684-691. refs
(Contract NCC2-575)
(AIAA PAPER 91-2638) Copyright

Nap-of-the-earth flight mode is extremely demanding on the rotorcraft pilots. This fact has motivated the research in automating various components of low altitude rotorcraft flight operations. Concurrent with the development of guidance laws, efforts are under way to develop systems for locating the terrain and the obstacles using inputs from passive electrooptical sensors such as TV cameras and infrared imagers. A passive obstable location algorithm that uses image sequences from cameras undergoing translational and rotational motion is developed. The algorithm is in a general form and can operate in multicamera imaging environments. Performance results using an image sequence from an airborne camera are given. Author

A91-49647#
A NONLINEAR APPROACH TO THE AIRCRAFT TRACKING PROBLEM
R. H. BISHOP (Texas, University, Austin) and A. C. ANTOULAS (Rice University, Houston, TX) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 692-703. refs
(AIAA PAPER 91-2639) Copyright

A nolinear approach to the problem of tracking a maneuvering aircraft is presented. A nonlinear aircraft maneuver model is proposed for state estimation as well as prediction. The nonlinear model describes planar trajectories. A geometric nonlinear filter (GNF) is presented. The results show a substantial overall improvement over the extended Kalman filter (EKF) approach. Applying a Liapunov stability approach, sufficient conditions for stability of the GNF estimation error are derived. The GNF was found to be stable in cases where the EKF was not stable. For the stable cases, the tracking performance of the GNF compares favorably with the EKF. The GNF offers substantial savings in computational time. Author

A91-49649#
DESIGN AND FLIGHT TEST OF ON-BOARD GUIDANCE FOR PRECISION LANDING
DAVID J. MOORHOUSE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 710-715. refs
(AIAA PAPER 91-2641)

The present study documents the solution to the requirement for adverse weather short landings without any ground aid, i.e., using existing onboard equipment to designate and then guide to a touchdown point. Attention is given to the STOL and Maneuver Technology Demonstrator Program. It is concluded that the required guidance for a precision manual landing can be generated using onboard equipment. P.D.

A91-49712*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISION-BASED OPTIMAL OBSTACLE-AVOIDANCE GUIDANCE FOR ROTORCRAFT
P. K. A. MENON, G. B. CHATTERJI, and B. SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1427-1435. refs
(Contract NCC2-575)
(AIAA PAPER 91-2755) Copyright

An optimal guidance scheme for vision-based obstacle avoidance is developed. The proposed approach is useful for automating low-altitude rotorcraft flight. It explicitly accounts for

the discrete nature of range information available from vision-based sensors and uses a linear combination of flight time, square of the vehicle acceleration and the square of the distance to various sensed obstacles as the performance index. A sixth-order, three-degree-of-freedom nonlinear point-mass vehicle model is included in the analysis. Numerical results using a sample image sequence is given. Author

A91-49713*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STATUS OF AUTOMATED NAP-OF-THE-EARTH ROTORCRAFT GUIDANCE
RICHARD A. COPPENBARGER and VICTOR H. L. CHENG (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1436-1450. refs
(AIAA PAPER 91-2756) Copyright

The status of automated nap-of-the-earth (NOE) flight guidance is discussed by examining two current research efforts that approach the problem of performing obstacle avoidance along a pre-planned course from different perspectives. The first, a real-time guidance system developed by Systems Technology Inc., focuses on the issue of pilot acceptable maneuvers, under the assumption of an ideal, but nonrealizable, obstacle detection system. The second, a system created at NASA Ames, concentrates on the utilization of realistic on-board sensor data for obstacle detection and avoidance-maneuver decisions. This paper examines the strengths and weaknesses of these two approaches, and how they might complement each other. The goal is an automatic NOE system that is both acceptable to pilots and capable of making intelligent use of realistic sensor information and path-selection logic. Author

A91-49863
PILOT-CONTROLLER COMMUNICATION - A LINE PILOT'S PERSPECTIVE
A. S. MATTOX, JR. (Allied Pilots Association, Arlington, TX) IN: Managing the modern cockpit; Proceedings of the 3rd Human Error Avoidance Techniques Conference, Dallas, TX, Dec. 4, 5, 1990. Warrendale, PA, Society of Automotive Engineers, Inc., 1990, p. 45-49.
(SAE PAPER 902354) Copyright

Pilot-controller communications errors impact the safety and efficiency of the National Airspace System (NAS). The success of airline data link systems has prompted trails of data linking pre-departure Air Traffic Control (ATC) clearances, Automatic Terminal Information Service (ATIS), and weather services through these systems. Trials of oceanic satellite data line communications and projects by NASA Langley explore data linking tactical and strategic ATC clearances. Initial efforts show promise and point to human factors issues and cockpit display considerations which effect full implementation of these concepts. Data link has the potential to improve pilot-controller communications. Author

A91-50461* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HELICOPTER AIRBORNE LASER POSITIONING SYSTEM (HALPS)
JOSEPH C. EPPEL, JEFFREY CROSS, JOSEPH TOTAH (NASA, Ames Research Center, Moffett Field, CA), and HOWARD CHRISTIANSEN (Northrop Services, Inc., Sunnyvale, CA) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 11-28. Previously announced in STAR as N90-23399. refs
Copyright

The theory of operation, configuration, laboratory, and ground test results obtained with an HALPS developed by Princeton University is presented. The HALPS measures the relative position between two aircraft in three dimensions using two orthogonal fan-shaped laser beams sweeping across an array of four detectors. Specifically, the HALPS calculates the relative range, elevation, and azimuth between an observation aircraft and a test helicopter with a high degree of accuracy. The detector array provides a wide field of view in the presence of solar interference due to compound parabolic concentrators and spectral filtering of the detector pulses. The detected pulses and their associated time delays are processed by the electronics and are sent as position errors to the helicopter pilot who repositions the aircraft as part of the closed loop system. Accuracies obtained in the laboratory at a range of 80 ft in the absence of sunlight were + or - 1 deg in elevation; +0.5 to -1.5 deg in azimuth; +0.5 to -1.0 ft in range; while elevation varied from 0 to +28 deg and the azimuth varied from 0 to + or - 45 deg. Accuracies in sunlight were approximately 40 deg (+ or - 20 deg) in direct sunlight. Author

A91-50468
NAVIGATIONAL GUIDANCE IN COMPLEX AIRSPACE
BARRY SCHIFF (Aircraft Owners and Pilots Association, Frederick, MD) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 100-106.
Copyright

A discussion is presented concerning the consequences of FAA Terminal Control Area policies for general aviation, in view of its associated proliferation of airport radar service areas. Attention is given to the changing situation at Los Angeles International Airport and the furnishing of VFR navigation services to similarly complex metropolitan areas, including New York, San Diego, San Francisco, and Washington D.C. O.C.

A91-50469
AN OVERVIEW OF INSTRUMENT FLIGHT AND CONTROLLED FLIGHT INTO TERRAIN
LAWRENCE HOLMES, JR. (Holmes Research, Inc., Midland Park, NJ) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 107-115.
Copyright

IFR navigation charts carry very little terrain information, with the occasional exception of mountains and tall towers and buildings. Attention is presently given to Microflyte, a novel automatic position/direction indicator that places a flashing light over a standard FAA-approved approach chart and is controlled by radio and heading information generated by equipment already operating in the given aircraft, as well as to the minimum-vectoring altitudes radio map, and the role of VORTAC-VOR/DME geodetic-coordination stations. O.C.

A91-50626
IN-FLIGHT ALIGNMENT OF INERTIAL NAVIGATION SYSTEMS
ITZHACK Y. BAR-ITZHACK (Technion - Israel Institute of Technology, Haifa) IN: Control and dynamic systems. Vol. 38 - Advances in aeronautical systems. San Diego, CA, Academic Press, Inc., 1990, p. 369-396. refs
Copyright

A comprehensive account is given of the nature of the process if in-flight alignment (IFA) of guided-weapon inertial-navigation systems (INSs) immediately before the moment of launch from an aircraft. The background of this IFA process is furnished by a discussion of INS alignment-at-rest (AAR). The advantage of IFA over AAR is expressed in terms of observability measures; in AAR, three out of ten system modes are unobserved, and IFA reduces this number to two. O.C.

A91-50926
ANNUAL INTERNATIONAL AERONAUTICAL TELECOMMUNICATIONS SYMPOSIUM ON DATA LINK INTEGRATION, 3RD, MCLEAN, VA, MAY 20-23, 1991, PROCEEDINGS
Symposium sponsored by FAA and Aeronautical Radio, Inc. Annapolis, MD, Aeronautical Radio, Inc., 1991, 261 p. For individual

items see A91-50927 to A91-50954.
Copyright

Various papers on data link integration are presented. Individual optics addressed include: integrated Satcom/ACARS data communication architecture for the Boeing model 777 aircraft, benefits to aviation of automated air reports, RTCA SC-162 Aviation Information Exchange System architectural model, managing wide area networks with OSI network management, ATN framework for automated reporting of meteorological data by aircraft, evaluation report of an experimental Satcom operation, airline experiences in satellite system access institutional processes, combined multichannel airborne satellite communication system, development of an airborne RF monitor for ACARS system, HF-data/voice link system, digital communication in the cockpit. Also discussed are: pilot's automated weather support system concepts, ATC evaluation of terminal data link services, ATN internetworking and routing protocols simulations, aeronautical VHF data link, Inmarsat's aeronautical satellite data link, FAA data link rapid deployment system for predeparture clearance, Traffic Information Service of data link, ATC data communications operational development and system implementation. C.D.

A91-50927
AIRLINE AND CIVIL AVIATION AUTHORITIES REQUIREMENTS FOR GLOBAL DATA LINK SERVICES - PROGRESS AND ISSUES

PAUL R. RYAN (Air Transport Association of America, Washington, DC; American Airlines, Inc., Dallas, TX) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 7-11.
Copyright

The goal of the Air Transport Association and International Air Transport Association is to improve the air traffic system network through the prudent use of data links. Data link services will be added to the system slowly, as the products will change both the ATS controllers' and pilots' operating procedures. This paper reports on the progress made to date and advocates the installation of global data link service products over the next ten years that will provide a good balance between the government funding for automation and the airline investment in data link equipment. The remaining issues that need to be addressed are the changes in the air traffic system policy and procedures that will provide time and fuel savings to offset the capital investment made by the airlines. Author

A91-50928
INTEGRATED SATCOM/ACARS

GEORGE A. COBLEY (Rockwell International Corp., El Segundo, CA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 13-19.
Copyright

It was in late September 1990 that the first revenue flights carried active Satcom systems integrated with ACARS. This provided seamless ACARS communications for Pacific service. The use of VHF communications links was augmented by using the first FAA certified Satellite Communications System to provide data link service to 747-400's of United Airlines through complete oceanic flight profiles. This paper presents a brief review of the development, then examines the operational results. Data is presented on the operational parameters collected at the Santa Paula Ground Earth Station operated by Comsat, and from message audits collected by Arinc. Author

A91-50929
DATA COMMUNICATION ARCHITECTURE FOR THE BOEING MODEL 777 AIRPLANE

ALVIN H. BURGEMEISTER (Boeing Commercial Airplanes, Seattle, WA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 21-25.
Copyright

The Boeing model 777 airplane will be the first aircraft designed from the ground up to provide data communications across the Aeronautical Telecommunications Network presently being developed to meet international telecommunications standards. This paper describes the avionics networks and equipment that are being developed 777 to communicate using that network, both internally and externally. Author

A91-50931
RTCA SC-162 AVIATION INFORMATION EXCHANGE SYSTEM (AIES) ARCHITECTURAL MODEL

V. J. SMALL (Boeing Co., Seattle, WA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 35-40.
Copyright

A description of a proposal for an Aviation Information Exchange System (AIES) Model to provide aviation data communication services, is presented. The AIES model consists of a Basic AIES model with the addition of application specific functions. The basic function provides the required functions of System Maintenance, System Security, Application Maintenance and message transfer. Extensions, which are application specific functions and short stack upper layer protocols, complete the AIES Model. The objective of developing the model is to provide an overview of the complete system and to provide the framework to help committees engaged in standardization activities coordinate their work. Author

A91-50933
TOWARD AN ATN FRAMEWORK FOR AUTOMATED REPORTING OF METEOROLOGICAL DATA BY AIRCRAFT

AUSTIN SNIVELY (American Airlines, Inc., Dallas, TX), DONALD J. TROMBLEY (Air Transport Association of America, Washington, DC), RONNIE D. LONDOT, and GEORGE T. LIGLER (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 51-53. refs
Copyright

A multidisciplinary ad hoc Working Group was formed in August 1990 to define a standard format for meteorological reports automatically generated by transport aircraft and communicated via the Aeronautical Telecommunications Network (ATN) end-to-end data link. Working Group background and activities are overviewed, and an application framework for future aircraft meteorological data reporting is discussed. Author

A91-50935
EVALUATION REPORT OF AN EXPERIMENTAL SATCOM OPERATION

HIROSHI OOKOUCHI (Japan Airlines, Tokyo) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 61-66.
Copyright

An inflight Satcom service trial was carried out using the Inmarsat system with a Japan Airline 747 passenger plane. A total of three digital voice/fax communication channels for AOC, AAC, and APC were established simultaneously by utilizing the class-A linear high-power amplifier and the combination of 9.6/4.8 kbps voice codecs. Through the trial, the voice quality of 4.8 kbps voice codec was recognized as satisfactory for the application for aeronautical satellite communication. Author

A91-50936
AIRLINE EXPERIENCES IN SATELLITE SYSTEM ACCESS INSTITUTIONAL PROCESSES

RICHARD E. HEINRICH (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23,

1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 67-72. refs
Copyright

The highly integrated nature of avionic communications (air traffic and airline operational control, administrative and passenger communications) creates the need for a stringent set of test requirements. The objective of testing is to verify proper system operation over a common space segment and ground network, where network-wide complexity mandates that a complete end-to-end testing of equipment and communications systems be performed to verify that levels of performance meet service contract requirements. This paper presents the test requirements as viewed by INMARSAT, the FAA and CAAs of the world, and the ground service providers. Author

A91-50937
A COMBINED MULTICHANNEL AIRBORNE SATELLITE COMMUNICATION SYSTEM
MOHAMED A. EL-RAYES and MOHAMED A. ABDELRAZIK (E-Systems, Inc., Dallas, TX) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 73-78. refs
Copyright

This paper provides a technical description of a multichannel airborne analog/digital communication system that uses the International Maritime Satellite (INMARSAT) Organization network. The system design required combining a 60-W, Class A high-power amplifier (HPA) and a 200-W, Class C HPA onto a mechanically steerable eight-element helical array antenna. The digital part, which uses the 60-W Class A HPA, provides two aviation quadrature phase shift keying toll-quality voice channels and an aviation binary phase shift keying data channel simultaneously, while the analog part, which uses the 200-W, Class C HPA, provides a frequency modulated high-quality voice channel. The aircraft user is provided with four simultaneous full-duplex channels that support telephone, data, and teletypewriter signals that meet the operational requirements of the 'Aeronautical Standard' and the 'Standard-A' of the INMARSAT Organization and the airworthiness requirements of the Federal Aviation Administration. Author

A91-50938
DEVELOPMENT OF AN AIRBORNE RF MONITOR FOR ACARS SYSTEM
DANIELLE K. MOSES, WILLIAM F. TRUSSELL, and CHARLES PFEIFFER (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 95-99.
Copyright

The benefits of monitoring the performance of the air/ground network from the aircraft's perspective have been recognized. A cooperative effort is underway to develop an automatic airborne RF monitor (ARFM) to enhance this monitoring need. The ARFM will provide greater performance in statistics-gathering capabilities than the current manned flight checks, thereby assisting in the early recognition of problems in the system on a real-time basis. Author

A91-50939
HF-DATA/VOICE LINK SYSTEM
GUENTER WICKER (Rohde & Schwarz GmbH und Co., Munich, Federal Republic of Germany) and FRIEDRICH HOELZEL (Telefunken System Technik GmbH, Ulm, Federal Republic of Germany) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 101-109. refs
Copyright

This paper presents a mature and proven High-Speed Data Link System via HF (Shortwave), to be used for air-ground/ground-air transmission. The described concept deals with the peculiarities and specifics of the HF-ACARS system, as a complement and potential back-up for the established VHF, resp. the future planned Satcomm Link. Author

A91-50940
INTEGRATED VOICE AND DATA VHF RADIO SUBNETWORK USING THE CELLULAR-TRUNKED AIR/GROUND (CTAG) RADIO SUBSYSTEM
KENNETH L. CROCKER and RONALD L. RICHARDS (Mitre Corp., McLean, VA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 111-118. refs
Copyright

An overview of the concepts of cellular and trunked radios is presented, as is an overview of OSI Internetwork routing employed on the Aeronautical Telecommunication Network (ATN). The ATN provides an international aeronautical data internetwork which links the various aeronautical air/ground and ground/ground subnetworks together. A comparison is made of the required addressing for cellular-trunked radio and the addressing information present at the network layer of the ATN. The paper concludes with an explanation of a possible CTAG access protocol demonstrating CTAG's interoperability with the ATN as a subnetwork. Author

A91-50941
DIGITAL COMMUNICATION IN THE COCKPIT
MICHAEL E. MURPHY (Boeing Commercial Airplanes, Seattle, WA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 119-123. refs
Copyright

A flight crew operations perspective on the potential role of aviation-related digital communication is presented. Specific guidelines that reflect both flight deck system design and digital communication system design are given. A conceptual aircraft digital communication system based on these guidelines is described. Issues related to the implementation of this concept are addressed, emphasizing issues related to digital communication with Air Traffic Services. C.D.

A91-50942* Vigyan Research Associates, Inc., Hampton, VA.
PILOT'S AUTOMATED WEATHER SUPPORT SYSTEM (PAWSS) CONCEPTS
N. L CRABILL (Vigyan, Inc., Hampton, VA) and E. R. DASH IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 125-132. refs
(Contract DTFA01-90-4-01019; NAS1-18585)
Copyright

The FAA and NASA are investigating concepts for providing automated support to pilots in obtaining and using weather information. The pilot's Automated Weather Support System (PAWSS) activity is using computer technology to assist the pilot in acquiring and displaying weather information in the cockpit, and to assist in assessing and applying weather data in flight management and en route support. The PAWSS concepts include data link communications with a short update cycle of new weather data, color-coded map depictions with alpha-numeric data available for backup and detailed data presentation, automated monitoring of weather trends with alerting for hazardous conditions, and expert system technology applications in weather data assessments and flight management applications. Author

A91-50943
THE ROLE OF DATA LINK WITHIN THE COOPERATIVE AIR TRAFFIC MANAGEMENT CONCEPT - CATMAC
KLAUS PLATZ and HERIBERT LAFFERTON (Bundesanstalt fuer Flugsicherung, Frankfurt am Main, Federal Republic of Germany) IN: Annual International Aeronautical Telecommunications

Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 135-143. refs
Copyright

The Cooperative Air Traffic Management Concept will increase air traffic control (ATC) capacity by cooperatively negotiating all necessary planning data between airspace users and ATC. Flight management systems will be integrated in this cooperative process via data link and perform assigned tasks. Author

A91-50944
AIR TRAFFIC CONTROLLER EVALUATION OF TERMINAL DATA LINK SERVICES
EMIL BLASSIC and KAROL KERNS (Mitre Corp., Bedford, MA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 145-154. Research supported by FAA. refs
Copyright

An FAA team has formulated a functional design for an initial set of services which would deliver radio frequency changes and routine terminal information to aircraft as well as tactical clearances to maneuver aircraft in preparation for final approach. The results of an evaluation of these services, summarized in this paper, indicate that as the proportion of data link equipped aircraft in the traffic sample increased, the amount of time controllers spent on the voice frequency and the total number of (voice and data link) instructions decreased. Aside from routine information transactions, the results indicated that heading and altitude assignment were the most frequently used data link instructions. They also revealed that the data link did not appear to have any negative effect on the perceived controller workload. Author

A91-50945
ATN INTERNETWORKING AND ROUTING PROTOCOLS SIMULATIONS
BERNARD CONIO (Eurocontrol, Brussels, Belgium) and FRANCIS BRANGIER (Centre d'Etudes de la Navigation Aerienne, Orly Aerogare, France) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 155-164.
Copyright

The MADAM (Mode S Air-ground Data link Analysis and Modeling) project consists in modeling and simulating the air-ground communications over the Mode S subnetwork, by means of queueing networks. The MADAM simulator aims at providing a performance evaluation of the data link between the adjacent ground and airborne routers connected via the mode S subnetwork. The main goal of the survey is to evaluate the data link capacity of the communication system and to estimate the influence of various functioning parameters. The paper presents the main simulation assumptions and the analysis of a set of simulation results. Author

A91-50946
ANALYSIS OF THE RESULTS OF THE PACIFIC ENGINEERING TRIALS AND THE IMPLEMENTATION OF AUTOMATIC DEPENDENT SURVEILLANCE
VIRGINIA L. WHITE (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 171-178. refs
Copyright

The Pacific Engineering Trials (PET) program is an ongoing effort to gain technical and operational experience in the automated transmission of periodic position reports, event-driven waypoint reports, and two-way Air Traffic Control (ATC) communications via a satellite data link. The PET is the first step in the evaluation of the implementation of Automatic Dependent Surveillance (ADS) and the impact of the ADS function on ATC. This paper interprets the cumulative results of the engineering trials to date. Author

A91-50947
AERONAUTICAL OSI PROFILE DEVELOPMENT AND THE INTEGRATED AVIONICS ARCHITECTURE
INGEBORG L. RAY (Honeywell, Inc., Phoenix, AZ) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 179-181. refs
Copyright

As specifications for Open Systems Interconnect (OSI) in the Aeronautical Telecommunications Network (ATN) mature and as implementations progress, it is now possible to explore the potential offered by these more flexible capabilities. This paper highlights some of the advancements in aeronautical OSI profile design and initial application in the ATN Project. The discussion then progresses toward advanced communication management systems based on integration of end system functions, using the efficient integrated avionics architecture of next generation airplanes. Author

A91-50948
AERONAUTICAL VHF DATALINK - PRESENT AND FUTURE
ALOKE ROY and ANTHONY D. MARTELLI (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 183-187. refs
Copyright

Air/ground datalink is essential for future air traffic and operational control applications. Three transmission media: VHF, Satellite, and Mode-S radar, are currently being enhanced/developed to meet the datalink requirements. The datalinks will be interoperable using the Aeronautical Telecommunications Network (ATN) architecture concept. This paper presents the ability of the existing and future VHF datalink to support the performance requirements of the evolving aeronautical applications. Author

A91-50949
INMARSAT'S AERONAUTICAL SATELLITE DATA LINK
K. SMITH and P. WOOD (International Maritime Satellite Organization, London, England) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 189-193. refs
Copyright

The development of Inmarsat's aeronautical satellite data link began in 1985. Initial operations began in 1990, and a global service became available in March 1991. A plan has been developed which will permit a smooth transition from a system supporting character oriented ACARS/AIRCOM messages, to one which fully supports OSI-compatible packet data services. It is anticipated that the final configuration, which will interwork with the Aeronautical Telecommunications Network, will be available by the end of 1992. Author

A91-50950
PRE-DEPARTURE CLEARANCE - AN FAA DATA LINK RAPID DEPLOYMENT SYSTEM
HUGH MCLAURIN (FAA, Washington, DC) and ENRIQUE M. MELENDEZ (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 197-200.
Copyright

In 1990 the FAA took on an ambitious challenge and announced a full-scale national deployment of the Pre-Departure Clearance (PDC) data communications service at a total of 30 airports in less than a year. PDC reflects the growing realization within the FAA of the benefits of developing rapid prototype systems for operational evaluation with the potential for accelerated fielding if the cost/benefits advantages truly exist. This PDC paper will examine the actual benefits recorded to date of the PDC system, the FAA PDC program long-term objectives of ensuring ATN

compatibility, and issues that had to be addressed with deploying an Air Traffic Control datalink application on a nationwide basis. Author

A91-50952
THE TRAFFIC INFORMATION SERVICE (TIS) OF DATA LINK
ROBERT D. GRAPPEL (MIT, Lexington, MA) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 213-221. Research sponsored by FAA.
Copyright

This paper describes an automatic system for the generation and transmission of traffic advisories using Mode S surveillance and data link capabilities. The Traffic Information Service (TIS) provides traffic information similar to TCAS-I but at lower cost, thus making the safety benefits of automatic traffic advisories available to smaller aircraft. Author

A91-50953
A PROGRESS REPORT ON DATA LINK ATC SERVICE DEVELOPMENT RESEARCH AT THE FAA TECHNICAL CENTER
NICHOLAS J. TALOTTA (FAA, Washington, DC) and CLARK A. SHINGLEDECKER (NTI, Inc., Dayton, OH) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 223-229. refs
Copyright

A91-50954
ATC DATA COMMUNICATIONS OPERATIONAL DEVELOPMENT AND SYSTEM IMPLEMENTATION
WAYNE ALESHIRE (United Airlines, Chicago, IL) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991, p. 231-238.
Copyright

The expanding role of satellites in ATC is discussed. The development of ATC data communications systems is examined and its use of satellite links is addressed, outlining the way that these links are evaluated. The preoperational trials of automatic position reporting known as Automatic Dependent Surveillance (ADS) are discussed along with the certification process. C.D.

A91-52123
USING GPS TO CALIBRATE LORAN-C
JOSEPH J. PISANO (Analytic Sciences Corp., Reading, MA), PER K. ENGE, and PETER L. LEVIN (Worcester Polytechnic Institute, MA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, July 1991, p. 696-708. refs
Copyright

Various techniques for using simultaneous Global Positioning System (GPS)/Loran data to estimate the propagation uncertainties that limit the absolute accuracy of Loran-C are discussed. Significant improvements in the absolute accuracy of Loran can be achieved with very simple calibrations. The absolute accuracy of Loran in the Gulf of Maine without calibration is presented. The maximum and rms absolute errors are between 700 and 500 m, depending on the choice of land model. Simple calibrations greatly improve the absolute accuracy of Loran. As shown, if the land conductivities are fixed a priori and a single parameter is optimized, the maximum and rms absolute errors fall to around 250 and 60 m, respectively. Alternatively, land can be treated as a single conductivity which can be adjusted to reduce offshore additional secondary phase factor errors. The performance of this practice is summarized in tables which show maximum and rms errors of around 300 to 100 m, respectively. I.E.

A91-52124
IMPROVED TRACKING WITH MODE-S DATA-LINKED VELOCITY MEASUREMENTS
CHRIS C. LEFAS (Technical University of Crete, Athens, Greece) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, July 1991, p. 709-714. Research supported by Eurocontrol. refs
Copyright

The use of downlinked airspeed and magnetic heading data to enhance tracking in mode-S equipped air traffic control (ATC) systems is examined. A tracker performing satisfactorily during straight line flight as well as during steep maneuvers is discussed. The filter copes easily with longitudinally accelerating targets and is suitable for tracking low-velocity targets like helicopters in all phases of flight. The filter assumes that the target flies in a circular path from sample to sample, which results in nonlinear system equations. The filter is suitable for implementation in three-dimensional tracking systems, particularly on the vertical axis, where target velocities are usually small. I.E.

A91-52125
TRACKING A 3D MANEUVERING TARGET WITH PASSIVE SENSORS
FRANCOIS DUFOUR (Ecole Normale Superieure, Cachan, France) and MICHEL MARITON (Matra, Laboratoire de Traitement des Images et du Signal, St.-Quentin-en-Yvelines, France) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, July 1991, p. 725-739. refs
(Contract DRET-89-357; NATO-0885/89)
Copyright

A novel application of the interacting multiple models (IMM) algorithm in which passive infrared sensors are fused for tracking a target maneuvering in three dimensions is discussed. More accurate models of target motion are proposed to improve performance. When general models are used to describe the maneuvering periods, it is shown that the IMM behavior is not satisfactory, in that the innovations associated with the different models do not discriminate between the corresponding target maneuvering regimes. The turning of the Markov chain transition matrix, i.e., a priori information, is then crucial to obtaining the correct ordering of the a posteriori regime probabilities. On the contrary, a more satisfactory behavior of the IMM algorithm is obtained by carefully selecting the target motion models in the different regimes. I.E.

A91-52163
CLASSIFICATION OF RADAR CLUTTER IN AN AIR TRAFFIC CONTROL ENVIRONMENT
SIMON HAYKIN, PETER WEBER (McMaster University, Hamilton, Canada), WOLFGANG STEHWIEN (Litton Systems Canada, Ltd., Etobicoke), CONG DENG (Bell-Northern Research, Ltd., Ottawa, Canada), and RICHARD MANN (Helsinki University of Technology, Espoo, Finland) IEEE, Proceedings (ISSN 0018-9219), vol. 79, June 1991, p. 742-772. Research supported by NSERC and DND. refs
Copyright

The results of an experimental study aimed at the classification of radar clutter encountered on ground-based coherent scanning radar systems used for air traffic control are presented. The clutter signals of interest are primarily those due to birds and to clouds and weather systems. A historical perspective on the radar clutter classification problem is given, and related issues are discussed. The important features of radar as a sensor in an air traffic control environment are described, and physical phenomena in radar clutter and targets, which provide the physical basis for the discrimination between the different radar clutter classes, are discussed. The feature of selection/extraction procedure, which is based on the multisegment Burg algorithm, is described. The experimental evaluation of a parametric Bayes classifier and a neural network classifier is reported. I.E.

A91-52196
DISCUSSION ON THE INTEGRATION APPROACHES AND NAVIGATION PERFORMANCE OF INTEGRATED GPS/INERTIAL NAVIGATION SYSTEMS
JIXIANG YU and GENGSHENG ZHANG (Northwestern

Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A287-A293. In Chinese. refs

There are two basic approaches for integrating the Global Positioning System (GPS) with the Inertial Navigation System (INS). One approach utilizes the navigation solution of GPS receiver to aid the INS. This paper discusses mainly the other approach, which utilizes the pseudorange and pseudorange rate measurements of the GPS receiver to integrate GPS with INS. It shows that the integrated system provides excellent performance which cannot be achieved by either GPS or INS alone. Author

A91-52953* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A STUDY OF DATA-LINK COMPATIBLE COMMUNICATION FOR UNEQUIPPED AIRCRAFT
MARVIN C. WALLER (NASA, Langley Research Center, Hampton, VA) ARINC and FAA, Aeronautical Telecommunications Symposium on Data Link Integration, Annapolis, MD, May 15-17, 1990, *Paper.* 7 p. *refs*

Results of a piloted simulation study are presented in which a simulated aircraft, with no data link equipment, received air traffic control (ATC) clearance messages over the conventional voice radio. The study resulted in pilot acceptance and message transaction times which compare favorably to previously documented simulation-study measurements of data-link message transactions. It is suggested that this concept could make it possible for air traffic controllers to use a data-link interface for communicating with both data-link equipped and unequipped aircraft. O.G.

A91-52964
APPLICATION OF LOW SPEED AVIONIC SYSTEM DISCRETE SIGNAL INTERFACES
SAE Aerospace Recommended Practice, ARP 4258, Oct. 25, 1990, 9 p.
(SAE ARP 4258) Copyright

Recommendations are given regarding the selection, comparison, and use of discrete signal interfaces for transmitting data at low frequency and power in aerospace applications. After giving applicable references and definitions for the avionic discrete-signal interfaces, practical concepts are described related to the connection of sensors, on/off-status indicators, and simple-event state indicators. The manifestations of discrete input are described including off/on-switch states, level-sensing devices, and impedance-level switching. Also described are discrete-output signal interfaces including critical and noncritical timing signalling, low-power switching, and conventional switching. It is concluded that standardized discrete-signal interfaces which fall within the variations defined in the paper should be incorporated into aerospace designs. C.C.S.

N91-29158# National Aeronautical Establishment, Ottawa (Ontario).
EVALUATION OF A PRE-PRODUCTION VERSION OF CANADIAN MARCONI CMA-786 GPS RECEIVER
T. ONNO and C. D. HARDWICK Mar. 1989 36 p
(NAE-LTR-FR-106; CTN-91-60030) Copyright Avail: NTIS HC/MF A03

An evaluation of suitability of the Canadian Marconi Company's (CMC) CMA-786 GPs receiver for accurately positioning an in-flight aircraft with data from the U.S. Global Positioning System is described. Receivers were tested in a variety of static and dynamic conditions. A number of performance limitations were identified, the most significant being the inability to maintain satellite tracking under highly dynamic flight conditions. Changes made by CMC resulted in reliable tracking up to Rate 2 turns (6 degrees per second turn rates). The use of two receivers for differential correction of position bias was evaluated. The method will correct for slow drift errors in dynamic operation where only minimum filtering is allowable. In the present version of the CMC Kalman filter differential correction program, any gaps in the data can cause large transient errors in output position. The satellites have occasionally given indications of erratic behavior, and crosschecking of results is essential if high accuracy is required. Within these limitations, the CMA-786 receiver has demonstrated the potential for a radically improved accuracy of aircraft navigation. Evaluation during one flight gave comparison within 20 meters against a high precision microwave transponder system during most of the steady parts of the flight. CISTI

N91-29159# National Aeronautical Establishment, Ottawa (Ontario). Inst. for Aerospace Research
FLIGHT EVALUATION OF COMPLEX APPROACHES IN A TWIN OTTER AIRCRAFT USING A MICROWAVE LANDING SYSTEM
JOHN B. CROLL Jul. 1990 111 p
(NAE-LTR-FR-114; CTN-91-60103) Copyright Avail: NTIS HC/MF A06

Flight testing of curved, segmented approaches using a microwave landing system (MLS) was conducted on a Twin Otter aircraft. Algorithms were written to define several different approach configurations and to provide precision guidance to both straight and curved segments. These algorithms were developed and validated in flight during the software development phase of the project. A pilot evaluation phase was subsequently flown to assess the tracking accuracies and pilot workload associated with flying these approaches. Seven experienced pilots flew several different approaches each. Standard aircraft electro-mechanical flight instruments were modified slightly to assist the pilots. All approaches were flown successfully using instruments only, despite some problems in the performance of the lateral flight director. Approach track deviations and pilot workload were found to increase as a direct function of the track angle changes on the curved segments, though influenced by the limitations of the lateral flight director. Automatic course updating was rated as most essential and the heading index presentations had some use. The normal radio magnetic indicator was not generally used and the distance measuring equipment was rated as occasionally useful. All pilots felt that a plan view of the approach should be displayed for approaches with five or more segments and that a presentation of the next waypoint number, its bearing and distance, and the along track distance to touchdown should be mounted on the instrument panel. Author (CISTI)

N91-29160# National Aeronautical Establishment, Ottawa (Ontario).
NAE PARTICIPATION IN THE UNITED STATES FAA VERTICAL SEPARATION STUDY
J. AITKEN Jan. 1989 21 p
(NAE-LTR-FR-105; CTN-91-60124) Copyright Avail: NTIS HC/MF A03

In order to assess the safety implications of reducing the vertical separation above flight level of 29,000 feet (FL290) from 2000 to 1000 feet, a number of International Civil Aviation Organization (ICAO) countries have conducted studies pertaining to aircraft height keeping performance. The National Aeronautical Establishment (NAE) of Canada participation in the United States Federal Aviation Administration Vertical Separation Study over the period of December 1984 to January 1987 is described. The NAE T-33 C-FSKH was flown a total of 289 hours. In conjunction with a NASA height finding radar, C-FSKH was used to determine accurate flight level heights in five study locations, one in Canada and four in the US. Extensive calibration studies were performed on the aircraft in support of the program. The studies included direct intercomparison flights with the program's second pacer aircraft, the NCAR Sabrelliner N307D. The study objectives are described along with the data collection procedures, the aircraft and instrumentation, the calibration procedures, and data transfer methods. It is reported that the major conclusion of the ICAO report is that 1000 vertical separation above FL290 is not feasible globally but may be feasible regionally. CISTI

N91-29162# Mitre Corp., Bedford, MA.
MOBILE MICROWAVE LANDING SYSTEM (MMLS) USER INTERFACE Final Report

S. K. VERMA May 1991 26 p
(Contract F19628-89-0001-5420)
(AD-A237470; MTR-11051; ESD-TR-91-205) Avail: NTIS HC/MF A03 CSCL 17/7

This paper describes a user friendly Mobile Microwave Landing System (MMLS) interface design, based on menu schemes, that needs only a small number of function keys and limited display size. Although the design was developed for consideration in the local and remote control units for the MMLS, it is suitable for implementation on other control system interfaces where weight, display size, and/or the number of keys be kept to a minimum. GRA

N91-30115# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
AUTOMATED FLIGHT STRIP MANAGEMENT SYSTEM FUNCTIONAL DESCRIPTION
S. D. THOMPSON 19 Nov. 1990 48 p
(Contract DTFA01-89-Z-02039)
(AD-A229606; ATC-174; FAA-ARD-90/27) Avail: NTIS HC/MF A03 CSCL 01/5

The purpose of this document is to provide a functional description of the Automated Strip Management System (ASMS). ASMS is designed to be an improvement over the current manual system of paper flight data strips, plastic holders, metal racks and felt-tip markers now employed in the Tower Cabs and TRACONS at major airports. The objectives for ASMS include improved coordination between controllers, a reduction of controller workload, and the automation of most manual record keeping procedures. ASMS will provide position-specific information to the controller when he or she needs it in a manner that displays the data in the most useable form for the controller to accomplish his or her job. ASMS will provide a better interface with controllers for data entry and transfer than exists with the present manual system, reducing the chance for errors and increasing productivity. Additionally, ASMS is intended to provide the Traffic Management Unit (TMU) in the Air Route Traffic Control Center (ARTCC) real time ground information suitable for traffic management, reducing or eliminating the requirement for voice communications. In addition to the objective listed above, the implementation ASMS at Logan Tower will remedy a deficiency in the existing system for passing Flight Progress Strip data for departing aircraft from the Tower Cab to the TRACON located in an adjacent building. GRA

N91-30116# Federal Aviation Administration, Atlantic City, NJ.
AIR TRAFFIC OPERATIONAL EVALUATION PLAN FOR THE LIMITED PRODUCTION AUTOMATED SURFACE OBSERVING SYSTEM (ASOS)
ELIZABETH TURCICH and BRUCE E. WARE Sep. 1991 21 p
(DOT/FAA/CT-TN91/13) Avail: NTIS HC/MF A03

The Automated Surface Observing System (ASOS) is a weather collection and display system that will be installed in air traffic control towers (ATCT). Data for the operational evaluation of the limited production ASOS system will be collected via questionnaires completed by air traffic control specialists at the three operational sites. The results of the evaluation will be used for consideration in making any necessary changes to the ASOS system prior to full production. Author

N91-30117# Computer Resource Management, Inc., Herndon, VA.
NAVIGATION OPERATIONAL CONCEPT
WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON, JR. Aug. 1991 59 p
(Contract DTFA01-91-Y-01004)
(NAS-SR-134; DOT/FAA/SE-91/2) Avail: NTIS HC/MF A04

A requirement for the National Airspace (NAS) is to provide for navigation, as identified in the NAS System Requirements Specification (NASSRS). This operational concept is one of many high level documents that will, in total, describe the operation of the NAS when the projected upgrade is complete. These documents will assist in linking the requirements specified in the NASSRS, including enroute navigation, terminal navigation, and visual navigation aids. This concept, and the other seven operational concepts, will complete the description of the system requirements as described in the NASSRS. The eight operation concepts are: communications, navigation, monitoring, maintenance and support, system effectiveness, air defense, flight planning, and traffic control and airspace management. Author

N91-30119# Aeronautical Research Inst. of Sweden, Stockholm. Flight Systems Dept.
INVESTIGATION OF SPEECH SYSTEMS FOR GROUND COLLISION WARNING IN MILITARY AIRCRAFT
RUTA AXELSSON and FOLKE STOBY Apr. 1991 65 p
(Contract FMV-82420-89-325-73-001)
(FFA-TN-1991-05; ETN-91-99787) Avail: NTIS HC/MF A04

A trend in both civil and military cockpit design is to incorporate some kind of speech system in the presentation of information. The decision has been made by Swedish Air Material department to introduce suitable speech systems in the aircraft Viggen and in the aircraft Gripen. A flight simulator experiment is used to investigate the following alternatives for ground collision warning: two types of speech generation, synthesized and digitized, female and male voices, six different words, lamp warning. To be able to create a realistic flight mission, a specific test method is designed. The flight task consists of head up as well as head down flying and the missions contain realistic ground collision warning situations. A tape recorded from authentic radio communication is used as a realistic background. As a further test of intelligibility for the different speech systems, unknown randomly positioned flight phrases are included. The results are unambiguous regarding the preference for speech systems but not so pronounced for the choice of warning words. ESA

N91-30120# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. fuer Systemtechnik und Navigation.
THE AIRPORT AND AIRSPACE SIMULATION MODEL SIMMOD OF THE FAA: FEATURES, EXAMPLES, AND EXPERIENCES
FRANZ KNABE Dec. 1990 27 p In GERMAN; ENGLISH summary
(DLR-MITT-91-01; ISSN-0939-298X; ETN-91-99792) Avail: NTIS HC/MF A03; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 12.50 DM

The Institute for Flight Guidance of the German Aerospace Research Establishment uses the airport and airspace simulation model SIMMOD of the Federal Aviation Administration (FAA) during a study on refinements to increase the capacity of the Frankfurt airport. The environment, in which the software package is operated, the structure and the features of SIMMOD are described. Some personal viewpoints from the work with SIMMOD are presented. ESA

N91-30121 Civil Aviation Authority, London (England).
UK AIRMISSES INVOLVING COMMERCIAL AIR TRANSPORT, JANUARY - APRIL 1990
Dec. 1990 36 p
(ISSN-0951-6301; ETN-91-99834) Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England

A list of airmisses involving commercial aircraft during the period from Jan. to Apr. 1990 is presented. Only the pilot of the aircraft can file an airmiss report and the decision to do so is exclusively his or hers. All airmiss reports in the United Kingdom (UK) airspace involving civil or military aircraft are investigated initially by the Joint Airmiss Section of the National Air Traffic Services. The airmisses are categorized as A, B or C in assessment of the degree of risk inherent in each airmiss. ESA

N91-30122 Civil Aviation Authority, London (England).
UK AIRMISSES INVOLVING COMMERCIAL AIR TRANSPORT, MAY - AUGUST 1990
Apr. 1991 85 p

(ISSN-0951-6301; ETN-91-99835) Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England

A list of airmisses involving commercial aircraft during the period from May to Aug. 1990 is presented. Only the pilot of the aircraft can file an airmiss report and the decision to do so is exclusively his or hers. All airmiss reports in the United Kingdom (UK) airspace involving civil or military aircraft are investigated initially by the Joint Airmiss Section of the National Air Traffic Services. The airmisses are categorized as A, B or C in assessment of the degree of risk inherent in each airmiss report. ESA

N91-30123# Royal Signals and Radar Establishment, Malvern (England).

THE PROFILE DATA STRIP: A NEW APPROACH TO THE PRESENTATION OF FLIGHT PROGRESS DATA

J. O. COOK and D. A. BASELEY Feb. 1991 17 p Original contains color illustrations

(RSRE-MEMO-4460; BR116728; ETN-91-99844) Copyright Avail: NTIS HC/MF A03

Advanced air traffic control systems are being designed to make full use of developments in aircraft flight management systems and air ground data links. Current flight progress displays do not represent in any detail the actions or intentions of aircraft. A method of using automation and modern graphic displays to make the presentation of flight progress data more dynamic and easily understood is described. ESA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A91-48535

INNOVATIONS IN AIRCRAFT BASED DIPPING SONAR WINCH SYSTEMS

OVID BALTEN (Breeze-Eastern, Union, NJ) and JOHN SCHMID (Vickers, Inc., Aerospace-Marine-Defense, Jackson, MS) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p.

(SAE PAPER 901797) Copyright

A microprocessor-controlled dipping sonar winch system based on digital technology is presented. The system is capable of providing solutions for desired winch system characteristics and performing system diagnostics. Advantages over electromechanical and analog servo hydraulic systems include accuracy, efficiency, and repeatability. It is concluded that the digital microcontroller system improves dynamic response, programmed sequencing, and system health diagnostics. O.G.

A91-48539

COMPARISON OF DC-10 AND MD-11 DESIGNS

MICHAEL D'ESPOSITO (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 14 p.

(SAE PAPER 901806) Copyright

The development of the MD-11 is considered with respect to the design innovations incorporated into the derivative product which utilizes a baseline airframe. The DC-10 design is reviewed in terms of its effectiveness, and the proposed improvements are presented. Significant weight savings, simplified operability, and high reliability are predicted from the incorporation of integrated drive generators. C.C.S.

A91-48562

S/MTD THRUST VECTORING/REVERSING FLIGHT TEST RESULTS

GREGORY V. LEWIS (USAF, Flight Test Center, Edwards AFB, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p.

(SAE PAPER 901843) Copyright

This paper briefly describes the initial flight test results from the NF-15B Short Takeoff and Landing/Maneuver Technology Demonstrator (S/MTD) Program. Program objectives and an aircraft description are followed by test from pitch thrust vectoring, reversing in ground effect, and inflight reversing. Even though full up hardware has been in flight test only since February 1990, many of the overall program goals have been achieved. Thrust vectoring and reversing using a two dimensional (2D) convergent-divergent exhaust nozzle have been shown to be both possible and practical. An integrated flight and propulsion control system can be used to enhance performance and simplify pilot workload during vectoring and reversing operations. Future tests of the S/MTD will further quantify performance, assess military utility, and investigate infrared signature changes due to the 2D nozzle in both vectoring and reversing. Author

A91-48585

FUTURE SUPERSONIC TRANSPORT STUDIES AT AEROSPATIALE

DUDLEY COLLARD (Aerospatiale, Division Avions, Toulouse, France) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p.

(SAE PAPER 901890) Copyright

Proprietary design studies have been undertaken for a second-generation Mach 2 cruise-speed SST capable of operating economies superior to those of Concorde, with technology that is expected to be available in the next 15 years. Improvements are foreseen in operating empty weight, cruise lift/drag, and powerplant SFC. Additional advantages are anticipated from restriction of cruise Mach number to 2, rather than attempting Mach 3; the subsonic aerodynamics of such a moderate cruise Mach-number vehicle will be superior to those of a Mach-3-optimized one. The maximum cruise altitude of a Mach 2 SST, of the order of 65,000 ft, may also be environmentally preferable to the higher altitude of a Mach 3 design. O.C.

A91-48587

TWO VARIABLE ENGINE CYCLE CONCEPTS FOR SECOND GENERATION SUPERSONIC TRANSPORT

B. W. LOWRIE (Rolls-Royce, PLC, London, England) and E. PORTEJOIE (SNECMA, Paris, France) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs

(SAE PAPER 901892) Copyright

Contemporary technical opinion is that a second generation Supersonic Transport will need to be commercially viable and meet environmental noise and emissions. Engines with large variability (flow multiplication) will be needed. Two engine designs have been developed for this requirement and their characteristics identified. Both potentially reduce cruise fuel consumption by up to 10 percent from that of the Olympus in Concorde, and subsonic fuel consumption by better than 15 percent. A 35 to 45 percent improvement is obtained in thrust/weight ratio. These two designs are a tandem fan system and the MCV99 Mid Fan system; the essential difference is a trade of weight and friction drag due to the larger intake, nacelle and nozzle of the one, versus wave drag due to a larger maximum cross section of the other.

Author

A91-48589

APU POD DESIGN CONCEPT FOR F-14 AIRCRAFT

JOHN DEMARTINO (Grumman Corp., Aircraft Systems Div., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs

(SAE PAPER 901897) Copyright

The advantages of providing the F-14 aircraft with auxiliary power unit (APU) pod are discussed. The capabilities of the podded APU are compared with those of internal APU and ground carts. Pod design and performance are examined, including candidate

pod aerodynamic contours, internal arrangements, electrical power requirements, and predicted engine start and aircraft cooling performance. C.D.

A91-48591
ELECTROMECHANICAL GUIDANCE FIN ACTUATION IN A FOUR INCH DIAMETER AIR VEHICLE
JOHN MORSE (Lucas Western, Inc., Electro Sytems Div., Brea, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p.
(SAE PAPER 901901) Copyright

Independent guidance fin actuation subsystems packaged within a four-inch diameter air vehicle section are discussed. Each actuator is capable of 45 Hz response and a variety of other functions. In addition to positioning the fins for guidance and stability, the subsystems also feature fin shaft bearing support, mechanical stop, fin fold, fin sweptback lock, fin shaft lock, and fin latch functions. Detailed data are given on the actuation performance. C.D.

A91-48592
STUDY OF FRACTURE BEHAVIOR OF CORD-RUBBER COMPOSITES FOR LAB PREDICTION OF STRUCTURAL DURABILITY OF AIRCRAFT TIRES
B. L. LEE, P. M. FOURSPRING (Pennsylvania State University, University Park), J. P. MEDZORIAN, G. J. MIGUT, M. H. CHAMPION, P. M. WAGNER, and P. C. ULRICH (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901907) Copyright

An aircraft tire durability study is under way to investigate the deformation and fracture behavior of cord-rubber composites. This study will identify the important parameters responsible for the structural failure of aircraft tires by the use of analytical and laboratory prediction methods. These methods will also identify the interaction between material property degradation and damage accumulation in cord-rubber composites. Preliminary results using coupon specimens of tire carcass have revealed that prolonged static and cyclic loading sequences produce extensive interply shear deformation at the free edges resulting in cord-matrix debonding followed by delamination type failure. These loading sequences represent the circumferential tension in the footprint region of aircraft tires. It was also determined experimentally that a fatigue endurance limit can be established for cord-rubber composites. Analytical methods using finite element models of coupon specimens have demonstrated reasonable accuracy in predicting load-displacement response and interply shear strain variations. Future plans will include the correlation between the fatigue resistance data of composite specimens and dynamometer test results of actual tires. Author

A91-48593
FINITE ELEMENT THERMAL MODEL OF AN AIRCRAFT WHEEL AND CARBON BRAKE ASSEMBLY
MARK P. DYKO (Aircraft Braking Systems Corp., Akron, OH) and BENJAMIN T. F. CHUNG (Akron, University, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p. refs
(SAE PAPER 901909) Copyright

An aircraft braking system thermal modeling approach which provides a high degree of temperature resolution has been developed. This finite element method (FEM) based approach has been successfully employed to model the transient, nonlinear thermal response of a large aircraft wheel and carbon brake assembly during and after a braking event. Commercially available software was utilized for graphics based model pre and post processing and generation of the FEM analysis results. Temperature distributions were determined at a level of detail much greater than that available from existing system thermal models. Good agreement between the model predictions and measured temperature histories from a dynamometer test using full scale braking system hardware was obtained. Author

A91-48594
AIRCRAFT LANDING INDUCED TIRE SPINUP
JOE PADOVAN, TONY H. KIM (Akron, University, OH), and AMIR S. KAZEMPOUR (Goodyear Tire and Rubber Co., Akron, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p. refs
(SAE PAPER 901910) Copyright

Based on the appropriate stiffness and inertial properties of prototypical aircraft landing gear suspension systems, a tire spinup model is developed. Due to its generality, the model can define the various governing dynamical fields. Here the effects of such factors as sink rate, runway friction and aircraft landing speed are considered. Main attention is given to defining the tire deflection-rotation-skidding history as well as the net and pointwise rate of work due to interfacial friction as it effects the growth or rotary inertia and slip work. To quantify the influence of such environmental factor as sink rate, friction and landing speed, a case study involving the shuttle main tires is included. Author

A91-48595* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
F-106B AIRPLANE ACTIVE CONTROL LANDING GEAR DROP TEST PERFORMANCE
WILLIAM E. HOWELL, JOHN R. MCGEHEE, ROBERT H. DAUGHERTY (NASA, Langley Research Center, Hampton, VA), and WILLIAM A. VOGLER (Lockheed Engineering and Sciences Co., Houston, TX) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. Previously announced in STAR as N91-13445. refs
(SAE PAPER 901911) Copyright

Aircraft dynamic loads and vibrations resulting from landing impact and from runway and taxiway unevenness are recognized as significant factors in causing fatigue damage, dynamic stress on the airframe, crew and passenger discomfort, and reduction of the pilot's ability to control the aircraft during ground operations. One potential method for improving operational characteristics of aircraft on the ground is the application of active control technology to the landing gears to reduce ground loads applied to the airframe. An experimental investigation was conducted on series-hydraulic active control nose gear. The experiments involved testing the gear in both passive and active control modes. Results of this investigation show that a series-hydraulic active control gear is feasible and that such a gear is effective in reducing the loads transmitted by the gear to the airframe during ground operations. Author

A91-48597* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRCRAFT RADIAL-BELTED TIRE EVALUATION
THOMAS J. YAGER, SANDY M. STUBBS, and PAMELA A. DAVIS (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901913) Copyright

An overview is given of the ongoing joint NASA/FAA/Industry Surface Traction And Radial Tire (START) Program being conducted at NASA Langley's Aircraft Landing Dynamics Facility (ALDF). The START Program involves tests using three different tire sizes to evaluate tire rolling resistance, braking, and cornering performance throughout the aircraft ground operational speed range for both dry and wet runway surfaces. Preliminary results from recent 40 x 14 size bias-ply, radial-belted, and H-type aircraft tire tests are discussed. The paper concludes with a summary of the current program status and planned ALDF test schedule. Author

A91-48600
HIGH ENERGY RF DESIGN AND PROTECTION
CHRIS M. KENDALL (CKC Laboratories, Inc., Mariposa, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p.
(SAE PAPER 901916) Copyright

This paper addresses some of the more important design

techniques for complying with high-energy RF requirements for allowing new avionic systems to deal with nuisance interference. The threat posed to such systems by radiation in the microwave, HF, VHF, and UHF regimes is briefly reviewed, and the main design issues are outlined. Particular attention is given to the requirements concerning aircraft shielding, cable shield termination, and aircraft grounding. A number of design rules are proposed based on the discussion. C.D.

A91-48606
HSCT AERODYNAMIC TECHNOLOGY FOR ENHANCED ECONOMIC VIABILITY
H. R. WELGE and D. L. ANTANI (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p.
(SAE PAPER 901924) Copyright

This paper identifies relevant high-payoff technologies and their performance goals required to enhance economic viability of the high-speed civil transport (HSCT). The emphasis is on the aerodynamic technologies, but improvements in several other technology areas are also addressed. Primary design constraints are presented to bound the problem and establish a baseline for comparison. The economics of planar and nonplanar configurations and their projected advances are discussed. Different approaches for improvements in skin friction, wave drag, and induced drag are presented. It is concluded that performance enhancements achieved by developing and applying advanced aerodynamic technology will contribute significantly toward enhancing HSCT economic viability. However, improvements in other technology areas and manufacturing cost reductions are also needed.
Author

A91-48607* Boeing Commercial Airplane Co., Seattle, WA.
HIGH-SPEED CIVIL TRANSPORT RESEARCH AND TECHNOLOGY NEEDS
JOHN D. VACHAL (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(Contract NAS1-18377)
(SAE PAPER 901925) Copyright

Market projections made by studies conducted under NASA contract have indicated a need for fleets of High Speed Civil Transports (HSCTs) by the years 2000-2005, in which each HSCT would carry 250-300 passengers over ranges of 5000-6500 nmi. The most promising HSCT concepts cruise at Mach 2.0-2.5. Both technology-readiness and environmental impact problems are addressed, giving attention to high lift wing leading-edge devices, NO(x) emission reductions via combustor design innovations, and configuration optimization for low sonic boom generation. O.C.

A91-48642
THE APPLICATION OF ADVANCED COMPOSITE MATERIALS TO NACELLE STRUCTURES
MICHAEL J. CURRAN (Westland Aerospace, Ltd., East Cowes, England) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p. refs
(SAE PAPER 901980) Copyright

An account is given of the design, development, and manufacturing processes employed to obtain lightweight, high specific strength-and-stiffness advanced composite nacelles for the DASH 8 STOL turboprop commuter aircraft, the Do 328 turboprop, and the MD11 turbofan airliner. Nomex core/kevlar-reinforced face panel sandwich structures are often employed, in conjunction with woven graphite fiber-reinforced epoxy. Attention is given to composite layup procedures. O.C.

A91-48645
DESIGN CONSIDERATIONS OF MATERIAL AND PROCESS SELECTION FOR COMMERCIAL AIRCRAFT ENGINE NACELLES
CLINT LUTTGEHARM (Boeing Commercial Strut and Nacelle Responsibility Center, Wichita, KS) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990, 10 p.
(SAE PAPER 901983) Copyright

An evaluation is made of the development status of various materials and fabrication processes applicable to various elements of commercial aircraft engine nacelle structures. Attention is given to resin transfer-molded graphite/epoxy thrust reverser blocker doors and cascades for a turbofan engine nacelle, as well as to a composite torque box, a composite pressure diaphragm panel, molded plastic access panels and fairings, and molded plastic fittings. Design considerations bearing on structural integrity, environmental durability, weight, and cost, are discussed. O.C.

A91-48646
ADVANCED NACELLE STRUCTURES
BRIAN NORRIS and LARRY SULLIVAN (Rohr Industries, Inc., Chula Vista, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901984) Copyright

An account is given of the advantages associated with advanced metallic and composite materials' application to turbofan nacelle fabrication. A carbon fiber-reinforced PMR-15 polyimide resin matrix system has been used to fabricate an engine core cowl. Ti-alloy honeycomb sandwich structures are extensively employed as sound-suppression structures. Superplastic forming/diffusion-bonding of Ti alloys for nacelle applications has reached the stage of a mature, high production-volume technique. O.C.

A91-48656
HYDRAULIC POWER LOSS PREVENTION ON COMMERCIAL TRANSPORT AIRCRAFT - AVAILABLE TECHNOLOGY
JAMES G. DRAXLER (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. Research supported by Boeing Co.
(SAE PAPER 901997) Copyright

Preventing total loss of hydraulic system effectiveness in commercial aircraft requires an enhancement of damage tolerance through redundant systems, improved hydraulic line separation, and/or the use of shutoff devices. These courses are rendered more critical by the impracticality of reversion to manual controls in commercial aircraft of B 747 size. The separation of redundant systems is difficult to retrofit and should accordingly be designed into new aircraft. O.C.

A91-48660
DYNAMIC HYDRAULIC SYSTEM SIMULATION - AN INTEGRATED APPROACH
BRIAN J. BANG and JAMES G. DRAXLER (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. Research supported by Boeing Co.
(SAE PAPER 902003) Copyright

This paper describes a dynamic aircraft hydraulic system simulator model. This model uses a flexible approach that accounts for flight control loads, system stiffness, line losses, internal leakage at individual valve packages, pump compensator response, and power input to engine-driven pumps at various engine rpm. The model integrates performance of the flight controls, hydraulics, and power sources allowing accurate simulation of the airplane.
Author

A91-48661
A CONCURRENT DESIGN/ANALYSIS TOOL FOR AIRCRAFT HYDRAULIC SYSTEMS
R. I. SCOVILLE and M. J. MAXWELL (General Dynamics Corp., Fort Worth, TX) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 13 p. refs
(SAE PAPER 902004) Copyright

The present effort to develop design and analytical techniques for aircraft hydraulic systems has resulted in a design/analysis tool which integrates control-surface commands and loads from

Aircraft Dynamic Simulation Software with an enhanced version of the HYTRAN program. Control-surface commands and loads from an Aircraft Dynamic Simulator Software version of a selected maneuver were used as a dynamic input to HYTRAN to predict hydraulic system response throughout the maneuver. Predicted hydraulic pressures are in excellent agreement with flight test data. O.C.

A91-49061
FUZZY CLUSTERING ANALYSIS OF GAS TURBINE ENGINE MISSION PROFILES
DEJING CHENG (Chinese Flight Test Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 126-128. In Chinese.

In order to obtain engine mission profiles from a large number of flight tests, the fuzzy matrix of the membership function of engine mission profile samples is established according to the theory of fuzzy sets and boolean algebra behaviors. The fuzzy matrix is examined by using a square method for meeting the equivalent conditions. When it meets equivalent conditions, the dynamic clustering is carried out by selecting various threshold values. The clustering analysis of the mission profiles for an actual engine has been completed by a complicated and enormous fuzzy calculation based on statistical data of the engine loads measured in flight test. The clustering method of three parameters (flight altitude, Mach number, and angle of throttle lever) is first employed in the clustering analysis and the results obtained are satisfactory. Author

A91-49150
HONEYCOMB SANDWICH COMPOSITE STRUCTURES USED ON THE V-22 OSPREY FUSELAGE
ERIC J. SCHULZE and WILLIAM J. KESACK (Boeing Helicopters, Philadelphia, PA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 1051-1069. refs
Copyright

This paper reviews the application of honeycomb sandwich structure used on the V-22 Osprey aircraft. Primary emphasis is on the fuselage area. Structural details as well as material selection are presented for several areas where honey-comb structure is used. Design philosophies along with analysis techniques used to develop these structures are discussed. Finally, a brief introduction is given on the testing methods used for the validation of these structures. Author

A91-49180
RE-EVALUATION OF DYNAMIC LIFT GENERATION DUE TO GAS ENVELOPE ITSELF OF AIRSHIP
SHIGENORI ANDO and KYOKO NITTA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 449, 1991, p. 322-326. In Japanese. refs

In order to improve normal maneuverability of airship, hybridization is conceived in which a part of the gross weight is supported by dynamic lift. The simplest way is to utilize the dynamic lift of the gas envelope itself. It was previously suggested that excessive induced drag happens due to the low aspect ratio. This problem is investigated here, being compared with the case where an additional fixed wing is adopted. It is concluded that the use of the dynamic lift due to the gas envelope itself is not necessarily inefficient, because of no additional structural weight. Author

A91-49196
DEVELOPMENT OF A RELIABILITY TEST PROFILE FOR AN ECM POD BASED ON MEASURED FLIGHT CONDITIONS
ROBERT E. SCHMIDT (Raytheon Co., Goleta, CA) (Institute of Environmental Sciences, Annual Technical Meeting, 37th, San Diego, CA, May 1991) IES, Journal (ISSN 1052-2883), vol. 34, July-Aug. 1991, p. 17-25. refs
Copyright

A reliability test profile has been developed for the ALQ-184 ECM Pod. The profile represents operational mission conditions on the F-4, F-16, and A-10 aircraft and uses two independent thermal profiles, one for circuit card assemblies and one for coolanol to duplicate the temperature distribution and gradients within the pod. Hardpoint vibration and acoustic stimulation allow multiaxis vibration responses to be simulated. Each of the 16 vibroacoustic levels is characterized by a specific spectral response of the pod structure. C.D.

A91-49271
FIRE/EXPLOSION VULNERABILITY REDUCTION OF ADVANCED AIRCRAFT
LEVELLE MAHOOD (Northrop Corp., Aircraft Div., Hawthorne, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p. refs
(SAE PAPER 901953) Copyright

The integration of fire/explosion vulnerability reduction technology into the system engineering process to develop advanced military aircraft is outlined. Conceptual designs for critical regions within the aircraft illustrate the unique demands of combat applications. To prevent excessive attrition in both peacetime and combat, the reduction of the vulnerability of advanced military aircraft to on-board fires and explosions is mandatory. The proliferation of lethal combat threats, along with severe limitations in cost, weight, volume, supportability and other resources, heavily stresses the need for fire/explosion protection technology. V.I.

A91-49612#
A ROBUST TECHNIQUE FOR RECONSTRUCTING FLIGHT RECORDER DATA FOR HELICOPTER SIMULATION AND TRAINING
K. KRISHNAKUMAR (Alabama, University, Tuscaloosa), R. K. PRASANTH, and J. E. BAILEY IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 359-369. refs
(AIAA PAPER 91-2721) Copyright

The use of flight-recorder data for training purposes is presented with consideration given to the technology required for simulator-based flight reconstruction. The state-estimator flight-simulator driver involves a Kalman filter with parametric uncertainties modeled as multiplicative white noise processes. The nonlinear UH-60 helicopter simulation is compared to the traditional approach and found to improve performance because it is insensitive to helicopter-model parameter changes. C.C.S.

A91-49648*# Georgia Inst. of Tech., Atlanta.
NONDIMENSIONAL FORMS FOR SINGULAR PERTURBATION ANALYSES OF AIRCRAFT ENERGY CLIMBS
A. J. CALISE, N. MARKOPOULOS, and J. E. CORBAN (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 704-709. refs
(Contract NAG1-922)
(AIAA PAPER 91-2640) Copyright

This paper proposes a systematic approach for identifying the perturbation parameter in singular perturbation analysis of aircraft optimal guidance, and in particular considers a family of problems related to aircraft energy climbs. The approach, which is based on a nondimensionalization of the equations of motion, is used to evaluatae the appropriateness of forced singular perturbation formulations used in the past for transport and fighter aircraft, and to assess the applicability of energy state approximations and singular perturbation analysis for airbreathing transatmospheric vehicles with hypersonic cruise and orbital capabilities. Author

A91-49673*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RANGE OPTIMIZATION FOR A SUPERSONIC AIRCRAFT
HANS SEYWALD (NASA, Langley Research Center, Hampton, VA), EUGENE M. CLIFF (Virginia Polytechnic Institute and State University, Blacksburg), and KLAUS H. WELL (DLR, Wessling, Federal Republic of Germany) IN: AIAA Guidance, Navigation

and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 967-974. refs
(Contract NAG1-946; AF-AFOSR-89-0001; F49620-87-C-0116)
(AIAA PAPER 91-2712) Copyright

Range optimal trajectories for an aircraft flying in the vertical plane are obtained from Pontryagin's Minimum Principle. Control variables are load factor n which appears nonlinearly in the equations of motion and throttle setting eta, which appears only linearly. Both controls are subject to fixed bounds, namely eta between values of 0 and 1 and absolute value of n not greater than n(max). Additionally, a dynamic pressure limit is imposed, which represents a first-order state-inequality constraint. For fixed flight time, fixed initial coordinates, and partially fixed final coordinates, the effect of the load factor limit absolute value of n not greater than n(max) is studied. Upon varying n(max), six different switching structures are obtained. All trajectories involve singular control along arcs with active dynamic pressure limit.
Author

A91-49674#
OPTIMAL ENERGY-HEADING TRANSIENTS FOR AN AIRBREATHING HYPERSONIC VEHICLE
MEGAERA C. HALTER and EUGENE M. CLIFF (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 975-983. refs
(Contract F49620-87-C-0016; AF-AFOSR-89-0001)
(AIAA PAPER 91-2713) Copyright

A time-range-fuel optimization problem is formulated for an airbreathing, hypersonic vehicle. Singular perturbation theory is used to decompose the problem into simpler subproblems. Analysis of the cruise-dash problem shows the vehicle has four interesting cruise points. Energy-heading transients are studied and a family of trajectories, fairing asymptotically to a cruise condition, are generated. The character of these transients is discussed.
Author

A91-49779#
AN AIRCRAFT MODEL FOR THE AIAA CONTROLS DESIGN CHALLENGE
RANDAL W. BRUMBAUGH (PRC, Inc., Edwards, CA) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 17 p. refs
(AIAA PAPER 91-2631)

This paper describes a generic, state-of-the-art, high-performance aircraft model, including detailed, full-envelope, nonlinear aerodynamics, and full-envelope thrust and first-order engine response data. While this model was primarily developed for the AIAA Controls Design Challenge, the availability of such a model provides a common focus for research in aeronautical control theory and methodology. This paper also describes an implementation of this model using the FORTRAN computer language, associated routines furnished with the aircraft model, and techniques for interfacing these routines to external procedures. Figures showing vehicle geometry, surfaces, and sign conventions are included.
Author

A91-49817#
DIVA/MIMO FLIGHT TEST DATA ANALYSIS FOR THE X-31A DEMONSTRATOR
G. WULFF and M. ZOELLNER (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) AIAA, Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 7 p. refs
(AIAA PAPER 91-2852) Copyright

For a preliminary data analysis between successive flight tests of the X-31A demonstrator, a mobile workstation was set up. Flight mechanics software packages were installed, including DIVA for interactive data analysis and NLHP1L for the maximum-likelihood parameter estimation. DIVA enables the flight test engineer to analyze data in the time domain as well as in the frequency domain. Several aircraft handling qualities criteria are implemented. With this software, single input/single output problems can be solved, including low-order approaches of high-order systems. The results can be compared with simulation results derived from systems of differential equations, which are generated by DIVA. Afterward, the flight test data were transferred to a main-frame computer, especially for the time-consuming determination of the multiple input/multiple output (MIMO) transfer functions of the correlated control signals and aircraft responses. The paper presents some data analysis results from the first flights of the X-31A Demonstrator computed with DIVA and MIMO software.
Author

A91-49989#
INSTRUMENT AIRCRAFT FLIGHT TEST - A SIMULATOR MANUFACTURER'S EXPERIENCE
J. SHLIEN (CAE Electronics, Ltd., Ville Saint Laurent, Canada) AIAA, Flight Simulation Technologies Conference, New Orleans, LA, Aug. 12-14, 1991. 8 p.
(AIAA PAPER 91-2931) Copyright

CAE's activities as well as lessons learned from the application of the International Air Transport Association document to several instrumented aircraft flight test programs are discussed. It is concluded that simulator manufacturers play an effective role in the definition of the flight test program and the subsequent development of the simulation data. It is considered to be essential to establish provisions to record specific data for supporting simulator data requirements at the earliest possible stages of prototype aircraft flight testing.
O.G.

A91-49990#
THE VALUE OF HARDWARE IN THE LOOP SIMULATION FOR FLIGHT CRITICAL SYSTEMS
DAVID S. TEDESCHI and JON P. CLAUSS (General Dynamics Corp., Fort Worth, TX) AIAA, Flight Simulation Technologies Conference, New Orleans, LA, Aug. 12-14, 1991. 7 p.
(AIAA PAPER 91-2957) Copyright

This paper addresses the benefits gained in the development of the updated versions of the F-16 aircraft. The benefits in the area of control law analysis, aircraft handling qualities, system engineering, pilot-vehicle interface, and customer confidence are discussed. Each step of the design process, from the early stages of system design to the flight test of the system are described. And the impact of simulation evaluation on the final system is examined.
Author

A91-51248
IMPROVEMENT THROUGH SIMPLIFICATION - THE BO 108'S BEARINGLESS MAIN ROTOR IS A BREAKTHROUGH IN INTEGRATED DESIGN
New-Tech News (ISSN 0935-2694), no. 2, 1991, p. 20-23.
Copyright

The bearingless main rotor (BMR) system first developed for the BO 105 helicopter has undergone further refinements, involving design simplifications and more advanced materials, prior to incorporation by the BO 108 lightweight helicopter. The key element of the BMR is the complex blade neck between the rigid blade joint at the rotor hub and the blade airfoil: whose torsional flexibility is obtained through the use of a cruciform cross-section, with the fibers aligned in the longitudinal direction. A thin, torsionally rigid torque tube is fitted over this torsionally soft beam and secured at the starting edge of the blade's airfoil section.
O.C.

A91-51398
VECTOR VICTOR
GUY NORRIS and GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 140, Aug. 28, 1991, p. 23-27.
Copyright

A review is presented of the F-15 STOL/MTD modified test aircraft used in evaluating 2D thrust-vectoring/reversing nozzles to demonstrate the ability to land and take off from sections of wet, bomb-damaged runway at night and in bad weather, in crosswinds up to 30 kt without ground navigation aids. The

integrated flight and propulsion control links the aircraft flight control computers with the digital electronic engine controls and special nozzle controllers. The aircraft has all-moving foreplanes that work with the nozzles to improve roll, pitch, and deceleration rates. During the tests no ground-based navigation aids were utilized and nothing was done to augment the runway's visibility on IR or radar. R.E.P.

A91-51422
NASA 'FLIES' F/A-18 IN AMES' LARGEST WIND TUNNEL
BRECK W. HENDERSON Aviation Week and Space Technology (ISSN 0005-2175), vol. 135, July 29, 1991, p. 38-40.
Copyright

NASA's high angle of attack research (AOA) program is described, where a complete F/A-18 has been mounted in the Ames Research Center wind tunnel. This full-scale wind tunnel work is helping researchers verify the accuracy of CFD calculations, compare subscale and full-scale data, and prepare for the final phase of this research program. In the final phase, NASA will test two concepts for exerting yaw control forces at the nose of the aircraft. Leading edge flaps, which are programmed to be completely deflected above 25-deg AOA in the F/A-18 flight control program, will be correctly positioned, and the horizontal tail will likewise be set in the correct trim position. CFD techniques are employed to calculate the vortex structures and surface flow patterns during flight at high AOA. R.E.P.

A91-51672
S/MTD DEMONSTRATES INFLIGHT REVERSING, 1,500 FT. FULL REVERSE LANDINGS
WILLIAM B. SCOTT Aviation Week and Space Technology (ISSN 0005-2175), vol. 135, Sept. 16, 1991, p. 54-57.
Copyright

The F-15 STOL/Maneuver Technology Demonstrator has shown that modern fighters can take off and land on an undamaged 1,500 ft section of a bomb-cratered runway if the aircraft are modified with integrated flight and propulsion control systems. The aircraft demonstrated that taking off and landing with a 30 kt crosswind within a 50 by 1,500 ft strip at night is technically feasible. Driven by high-speed actuators and a modified 3,000 psi hydraulic system, the canards can either traverse their full range of motion in a fraction of a second, or can be positioned incrementally for handling studies. With a computer integrating the thrust/pitch axes, pitch and airspeed response are decoupled, with the pitch and flight path response having minimal changes in airspeed. R.E.P.

A91-51911
THE PHOTOELASTIC DIET - WEIGHT AND STRESS REDUCTION EXPERIENCES ON THE A330/340 AIRBUS PROJECT
E. W. O'BRIEN (British Aerospace, PLC, London, England) IN: 1990 SEM Spring Conference on Experimental Mechanics, Albuquerque, NM, June 4-6, 1990, Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1990, p. 110-116.
Copyright

An approach which employs 'better-than-average stress models' is developed to improve the design of lightweight structures for civil aircraft. Solid linear-elastic epoxy-resin models are made for the components under consideration, the models are coated for photoelastic reflection analysis, and are checked with strain gaging. Weight and stress reductions can be identified by means of the linear-elastic epoxy photoelastic-stress model when combined with other design methodologies. C.C.S.

A91-52219
A COMPUTER SIMULATION FOR A HELICOPTER CARRYING AN EXTERNALLY SUSPENDED LOAD
CHARLES HAN (Electric Power Construction Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B295-B299. In Chinese. refs

A digital computer program developed for studying a single-rotor helicopter with an externally suspended load is described. Special attention is given to the motion equations of a helicopter with external loads and the calculations of all parameters of these equations, the desired mission trace equations and load equations, the principle of calculating the attitudes and control inputs, and the integration-of-motion equations when the helicopter flies according to the desired mission track. The computed errors of the program are less than 0.01 percent. I.S.

A91-52249
AIRCRAFT TIRES - BIAS OR RADIALS?
Aerospace Engineering (ISSN 0736-2536), vol. 11, Sept. 1991, p. 13, 14.
Copyright

A review is presented of the increased utilization of radial tires on commercial and military aircraft and the factors considered in their application. Standards are established to provide common guidelines for the design of interchangeable radial tires mixable with their bias equivalents. Mixability is possible if the mix of radial tires with bias tires does not generate more uneven loading than is presently encountered when intermixing bias tires only. Attention is given to average carcass life, which includes tread life, multiple retreading, and rejection rate. Operational experience indicates that, everything considered, radial tires are more reliable than bias tires. R.E.P.

A91-52278
CONTROL CONFIGURATION OF A RELAXED STABILITY AIRSHIP
B. L. NAGABHUSHAN (Saint Louis University, Cahokia, IL) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 558-563. Research supported by Saint Louis University and Goodyear Aerospace Corp. Previously cited in issue 07, p. 918, Accession no. A90-20585. refs
Copyright

A91-52500
C-17 MAKES FIRST FLIGHT, BUT MORE COST HURDLES LIE AHEAD
BRUCE A. SMITH and WILLIAM B. SCOTT Aviation Week and Space Technology (ISSN 0005-2175), vol. 135, Sept. 23, 1991, p. 18-24.
Copyright

A status report is presented of the C-17 program following the successful first flight of the T-1 aircraft on Sept. 15, 1991. The T-1 was carrying about 20,000 lb of palletized concrete blocks in the cargo area to maintain a forward center of gravity. The first production aircraft (P-1) will serve as the flight loads aircraft in the test program, while P-2 is designated for avionics testing, P-3 will undergo climatic testing and some electromechanical evaluations, and P-4 will be utilized for cargo loading evaluations. USAF loadmasters are preparing cargo pallets and parachute extraction systems for the C-17 development program that will enable an unprecedented level of control over specialized test loads. Air delivery platform equipment is designed in such a way that extraction parachutes pull loads from the aircraft's aft cargo ramp, then transfer forces to the main cargo parachutes. R.E.P.

A91-52833
DESIGN EVOLUTION IN JET TRANSPORT
THOMAS DERBYSHIRE, WILLIAM JENKINSON, and DOUGLAS MILLER (Boeing Commercial Airplanes, Seattle, WA) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 44-46.
Copyright

A review is presented of the rapid advances made in jet transport design and development from the late 1940's through the early 1970's and the stagnation in new design concepts since then. Many factors are cited for the demise in any innovative design of new commercial transports including the abandonment of the SST, concentration on missile and space programs, jet fuel cost increases requiring greater attention to low fuel consumption, early retirement of aircraft due to new stringent environmental regulations, and development of new materials serving to improve

current designs. Consideration is given to the advanced design concepts that may be more easily conceived through the advent of computer design as illustrated by the B-2 and B-777. R.E.P.

A91-52835* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
V/STOL GETS A LIFT
TOM BIESIADNY (NASA, Lewis Research Center, Cleveland, OH) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 52-55.
Copyright

The concept of a supersonic STOVL that could offer enhanced mission capability, survivability, operational flexibility, and utility over conventional aircraft is presented. Emphasis is currently on design studies, CFD work, small- and large-scale wind tunnel tests, simulation activities, flight experiments, and ground environment experiments. Propulsion system technology centers about the adaptation of existing or off-the-shelf engines. Concepts under study include separate flow in hover, gas-driven lift fan, and shaft-driven lift fan. NASA is examining generic valve and ducting configurations with airflow at ambient temperature and at temperatures up to 1000 F to gather pressure loss and heat transfer data. Advanced civil rotorcraft technologies examined include high-efficiency/dual-mode components such as torque converters; lightweight, quiet transmissions; and variable geometry power turbines; along with dual-function or convertible engines. R.E.P.

A91-52937
DEVELOPMENT AND CERTIFICATION FLIGHT TEST ON THE PIAGGIO P.180 AVANTI AIRCRAFT - A GENERAL OVERVIEW
ROBERTO DE'POMPEIS, PAOLO CINQUETTI, and SERGIO MARTINI (Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa, Italy) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 14 p. refs
(SAE PAPER 911003) Copyright

An account is given of the developmental and certification flight test regimen employed for the Avanti twin-turboprop aircraft, which had to give attention to the performance characteristics of such unique features of the configuration as three lifting surfaces, pusher propellers, and aft main wing. Intensive testing was conducted on high-alpha stability and control, icing, behavior on wet runways, longitudinal control, and extent of natural laminar flow over wings. More than 2000 flight hours were required to obtain Italian and U.S. certification. O.C.

A91-52939* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IN-FLIGHT OFF-SURFACE FLOW VISUALIZATION USING INFRARED IMAGING
GREGORY S. MANUEL, KAMRAN DARYABEIGI, DAVID W. ALDERFER, and CLIFFORD J. OBARA (NASA, Langley Research Center, Hampton, VA) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 11 p. refs
(SAE PAPER 911006) Copyright

A light test investigation was conducted to evaluate an infrared (IR) imaging technique to visualize off-surface flow phenomena. A single-engine, general-aviation airplane was equipped with an IR imaging system that viewed the region around the left wingtip. Vortical flow at the wingtip was seeded with surfur hexafluoride, a gas with strong infrared absorbing and emitting characteristics. Different terrain and sky backgrounds were evaluated for their effect on IR images of vortical flow. The best IR images were obtained with a clear background. The results of the investigation indicate that IR flow visualization compliments existing smoke generator methods for off-surface flow visualization. Author

A91-52944
COMPOSITE PROTOTYPE AIRCRAFT DEVELOPMENT - A METHOD FOR DESIGN, FABRICATION AND TEST TRAINING
GEORGE BENNETT, JOHN C. MCWHORTER, GLENN BRYANT, HAROLD KOELLING, and GIFFORD BULL (Mississippi State University, Mississippi) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 23 p. refs
(SAE PAPER 911015) Copyright

A turbine engine-powered, high-altitude pressurized cabin, single-engine aircraft has been prototyped by means of extensive use of composites in the modification of the Beechcraft A-36 design. The A-36 structure was replaced in three steps of increasing complexity, respectively involving the empennage, the wings, and finally the fuselage. The sandwich structures employed in the new structures were fabricated via 250 F vacuum-bag cures. The new, higher aspect ratio wing led to a striking reduction in stall speed. O.C.

A91-52949* Kansas Univ., Lawrence.
DESIGN DEVELOPMENTS FOR ADVANCED GENERAL AVIATION AIRCRAFT
JAN ROSKAM and CHARLES GOMER (Kansas, University, Lawrence) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 17 p. Research supported by University of Kansas, NASA, and Universities Space Research Association. refs
(SAE PAPER 911022) Copyright

Design study results are presented for two advanced general-aviation aircraft incorporating fly-by-light/fly-by-wire controls and digital avionics and cockpit displays. The design exercise proceeded from a database of information derived from a market survey for the 4-10 passenger aircraft range. Pusher and tractor propeller configurations were treated, and attention was given to the maximization of passenger comfort. 'Outside-in' tooling methods were assumed for the primary structures of both configurations, in order to achieve surface tolerances which maximize the rearward extent of laminar flow. O.C.

A91-52951
AERODYNAMIC IMPACT OF DEICING/ANTI-ICING FLUIDS ON COMMUTER AIRCRAFT
EDWARD LIM, NORMAN D. ELLIS, PIERS J. TEELING, and SHANGXIANG ZHU (Boeing Canada, De Havilland Div., Downsview) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 14 p. refs
(SAE PAPER 911026) Copyright

A wind tunnel test simulating takeoffs of a typical commuter aircraft was conducted at NASA LeRC IRT to understand the aerodynamic impact of the ground deicing/anti-icing fluids on an aircraft. It was found that the magnitude of degradation in the maximum lift and climb gradient at climb out for the wing/flap model appears to differ for each fluid, rotation speed and time to rotation, range of temperature and fluid dilution. The effect of increasing the time to rotation constitutes the most significant finding. Tests indicated that a type II deicing/anti-icing fluid, for a rotation time of 15 seconds, had no significant clearing of the fluid from the wing/flap model, resulting in a large aerodynamic penalty which is considered unacceptable. Exposed to a 30 second rotation time, the same fluid showed a significant improvement, and even with the lower rotation speed, most of the degradation caused by the reduction of the rotation speed was gained back. This test also shows that deicing/anti-icing fluid has a more significant impact on the commuter-type of aircraft operating at a shorter time to rotation and lower rotation speed than the jet aircraft. V.I.

A91-52955
AEROSPACE INFORMATION REPORT AIR 1869 - WIDE-BODY AND STANDARD-BODY AIRCRAFT LOWER LOBE CARGO COMPARTMENT ULD CAPACITIES
SAE Aerospace Information Report, AIR 1869, Oct. 1984, 79 p.
(SAE AIR 1869) Copyright

The lower-lobe cargo storage capacities of standard- and wide-body commercial aircraft are presented. The information encompasses container and pallet configurations, maximum usable container, pallet and bulk compartment volumes, tare weights, and cargo sizes for the lower lobe of various wide-body aircraft. Bulk

compartment volumes are included for standard-body aircraft. The aircraft in question are the A300, A310, B-747, B-767, L-1011, and DC-10. O.C.

N91-29165# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
REVIEW OF CANADIAN AERONAUTICAL FATIGUE WORK: 1987-1989
D. L. SIMPSON 15 May 1989 50 p Presented at the 21st Conference of the International Committee on Aeronautical Fatigue
(NAE-LTR-ST-1706; CTN-91-60024) Copyright Avail: NTIS HC/MF A03

A review is provided of Canadian work associated with fatigue of aeronautical structures during the period 1987 to 1988. Brief descriptions of each research project are provided, including the main results to date and future research plans. All aspects of structural technology are covered including full scale tests, loads monitoring, fracture mechanics, composite materials, and engine fatigue. The review covers work being performed by Canadian industry, universities, and governmental agencies involved in aeronautical fatigue studies. CISTI

N91-29166# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
A FULL FUNCTION CHECKOUT TEST FOR THE NAE FULL SCALE STRUCTURAL TEST CONTROL AND DATA ACQUISITION SYSTEM
R. L. HEWITT and B. E. SHAVER Feb. 1989 70 p Sponsored by Department of National Defense
(NAE-LTR-ST-1696; CTN-91-60029) Copyright Avail: NTIS HC/MF A04

A test of a control and data acquisition system for full scale aircraft structural fatigue testing is described. The test attempted to duplicate all the conditions that would be encountered in a full scale test of an aircraft structure by using a large structure with 4 controlled actuators and 6 additional channels of data acquisition. The test rig consisted of two aluminum beams attached at right angles loosely simulating an aircraft fuselage and wings. The aircraft was suspended from the wing tips and was also pivoted about the nose. It was loaded with four actuators, located at the tail, the center of the fuselage and at each wingtip. The wing actuators could apply only tension while the other could apply both tension and compression. Five different types of loads were considered corresponding to the maximum bending moments in the wing or fuselage, maximum shears in the fuselage, and maximum up and down tail loads. System fault simulations included hydraulic failure or loss of power to the pumps; total power failure; servo-valve failure, loss of computer or loss of loadcell; structural failure; and loss of strain gauge channel. A number of problems were encountered and solved. Some critical problems became apparent only after extensive testing. It was concluded that checkout tests were very useful and should be continued as long as is feasible. With suitable system changes all options expected to be used in a full scale fatigue test worked successfully. CISTI

N91-29167# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
TUTOR AFT FUSELAGE AND EMPENNAGE FULL-SCALE TEST: PROCEDURES FOR CREATING A DAMAGE LOG
B. SHAVER Feb. 1990 10 p Sponsored by Department of National Defence
(NAE-ST-576; CTN-91-60061) Copyright Avail: NTIS HC/MF A02

Full scale fatigue tests are being performed on the aft fuselage and empennage of a Canadian Forces CT-114 Tutor aircraft as part of a technology development program. Several logbooks are to be maintained during the test, including a damage logbook, whose purpose is to provide comprehensive, accurate information on the effects of the test on the specimen. The specific procedures for damage reporting, recording, and presentation of information during this test are described. A typical damage log entry is included for illustration. CISTI

N91-29168# National Aeronautical Establishment, Ottawa (Ontario). Unsteady Aerodynamics Lab.
A NEW LOOK AT THE TOBAK-SCHIFF MODEL OF NONPLANAR AIRCRAFT DYNAMICS
M. E. BEYERS Dec. 1989 38 p
(NAE-LTR-UA-101; CTN-91-60082) Copyright Avail: NTIS HC/MF A03

Tobak and Schiff have developed an elegant model of nonlinear aerodynamic phenomena observed on aircraft at high angles of attack. The fundamental premise underlying this model is that the total aerodynamic reactions experienced by the aircraft in flight may be synthesized from the individual reactions to a small number of elementary characteristic motions. The underlying assumptions were that the aerodynamic reactions to a steady motion are themselves steady and single valued functions of the attitude of the aircraft. These assumptions are analyzed. The formulations restricted to linear dependence on the motion rates are derived in detail. Analysis of the kinematical relationships shows that the body axes formulations are expressed exactly in terms of the measured fixed axis derivatives. A formulation of the restricted nonplanar model in body axes is derived explicitly in terms of the aerodynamic angles. An interpretation is given of the identity linking the formulations in the aerodynamic and body axes systems. The derivation of the restricted nonplanar model was verified independently by comparing formulations in two systems of notation. The formulations in the aerodynamic and body axes systems, as well as the identity linking the formulations in the two systems, express the oscillatory derivative terms exactly in the form of measured fixed axis derivatives. The body axes formulation can be expressed in terms of conventional angles of attack and sideslip and the freestream velocity. The identity may be viewed as an equality between an effective rotary parameter and a resultant, planar damping parameter. CISTI

N91-29170 Georgia Inst. of Tech., Atlanta.
UNSTEADY COMPRESSIBLE LIFTING SURFACE ANALYSIS FOR ROTARY WINGS USING VELOCITY POTENTIAL MODES Ph.D. Thesis
VASUDEVAN MUNDAKIZHI KALADI 1990 136 p
Avail: Univ. Microfilms Order No. DA9115382

The compressible, unsteady lifting surface problem of a helicopter blade in hover using the velocity potential formulation is solved using a modal expansion technique. The mathematical formulation of the problem is presented and a panel method which has previously been applied to its solution is described. The model approach is offered as an alternate solution method.
Dissert. Abstr.

N91-29171# Wright Research Development Center, Wright-Patterson AFB, OH.
AIRCRAFT OPERATIONS FROM RUNWAYS WITH INCLINED RAMPS (SKI-JUMP)
ELIJAH W. TURNER May 1991 19 p
(Contract AF PROJ. 2401)
(AD-A237265; WRDC-TM-90-337-FIBE) Avail: NTIS HC/MF A03 CSCL 01/5

The use of inclined ramps to launch aircraft from short runways is proposed as a possible solution to the runway denial problem in Europe. Past efforts to launch aircraft in this manner, including a very successful program conducted by the U.S. Navy to launch the T-2C, F-14, and F-18 aircraft, are reviewed. An analytical study was conducted for the launch of the F-16, F-15, A-10, A-7D and F-4E from inclined ramps. The takeoff ground roll, stabilizer trim setting, landing gear loads and flight trajectory are reported. The F-15 was selected as a candidate aircraft for a USAF flight test program to be patterned after the Navy program and additional studies were performed. Perturbations in center of gravity, thrust, and ramp exit angle were investigated. A ramp contour was designed for launch of the F-15, F-16, A-7D and A-10 which minimized the length and height of the ramp while maintaining the landing gear loads below 90 percent of their design limit.
GRA

N91-29173# Naval Postgraduate School, Monterey, CA.
THE DESIGN AND CONSTRUCTION OF A SHIPLAUNCHED VTOL UNMANNED AIR VEHICLE M.S. Thesis
BRYAN M. BLANCHETTE Jun. 1990 103 p
(AD-A238053) Avail: NTIS HC/MF A06 CSCL 01/3

A Vertical Takeoff and Landing (VTOL) Unmanned Air Vehicle (UAV) was designed to serve as a shiplaunched reconnaissance and over the horizon targeting aircraft. Modeled after the U.S. Army's Aquila, the aircraft features a unique tilting ducted fan propulsion unit. The duct contains the engine, propeller, and control vanes used to provide the VTOL capability and is designed to be rotated as a unit for transition into horizontal flight. The duct also provides a measure of shipboard safety by eliminating the potential propeller blade and other hazards associated with the launch and recovery cycle currently experienced by topside personnel. The advantage of using tilting ducted fan technology is that it allows the vehicle to operate off any ship and to have the dash speed to arrive on station in a timely manner. A 1/2 scale model was built using composite wet lay-up techniques as a technology demonstrator and flight test vehicle. The engine system was tested but failed to produce enough static thrust for vertical takeoff. Research is continuing in the development of a propeller that will provide the necessary thrust. GRA

N91-29174# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AGILITY: PRESENTATION AND FLIGHT TEST METHODS FOR THE OPERATIONAL FIGHTER PILOT M.S. Thesis
WILLIAM R. LANGDON Mar. 1991 114 p
(AD-A238456; AFIT/GAE/ENY/91M-2) Avail: NTIS HC/MF A06 CSCL 01/1

This thesis develops both metrics and flight test techniques to measure agility. During development of both the agility metrics and the flight test techniques, previous work conducted by the agility community and the Flight Test Center at Edwards Air Force Base was used as a lessons learned tool to insure favorable results. Both simulator and flight testing was performed to validate the flight test techniques. During simulator testing several problems with the original flight test techniques were noted. Flight testing on the pitch agility flight test technique solved most of its problems but problems found during roll testing in the simulator were not flight tested. Flight testing was limited to pitch agility testing only due to time and resource constraints. Results from the flight test were impressive showing a significant advantage using post-stall agility in the A-37B aircraft. Up to 40 deg of heading change was obtained in approximately one second. This turn rate exceeds all maximum instantaneous turn rates for current front line fighters. These results were analytically applied to 180 deg turn maneuvers and resulted in up to a 20 percent time savings from conventional turn methods. This will ultimately allow the fighter pilot to make an educated decision which flight condition is best to defeat a threat. GRA

N91-29175# Rensselaer Polytechnic Inst., Troy, NY. Dept. Engineering and Mechanics.
RESPONSE AND STABILITY ANALYSIS OF HELICOPTER ROTOR BLADES USING COMPUTERIZED SYMBOLIC MANIPULATION Final Report, 20 Sep. 1987 - 19 Mar. 1991
MARCELO R. CRESPODASILVA May 1991 9 p
(Contract DAAL03-87-K-0116)
(AD-A238660; ARO-24456.5-EG) Avail: NTIS HC/MF A02 CSCL 20/4

The importance of nonlinearities, and of certain approximations, in the analysis of beams and rotor blades has been addressed in detail. For this, special care was taken in formulating the differential equations of motion of rotor blades in order to be able to identify sources of problematic approximations. In addition, the response of a rotor blade was analyzed by a methodology using an essentially exact solution for the equilibrium state of the blade and by subsequently determining the essentially exact eigenfunctions and eigenvalues associated with the perturbed motion of the blade. The results obtained could serve as a gauge for validating approximate results such as those obtained by a Galerkin procedure. A perturbation methodology was also used to analyze the response of a blade that is either in hover or in forward flight. GRA

N91-29176*# Research Triangle Inst., Research Triangle Park, NC. Center for Digital Systems Research.
ASSESSMENT TEAM REPORT ON FLIGHT-CRITICAL SYSTEMS RESEARCH AT NASA LANGLEY RESEARCH CENTER
DANIEL P. SIEWIOREK, comp. and JANET R. DUNHAM, comp. Aug. 1989 71 p
(Contract NAS1-17964)
(NASA-CR-181850; NAS 1.26:181850) Avail: NTIS HC/MF A04 CSCL 01/3

The quality, coverage, and distribution of effort of the flight-critical systems research program at NASA Langley Research Center was assessed. Within the scope of the Assessment Team's review, the research program was found to be very sound. All tasks under the current research program were at least partially addressing the industry needs. General recommendations made were to expand the program resources to provide additional coverage of high priority industry needs, including operations and maintenance, and to focus the program on an actual hardware and software system that is under development. Author

N91-29177*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PRELIMINARY FLIGHT-DETERMINED SUBSONIC LIFT AND DRAG CHARACTERISTICS OF THE X-29A FORWARD-SWEPT-WING AIRPLANE
JOHN W. HICKS and THOMAS HUCKABINE Aug. 1989 43 p
(NASA-TM-100409; H-1431; NAS 1.15:100409) Avail: NTIS HC/MF A03 CSCL 01/3

The X-29A subsonic lift and drag characteristics determined, met, or exceeded predictions, particularly with respect to the drag polar shapes. Induced drag levels were as great as 20 percent less than wind tunnel estimates, particularly at coefficients of lift above 0.8. Drag polar shape comparisons with other modern fighter aircraft showed the X-29A to have a better overall aircraft aerodynamic Oswald efficiency factor for the same aspect ratio. Two significant problems arose in the data reduction and analysis process. These included uncertainties in angle of attack upwash calibration and effects of maneuver dynamics on drag levels. The latter problem resulted from significantly improper control surface automatic camber control scheduling. Supersonic drag polar results were not obtained during this phase because of a lack of engine instrumentation to measure afterburner fuel flow. Author

N91-30124# Systems Control Technology, Inc., Arlington, VA.
ROTORCRAFT USE IN DISASTER RELIEF AND MASS CASUALTY INCIDENTS: CASE STUDIES Final Report
SANDRA HENNINGER, JACK THOMPSON, and ROBERT NEWMAN Jun. 1990 122 p
(Contract DTFA01-87-C-00014)
(AD-A229569) Avail: NTIS HC/MF A06 CSCL 01/3

The primary purposes of this report are to document helicopter involvement in disaster relief efforts and to bring about an understanding of the general nature of such helicopter operations. A representative series of 18 case histories detailing disaster situations (i.e., airliner crashes, high rise fires, natural disasters, etc.) where helicopters have been involved in rescue and relief operations are studied in a case history format. Each case addresses to the greatest extent possible the circumstances of the disaster, the extent of rescue and relief efforts, the nature and extent of relief planning done prior to the incident in question, the nature of actual rotorcraft involvement, the number of people endangered in the situation, the number of people assisted through the application of rotorcraft, the success or non-success of the rotorcraft participation, analysis of the rotorcraft application, the types of landing areas used, and documentation of lessons learned and post-situation analyses. In the 18 case studies presented, rotorcraft transported approximately 3,357 people and contributed to the saving of approximately 187 lives. GRA

N91-30125*# Oklahoma Univ., Norman. School of Aerospace and Mechanical Engineering.
AN INTEGRATED AERODYNAMIC/PROPULSION STUDY FOR GENERIC AERO-SPACE PLANES BASED ON WAVERIDER CONCEPTS Final Report
G. EMANUEL and M. L. RASMUSSEN Aug. 1991 26 p
(Contract NAG1-886)
(NASA-CR-188691; NAS 1.26:188691) Avail: NTIS HC/MF A03 CSCL 01/3

Research efforts related to the development of a unified aerospace plane analysis based on waverider technology are summarized. Viscous effects on the forebodies of cone-derived waverider configurations were studied. A simple means for determining the average skin friction coefficient of laminar boundary layers was established. This was incorporated into a computer program that provides lift and drag coefficients and lift/drag ratio for on-design waveriders when the temperature and Reynolds number based on length are specified. An effort was made to carry out parabolized Navier-Stokes (PNS) calculations for cone-derived waveriders. When the viscous terms were turned off (in the Euler mode) computations for elliptic cone-derived waveriders could be carried out for a wide range of on-design and off-design situations. Work related to waveriders derived from power law shocks is described in some detail. M.G.

N91-30127# National Aeronautical Lab., Bangalore (India).
PROPOSED MODIFICATIONS. IMPROVEMENTS TO THE DRAFT SPECIFICATIONS OF DGCA, NEW DELHI, ON REQUIREMENTS FOR AIRWORTHINESS CERTIFICATION OF EXPERIMENTAL AIRCRAFT
R. B. DAMANIA and P. T. VARUTE Mar. 1991 32 p
(NAL-PD-FE-9101) Avail: NTIS HC/MF A03

Changes and modifications suggested by the authors to the original draft of the DRD, DGCA, New Delhi, on Requirements for Airworthiness Certification of Experimental Aircraft are documented. Topics covered include aircraft design and construction, security clearance, general operation and flight rules, inspections, recommended safety precautions, a recommendation for logging flight data, the issuance of the unrestricted special airworthiness certificate, and additional requirements for rotorcraft, gliders, and sailplanes. Author

N91-30128*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
THE ROLE OF THE REMOTELY AUGMENTED VEHICLE (RAV) LABORATORY IN FLIGHT RESEARCH
DOROTHEA COHEN and JEANETTE H. LE Sep. 1991 16 p Presented at the AIAA Flight Simulation Technologies Conference and Exhibit, New Orleans, LA, 12-14 Aug. 1991
(NASA-TM-104235; H-1728; NAS 1.15:104235) Avail: NTIS HC/MF A03 CSCL 01/3

An overview is presented of the unique capabilities and historical significance of the Remotely Augmented Vehicle (RAV) Lab at NASA-Dryden. The role is reviewed of the RAV Lab in enhancing flight test programs and efficient testing of new aircraft control laws. The history of the RAV Lab is discussed with a sample of its application using the X-29 aircraft. The RAV Lab allows for closed or open loop augmentation of the research aircraft while in flight using ground based, high performance real time computers. Telemetry systems transfer sensor and control data between the ground and the aircraft. The RAV capability provides for enhanced computational power, improved flight data quality, and alternate methods for the testing of control system concepts. The Lab is easily reconfigured to reflect changes within a flight program and can be adapted to new flight programs. Author

N91-30129 California Univ., Los Angeles.
NONLINEAR COUPLED ROTOR-FUSELAGE VIBRATION ANALYSIS AND HIGHER HARMONIC CONTROL STUDIES FOR VIBRATION REDUCTION IN HELICOPTERS Ph.D. Thesis
IOANIS PAPAVASSILIOU 1991 313 p
Avail: Univ. Microfilms Order No. DA9115438

A fundamental study of vibration prediction and vibration reduction in helicopters using active controls is performed. The nonlinear equations of motion for a coupled rotor/flexible fuselage system were derived using computer algebra on a special purpose symbolic computing facility. The details of the derivation using the symbolic manipulation program MACSYMA are described. The analysis is carried out for two different rotor-fuselage configurations, namely one which has an offset hinged spring restrained rigid blade model and another with fully elastic blades. The trim state and vibratory response of the helicopter are obtained in a single pass by applying the harmonic balance technique for all rotor and fuselage degrees of freedom. The influence of the fuselage flexibility on the vibratory response is studied. Open loop higher harmonic control (HHC) studies are performed to determine the optimal HHC inputs necessary to minimize either the vibratory hub shears or accelerations at various fuselage locations. It is shown that when the fuselage is modelled as a flexible body, conventional single frequency HHC is capable of reducing either the hub loads or on the fuselage accelerations but not both simultaneously. It is demonstrated that for simultaneous reduction of hub shears and fuselage accelerations a new scheme called multiple higher harmonic control (MHHC) is required. The fundamental aspects of this scheme are described in detail. A physical explanation of the MHHC control inputs for simultaneous reduction of hub shears and fuselage acceleration is provided. The effects, on the MHHC scheme, of varying the advance ratio, changing the fuselage flexibility and using the acceleration levels at different locations inside the fuselage as the objective function to be minimized are studied. Furthermore, a multiple blade tracking (MBT) analysis capability is developed which enables one to determine the response of each individual blade comprising the rotor system. This treatment allows the evaluation of the vibratory response of the rotor and the fuselage when the blades are not tracking. Finally, effectiveness of the MHHC scheme combined with MBT is demonstrated. The results obtained indicate that MHHC has very significant potential for vibration in rotorcraft.
Dissert. Abstr.

N91-30130*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A PRELIMINARY INVESTIGATION OF THE USE OF THROTTLES FOR EMERGENCY FLIGHT CONTROL
F. W. BURCHAM, JR., C. GORDON FULLERTON, GLENN B. GILYARD, THOMAS D. WOLF, and JAMES F. STEWART Sep. 1991 24 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; sponsored by AIAA, ASME, SAE, and ASEE Previously announced as A91-41731
(NASA-TM-4320; H-1737; NAS 1.15:4320; AIAA-91-2222)
Copyright Avail: NTIS HC/MF A03 CSCL 01/3

A preliminary investigation was conducted regarding the use of throttles for emergency flight control of a multiengine aircraft. Several airplanes including a light twin-engine piston-powered airplane, jet transports, and a high performance fighter were studied during flight and piloted simulations. Simulation studies used the B-720, B-727, MD-11, and F-15 aircraft. Flight studies used the Lear 24, Piper PA-30, and F-15 airplanes. Based on simulator and flight results, all the airplanes exhibited some control capability with throttles. With piloted simulators, landings using manual throttles-only control were extremely difficult. An augmented control system was developed that converts conventional pilot stick inputs into appropriate throttle commands. With the augmented system, the B-720 and F-15 simulations were evaluated and could be landed successfully. Flight and simulation data were compared for the F-15 airplane. Author

N91-30131*# Systems Control Technology, Inc., Palo Alto, CA.
APPLICATION OF MODERN CONTROL DESIGN METHODOLOGY TO OBLIQUE WING RESEARCH AIRCRAFT
JAMES H. VINCENT Jul. 1991 134 p Sponsored by NASA. Dryden Flight Research Center
(Contract N00421-85-D-0155)
(NASA-TM-105058; NAS 1.15:105058; SCT-4520-280-1) Avail: NTIS HC/MF A07 CSCL 01/3

A Linear Quadratic Regulator synthesis technique was used to

design an explicit model following control system for the Oblique Wing Research Aircraft (OWRA). The forward path model (Maneuver Command Generator) was designed to incorporate the desired flying qualities and response decoupling. The LQR synthesis was based on the use of generalized controls, and it was structured to provide a proportional/integral error regulator with feedforward compensation. An unexpected consequence of this design approach was the ability to decouple the control synthesis into separate longitudinal and lateral directional designs. Longitudinal and lateral directional control laws were generated for each of the nine design flight conditions, and gain scheduling requirements were addressed. A fully coupled 6 degree of freedom open loop model of the OWRA along with the longitudinal and lateral directional control laws was used to assess the closed loop performance of the design. Evaluations were performed for each of the nine design flight conditions. Author

N91-30132*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
REAL-TIME IN-FLIGHT ENGINE PERFORMANCE AND HEALTH MONITORING TECHNIQUES FOR FLIGHT RESEARCH APPLICATION
RONALD J. RAY, JOHN W. HICKS, and KEITH D. WICHMAN Sep. 1991 34 p
(NASA-TM-104239; H-1750; NAS 1.15:104239) Avail: NTIS HC/MF A03 CSCL 01/3

Procedures for real time evaluation of the inflight health and performance of gas turbine engines and related systems were developed to enhance flight test safety and productivity. These techniques include the monitoring of the engine, the engine control system, thrust vectoring control system health, and the detection of engine stalls. Real time performance techniques were developed for the determination and display of inflight thrust and for aeroperformance drag polars. These new methods were successfully shown on various research aircraft at NASA-Dryden. The capability of NASA's Western Aeronautical Test Range and the advanced data acquisition systems were key factors for implementation and real time display of these methods. Author

N91-30133# *Deutsche Forschungsanstalt fuer Luft- und* Raumfahrt, Brunswick (Germany, F.R.). Abt. Mathematische Verfahren und Datentechnik.
SOME RESULTS OF ATTAS FLIGHT DATA ANALYSIS USING MAXIMUM LIKELIHOOD PARAMETER ESTIMATION METHOD
GIRIJA GOPALRATNAM and RAVINDRA JATEGAONKAR (Technische Univ., Brunswick, Germany, F.R.) Feb. 1991 46 p
(DLR-FB-91-04; ISSN-0939-2963; ETN-91-99541) Avail: NTIS HC/MF A03; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 19.50 Deutsch marks

The maximum likelihood parameter estimation method for nonlinear systems is applied to estimate from flight data at a few selected flight conditions the aerodynamic derivatives of the ATTAS (Advanced Technologies Testing Aircraft System). The coupled equations of aircraft motion pertaining to the longitudinal and lateral directional motion in the wind axis system and an aerodynamic model in terms of nondimensional derivatives are employed. In addition, details of the specially carried out flight maneuvers which enable separate estimation of the two pitch damping derivatives due to the pitch rate and rate of change of angle of attack from flight data, are provided. ESA

N91-30134# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
A MEASUREMENT SYSTEM FOR PRODUCTION FLIGHT TESTS OF NEW AIRCRAFT
R. VANDELEIJGRAAF, W. A. VANDORP, S. STORMVANLEENUWEN, and R. UDO 1 Aug. 1989 17 p Previously announced in IAA as A91-20984
(NLR-TP-89222-U; ETN-91-99644) Avail: NTIS HC/MF A03

A measurement system developed for production flight tests with the Fokker 50 and the Fokker 100 production aircraft is described. The objectives of this sytem and its composition (the data acquisition module and the data processing module) are addressed. The measurement system for the production flight test is described with the emphasis on the hardware and software description of the data processing module. The use of the system in the operational phase and experience from the first few flights with this system are given. ESA

N91-30136*# Douglas Aircraft Co., Inc., Long Beach, CA.
THE 1989 HIGH-SPEED CIVIL TRANSPORT STUDIES Summary Report
Sep. 1991 22 p
(Contract NAS1-18378)
(NASA-CR-187545; NAS 1.26:187545) Avail: NTIS HC/MF A03 CSCL 01/3

The results of the Douglas Aircraft Company system studies related to high speed civil transports (HSCT) are discussed. The studies were conducted to assess the environmental compatibility of a high speed civil transport at a design Mach number of 3.2. Sonic boom minimization, external noise, and engine emissions were assessed together with the effect of the laminar flow control (LFC) technology on vehicle gross weight. The general results indicated that a sonic boom loudness level of 90-PLdB at Mach 3.2 may not be achievable for a practical design; the high flow engine cycle concept shows promise of achieving the sideline FAR Part 36 noise limit, but may not achieve the aircraft range design goal of 6,500 nautical miles; the rich burn/quick quench (RB/QQ) combustor concept shows promise for achieving low EINO sub x levels when combined with a premixed pilot stage/advanced technology, high power stage duct burner in the Pratt and Whitney variable steam control engine (VSCE); and full chord wing LFC has significant performance and economic advantages relative to the turbulent wing baseline. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A91-48549
HIGH PERFORMANCE MODERN AVIONIC INSTRUMENTS - THE LED FLAT PANEL DISPLAY SOLUTION
EDWIN BERNARD (Teledyne Microelectronics, Los Angeles, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901819) Copyright

The cockpit display applications most suitable for LED flat panel displays encompass counter-pointer-type instrumentation, bar graphs, and numeric and alphanumeric strips and matrix displays. Excellent legibility has been demonstrated under all lighting conditions and during the wearing of night-vision goggles. The LED-component customization capability that has been developed allows great flexibility in instrumentation/display format configuration. O.C.

A91-48550
ELECTROLUMINESCENT DISPLAYS (EL) FOR GENERAL AVIATION COCKPITS
DANNER DELYLE (ARNAV Systems, Inc., Portland, OR) and JACOBS GALE (Flight Dynamics, Inc., Portland, OR) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. refs
(SAE PAPER 901822) Copyright

From failure to success in developing a direct sunlight readable electroluminescent display for use in general aviation cockpits. Initial attempts using existing technologies resulted in failure of a product design. Using new EL driver design approaches a 76.2 mm x 127 mm EL display with an unfiltered average brightness of 65 foot lamberts (1) was developed which proved to be satisfactory

across the range of dark night to bright day sunlight ambient lighting conditions within an aircraft cockpit. A circular polarized contrast enhancement filter was developed for the EL display. Although the filter lowered the average brightness to 24 foot lamberts the overall readability was increased. EL displays may be a good alternative to other technologies for use in direct sunlight applications. Author

A91-48551
FAULT-TOLERANT HEXAD RLG IRU
MAHESH K. JEERAGE (Honeywell Systems and Research Center, Minneapolis, MN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901825) Copyright

The performance test results of a fault-tolerant inertial reference system are presented. The system incorporates several state-of-the-art technologies in ring laser gyros, hexad sensor skew redundancy, fault-tolerant electronics, and failure detection and isolation (FDI) algorithms. The flight control FDI employs large thresholds and short time constants consistent with flight control requirements. Small deviations in sensor performance are detected by heavy filtering and low thresholds to maintain navigation accuracy. Results of both laboratory and flight tests demonstrate the fault-tolerant capabilities of the hexad brassboard for detecting the sensor failures. It is concluded that the system utilizing fault-tolerant inertial reference units can meet the reliability requirements of fly-by-wire and fly-by-light aircraft control systems. O.G.

A91-48553
IMPROVING SITUATIONAL AWARENESS THROUGH THE USE OF INTUITIVE PICTORIAL DISPLAYS
JOSEPH G. OLIVER (Air Line Pilots Association, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901829) Copyright

An account is given of the progress thus far made in optimizing transport-aircraft cockpit displays and HUDs to present situational information in the most intuitive fashion. When flight path is depicted by a HUD, very accurate corrections can be made to aircraft trajectory. When that trajectory is further correlated to the outside scene, very accurate flight control becomes possible. O.C.

A91-48554
HUD POTENTIAL FOR NARROW-BODIED AIR CARRIER AIRCRAFT
HOWARD A. LONG (Delta Air Lines, Inc., Atlanta, GA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901831) Copyright

The Head-up Display (HUD) can provide significant benefits when installed on narrow-bodied air carrier aircraft. These benefits should include Category III approach minimums, reduced takeoff minimums, less restrictive takeoff alternate weather requirements, lower non-precision approach minimums, and general safety benefits. Twenty-five B-727s are presently operating to 700 feet RVR on hand flown ILS approaches using a Cat IIIa HUD with guidance. A Hybrid HUD system using a similar HUD as a monitor, integrated with a fail-passive autoland system, should qualify for Category IIIb minimums as low as 300 feet RVR. Author

A91-48555
HEADS UP DISPLAY APPLICATIONS FOR WIDE BODY TRANSPORT AIRCRAFT - AN OPERATIONAL POINT OF VIEW
DUANE EDELMAN (Northwest Airlines, Inc., Minneapolis, MN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p. refs
(SAE PAPER 901832) Copyright

Specific applications of a heads-up display (HUD) system for wide-body transport aircraft are discussed, focusing on the improved operational safety and operating efficiencies associated with the system. The HUD system is shown to provide the highest payback of any single system through operational flexibility and growth capability. The system will make it possible to achieve safety and operating efficiencies required for the 21st century by means of (1) reduction or elimination of the number of accidents/incidents associated with the taxi, takeoff, and landing phases of flight; (2) reduction of delays, cancellations, and diversions caused by weather; (3) reduction of training costs through standard operating procedures for all aircraft and operations; and (4) reduction of aircraft operational wear through more precise control of flight path and energy. O.G.

A91-48556
THE HUD AS PRIMARY FLIGHT INSTRUMENT
CHRIS N. TAYLOR (GEC Avionics, Ltd., Rochester, England) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901833) Copyright

The current and future status of the HUD as a primary flight instrument is examined in detail, and the HUD architecture for CAT IIIB and CAT IIIC approaches is presented. It is concluded that the development of a HUD which is capable of certification for CAT IIIB or CAT IIIC approaches, with corresponding reduction in takeoff minima, and with engine-out guidance, may lead to a reevaluation of the HUD for narrow-body aircraft with fail-passive autoland systems. It is suggested that the additional benefits of a stroke-on-raster HUD designed for integration into the modern avionics set may lead to acceptance of the HUD as a primary instrument even for wide-body aircraft with existing fail-operational landing systems. O.G.

A91-48565
ADVANCED CUEING AND DISPLAYS FOR SUPER AGILE AIRCRAFT
ROBERT C. ETTINGER, JAMES R. COBASKO, STEVE M. MOSHER, and LEON ROSENSHEIN (Eidetics International, Inc., Torrance, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p. refs
(SAE PAPER 901850) Copyright

This paper highlights recent results of a manned, high fidelity, air-to-air combat simulation experiment to evaluate new display and cueing concepts for post-stall maneuver capable fighter aircraft. Three candidate cueing display suites were evaluated in simulated close-in air-to-air combat in the NASA Langley Differential Maneuvering Simulation by six pilots. Visual pitch-pointing authority, roll authority, maximum maneuver and selected bleed rate cues were evaluated in this effort. Audible airspeed, angle-of-attack, maximum maneuver and selected bleed rate voice and tone cues were also evaluated. Observations about the effectiveness of these innovative cueing and display concepts were drawn from a detailed analysis of 432 engagements. Author

A91-48603
ENHANCED HUD SYMBOLOGY ASSOCIATED WITH RECOVERY FROM UNUSUAL ATTITUDES
JOHN E. DEATON, MICHAEL BARNES (U.S. Navy, Naval Air Development Center, Warminster, PA), JONATHAN KERN, and DOUGLAS WRIGHT (Veda, Inc., Warminster, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901919) Copyright

The present study examined the degree of spatial awareness obtained using what has been called an Augie Arrow, enabled so that it could be displayed as either a 'nearest horizon pointer' (NH) or an 'up arrow' (UP) indicator. Another issue investigated concerned the usefulness of analog dials vice digital readouts of airspeed and altitude as an aid to recovery. During simulated flight, twelve subjects were required to recover from six unusual attitudes employing one of four HUD formats: (1) Standard HUD, (2) Augie Arrow, (3) Analog Dials, and (4) Augie Arrow with Analog Dials. Results revealed that the Augie Arrow produced the most rapid recovery time. The Augie Arrow configuration was optimal at the most severe unusual attitudes, especially for the NH mechanization. The Dials only HUD was not particularly helpful in recovery, and the Arrow with Dials HUD was rated as a significant clutter problem.

Future work needs to be done to clarify the mechanization of the Augie Arrow for other HUD modes, while the issue of when to display the arrow should be assessed in greater detail. Issues related to the difficulty of performing simulation studies in this area were discussed. Author

A91-48635
ALTITUDE MEASUREMENT CAPABILITY AS RELATED TO ALTITUDE MEASUREMENT PERFORMANCE
ALEX P. SCHUST (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 10 p. refs
(SAE PAPER 901972) Copyright

An examination is conducted of the difference between designed altitude-measurement capability and actual in-service measurement performance. An altimetry system error model is defined for the development of airframe error measurement and altimetry instrument error standards. Attention is given to static source sensor tolerances, manufacturing and production line tolerances, and calibration accuracy and repeatability. O.C.

A91-48636
DEVELOPING AIRCRAFT ALTITUDE MEASUREMENT STANDARDS THROUGH OPERATIONAL FLIGHT TESTING AND STATISTICAL RISK ANALYSIS
ALEX P. SCHUST (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) and BRIAN COLAMOSCA (FAA, Technical Center, Atlantic City, NJ) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 13 p. refs
(SAE PAPER 901974) Copyright

Aircraft altitude measurement standards developed under Federal Aviation Administration Vertical Separation Standards Program are considered. The standards are based on a combination of altimetry system error measurements by aircraft type and statistical analysis of individual aircraft type performance. It is found that aircraft type altimetry system error is essentially Gaussian in nature. Using this finding, altimetry system standards are developed using a parametric relationship between altitude keeping and altitude measurement. O.G.

A91-48638
APPLICATION OF OVERALL STANDARDS FOR ALTIMETRY SYSTEMS TO INDIVIDUAL ALTIMETRY SYSTEM FITS
BRIAN COLAMOSCA (FAA, Technical Center, Atlantic City, NJ) and ALEX P. SCHUST (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p. refs
(SAE PAPER 901976) Copyright

An approach is proposed for the evaluation of an aircraft type's altimetry system involving the testing of one airframe of the aircraft type; this allows the application of overall standards for altimetry systems in individual altimetry fits. This approach maintains consistency with standards set forth in draft ICAO guidance material by developing requirements that are analogous to those of the mean standard deviation for an altimetry system type. O.C.

A91-48831
HELICOPTER PITOT INTAKE PERFORMANCE AND FLOW COEFFICIENT RELATIONSHIP
ALAN NURICK (University of the Witwatersrand, Johannesburg, Republic of South Africa) and JOHANNES P. VAN DER WALT American Helicopter Society, Journal (ISSN 0002-8711), vol. 36, July 1991, p. 84-88. refs
Copyright

The performance of a pitot type intake used on helicopter engines is analyzed for hover and forward flight, in terms of the DC(60) distortion index and pressure recovery factor. It is shown that for particular intakes these parameters may be correlated with the flow coefficient requiring limited empirical constants. The method provides a practical means for correlating engine intake performance parameters with the flow coefficient. Author

A91-49614*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ESTIMATION OF OPTICAL FLOW IN AIRBORNE ELECTRO-OPTICAL SENSORS BY STOCHASTIC APPROXIMATION
S. J. MERHAV (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 380-389. refs
(AIAA PAPER 91-2723) Copyright

The essence of motion or range estimation by passive electrooptical means is the ability to determine the correspondence of picture elements in pairs of image frames and to estimate their coordinates and their disparity (relative shifts) in the image plane of an electrooptical imaging sensor. The disparity can be in successive frames due to self-motion or in simultaneous frames of a stereo pair. A key issue is to provide these estimates on-line. This paper describes the theoretical background of such an interframe shift estimator. It is based on a stochastic gradient algorithm, specifically implementing a form of stochastic approximation, which can achieve rapid convergence of the shift estimate. Analytical and numerical simulation examples for random texture and isolated features validate the feasibility and the effectiveness of the estimator. Author

A91-49729*# Princeton Univ., NJ.
ROBUST KALMAN FILTER DESIGN FOR PREDICTIVE WIND SHEAR DETECTION
ALEXANDER D. STRATTON and ROBERT F. STENGEL (Princeton University, NJ) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1549-1556. refs
(Contract NAG1-834)
(AIAA PAPER 91-2778)

Severe, low-altitude wind shear is a threat to aviation safety. Airborne sensors under development measure the radial component of wind along a line directly in front of an aircraft. In this paper, optimal estimation theory is used to define a detection algorithm to warn of hazardous wind shear from these sensors. To achieve robustness, a wind shear detection algorithm must distinguish threatening wind shear from less hazardous gustiness, despite variations in wind shear structure. This paper presents statistical analysis methods to refine wind shear detection algorithm robustness. Computational methods predict the ability to warn of severe wind shear and avoid false warning. Comparative capability of the detection algorithm as a function of its design parameters is determined, identifying designs that provide robust detection of severe wind shear. Author

A91-49787#
PILOT'S ASSOCIATE
R. E. LAMBERT, K. J. KELLER, and S. A. MEYER (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 10 p. refs
(AIAA PAPER 91-2757) Copyright

The Pilot's Associate (PA) is a decision aiding system that provides the aircraft pilot with the right information at the right time and helps him/her make use of all the aircraft systems that exist to help him/her. An overview of the PA program is given, and the design process of the PA program is described. The PA software architecture is examined, and demonstration and mission functionality is briefly addressed along with transition analysis. C.D.

A91-49789#
ZERO-LOCK LASER GYRO
CHARLES H. VOLK, JOHN M. CANFIELD, and STEVEN C. GILLESPIE (Litton Aero Products, Guidance and Control Systems Div., Woodland Hills, CA) AIAA, Guidance, Navigation and Control

Conference, New Orleans, LA, Aug. 12-14, 1991. 5 p. refs
(AIAA PAPER 91-2764) Copyright

The theory of operation and the performance of Litton's second generation gyroscope, the ZLG, is reviewed. Instrument and system-level data supporting the instrument's capability to fulfill the requirements of aircraft navigation are presented. C.D.

A91-50459
COCKPIT DISPLAYS AND VISUAL SIMULATION; PROCEEDINGS OF THE MEETING, ORLANDO, FL, APR. 17, 18, 1990

HARRY M. ASSENHEIM, ED. (Garrett Canada, Rexdale) and HERBERT H. BELL, ED. (USAF, Human Resources Laboratory, Williams AFB, AZ) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1289), 1990, 199 p. For individual items see A91-50460 to A91-50475.
(SPIE-1289) Copyright

The present conference discusses situational awareness in large aircraft, HUD combiners yielding enhanced instantaneous field-of-view/display brightness, holographic HUD combiners with optimal photometric efficiency and uniformity, LCDs, an electronically tunable light filter, navigational guidance in complex airspace, and nap-of-the-earth flight and real-time simulation of dynamic terrain. Also discussed are visual data base requirements for A-6E mission training, computer image-generation, two-crew cockpit displays, the evaluation of eye-tracking measurement systems for use with fiber-optic helmet-mounted display, and system requirements for a high-gain dome-display surface. O.C.

A91-50460
SITUATIONAL AWARENESS IN LARGE AIRCRAFT

ERWIN A. ULBRICH (Douglas Aircraft Co., Long Beach, CA) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 2-10.
Copyright

This paper shows the results of a research program funded by Douglas Aircraft Co. (DAC) to enhance the situational awareness of pilots flying large aircraft low to the ground in high-threat environments. Radical display formats are employed in flying the aircraft. These formats relate to the spatial alignment of a pilot to mobile threats, imprecisely located destinations, moving weather, and fixed terrains. Assumed in the program is a survival-enhancing intelligent avionics autopilot, called Adaptive Network for Avionics Research Management (ANARM). Demonstrations can be done on any IBM-compatible personal computer supporting VGA displays. The capability to allow a pilot to modify the situation's pseudo 3D viewpoint as a function of time appears to be of particular importance. Author

A91-50462
HUD COMBINERS GIVING ENHANCED IFOV/DISPLAY BRIGHTNESS

P. J. ROGERS, A. J. KIRKHAM, M. JEFFS, and J. W. WHITE (Pilkington Optronics, Saint Asaph, England) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 30-37. refs
Copyright

While holographic single combiners can be retrofitted to HUDs to obtain a significant enhancement of display visibility, there is an associated tradeoff in permissible vertical head movement. It is presently shown that dual combiners can be retrofitted to well-corrected HUDs in place of single combiners to yield appreciable increases in elevation's instantaneous field-of-view. It is possible to use holographic graded-reflective coatings on the combiners to obtain greater display visibility. O.C.

A91-50464
HOLOGRAPHIC HEAD-UP DISPLAY COMBINERS WITH OPTIMAL PHOTOMETRIC EFFICIENCY AND UNIFORMITY

ROBERT B. WOOD and MARK A. THOMAS (Flight Dynamics, Inc., Portland, OR) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 50-62. refs
Copyright

Head-Up Displays (HUDs) utilizing holographic combiner elements can suffer from poor display brightness uniformity across the head motion volume or field of view. The brightness non-uniformity is due to angle differences between the construction and the end use or reconstruction geometries. This problem is especially acute when holographic combiner elements are positioned relatively close to the pilot's design eye location, when large head motion volumes are desired, and when narrow-band phosphors (e.g. P-53) are used. This paper presents a hologram design approach that maximizes the HUD combiner phosphor reflectivity, the transmissivity through the combiners, and the display brightness uniformity. This technique can be applied to HUDs using dual combiners or wide field-of-view combiners. Author

A91-50465
B-52 NIGHT VISION GOGGLE HEAD-UP DISPLAY DEVELOPMENT

JEFFREY L. CRAIG and BRADLEY D. PURVIS (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 63-71. refs
Copyright

The Night Vision Goggle (NVG) HUD systems being procured by SAC for B-52Gs display flight and navigation data onto a combiner glass mounted to one of the NVG objective lenses. This configuration allows the pilot to have an 'eyes-out' orientation which enhances situational awareness and mission effectiveness. SAC has initiated a statement of operational need for an aircrew ejection-capable NVG that would begin operations in 1994. O.C.

A91-50466
AN AVIONIC GRAY-SCALE COLOR HEAD DOWN DISPLAY

D. L. JOSE, S. N. LEE, R. G. STEWART, A. C. IPRI, and S. A. LIPP (David Sarnoff Research Center, Princeton, NJ) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 74-80. refs
Copyright

An account is given of a 320,000-pixel self-scanned LCD with CMOS-TFT gray-scale generators. At 100 x 200 mm, this is the largest wafer-scale IC thus far produced; integration of the scanning circuitry on the plate has reduced the number of input leads from 1200 to 44. The configuration was first preassembled on a CAD workstation and then partitioned into 16 smaller reticle segments. O.C.

A91-50572
STEALTH AIRCRAFT AND TECHNOLOGY FROM WORLD WAR II TO THE GULF. II - APPLICATIONS AND DESIGN

ROGER A. STONIER SAMPE Journal (ISSN 0091-1062), vol. 27, Sept.-Oct. 1991, p. 9-18. refs
Copyright

The F-117a Stealth fighter aircraft and the Flying Wing B-2 bomber are discussed, Stealth materials and design concepts are presented, and new technology systems being developed to detect these Stealth aircraft are summarized. Both the F-117A and the B-2 incorporate new technology including composites to achieve low observable characteristics for current radar, electro-optical, acoustic, and infrared detection techniques. It is concluded that the technology using fiber and particulate reinforced plastic composites provides 'signatures' which are difficult to detect until the aircraft is at close range. O.G.

A91-51085
HELMET DISPLAYS OPTIONS - A ROUTEMAP

GEORGE C. BULL (GEC Avionics, Ltd., Rochester, England) IN:

Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 81-92. refs
Copyright

Guidelines for the selection of key helmet display parameters are presented. It is shown that it is possible to optimize a helmet display for day use or for night use, but not for both day and night use. C.D.

A91-51086
REQUIREMENTS OF AN HMS/D FOR A NIGHT-FLYING HELICOPTER

H.-D. V. BOEHM and R. SCHRANNER (MBB GmbH, Munich, Federal Republic of Germany) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 93-107. Previously announced in STAR as N91-11383. refs
Copyright

Requirements of a Helmet Mounted Sight (HMS/D) are studied. The development goal for the near future should be an integrated, lightweight helmet with a binocular display on the visor providing two or three sensor images. Operational requirements, human engineering aspects and the requirements of an integrated lightweight helmet with two Night Vision Goggle (NVG) tubes and two cathode ray tubes to display superimposed NVG and thermal imaging images with flight symbologies are described. Author

A91-51087
DESIGN AND FLIGHT TESTING OF AN ELECTRONIC VISIBILITY SYSTEM

MARK S. ROLWES (McDonnell Douglas Corp., Saint Louis, MO) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 108-119.
Copyright

Providing pilots with direct external visibility may not be possible or desirable in the next generation of aircraft. The drive to increase performance will result in highly swept, low drag forebody designs inconsistent with forward-looking windows. Future tactical aircraft may have to enclose pilots in windowless cockpits in order to protect them from threats. Visibility as a design variable is not a new problem, but the solutions of the past have often been brute force approaches that impart significant weight penalties on vehicle design. This paper discusses the design and flight testing of an electronic visibility system concept developed by McDonnell Douglas that provides a low weight, high reliability, flexible alternative approach to providing pilots with external vision. Author

A91-51088
REAL-TIME SPACE STABILIZED DIGITAL GIMBAL

MARK S. CLINGAN and MICHAEL J. PARISE (Honeywell, Inc., Saint Louis Park, MN) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 120-127.
Copyright

Advances in electronics, specifically in the area of digital video processing, have opened the door to many new solutions to old problems. Visually coupled systems using Helmet Mounted Displays have been used for years as an aid to pilot vision. These functions are generally accomplished using a helmet display, head tracker and a mechanically gimbaled sensing system. Although this system has proven to be one effective solution in achieving a wide field of regard with a smaller displayed field of view, it has its limitations and drawbacks. A solid state digital gimbaled system has been developed and flight-tested as part of a joint study conducted by McDonnell Douglas and the National Aeronautics and Space Administration. This paper will discuss advantages and limitations of digital gimbal systems. Author

A91-51089
THE DEVELOPMENT OF AN AVIATORS HELMET MOUNTED NIGHT VISION GOGGLE SYSTEM

G. H. WILSON and R. J. MCFARLANE (GEC Ferranti Defence Systems, Ltd., Displays Systems Div., Edinburgh, Scotland) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 128-139. refs
Copyright

Helmet-Mounted Systems (HMS) must be lightweight, balanced, and compatible with life support and head protection assemblies. This paper discusses the design of one particular HMS, the Nite-Op/Nightbird aviator's Night Vision Goggle (NVG) developed under contracts to the Ministry of Defence for all three services in the United Kingdom (UK) for Rotary Wing and fast jet aircraft. The existing equipment constraints, safety, human factor, and optical performance requirements are discussed before the design solution is presented after consideration of these material and manufacturing options. Author

A91-51096
THE DEVELOPMENT AND USAGE OF HELMET-MOUNTED DISPLAYS

G. J. N. CLARKSON and A. KARAVIS (Royal Aerospace Establishment, Farnborough, England) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 216-225.
Copyright

An account is given of a comprehensive approach to enhancing the capabilities of fast-jets specifically in the air combat role by utilizing helmet-mounted equipment. Ground rigs, simulators, and aircraft were employed in the development of the devices and their integration with the weapons system. The paper concludes that although ground and simulator trials are a necessary prelude, airborne assessment is essential. Author

A91-51097
F-16 HELMET-MOUNTED DISPLAY FLIGHT EVALUATIONS

BRUCE L. BUTTERFIELD (General Dynamics Corp., Fort Worth, TX) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 226-235. Research supported by General Dynamics Corp., GEC Avionics, Ltd., Honeywell, Inc., et al.
Copyright

The helmet-mounted-display (HMD) concept has long been regarded as a significant advantage to the modern combat pilot. This concept, however, has been limited to simulators, helicopters, and simplistic display types on fighter aircraft. For the first time, wide field of view HMDs, coupled with a head-steered FLIR, have undergone significant flight tests aboard a state of the art fighter aircraft. This paper discusses some of the lessons learned concerning the use of HMDs in a high performance fighter aircraft. Author

A91-51098
EVALUATION OF VIRTUAL COCKPIT CONCEPTS DURING SIMULATED MISSIONS

M. G. KAYE, JUDITH INESON, D. N. JARRETT, and G. WICKHAM (Royal Aerospace Establishment, Farnborough, England) IN: Helmet-mounted displays II; Proceedings of the Meeting, Orlando, FL, Apr. 19, 20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 236-245. Previously announced in STAR as N91-20385.
Copyright

The Virtual Environment Integratiaon Laboratory (VEIL) of the Royal Aerospace Establishment (RAE) is described. The VEIL program is intended to provoke appropriate technological developments by exploring the human requirements of operating within a virtual cockpit whilst conducting demanding missions. Under construction is a lightweight binocular, color helmet mounted display with a wide field of view, driven by a versatile parallel

architecture computer graphic system which accommodates simulated sensor images from a camera and terrain model. Prototypes of suitable display formats will be developed using a bench mounted stereoscopic viewing rig which will also facilitate investigation of critical psychophysical issues. The complete VEIL hardware will integrate eye and head position sensors, three-dimensional sound, direct voice input, and tactile sensors with the binocular display system. When allied to the ground attack, helicopter and air combat simulator facilities of Mission Management Department, it will enable the practicality of operating virtual cockpit systems in a wide variety of missions and tasks to be adressed. Author

A91-52037* Technion - Israel Inst. of Tech., Haifa.
COMPENSATING SAMPLING ERRORS IN STABILIZING HELMET-MOUNTED DISPLAYS USING AUXILIARY ACCELERATION MEASUREMENTS
S. MERHAV (Technion - Israel Institute of Technology, Haifa) and M. VELGER (El-Op Electro-Optics Industries, Ltd., Rehovot, Israel) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 1067-1069. Research supported by USAF and NASA. refs
Copyright

A method based on complementary filtering is shown to be effective in compensating for the image stabilization error due to sampling delays of HMD position and orientation measurements. These delays would otherwise have prevented the stabilization of the image in HMDs. The method is also shown to improve the resolution of the head orientation measurement, particularly at low frequencies, thus providing smoother head control commands, which are essential for precise head pointing and teleoperation. L.M.

A91-52115
THREE-DIMENSIONAL TRACKING USING ON-BOARD MEASUREMENTS
C. M. REKKAS, N. J. KRIKELIS (Athens, National Technical University, Greece), and CHRIS C. LEFAS (Technical University of Crete, Athens, Greece) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, July 1991, p. 617-624. refs
Copyright

The development of a three-dimensional tracker using onboard measurements is described. A system model based on aircraft dynamics is derived. A full 3-D tracking system that can be split, with a part operating onboard and a part operating on the ground, is developed. Attitude angle and aircraft airspeed measurements are processed to estimate the components of the aircraft velocity with respect to the surrounding air. These are then used to obtain estimates of the aircraft position and ground speed. The tracker is designed so that the number of quantities transmitted to the ground station is kept to a minimum. The tracker was evaluated with real data and was found to perform well, resulting in a considerable improvement over the conventional first-order Kalman filter. I.E.

A91-52126* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPARISON OF MOTION AND STEREO METHODS IN PASSIVE RANGING SYSTEMS
BANAVAR SRIDHAR and RAYMOND SUORSA (NASA, Ames Research Center, Moffett Field, CA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, July 1991, p. 741-746. refs
Copyright

The authors compare the estimates in passive ranging systems using motion and stereo approaches. It is shown that an integrated approach is necessary to provide better range estimates over a field-of-view (FOV) of interest in helicopter flight. The recursive approach for processing a sequence of stereo images, described together with a recursive motion algorithm (RMA), provides the basis for an integrated method to provide more accurate range information. Results based on motion sequences of stereo images are presented. I.E.

A91-52940
INTEGRATED AVIONICS SYSTEM DESIGN HONEYWELL SPZ-5000
DEAN WILKENS (Honeywell, Inc., Minneapolis, MN) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 8 p.
(SAE PAPER 911007) Copyright

Consideration is given to the SPZ-5000 system using the advantages of integrating fully digital fail passive flight controls, the large format of a conventional display electronic flight instrument system, and the engine instrument and crew advisory system functions combined in a single LRU. This level of integration makes it possible to meet the cost, size, and weight requirements of a lower cost business and regional airline aircraft. The SPZ-5000 involves combining the primary avionics subsystems such as flight guidance and cockpit displays into a common computing engine and goes far beyond repackaging separate boxes into a common chassis. O.G.

A91-52956
GUIDE TO TEMPERATURE MONITORING IN AIRCRAFT GAS TURBINE ENGINES
SAE Aerospace Information Report, AIR 1900, Feb. 7, 1991, 55 p. refs
(SAE AIR 1900) Copyright

Data regarding temperature-monitoring systems (TMSs) are presented to facilitate the selection and use of such systems with aircraft gas-turbine engines. The present need for and use of TMSs is discussed, sensor types are examined extensively, and measurement locations are listed. System considerations include signal source location, mounting, signal transmission and processing, and the use of shared signals. Selection criteria are defined for TMSs and related subsystems and include measurement type, general performance and accuracy, total cost, reliability and maintainability, as well as considerations regarding interfaces. Errors are inherent in certain measurement processes and technologies, although the inaccuracies can be understood and accommodated by the system designer by means of system selection and adequate review of the technology and methodology involved. C.C.S.

A91-52963
LAVATORY SMOKE DETECTORS
SAE Aerospace Recommended Practice, ARP 4001, Jan. 28, 1991, 7 p.
(SAE ARP 4001) Copyright

The important features of a recommended lavatory smoke detector are delineated with attention given to input from aircraft operators and manufacturers. Single-station commercial-type detectors and detection systems with a central panel are considered, and the design criteria are equally applicable to each type. Mechanical recommendations include the minimization of weight, the preclusion of unauthorized deactivation and false activation, and optimal locations. Electrical recommendations include protection against reverse polarity, insulation resistance, and current leakage. Important factors are also outlined related to markings, maintenance, and reliability. Specific recommendations are given for type-I (single station) and type-II (central panel) smoke detectors, with environmental parameters listed for all materials. C.C.S.

N91-30137# National Aeronautical Lab., Bangalore (India).
GRAPHIC DISPLAY OF COCKPIT INSTRUMENTS FOR FLIGHT SIMULATION
K. KRISHNA MURTHY and S. BALAKRISHNA Jun. 1991 46 p
Original contains color illustrations
(NAL-PD-FC-9111) Avail: NTIS HC/MF A03

A generalized software to visualize the behavior of an aircraft in simulated flight, through cockpit instruments was designed and developed. The display is achieved by incorporating the Masscomp

Aurora Graphics routines in the program. It was found that the update time of display of various parameters is 20 milliseconds.
Author

N91-30138 Nottingham Univ. (England).
ELECTROSTATIC TRANSDUCERS FOR AIRBORNE ULTRASONICS Ph.D. Thesis
HILARY J. CARR 1989 346 p
Avail: Univ. Microfilms Order No. BRD-91981

Work in which both ultrasonic and optical experimental techniques have been used to study ultrasonic electrostatic transducers designed to operate in air is described. The results were compared to an analytical model. The frequency response of a transducer was found to be dependent on both the gross surface features and the microscopic features of a backplate, such as grooves and the surface roughness respectively. The results obtained show that the resonant frequency of a transducer assembled with a backplate that possessed a roughened surface was determined primarily by the mean depth of the air layer formed between the membrane and the backplate, with a shallow air depth producing a high resonant frequency. In addition, they indicated that for smooth optically flat backplates, the depth of the air layer was governed by the surface of the membrane. A Michelson interferometer was used to determine high resonant frequencies which when measured ultrasonically were found to be attenuated by air. It was found that the intensity of the frequency response of transducers constructed with a roughened surface backplates was governed by both the mean depth of the trapped air layer and the average wavelength of the backplates' surface. A detailed optical investigation of a transducer assembled with a grooved backplate showed that the multi-peaked frequency response observed was a consequence of the annular membranes formed by the transducer membrane above the grooves. The annular membranes were shown to be driven by the action of the membrane above adjacent rails. It is the frequency response of the annular membrane that forms the frequency response of a transducer. However, it was found that the resonant frequency of a transducer could correspond to an overtone of the natural frequency and not the natural frequency of the annular membrane. The frequency which forms the resonant frequency of the transducer is influenced by the ratio of the rail width to groove width. In general, the intensity of the frequency response of transducers was found to be determined by the width of a groove, with a narrower annular membrane producing the more intense response.
Dissert. Abstr.

N91-30139# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
AVIONICS SYSTEMS FOR FUTURE HELICOPTERS [AVIONIK-SYSTEME FUER ZUKUENFTIGE HUBSCHRAUBER]
RUDOLF SCHRANNER 16 May 1990 23 p In GERMAN
Presented at the 18th Hubschrauberforum Bueckeburg, Bueckeburg, Fed. Republic of Germany, 16 May 1990
(MBB-UD-0591-90-PUB; OTN-013096; ETN-91-99446) Avail: NTIS HC/MF A03

The boundary conditions for system design are given, e.g., user requirements, technology, and integration aspects such as available mass/volume. The interaction of these categories of requirements are shown. The economical aspect and market competition are prevailing for civil projects. The essential element of design of avionics system is the systematic analysis of user requirements. The external integration conditions, such as environmental requirements, radiation safety and standardization of housings exert an influence on avionics design. The aim of system design is to meet with user analysis function, using available technology and considering integration aspects. When taking these conditions into account, a number of possible systems are defined by combination and suitable integration.
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.

A91-48536
EMI/EMC CONSIDERATIONS WITH RESPECT TO DISTORTION REQUIREMENTS IN AIRCRAFT ELECTRIC POWER GENERATING SYSTEMS
D. E. BAKER (Westinghouse Electric Corp., Pittsburgh, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 14 p.
(SAE PAPER 901801) Copyright

The problem of electromagnetic interference from electrical-power generating systems on aircraft is addressed, and practical suggestions are presented. Significant differences between the power quality specifications normally used by designers and the stricter requirements of EMI analysts are pointed out and illustrated with graphs of typical test data. It is argued that most proposed improvement methods do not work and that the most practical option is to relax the EMI emission-specific limits to be compatible with the distortion-spectrum limits - inasmuch as many present systems which are in violation of EMI standards at 14-500 kHz operate without any apparent deleterious effects.
T.K.

A91-48537
APPLICATION OF A FAULT TOLERANT ELECTRICAL POWER SYSTEM
DAVID L. SOMMER (Boeing Co., Military Airplanes Div., Seattle, WA) and MIGUEL A. MALDONADO (USAF, Aero Propulsion and Power Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901803) Copyright

A fault tolerant electrical power system demonstrator is presented. The system includes MIL-STD-1750A-based power system processors and electrical load management centers and provides uninterruptible power to flight-critical and mission-critical loads. It is concluded that the electrical power system design meets the requirements of advanced aircraft incorporating fly-by-wire and power-by-wire technologies.
O.G.

A91-48538
AUTOMATIC ELECTRIC LOAD MANAGEMENT CENTERS
DAVID A. HAAK and LAWRENCE W. MESSENGER (Sundstrand Aviation, Rockford, IL) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p.
(SAE PAPER 901804) Copyright

Concepts and developments of an automatic electrical load management center (AELMC) are summarized. These centers are designed to provide redundant aircraft electric power distribution systems to increase mission completion probability when various components are not operating to required performance levels.
O.G.

A91-48564
THRUST VECTORING CONTROL CONCEPTS AND ISSUES
BARTON H. SNOW (GE Aircraft Engines, Evendale, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 14 p.
(SAE PAPER 901848) Copyright

An account is given of the design features and performance characteristics of an axisymmetric vectoring exhaust nozzle (AVEN) concept for fighter aircraft maneuvering agility/controllability capabilities enhancement. Candidate implementations of an AVEN system are considered; a configuration with dual-vector control and simplex hydraulics achieved the highest figure-of-merit, and

may be seen as a reasonable balance-point between safety, cost, complexity, and weight. The scheme can be retrofitted on existing aircraft. O.C.

A91-48586
HIGH SPEED CIVIL TRANSPORT PROPULSION SYSTEM STUDIES
MARTIN G. SMITH, JR. (Pratt and Whitney Group, East Hartford, CT) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901891) Copyright

An evaluation was made of advanced technology engine cycles, low emissions combustors and low noise exhaust nozzles which identified payoffs for advanced propulsion technology in terms of aircraft gross weight, stratospheric cruise emissions and airport noise reduction. Two types of variable cycle engines were studied; turbine bypass engine (TBE) and variable stream control engine (VSCE). Results of the study showed the TBE is clearly superior to the VSCE for Mach 2.4 and Mach 3.2 cruise. Critical component technologies which must be developed and validated before full scale engine development were also identified on the basis of system viability, technological challenges and degree of risk. Author

A91-48588
SECONDARY POWER INTEGRATION FOR AEROSPACE PLANES
KENT WEBER (Sundstrand Corp., Rockford, IL) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p.
(SAE PAPER 901893) Copyright

The unique features of aerospace planes are evaluated, and integrated cooling and accessory power configurations are recommended that can save substantial weight over nonintegrated systems. The roles of propulsion engines, heat engines, stored energy, turbine-driven accessory power units, fuel cells, and batteries in such configurations are addressed. C.D.

A91-48628
THERMAL MANAGEMENT OF ADVANCED AIRCRAFT SECONDARY POWER SYSTEMS
SRIDHAR K. IYA (Boeing Military Airplanes, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901959) Copyright

A thermal management system study for a hydrocarbon-fueled Mach 6 aircraft is presented. The cooling system arrangements are reported for three types of secondary power systems with which the aircraft is equipped: (1) a conventional system with hydraulic actuators and turbine-driven fuel pumps, (2) a more electric system with electromechanical actuators and turbine-driven fuel pumps, and (3) an all-electric system with electromechanical actuators and electrically driven fuel pumps. An overview is given of an overall thermal management system for the total aircraft. C.D.

A91-48662* Air Force Systems Command, Wright-Patterson AFB, OH.
PROPULSION TECHNOLOGY FOR NATIONAL AERO-SPACE PLANE
C. W. ANDERSON (National Aerospace Plane Joint Program Office, Wright-Patterson AFB, OH), CHARLES R. MCCLINTON, and R. W. GUY (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 22 p. refs
(SAE PAPER 902005) Copyright

The National Aerospace Plane (NASP) program is briefly reviewed, including its growth, objectives, team organization, and schedule. The NASP propulsion technology is discussed, and the results of engine module tests are described. Future large-scale and higher-speed testing needs are examined. C.D.

A91-48663
FLEX-CYCLE COMBUSTOR COMPONENT FOR RAPIDLY STARTING AN INTEGRATED POWER UNIT
R. M. KLAASS, MARK M. HARRIS, and DAVID N. MARSH (Allied-Signal Aerospace Co., Garrett Auxiliary Power Div., Phoenix, AZ) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(Contract F33615-87-C-2807)
(SAE PAPER 902022) Copyright

This paper describes the design of an advanced emergency power system meeting future More-Electric aircraft demands for starting at 50,000 feet (16,000 meters) and acceleration to full power in two seconds. This rapid starting requirement stems from the need for uninterrupted electric control power in the event of main engine shutdown at high altitude. Key to developing this power system is a flexible-cycle (flex-cycle) combustor. The combustor, with other shared auxiliary power unit (APU) components, constitutes an Integrated Power Unit (IPU). The IPU, gearbox, and stored energy components form the aircraft secondary power system. The flex-cycle combustor design accommodates a high exit temperature, a rapid temperature rise, and a high heat-release rate. High combustor performance is achieved with thermal barrier coatings, effusion cooling, and air-assist atomizers. The flex-cycle combustor design, IPU starting analysis, and proposed development test plan are discussed. Author

A91-48799
ADVANCED MATERIALS AND THE PIVOTING DOOR REVERSER [LES MATERIAUX DE HAUTE TECHNOLOGIE ET LES INVERSEURS A PORTES A PIVOT FIXES]
JEAN-ALAIN JOUAN (Hurel-Dubois, Meudon-La-Fotet, France) Materiaux et Techniques (ISSN 0032-6895), vol. 79, May-June 1991, p. 49-55. In French and English.
Copyright

This paper describes the development of the pivoting door reverser for the Trent engine to be used in the MD11 and A330 commercial transports. Attention is focused on the predominantly composite thrust reverser door structure, acoustic treatment with composite sandwich, and the inner fixed structure design using carbon bismaleimide material. The pivoting door reverser is compared to the typical cascade reverser, and attention is given to advanced materials and technology for the Trent engine, and operational features of the inner fixed structure. R.E.P.

A91-48967
CALCULATIONS OF THE COMBUSTION TIME LAG IN COAXIAL-DUMP RAMJET COMBUSTORS
FREDERICK H. REARDON (California State University, Sacramento) and AMARANDRA DUVVUR (California, University, Irvine) IN: Heat Transfer and Fluid Mechanics Institute, 32nd, Sacramento, CA, June 6, 7, 1991, Proceedings. Sacramento, CA, California State University, 1991, p. 325-335. refs
Copyright

Ramjet combustors are studied theoretically to determine the existence and effects of the combustion time lag (CTL) and particularly examine the introduction of combustion instability. A CFD code is employed to describe the performance of a coaxial-dump ramjet combustor with respect to axial velocity and the axial distribution of the mean gas temperature. Two fuel injection methods are considered in determining the relationships between CTL and various design parameters. CTL is found to increase with fuel drop diameter and jet penetration distance and decrease with higher air velocity and greater fuel/air ratios when fuel is injected immediately upstream of the dump plane. When fuel is injected uniformly at a substantial distance upstream of the dump plane, the CTL increases as the combustor length increases and is unaffected by drop size and fuel/air ratio. C.C.S.

A91-49070
EFFECT OF ABRUPT INLET DISTORTION ON ENGINE STABILITY
XIAOFENG WANG (Chinese Flight Test Establishment, People's Republic of China) and NAIXING WANG (Northwestern

Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 167-169. In Chinese. refs

The unsteady response of a compressor to abrupt change of inlet temperature has been calculated by numerical integration with the 'actuator-volume' and the second order delay models. The calculated results compare favorably with flight test data. The unsteady response of the compressor to abrupt change of inlet pressure (or combined with inlet temperature) has also been calculated in the same manner. The calculated results show that the effects of the abrupt inlet pressure on compressor stability cannot be ignored. Author

A91-49178
QUICK AUTOMATIC EVALUATION OF PROPELLER PERFORMANCE COMBINED TO AN ENGINE

SHIGENORI ANDO and MICHIYO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 449, 1991, p. 294-302. In Japanese. refs

A quick automatic method is presented for evaluating a propeller performance combined to an engine. The formulation is obtained through drastic simplification by retaining the essential parts only. A scheme - 'thrust-consistent scheme' - is constructed for the part of propeller analysis. Accuracy examination has been made both for the static and the forward-moving conditions, and confirmed to be within 10 percent errors. One example of application to an engine-propeller combination is presented, which shows that the present method can be used to select the best set of several parameters such as diameter, solidity, and pitch. Author

A91-49209
THE KEY VECTORING ISSUE - THRUST CONTROL

Aerospace Engineering (ISSN 0736-2536), vol. 11, Aug. 1991, p. 25-27.
Copyright

Studies conducted to investigate the feasibility of incorporating thrust vectoring capability into propulsion systems for tactical aircraft are presented. For purposes of these studies, a group of 12 parameters were examined for each of the nine design schemes that include: (1) single vector electronics, single vector hydraulics, (2) dual vector electronics, dual vector hydraulics, and (3) dual vector and engine electronics, single vector hydraulics. Evaluation of the many design approaches to configuring a vector nozzle control system leads to the conclusion that the most viable option would be one with dual vector electronics and single vector hydraulics. R.E.P.

A91-49210
AIR PRECOOLING FOR AEROSPACEPLANE ENGINE - SOVIET STYLE

Aerospace Engineering (ISSN 0736-2536), vol. 11, Aug. 1991, p. 29, 30.
Copyright

A Soviet study is presented which indicates that an expanded air turborocket would be a good option for an aerospaceplane propulsion system. These engines operate with relatively high specific impulse at moderate specific mass and with air excess or at nearly stoichiometric conditions. After investigating four principal candidate engines, researchers focused on a specific version of an air turborocket configuration which has separated ducts, deep air cooling before the compressor, and without afterburning. Despite the only moderate increase in specific impulse, this configuration remains viable because it has low specific mass and it may be feasible to integrate it with ramjet cycles and also integrate its structure with the rocket engine structure. R.E.P.

A91-49742#
ROBUST FAULT DETECTION OF JET ENGINE SENSOR SYSTEMS USING EIGENSTRUCTURE ASSIGNMENT

R. J. PATTON and J. CHEN (York, University, England) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1666-1675. Research supported by SERC and Ministry of Defence of England. refs
(AIAA PAPER 91-2797) Copyright

A robust fault detection scheme which can be used to detect faulty sensors of a gas turbine engine system is examined. A robust fault detection approach based on eigenstructure assignment both in the continuous and discrete-time domains is described. By assigning the left eigenvectors of the observer orthogonal to the disturbance, the robust fault detection is achieved. Modeling errors are considered as disturbances acting upon the fault detection scheme. Simulation results show that the scheme can detect soft or incipient faults efficiently. P.D.

A91-50920
SYNTHESIS OF THE OPTIMAL DIGITAL CONTROL OF A GATE ENGINE FOR A TEST RIG [SINTEZ OPTIMAL'NOGO TSIFROVOGO UPRAVLENIIA VENTIL'NYM DVIGATELEM DLIA ISPYTATEL'NOGO STENDA]

V. M. VINOKUR, IU. G. ZHEZHELEV, B. I. IAKHINSON (Permskii Politekhnicheskii Institut, Perm, USSR), and G. A. STOROZHEV (Vsesoiuznyi Nauchno-Issledovatel'skii Proektnyi Institut Tiazhpromelektroproekt, Perm, USSR) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 13, May-June 1991, p. 48-52. In Russian. refs
Copyright

The suitability of using a gate engine as the electric drive of a test rig for fuel-regulating equipment of a gas turbine engine is demonstrated. A version of microprocessor control of the gate engine is considered. The optimization criterion is formulated, and algorithms for the optimal digital control of the gate engine are presented. L.M.

A91-51613
THE EXPERIMENTAL INVESTIGATION OF ROTATING STALL OF AN INSTALLED COMPRESSOR

DIYI TANG, LIJUN LI, WENLAN LI, and ZHENGFENG HU (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, July 1991, p. 253-261. In Chinese. refs

The complex process of inception, development, and disappearance of rotating stall in a multistage axial compressor has been observed and studied in detail. The characteristic parameters such as stall inception point, cell number, frequency, and relative propagation velocity are reported, and the flow fields in the stall cell and the unstalled portion are presented. The rotating stall is of the one-cell configuration. It is confirmed that the rotating stall behavior in multistage compressors is simpler. Analysis reveals that the abrupt stall occurring at medium speed can be diagnosed using measurements from a given empirical criterion. When the measurements go beyond the empirical range there are still one to two minutes left before the whole compressor loses its stability, an adequate warning time for preventing the occurrence of rotating stall. At low speed the stability limit has two branches: the stall line of the whole compressor and the rotating stall inception margin of the first stage. C.D.

A91-51760
AIR-BREATHING PROPULSION

WILLIAM C. ELROD (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Critical technologies for national defense. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 149-164. refs
Copyright

Air-breathing propulsion technologies are essential elements of such military vehicular systems as aircraft, cruise missiles, land combat vehicles, and naval vessels; these employ gas turbine, ramjet, and diesel engines. A major development thrust for the most often employed of these is the U.S. DOD's Integrated High-Performance Turbine Engine Technology (IHPTET) program, whose aim is the doubling of aircraft gas turbine system capabilities by the year 2000 through the maximization of combustor and turbine temperatures. IHPTET is giving attention to high service

temperature low-density materials such as ceramic-matrix composites, carbon/carbon composites, and intermetallic alloys, as well as to their production methods and structural design practices. O.C.

A91-52220
A DYNAMIC MODEL OF TWO-SPOOL TURBO-JET ENGINE WITH POST-STALL CAPABILITY
SHIMIN HU, JIANGUO SUN, CAIHONG JIANG, BAOHUI WANG (Nanjing Aeronautical Institute, People's Republic of China), WANGFENG SUN, and GUANGPING ZHU (Shenyang Aeroengine Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B300-B303. In Chinese. refs

A dynamic model of two-spool turbo-jet engine with post-stall capability is developed. Combustors with rich fuel and lean fuel are both considered. By the use of conservation equations of fluid energy, mass, and momentum, the volume dynamics are described in detail. The utilization of this model with surge or stall is successfully induced by changes of nozzle area, the main combustor fuel-step, and closing nozzle. The simulation results to induce surge coincide with the test results at home and abroad. Author

A91-52301
EXPERIMENTAL STUDY ON AUTOIGNITION IN A SCRAMJET COMBUSTOR
YUKINORI SATO, MASAMI SAYAMA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), GORO MASUYA, TOMOYUKI KOMURO, KENJI KUDOU, ATSUO MURAKAMI, KOUICHIRO TANI, and NOBUO CHINZEI (National Aerospace Laboratory, Miyagi, Japan) (International Symposium on Air Breathing Engines, 9th, Athens, Greece, Sept. 3-8, 1989, Proceedings. Volume 1, p. 569-576) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 657, 658. Abridged. Previously cited in issue 02, p. 150, Accession no. A90-12559. refs
Copyright

A91-52310
STUDY OF TWO-PHASE FLOW FOR A RAMJET COMBUSTOR
D. LAREDO, Y. LEVY, and Y. M. TIMNAT (Technion - Israel Institute of Technology, Haifa) (International Symposium on Air Breathing Engines, 9th, Athens, Greece, Sept. 3-8, 1989, Proceedings. Volume 1, p. 305-324) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 724-731. Previously cited in issue 02, p. 149, Accession no. A90-12532. refs
Copyright

A91-52506
MATERIALS AND PROCESS DIRECTIONS FOR ADVANCED AERO-ENGINE DESIGN
D. DRIVER (Rolls-Royce, PLC, Derby, England) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 883-902. refs
Copyright

Civil and military trends in aircraft engine design are reviewed. It is noted that the associated demands in materials technology are for high specific strengths and stiffness as well as increased temperature capability. Also required are manufacturing processes which enable components with tailored microstructure and properties to be made in a consistent and cost-effective manner. The trend toward 'designer materials' is being demonstrated with single-crystal technology and with thermomechanicaly processed and powder-processed components. Future demands will require a move from monolithic materials to more complex metal-matrix, intermetallic, glass, and ceramic composite structures. L.M.

A91-52507
SPECIFIC PROBLEMS IN ADVANCED STATIONARY GAS TURBINE DESIGN
T. SCHULENBERG (Siemens AG, Muelheim an der Ruhr, Federal Republic of Germany) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 903-912.
Copyright

The paper summarizes the objectives of current development for stationary, heavy duty gas turbines, which shall be installed in peak load or base load power stations. The importance of advanced materials for high temperature applications is highlighted. Future trends for increasing turbine inlet temperatures and net efficiencies of different power plants are discussed. Author

A91-52932
PROPELLER TECHNOLOGIES FOR REGIONAL AIRCRAFT
PAUL METHVEN (Dowty Aerospace Gloucester, England) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 11 p. refs
(SAE PAPER 910997) Copyright

Operating experience with the state-of-the-art composite bladed propellers at Dowty Aerospace Gloucester is reviewed. Problems discussed include composite blade development, control system design, hub design, and aerodynamics/acoustics. Prospects for future developments are addressed as the commuter market moves forward to the high speed turboprop and is challenged by the Regional Jet. O.G.

A91-52942
GARRETT TPF351-20 ENGINE FLIGHT TEST AND GROUND TEST PERFORMANCE
R. D. MILLER (Allied-Signal Aerospace Co., Garrett Engine Div., Phoenix, AZ) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 7 p.
(SAE PAPER 911011) Copyright

The status of the Garrett TPF351-20 engine test program is described. The engine design is presented and features that include a two-stage centrifugal-flow compressor, axial flow turbines, and gearboxes to accommodate engine components are outlined. Results of dynomometer testing, propeller stand testing, and flight tests are given. No major problems were encountered during the 2285 test hours and 295 flight hours accumulated by the TPF351-20 engines as of February 1, 1991. V.I.

A91-52943
LF500 ENGINES AND THE REGIONAL AIRLINE MARKET
ALFRED A. BOUTIN (Textron Lycoming, Stratford, CT) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 7 p.
(SAE PAPER 911012) Copyright

Some of the major issues that determine the success of a gas turbine engine in the demanding regional airline market are outlined. The application of conclusions drawn from nearly ten years of experience in the extensive corporate and regional airline operations is described in detail. Lessons learned, incorporated into current and future models, are associated with short haul reliability, maintainability, operating cost and foreign object damage. *This series has the capability to achieve 14,000 pounds thrust,* using low risk derivative development to give the operator a proven, reliable, and cost-effective powerplant. V.I.

A91-52945
TURBOSHAFT ENGINE DEVELOPMENT FOR COMMERCIAL TILTROTOR AIRCRAFT
HOWARD A. CHAMBERS (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 14 p. refs
(SAE PAPER 911017) Copyright

An evaluation is made of the development process of the T406-AD-400 turboshaft engine employed by the V-22 tilt-rotor VTOL aircraft, with a view to the consequences of the lessons thus learned for the prospective development of the GMA2100 turboprop, GMA3007 turbofan, and GMA1107 turboshaft. The lessons encompass variable-engine attitude capabilities, the

integration of a fly-by-wire control system, the incorporation of flight test experience into engine design, and the development of unique test facilities which addressed the requirements of each major component. O.C.

A91-52946
FULL AUTHORITY DIGITAL ELECTRONIC CONTROL OF PRATT AND WHITNEY 305 TURBOFAN ENGINE
A. SOLOMON (Pratt and Whitney Canada, Longueil) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 8 p. refs
(SAE PAPER 911018) Copyright

A general overview of the requirements, development, operability and performance of the PW305 propulsion system is given. The system is equipped with a full authority digital electronic control to meet the increased demand on performance and safe operation of the propulsion system, in particular for commuter and business aircraft. It is designed to provide optimum engine operation within safe limits, reduced pilot workload and high reliability over the whole flight envelope. Accurate control of the dynamic behavior of the engine was obtained over the entire flight envelope. To achieve the set objectives, a combination of analytical design and experimental tuning was used. V.I.

A91-52958
A CURRENT ASSESSMENT OF THE INLET/ENGINE TEMPERATURE DISTORTION PROBLEM
SAE Aerospace Resource Document, ARD 50015, Jan. 22, 1991, 75 p.
(SAE ARD 50015) Copyright

Future aircraft engines requiring transient or sustained high engine power operations that involve temperature distortions may exceed the capabilities of current compensation methods based on avoidance and/or accommodation. An industry-wide methodology for temperature distortion assessment/verification is accordingly required. It is presently noted that spatial temperature distortions, and a temperature ramp, can be analyzed by assuming that spatial temperature distortions degrade the surge line, while a temperature ramp raises the operating line. These effects are additive. O.C.

A91-52961
GAS TURBINE ENGINE INTERFACE TEST DATA REDUCTION COMPUTER PROGRAMS
SAE Aerospace Recommended Practice, ARP 1210, Nov. 20, 1990, 10 p.
(SAE ARP 1210) Copyright

A class of digital computer programs are described which can reduce engine-test data relating to the engine interface in the airframe or test facility. The engine and the instrumentation required to obtain data are given, and the program is described both as a subroutine and as an independent program. The test-data reduction can be applied to component performance and/or external performance parameters such as thrust and airflow. The program language is FORTRAN, and key parameters of programming practices are listed in users manuals or given particular specifications. Program capabilities include installed performance effects and logic for situations such as data-element omission and rejection and bad-data recognition. Specifications are also given for input/output, program identification and checkout, and revisions. C.C.S.

N91-29178# National Research Council of Canada, Ottawa (Ontario). Engine Lab.
COMPRESSOR FAULT MODELLING FOR ENGINE HEALTH MONITORING: REVIEW AND RECOMMENDATIONS
P. J. TURYK Apr. 1989 147 p
(NRC-TR-ENG-004; NRC-31204; CTN-91-60034) Copyright
Avail: NTIS HC/MF A07

A critical literature review was carried out concerning methods of gas turbine compressor performance calculations, and performance loss sources in compressors caused by rotor blade tip clearance, airfoil surface roughness and leading edge deterioration. The focus of the review was on engine health monitoring (EHM) requirements for accurate and reliable calculation procedures, and on engine performance losses related to damage to gas-path turbomachinery components. The performance calculation methods and loss sources in the literature were then evaluated in EHM engine simulation component models. The major conclusions were as follows: (1) Performance analysis methods are generally superior to design analysis procedures in calculating compressor performance; (2) The reliability and accuracy of computational methods increased with modelling sophistication, that is from one dimensional (1-D) to 3-D; (3) 3-D methods are well suited to fluid mechanics investigations while 1- and 2-D methods are suited to calculation of compressor maps for EHM component simulation; (4) A 2 to 3 percent loss in efficiency is experienced in a compressor stage for each 1 pct. increase in tip clearance relative to blade height (An engine scale effect was noted); and (5) Surface roughness losses depend on Reynolds number of the flow, and on the roughness characteristics. Few numerical expressions exist which relate performance losses to surface roughness. CISTI

N91-29180# National Aeronautical Establishment, Ottawa (Ontario). Inst. for Aerospace Research
THE FAILURE OF COMPONENTS IN POWER GENERATION EQUIPMENT
W. WALLACE, J.-P. IMMARIGEON, and A. K. KOUL 15 Jun. 1990 52 p Presented at a Short Course on Failure Analysis, Doha, Qatar, Oct. 1990 Prepared for Qatar Univ., Doha
(NAE-LTR-ST-1774; CTN-91-60099) Copyright Avail: NTIS HC/MF A04

The modern gas turbine engine is described in terms of the functions and operating conditions of the main sections including fan and compressor, combustion chamber, and the turbine section. Materials used for the primary structural components are indicated and the modes of deterioration affecting these components in service are reviewed. Failure of structural components may be due to material or manufacturing defects, to improper design or maintenance, or to insufficient knowledge of the modes and rates of damage accumulation in service. The need to understand the physical metallurgy of gas turbine materials and the way alloys respond to different engine operating conditions is emphasized. There is a need to control microstructures in all stages of processing since microstructures determine how the materials perform in service. Physical defects such as cavities, and microstructural discontinuities such as plate-like inclusions or precipitates must be avoided. The response to engine operation conditions in terms of the life limiting modes of degradation and their rates of damage accumulation must be known. Parts with finite lives must be withdrawn from service and either replaced or repaired before damage becomes critical. CISTI

N91-29182# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
GENERALIZED SIMPLIFIED ANALYTIC SOLUTION OF OPTIMUM CYCLE PARAMETERS FOR LAND AND AIRCRAFT GAS TURBINE ENGINES AND ITS APPLICATIONS
JIYA CUI 3 May 1991 20 p Transl. into ENGLISH from Jixie Gongcheng Xuebao (China), v. 25, no. 2, Jun. 1989 p 85-92
(AD-A237414; FTD-ID(RS)T-0647-90) Avail: NTIS HC/MF A03
CSCL 21/5

Nearly half a century has elapsed since the advent of gas turbines. In cycle analysis, there are equations for deriving power or thrust from the specific heat, thermal efficiency, and various optimal (optimal reheating or increase in stress) pressure ratios of turbine exit pressures. However, there are no equations for the optimal pressure ratios of the fuel consumption rate with more complex relations. By using the parameter section simplified method system, the paper derives the simplified solution of the optimal pressure ratios; in addition, examples are cited in comparing the results of calculations and the precise solutions of the variable specific heat in order to have a correct evaluation of the extent of approximation and applications. GRA

N91-29183# *United Technologies Research Center, East Hartford, CT.*
HYDROGEN-FUELED SCRAMJET INVESTIGATION Final Report, Feb. 1987 - Apr. 1990
W. T. PESCHKE, T. J. BARBER, L. CHIAPPETTA, T. J. ANDERSON, and W. J. ECKERLE Feb. 1991 384 p
(Contract F33615-86-C-2695)
(AD-A237569; UTRC/R90-957663-1; WRDC-TR-90-2065) Avail: NTIS HC/MF A17 CSCL 21/2

An experimental and analytical study of the supersonic mixing and combustion processes associated with a free-shear layer is examined. A specific objective comprised quantifying the effects on the mixing and combustion processes of pressure gradients associated with the production of shock waves in the flow field. An experiment was conducted in a generic supersonic combustion configuration that incorporated the essential characteristics of scramjet combustors currently being considered for flight application. The objective of the analytical effort was to evaluate mixing and combustion models in state-of-the-art computational fluid dynamics (CFD) codes. The experiments provided accurate data used to formulate code input conditions and to evaluate codes that were formulated for application in current high speed propulsion design activities. Species concentration, total and static temperature, and pitot pressure profiles were measured in a shear layer experiment in which gaseous hydrogen was injected tangentially into a Mach 3 (nominal) vitiated air stream. In this experiment, hydrogen was injected adjacent to the upperwall of the test section. A nonintrusive optical diagnostic technique was used in conjunction with intrusive probing to define the flow field initial conditions and to characterize the detailed features of the flow field subsequent to hydrogen injection and combustion. GRA

N91-29184# Naval Postgraduate School, Monterey, CA.
EVALUATION OF AIRCRAFT TURBINE ENGINE REDESIGNS M.S. Thesis
EUGENE G. SUDOL, JR. and LARRY D. PRICE Jun. 1990 70 p
(AD-A237599) Avail: NTIS HC/MF A04 CSCL 21/5

This study of the Aircraft Turbine Engine Component Improvement Program (CIP) examines some of the problems associated with determining benefits accrued from CIP. The major emphasis of the thesis was developing a component selection method and an analysis procedure for detecting changes in logistics parameters. The data for this report come from aviation organizational level maintenance activities and squadrons. The thesis reached the conclusion that the effects of CIP are more effectively assessed at the component level rather than at the system level. The thesis further demonstrated the logical and data collection difficulties encountered in the process of isolating and measuring the incremental benefits obtained from CIP expenditures. GRA

N91-29186# Iowa State Univ. of Science and Technology, Ames. Dept. of Mechanical Engineering.
MODIFICATION OF AXIAL-FLOW COMPRESSOR STALL MARGIN BY VARIATION OF STATIONARY BLADE SETTING ANGLES Final Technical Report
JOHN P. RUKAVINA and THEODORE H. OKIISHI Apr. 1991 193 p
(Contract F33615-87-C-2739)
(AD-A238406) Avail: NTIS HC/MF A09 CSCL 13/7

The useful operating range of the multistage, axial-flow compressor component of a gas turbine engine limits the extent of operation of that engine. Generally, the compressor stalls or surges at a low flow rate and chokes a a high flow rate. Thus, any improvement in the range between these compressor aerodynamic limits is normally of benefit to the engine also. An idea for delaying the onset of rotating stall in a multistage, axial-flow compressor which involved circumferentially varying the blade setting angles of stationary blades upstream of the compressor rotors was investigated. Tests involving two low-speed, multistage, axial-flow compressors and an intermediate-speed, three-stage, axial-flow compressor were completed. Comparisons between baseline compressor (circumferentially uniform setting angles) and modified compressor (circumferentially varying setting angles) performance data were made. A variety of blade setting angle circumferential variation patterns were tested. GRA

N91-29188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A LINEAR CONTROL DESIGN STRUCTURE TO MAINTAIN LOOP PROPERTIES DURING LIMIT OPERATION IN A MULTI-NOZZLE TURBOFAN ENGINE
DUANE MATTERN (Sverdrup Technology, Inc., Brook Park, OH.) and PETER OUZTS 1991 28 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and ASEE Previously announced as A91-45780
(Contract NAS3-25266)
(NASA-TM-105163; E-6452; NAS 1.15:105163; AIAA-91-1997)
Avail: NTIS HC/MF A03 CSCL 21/5

The implementation of multi-variable control systems on turbofan engines requires the use of limit protection to maintain safe engine operation. Since a turbofan engine typically encounters limits during transient operation, the use of a limit protection scheme that modifies the feedback loop may void the desired 'guarantees' associated with linear multi-variable control design methods, necessitating considerable simulation to validate the control with limited protection. An alternative control design structure is proposed that maintains the desired linear feedback properties when certain safety limits are encountered by moving the limit protection scheme outside the feedback loop. This proposed structure is compared to a structure with a limit protection scheme that modifies the feedback loop properties. The two design structures are compared using both linear and nonlinear simulations. The evaluation emphasizes responses where the fan surge margin limit is encountered. Author

N91-30140# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.
***AIR FORCE RESEARCH IN AERO PROPULSION* TECHNOLOGY (AFRAPT) Final Report, 1 Sep. 1989 - 31 Aug. 1990**
J. DUGUNDJI, A. EPSTEIN, M. GILES, E. GREITZER, and M. MARTINEZ-SANCHEZ 27 Sep. 1990 30 p
(Contract AF-AFOSR-0288-85)
(AD-A229612; AFOSR-90-1154TR; AFOSR-A4) Avail: NTIS HC/MF A03 CSCL 21/5

This research grant consisted of ten separate projects: (1) Turbomachinery noise reduction through distortion amelioration; (2) Fluid mechanics of discrete passage diffusers; (3) Compressor stabilization through structural feedback; (4) Linearized Euler solutions for turbomachinery flutter and forced response; (5) Vortical flow behavior downstream of convoluted trailing edges; (6) Turbine blade tip forces; (7) Influence of inlet radial temperature distribution on turbine rotor heat transfer; (8) Effect of circumferential inlet distortion on the formation of turbine secondary flow vortices; (9) Inlet distortion with application to STOVL; and (10) Instability and distortion in multistage compressors. GRA

N91-30141*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE NAVY/NASA ENGINE PROGRAM (NNEP89): A USER'S MANUAL
ROBERT M. PLENCNER and CHRISTOPHER A. SNYDER Aug. 1991 118 p
(NASA-TM-105186; E-6484; NAS 1.15:105186) Avail: NTIS HC/MF A06 CSCL 21/5

An engine simulation computer code called NNEP89 was written to perform 1-D steady state thermodynamic analysis of turbine engine cycles. By using a very flexible method of input, a set of standard components are connected at execution time to simulate almost any turbine engine configuration that the user could imagine. The code was used to simulate a wide range of engine cycles from turboshafts and turboprops to air turborockets and supersonic

cruise variable cycle engines. Off design performance is calculated through the use of component performance maps. A chemical equilibrium model is incorporated to adequately predict chemical dissociation as well as model virtually any fuel. NNEP89 is written in standard FORTRAN77 with clear structured programming and extensive internal documentation. The standard FORTRAN77 programming allows it to be installed onto most mainframe computers and workstations without modification. The NNEP89 code was derived from the Navy/NASA Engine program (NNEP). NNEP89 provides many improvements and enhancements to the original NNEP code and incorporates features which make it easier to use for the novice user. This is a comprehensive user's guide for the NNEP89 code. Author

N91-30143# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
HIGH TEMPERATURE RESEARCH AT NLR
C. E. W. LOOIJE 10 Aug. 1988 14 p In DUTCH; ENGLISH *summary* *Submitted for publication*
(NLR-MP-88051-U; ETN-91-99653) Avail: NTIS HC/MF A03

High temperature research activities and test facilities at the NLR is surveyed. Research is directed towards the life extension of gas turbine components. Special attention is paid to corrosion prevention, materials selection, advanced repair techniques and life prediction. ESA

N91-30144# Royal Aerospace Establishment, Farnborough (England).
DESIGN OF ADVANCED BLADING FOR A HIGH-SPEED HP COMPRESSOR USING AN S1-S2 FLOW CALCULATION SYSTEM
R. B. GINDER, A. J. BRITTON, W. J. CALVERT, I. R. I. MCKENZIE, and JUDITH M. PARKER 30 Nov. 1990 14 p Presented at the I Mech E European Conference on Turbomachinery, London, England, 19-20 Mar. 1991
(RAE-TM-P-1196; BR300630; ETN-91-99853) Copyright Avail: NTIS HC/MF A03

A set of advanced blading has been designed for a five stage high speed research core compressor. The blade profiles were aerodynamically tailored using a sophisticated S1-S2 flow calculation system which incorporates inviscid-viscous blade to blade code. The design and measured performance of the compressor are compared with an initial conventionally bladed four stage version. The new design achieved a peak level of polytropic efficiency approaching 91 pct., a substantial improvement on the initial version. ESA

N91-30146# Royal Aerospace Establishment, Farnborough (England).
DESIGN AND PERFORMANCE OF ADVANCED BLADING FOR A HIGH-SPEED HP COMPRESSOR
R. B. GINDER 15 Jan. 1991 14 p Presented at the 36th ASME International Gas Turbine and Aeroengine Congress, Orlando, FL, 3-6 Jun. 1991
(RAE-TM-P-1201; BR301645; ETN-91-99893) Copyright Avail: NTIS HC/MF A03

A set of advanced blading was designed for a five stage high speed research cone compressor. The blade profiles were aerodynamically tailored using a sophisticated quasi three dimensional S1-S2 flow calculation system. This system involves iteration between blade to blade calculations using an inviscid viscous code, and a streamline curvature calculation for the pitchwise averaged throughflow. The design and measured performance of the new compressor are compared with an initial conventionally bladed four stage version. The new design achieved a peak level of polytropic efficiency approaching 91 percent, a substantial improvement on the initial version, but showed a shortfall in pressure ratio compared with design intent. Post test analyses based on measured performance data are used to give further insight into this result and indicate possible improvements in the design approach. ESA

N91-30147# Royal Aerospace Establishment, Farnborough (England).
APPLICATION OF S1BYL2 TO THE AGARD WG18 COMPRESSOR TEST CASES
W. J. CALVERT 27 Feb. 1991 21 p Presented at the 77th AGARD Propulsion and Energetics Panel Symposium on CFD Techniques for Propulsion Applications, San Antonio, TX, 27-31 May 1991
(RAE-TM-P-1204; BR301533; ETN-91-99894) Copyright Avail: NTIS HC/MF A03

S1BYL2 is an inviscid viscous blade to blade method for calculating the detailed aerodynamics and overall performance of compressor blades. It may be applied either on its own to predict the flow for individual blade sections, such as the mid span of a linear cascade, or in conjunction with a throughflow calculation to predict the performance of a complete axial compressor. New predictions for the V2 and ARL SL19 cascades and for the high speed compressor cases are presented. It is hoped that this will be one of many sets of calculations for these cases, so that an improved understanding of each case may be obtained, together with an appreciation of the strengths and weaknesses of different computational approaches. ESA

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A91-48609 National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
INTEGRATED FLIGHT-PROPULSION CONTROL CONCEPTS FOR SUPERSONIC TRANSPORT AIRPLANES
FRANK W. BURCHAM, JR., GLENN B. GILYARD (NASA, Flight Research Center, Edwards, CA), and PAUL A. GELHAUSEN (NASA, Ames Research Center, Moffett Field, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 16 p. refs
(SAE PAPER 901928) Copyright

Increased powerplant thrust and reduced fuel consumption are obtainable by controlling engine stall margins as a function of flight and engine operating conditions. An evaluation is presently conducted of the performance improvements obtainable by these means in SSTs. It is noted that inlet pressure recovery increases and inlet drag reductions are obtainable via inlet control system integration; the use of propulsion system forces and moments to augment the flight control and aircraft stabilization system can also reduce empennage areas, weights, and drag. Special control modes may be instituted for community noise minimization and emergency procedures. O.C.

A91-48637
USING INDEPENDENT DATA COLLECTIONS TO ESTABLISH ALTITUDE-KEEPING PERFORMANCE CHARACTERISTICS OF AIRCRAFT TYPES
ALEX P. SCHUST and KIMBERLY T. JOYCE (Arinc Research Corp., Aviation Systems Group, Annapolis, MD) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. refs
(SAE PAPER 901975) Copyright

The analysis of data from such sources as airworthiness certifications, height-measuring radar data collections, and manufacturer bench tests, can be used in the assessment of vertical aircraft performance bearing on the establishment of lateral, vertical, and longitudinal separation standards for aircraft traffic control. Tabulations are presented for the tolerance bands and altitude-measurement capability of such aircraft as the B 737, B 747, DC9, DC10, and L1011. O.C.

A91-49269
ARE YOU READY FOR LOC?
T. E. ARCHER Cockpit (ISSN 0742-1508), Apr.-June 1991, p. 5-12.
Copyright

A review is presented of the problems involved and the means of dealing with loss-of-control (LOC) i.e., failure of a tactical jet aircraft to respond to control inputs. It is contended that the predominant cause of LOC mishaps is inadequate stall/departure/spin training and the absence of a realistic tactical jet spin trainer. The difference between the spin/recovery characteristics of a jet trainer and those of a fighter/attack aircraft lies in the mass distribution of the aircraft, which has a pronounced effect on departure and spin characteristics. Consideration is given to wing-loaded versus fuselage loaded aircraft, the effects of mass distribution on the spin, and inertia yawing moment factors in determining spin characteristics. R.E.P.

A91-49275
ANALYSIS OF AIRCRAFT CONTROLLABILITY [ANALIZA STEROWNOSCI SAMOLOTU]
RYSZARD LEWANDOWSKI (Instytut Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 123, 1990, p. 3-102. In Polish. refs

The response of an aircraft to control surface deflections is analyzed with reference to the technical specifications and airworthiness standards. It is shown that relatively simple solutions for the controllability problem can be obtained by starting with the basic equations of aircraft motion and using a nondimensional system, Laplace transformation, and the transfer function concept. Aircraft responses are analyzed for different types of input conditions. Attention is given to abrupt and pulsed perturbation functions and output frequency characteristics as well as their interrelations. An analysis of maneuvers corresponding to large changes in motion parameters is presented. Some inverse problems are also discussed. V.L.

A91-49578
AIAA GUIDANCE, NAVIGATION AND CONTROL CONFERENCE, NEW ORLEANS, LA, AUG. 12-14, 1991, TECHNICAL PAPERS. VOLS. 1, 2, & 3
Conference sponsored by AIAA. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. Vol. 1, 707 p.; vol. 2, 646 p.; vol. 3, 705 p. For individual items see A91-49579 to A91-49776.
Copyright

Topics discussed include control design using parameter optimization; the theory and design for flexible structure control; the missile flight control; the aerospace guidance, navigation, and tracking; optimal control and optimization; the attitude control of flexible structures; the German approach to flight design; and the Space Station attitude. Some of the other topics are on H-infinity control and estimation; experiments in flexible structure control; the spacecraft attitude determination and control; nonlinear and optimal aircraft control; artificial intelligence applications; loop transfer recovery; the modeling and identification of flexible structures; and the optimal launch vehicle control. Attention is also given to the rotorcraft guidance and control; the pilot's associate; guidance, navigation, and control components and avionics; the robustness analysis and design; robotics for aerospace applications; integrated/multidisciplinary flight control; fuzzy logic applications; digital control and estimation; space transportation guidance and control; and control of large scale/multibody systems. I.S.

A91-49579#
FINE TUNING OF AIRCRAFT CONTROL LAWS USING PRO-MATLAB SOFTWARE
LEONARD R. ANDERSON (Boeing Co., Seattle, WA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1-7. refs
(AIAA PAPER 91-2600) Copyright

A method is described for 'tuning' the aircraft-designing control laws to a mixed set of stability and performance requirements, using the PRO-MATLAB software. Two design examples taken from commercial aircraft applications are described, demonstrating the ability of the method to tune the aircraft control laws containing many design variables to satisfy the requirements. I.S.

A91-49589#
AN APPROACH TO AUTOPILOT DESIGN FOR HOMING INTERCEPTOR MISSILES
DAVID V. STALLARD (Raytheon Missile Systems Laboratories, Tewksbury, MA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 99-113. refs
(AIAA PAPER 91-2612) Copyright

For the assumptions of a rigid missile, zero cross-coupling between axes and negligible lags in instruments and fin servos, the transfer functions in roll and pitch (yaw) of the airframe are derived. The design of the roll autopilot is summarized. An algebraic design method for a three-loop pitch (yaw) autopilot is presented, with constraints on the gain-crossover frequency and three closed-loop poles, based on high-frequency stability and the attitude loop through the randome error characteristic. Tail-controlled and wing-controlled airframes are compared, and the effects of C(m-alpha) are discussed. Examples of pitch (yaw) autopilot designs for tail-controlled and wing-controlled airframes are given. Author

A91-49590#
APPROXIMATING A LINEAR QUADRATIC MISSILE AUTOPILOT DESIGN USING AN OUTPUT FEEDBACK PROJECTIVE CONTROL
KEVIN A. WISE (McDonnell Douglas Missile Systems Co., Saint Louis, MO) and FARHAD DEYLAMI (Electronic Data Systems, Ypsilanti, MI) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 114-122. refs
(AIAA PAPER 91-2613) Copyright

This paper presents a projective controls approach used to design a bank-to-turn missile autopilot. Projective controls is used to obtain the eigenstructure of a linear quadratic state feedback regulator using output feedback, and retains the performance and robustness properties of the state feedback design. The steps of the design and analysis are presented. The results are compared to a Linear Quadratic Gaussian with Loop Transfer Recovery design. Author

A91-49591#
HIGH PERFORMANCE, ADAPTIVE, ROBUST BANK-TO-TURN MISSILE AUTOPILOT DESIGN
C. F. LIN, J. C. JUANG, Q. WANG (American GNC Corp., Chatsworth, CA), J. R. CLOUTIER, and J. H. EVERS (USAF, Armament Directorate, Eglin AFB, FL) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 123-137. refs
(Contract F08635-90-C-0362)
(AIAA PAPER 91-2614)

A general form for the missile autopilot design formulation is presented, and the HAVE DASH II autopilot is examined in detail. Two autopilot-design procedures are applied to the HAVE DASH II system, and the design insight due to each individual design method is combined and used to quantify and improve the resulting autopilot. I.S.

A91-49592#
MULTIVARIABLE STABILITY MARGINS FOR MISSILE AUTOPILOT COUPLING
W. F. ARNOLD, III, N. D. GATES (Sverdrup Technology, Inc.,

Eglin AFB, FL), and ARLYNN W. WILSON (Sverdrup Technology, Inc., Huntsville, AL) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 138-145. refs
(AIAA PAPER 91-2615) Copyright

Results are presented of performing multivariable stability margin calculations using a linearized multi-input/multi-output missile airframe/actuator/autopilot model that includes inertial, kinematic and aerodynamic cross-coupling phenomena. The effects of coupling on the performance of a typical tail controlled air-to-air missile airframe configuration is studied. The margin calculated allows an arbitrary number of system parameters to vary simultaneously in a real sense over a prescribed range. The calculation process not only provides stability margin information as a function of frequency, but also determines the combination of parameter variations that yields the minimum margin. It is found that the real multivariable stability margin calculation can be a useful tool in studying cross-coupling effects on missiles. Author

A91-49602#
REDESIGN OF THE FEEDBACK STRUCTURE FOLLOWING A BATTLE DAMAGE AND/OR A FAILURE ON A CONTROL SURFACE BY EIGENSTRUCTURE ASSIGNMENT
MARCELLO R. NAPOLITANO (West Virginia University, Morgantown) and ROBERT L. SWAIM (Oklahoma State University, Stillwater) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 247-254. refs
(AIAA PAPER 91-2626) Copyright

A method is proposed for redesigning the feedback structure of a damaged or failed control surface. Eigenstructure assignment is employed as a control-law-synthesis approach to redesign the gain matrix for an aircraft with a damaged stabilizer in order to restore the necessary handling qualities. The feedback structure is employed successfully to remove the damage induced dynamic coupling between longitudinal and lateral dynamics, to shape the eigenvectors, and to assign the necessary eigenvalues for good aerodynamics. C.C.S.

A91-49603*# McDonnell Aircraft Co., Saint Louis, MO.
HIGH ANGLE OF ATTACK CONTROL LAW DEVELOPMENT FOR A FREE-FLIGHT WIND TUNNEL MODEL USING DIRECT EIGENSTRUCTURE ASSIGNMENT
THOMAS R. WENDEL, JOSEPH R. BOLAND (McDonnell Aircraft Co., Saint Louis, MO), and DAVID E. HAHNE (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 255-266. refs
(AIAA PAPER 91-2627) Copyright

Flight-control laws are developed for a wind-tunnel aircraft model flying at a high angle of attack by using a synthesis technique called direct eigenstructure assignment. The method employs flight guidelines and control-power constraints to develop the control laws, and gain schedules and nonlinear feedback compensation provide a framework for considering the nonlinear nature of the attack angle. Linear and nonlinear evaluations show that the control laws are effective, a conclusion that is further confirmed by a scale model used for free-flight testing. C.C.S.

A91-49604*# California Polytechnic State Univ., San Luis Obispo.
DESIGNING LOW BANDWIDTH PROPULSIVE-ONLY FLIGHT CONTROLLERS
DANIEL J. BIEZAD (California Polytechnic State University, San Luis Obispo) and CHRISTOPHER P. AZZANO (USAF, Washington, DC) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 267-275. refs
(Contract NCC2-711)
(AIAA PAPER 91-2628) Copyright

Results from an investigation of using engine commands to control flight attitude are described. In-flight operation with simulated failed flight controls is reviewed and ground simulations of piloted propulsive-only control to touchdown are analyzed. A design of an optimal control law to assist the pilot is presented. Recommendations are made for more robust design and implementation. Results to date indicate that simple and effective augmented control can be achieved in a wide variety of failed configurations. Author

A91-49605*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ACTIVE FLUTTER SUPPRESSION - CONTROL SYSTEM DESIGN AND EXPERIMENTAL VALIDATION
MARTIN R. WASZAK (NASA, Langley Research Center, Hampton, VA) and S. SRINATHKUMAR (National Aeronautical Laboratory, Bangalore, India) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 276-286. refs
(AIAA PAPER 91-2629) Copyright

The synthesis and experimental validation of an active flutter suppression controller for the Active Flexible Wing wind-tunnel model is presented. The design is accomplished with traditional root locus and Nyquist methods using interactive computer graphics tools and with extensive use of simulation-based analysis. The design approach uses a fundamental understanding of the flutter mechanism to formulate a simple controller structure to meet stringent design specifications. Experimentally, the flutter suppression controller succeeded in simultaneous suppression of two flutter modes, significantly increasing the flutter dynamic pressure despite errors in flutter dynamic pressure and flutter frequency in the mathematical model. The flutter suppression controller was also successfully operated in combination with a roll maneuver controller to perform flutter suppression during rapid rolling maneuvers. Author

A91-49606#
SIMULTANEOUS CONTROL-LAW SYNTHESIS OF AN AIRCRAFT YAW-DAMPER AND MODAL SUPPRESSION SYSTEM USING PARAMETER OPTIMIZATION
MARTIN C. BERG (Washington, University, Seattle) and STEVEN D. EVERS IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 287-297. refs
(AIAA PAPER 91-2630) Copyright

A new method is presented for the simultaneous control-law synthesis of a yaw-damper and low-order modal suppression system (MSS) for a commercial aircraft. Traditional yaw-damper designs primarily address stabilization of only the aircraft rigid-body modes. The MSS control-law is often synthesized after a yaw-damper design has already been completed, and acts to attenuate aircraft structural vibration encountered in flight through turbulence. A new control-law parameter optimization algorithm, implemented in the computer program SANDY, is presented that allows for the direct synthesis of a combined yaw-damper/MSS system having a low-order and multiple-input/multiple-output structure. Measures of closed-loop performance and stability robustness are evaluated using a 33rd-order aircraft model. Results of the synthesized 4th-order and 8th-order control-laws are compared with those of LQR optimal full-size feedback control-laws and a classical yaw-damper design. Author

A91-49607#
MULTIOBJECTIVE CONTROL LAW TRAINING METHODOLOGY FOR AIAA AIRCRAFT CONTROL DESIGN CHALLENGE
YING-JYI P. WEI (General Dynamics Corp., Fort Worth, TX) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC,

American Institute of Aeronautics and Astronautics, 1991, p. 298-307. refs
(AIAA PAPER 91-2632) Copyright

A training methodology formulated by constrained optimization is applied to aircraft control design in which the multiple control-system design requirements are expressed as a cost function and a set of constraints. The control methodology is employed to develop a model-following pitch-axis control law for stability augmentation into an autopilot control package. Because the design requirements and system nonlinearities are directly incorporated into the design process, the control law is effective and is validated during the design. C.C.S.

A91-49608#
LINEAR AND NONLINEAR FLIGHT-CONTROL OF THE AIAA CONTROLS DESIGN CHALLENGE AIRPLANE

KEVIN A. WISE, ARJUN GODHWANI, KEQIN GU (Southern Illinois University, Edwardsville, IL), MICHAEL W. DIERKS, BRUCE KERKEMEYER, and JICHENG TANG IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 308-318. refs
(AIAA PAPER 91-2634) Copyright

This paper presents and compares linear and nonlinear flight-control system designs for the AIAA Controls Design Challenge Airplane. The linear flight-control system is designed by separating pitch and roll-yaw dynamics and designing independent autopilots. The pitch flight control system uses proportional-plus-integral control and is designed using linear quadratic theory. The roll-yaw flight control system is designed using parameter-optimization techniques on a fixed controller structure in an H-infinity sensitivity minimization. Both the pitch and roll-yaw gain selection has been completely automated. The nonlinear autopilot has similar command loops as the linear-gain scheduled control law, but also uses dynamic model inversion to cancel gyroscopic effects in the moment equations. This is expected to improve performance during maneuvers and at high angles of attack. Author

A91-49609#
NONLINEAR MODEL-FOLLOWING CONTROL APPLICATION TO AIRPLANE CONTROL

WAYNE C. DURHAM, FREDERICK H. LUTZE (Virginia Polytechnic Institute and State University, Blacksburg), M. R. BARLAS, and BRUCE C. MUNRO IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 319-335. refs
(AIAA PAPER 91-2635) Copyright

Nonlinear model-following control design is applied to the problem of control of the six degrees of freedom of an airplane that lacks direct control of lift and side-force. The nonlinear expressions for the error dynamics of the model-following control are examined using Liapunov stability analysis. The analysis results in nonlinear feedforward and feedback gains that are functions of the airplane and model states. As a consequence, gain scheduling requirements for the implementation of the model-following control are reduced to only those involving the estimation of stability and control derivatives of the airplane. The use of these gains is shown through an example application to the control of a nonlinear aerodynamic and engine model provided by NASA Ames-Dryden Flight Research Facility. The model being followed is based on a trajectory generation algorithm. Author

A91-49610#
OPTIMIZATION-BASED LINEAR AND NONLINEAR DESIGN METHODOLOGIES FOR AIRCRAFT CONTROL

CHIEN HUANG, JAMES TYLOCK, PAUL MARTORELLA, and GARETH KNOWLES (Grumman Corp., Bethpage, NY) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 336-346. refs
(AIAA PAPER 91-2636) Copyright

Preliminary control designs for the AIAA Control Design Challenge are described. Two methods, one based on classical and one based on modern control concepts, were applied. The designs were easy to carry out, which allowed fast turn-arounds. The designs were evaluated using an altitude-command, velocity-hold command for a low dynamic pressure flight condition. The results show that the goals can be met only if the low rate limit of actuators is raised. Comments about the design aircraft and control requirements are also included. Author

A91-49611#
LEARNING AUGMENTED FLIGHT CONTROL FOR HIGH PERFORMANCE AIRCRAFT

WALTER L. BAKER and JAY A. FARRELL (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 347-358. refs
(AIAA PAPER 91-2836) Copyright

The approach to flight control presented emphasizes the incorporation of learning systems in the design, development, and implementation of automatic control systems. Learning systems automatically synthesize data from multivariable functional mapping to incorporate the synthesis into the control system architecture. The learning control system is described as part of a combination with the adaptive control system, and the concept of spatially localized learning is presented. Application considerations are listed including control law design, posterior estimators, and the training procedure. The methodology can be applied to control system design, the on-line accommodation of uncertainty, and closed-loop system performance. Higher levels of performance can be expected from learning augmentation because of the resulting synergistic hybrid control systems with high capabilities. C.C.S.

A91-49638#
CLASSICAL TURNING PERFORMANCE OF A FIGHTER AIRCRAFT REVISITED

ERIC HOFFMAN and HAROLD STALFORD (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 606-616. refs
(AIAA PAPER 91-2667) Copyright

An analytical model of a high angle of attack fighter aircraft is considered. The 6-degree-of-freedom dynamics is related to the type of dynamics treated previously by other authors. Classical turning performance characteristics are evaluated, and simple turning tactics based on multiple time scales are explored. The results show that turning performance with constant energy along the trajectory is only a small improvement over a classical index of turning performance defined by constant altitude and constand speed. Thrust vectoring was found to have an insignificant effect on turning performance for constant altitude turns and for turns in which energy is constant along the trajectory. Author

A91-49641#
ENDURANCE INCREASE BY PERIODIC OPTIMAL CAMBER CONTROL

GOTTFRIED SACHS and RAINER MEHLHORN (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 635-641. refs
(AIAA PAPER 91-2670) Copyright

Aircraft endurance optimization is proposed by means of periodic optimal control of the variable camber corresponding to the control of the throttle and elevator. The variable camber allows the optimization of the lift/drag ratios in terms of each flight condition encountered during the unsteady phases of endurance cruises. The method - tested on a model for aircraft aerodynamics

and power-plant characteristics - is found to be superior to steady state flights in terms of increasing the endurance of the aircraft. C.C.S.

A91-49642#
ROBUST FLIGHT PATH CONTROL SYSTEM DESIGN WITH MULTIPLE DELAY MODEL APPROACH
YOSHIKAZU MIYAZAWA (National Aerospace Laboratory, Tokyo, Japan) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 642-652. refs
(AIAA PAPER 91-2671) Copyright

Multiple delay models (MDMs), linear quadratic regulators, and proportional output feedback are combined to develop a system design for flight control. The MDM concept is introduced to permit the representation of uncertain dynamics in the high frequency range without requiring adjustment of the weighting matrices in the quadratic performance index. The feasibility of the approach is examined by applications to a conventional transport and a powered-lift STOL, and the numerical results prove the method effective. C.C.S.

A91-49643#
NEURAL NETWORKS APPROACH TO AIAA AIRCRAFT CONTROL DESIGN CHALLENGE
C. M. HA (General Dynamics Corp., Fort Worth, TX) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 653-663. refs
(AIAA PAPER 91-2672) Copyright

This paper focuses on designing a discrete-time lateral-directional control law for a high-performance aircraft using neural networks. The control law structure is composed of feedback and filter components formulated in the form of a 3-layer feedforward neural network whose parameters are adjusted by a gradient descent algorithm to provide stabilization about the aircraft center-of-mass and asymptotic tracking of pilot command input. The number of parameters was chosen in an ad hoc manner. Only rate gyro and lateral accelerometer outputs are available for feedback, while rudder pedal and lateral stick commands are input signals to the filter. Linear simulation results at an operating point within the aircraft's envelope in the presence of atmospheric turbulence, actuator and sensor noises shed light on the ability of neural networks to serve as a practical tool for flight control law designers. Author

A91-49644#
AIRCRAFT CONTROL-LAW SYNTHESIS USING CONSTRAINED PARAMETER OPTIMIZATION - APPLICATION TO 1991 DESIGN CHALLENGE
UY-LOI LY, DUANE EASTERLY, and SANJAY SWAMY (Washington, University, Seattle) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 664-676. refs
(AIAA PAPER 91-2675) Copyright

This paper describes the application of a multivariable control design method based on parameter optimization to the design of a multiloop aircraft-flight-control system. Specifically, the design approach is applied to the direct synthesis of a multivariable 'inner-loop' feedback control system based on total-energy principles. The design procedure offers a structured approach for the determination of a set of controller gains that meet design specifications in closed-loop stability, command tracking performance, disturbance rejection, and limits on control activities. Direct trade-off among many real design goals are rendered systematic by the proposed method following proper formulation of the design objectives and constraints. A command augmentation design is synthesized and its performance shown for one of eight flight configurations. Author

A91-49671#
TIME-OPTIMAL REORIENTATION MANEUVERS FOR AN AIRCRAFT WITH THRUST-VECTOR CONTROL
FREDERICK H. LUTZE, EUGENE M. CLIFF, KLAUS H. WELL (Virginia Polytechnic Institute and State University, Blacksburg), and SPIRO BOCVAROV IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 936-948. refs
(Contract F49620-87-C-0016; AF-AFOSR-89-0001)
(AIAA PAPER 91-2709) Copyright

Results are presented from a study of time-optimal reorientation maneuvering of an aircraft with thrust-vectoring capability. An accurate mathematical model of the aircraft and the interacting environment (the aerodynamic forces and moments) is developed. First-order necessary conditions for optimality are applied and a family of extremal solutions obtained for a few reorientation maneuvers of interest. The thrust-vectoring power is parametrically varied and thus an estimate of the reduction in time to perform specific maneuvers, due to the thrust-vectoring enhancement of the aircraft, is determined. Author

A91-49672*# Minnesota Univ., Minneapolis.
OPTIMIZATION OF LATERAL-DIRECTIONAL DYNAMICS FOR AN AIRCRAFT OPERATING AT HIGH ANGLE OF ATTACK
S. A. SNELL, WILLIAM L. GARRARD, JR. (Minnesota, University, Minneapolis), and DALE F. ENNS (Honeywell Systems and Research Center; Minnesota, University, Minneapolis) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 949-966. refs
(Contract NAG1-321)
(AIAA PAPER 91-2711) Copyright

In this paper, the control laws for the lateral-directional dynamics of a supermaneuverable aircraft is analyzed with a view to reducing the levels of lateral acceleration and sideslip, which are encountered during aggressive rolling maneuvers at high angles of attack. The analysis uses a linearized model of the lateral-directional dynamics and thus H-free-flow techniques can be applied. It is shown that trade-offs exist between simultaneously minimizing lateral acceleration measured at the pilot's station, ny(p), minimizing sideslip and minimizing tracking errors between the roll-rate about the velocity vector and its command. The paper concludes that a significant reduction in ny(p) is only attainable by compromising the roll-rate performance. Author

A91-49676*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEURAL NETWORK APPLICATION TO AIRCRAFT CONTROL SYSTEM DESIGN
TERRY TROUDET, SANJAY GARG, and WALTER C. MERRILL (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 993-1009. Previously announced in STAR as N91-27167. refs
(AIAA PAPER 91-2715) Copyright

The feasibility of using artificial neural network as control systems for modern, complex aerospace vehicles is investigated via an example aircraft control design study. The problem considered is that of designing a controller for an integrated airframe/propulsion longitudinal dynamics model of a modern fighter aircraft to provide independent control of pitch rate and airspeed responses to pilot command inputs. An explicit model following controller using H infinity control design techniques is first designed to gain insight into the control problem as well as to provide a baseline for evaluation of the neurocontroller. Using the model of the desired dynamics as a command generator, a multilayer feedforward neural network is trained to control the vehicle model within the physical limitations of the actuator dynamics. This is achieved by minimizing an objective function which is a weighted sum of tracking errors and control input

commands and rates. To gain insight in the neurocontrol, linearized representations of the nonlinear neurocontroller are analyzed along a commanded trajectory. Linear robustness analysis tools are then applied to the linearized neurocontroller models and to the baseline H infinity based controller. Future areas of research identified to enhance the practical applicability of neural networks to flight control design. Author

A91-49688#
CONTROL OF AN ADVANCED FIGHTER AIRCRAFT USING LOOP SHAPING
ANDREW SPARKS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1136-1144. refs
(AIAA PAPER 91-2730)

The control of the lateral-directional axis of an advanced fighter aircraft model is studied. The addition of canards to the conventional lateral force and moment control effectors permits unconventional flight modes. Flight control laws are designed for the aircraft's lateral-directional axis using mixed H-2 and H-infinity optimal control law synthesis with loop transfer recovery. The desired loop shape is selected to meet performance and robustness goals. The choice of design parameters to achieve the desired loop shape and the tradeoffs used in the design are illustrated. The closed loop aircraft performance during conventional maneuvers, as well as during a flat turn strafing maneuver, are examined. Author

A91-49689#
THE DESIGN OF REDUCED-ORDER LUENBERGER OBSERVERS WITH PRECISE LTR
JEWEL B. BARLOW, DIANNE P. O'LEARY (Maryland, University, College Park), and MOGHEN M. MONAHEMI IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1145-1159. refs
(Contract AF-AFOSR-87-0158)
(AIAA PAPER 91-2731) Copyright

This work concerns the design of reduced-order observers for controllable, observable, and regular systems in which the number of measurements is more than the number of controls. It uses eigenstructure assignment whereas other approaches use Kalman filter (LQG/LTR) methods. The advantages of this approach are: (1) precise LTR rather than approximate LTR, (2) no restriction to minimum phase systems, (3) finite observer gain rather than asymptotic observer gain, and (4) simpler and more efficient numerical calculation. Case studies are presented illustrating these features in aircraft control applications. Author

A91-49708#
DESIGN AND ROBUSTNESS ISSUES FOR HIGHLY AUGMENTED HELICOPTER CONTROLS
STEPHEN OSDER and DONALD CALDWELL (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1370-1380. refs
(AIAA PAPER 91-2751) Copyright

This paper discusses design procedures for achieving a multiple input, multiple output, fly-by-wire flight control system for helicopters. It defines an interpretation of 'highly augmented' as requiring tight stabilization of all commanded states, including automatic trimming. Design procedures are given which provide physical insights into how control decoupling and desired bandwidths are achieved, using a contemporary attack helicopter as the model. A high gain, explicit model following system is shown to meet practical robustness criteria that are designed to validate performance and stability when extremes of the helicopter nonlinear dynamics become part of the control problem. Comparison of this system's performance with published 'optimal' designs based on the same high order, linear helicopter model are made, showing that these other designs will not meet the proposed practical robustness tests. Author

A91-49709#
DESIGN OF FLIGHT CONTROL SYSTEMS TO MEET ROTORCRAFT HANDLING QUALITIES SPECIFICATIONS
EICHER LOW and WILLIAM L. GARRARD (Minnesota, University, Minneapolis) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1381-1391.
(Contract DAAL03-86-K-0056)
(AIAA PAPER 91-2752) Copyright

This paper describes a methodology for the design of control laws for improvement of helicopter handling qualities. The design procedure uses eigenstructure assignment techniques for the design of inner loop control laws which decouple roll, pitch, and yaw rates and vertical velocity, provide appropriate bandwidths in all channels, and stabilize low-frequency open-loop instabilities. With the inner loops closed, the angular rates and vertical velocity responses to commands are approximated by four decoupled first-order systems. Various response types can then be easily realized by simple single-loop feedbacks and feedforwards wrapped around these inner loops. Both time and frequency responses show that the closed loop helicopter provides excellent nominal performance in terms of tracking pilot commands and achievement of desired response type characteristics. The control laws presented in this paper provide better stability and performance robustness and are simpler in structure than those designed using a previous eigenstructure procedure proposed by the authors. Author

A91-49710*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HELICOPTER FLIGHT-CONTROL DESIGN USING AN H(2) METHOD
MARC D. TAKAHASHI (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1392-1416. refs
(AIAA PAPER 91-2753) Copyright

Rate-command and attitude-command flight-control designs for a UH-60 helicopter in hover are presented and were synthesized using an H(2) method. Using weight functions, this method allows the direct shaping of the singular values of the sensitivity, complementary sensitivity, and control input transfer-function matrices to give acceptable feedback properties. The designs were implemented on the Vertical Motion Simulator, and four low-speed hover tasks were used to evaluate the control system characteristics. The pilot comments from the accel-decel, bob-up, hovering turn, and side-step tasks indicated good decoupling and quick response characteristics. However, an underlying roll PIO tendency was found to exist away from the hover condition, which was caused by a flap regressing mode with insufficient damping. Author

A91-49711#
INPUT-OUTPUT LINEARIZATION OF A THREE DIMENSIONAL MODEL OF A TWIN-LIFT HELICOPTER SYSTEM
MANOJ MITTAL and J. V. R. PRASAD (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1417-1426. refs
(AIAA PAPER 91-2754) Copyright

A twin-lift system offers an efficient and economically attractive solution to the heavy lift problem. This work deals with the design of a nonlinear controller for such a system. The controller design is based on input-output linearization of a three-dimensional model of the system. A comprehensive model including the rigid body

dynamics of the two helicopters, the spreader bar, and the load is developed. The mathematical model for helicopter aerodynamics consists of generic, nonlinear, force and moment models for each helicopter component: main rotor, tail rotor, fuselage, and empennage. The spreader bar and load aerodynamics are also included in the system model. The nonlinear control scheme is implemented in a numerical simulation of the twin-lift model developed. Author

A91-49717#
USING 'SMART' ACTUATORS TO IMPLEMENT EMERGING ACTIVE CONTROL FUNCTIONS
MARC STEINBERG (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1471-1481. refs
(AIAA PAPER 91-2763)

Recent advances in electronics technology have made it feasible to locate microprocessors on or near aircraft actuators and create smart actuation systems. This paper examines the potential role of such systems in the implementation of emerging active control functions such as actuator rate saturation compensation, reconfigurable control, and active flutter suppression. For rate saturation compensation, a novel approach is presented that makes full use of the capabilities of smart actuation systems. The benefits of this approach are demonstrated through the results of analysis, simulation, and some initial laboratory testing. In addition, a brief description of two smart actuation systems is presented to show the potential of these devices. Author

A91-49724*# Arizona State Univ., Tempe.
A SEQUENTIAL APPROACH TO MULTIVARIABLE STABILITY ROBUSTNESS ANALYSIS
BRETT NEWMAN and DAVID K. SCHMIDT (Arizona State University, Tempe) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1510-1518. refs
(Contract NAG1-758)
(AIAA PAPER 91-2771) Copyright

In sequential loop closure, the importance of evaluating the stability and stability robustness at the intermediate loop closures is well known, yet how the stability and stability robustness evaluated at the intermediate steps contribute to the stability and stability robustness of the overall feedback system must be developed. An analysis of the complete feedback system reveals the multivariable Nyquist contributions from the intermediate loop closures. It is also shown that the results greatly simplify if frequency separation exists between the intermediate loops. The analysis is presented with a two-step loop closure procedure using 'inner' and 'outer' loops which can be generalized to multi-step situations. The control of the longitudinal dynamics of an aircraft is addressed to further clarify and demonstrate the results. Author

A91-49730#
PERFORMANCE ANALYSIS METHOD FOR EVALUATING DESIGN FEATURES OF TACTICAL HYPERSONIC INTERCEPTS
JAIMIE TILEY, RAMANA V. GRANDHI, WILBUR L. HANKEY, and PAUL BELCHER (Wright State University, Dayton, OH) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1557-1565. refs
(AIAA PAPER 91-2779)

A performance analysis method is developed to analyze aerodynamic design features for advanced hypersonic intercept vehicles. The control laws and guidance control method are evaluated to intercept a known penetrator in minimal time. Two cases of penetrator performance are investigated with the optimal switching point from optimal climb to intercept maneuvering defined. Evaluated are tradeoffs between control law parameters, missed distance, intercept time, and intercept guidance control range for a selected vehicle. Author

A91-49739#
CONTROL CONFIGURATION DESIGN FOR A MIXED VECTORED THRUST ASTOVL AIRCRAFT IN HOVER
R. F. HOSKIN (Rolls-Royce, Inc., Atlanta, GA), C. N. NETT, and D. E. REEVES (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1625-1642. refs
(AIAA PAPER 91-2793) Copyright

In this paper a recently developed theory for control configuration design in concisely reviewed and then applied to the problem of longitudinal axis control of a mixed vectored thrust, advanced short takeoff and vertical landing (ASTOVL) aircraft operating in hover. The results of this application demonstrate the effectiveness of the control configuration design theory for minimizing significant aspects of control system complexity subject to the achievement of accuracy specifications in the face of uncertainty. The results also provide significant evidence to support a novel integrated flight/propulsion control mode for the ASTOVL aircraft. Author

A91-49740*# Arizona State Univ., Tempe.
ANALYSIS OF AIRFRAME/ENGINE INTERACTIONS IN INTEGRATED FLIGHT AND PROPULSION CONTROL
JOHN D. SCHIERMAN and DAVID K. SCHMIDT (Arizona State University, Tempe) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1643-1651. refs
(Contract NAG3-998)
(AIAA PAPER 91-2794) Copyright

An analysis framework for the assessment of dynamic cross-coupling between airframe and engine systems from the perspective of integrated flight/propulsion control is presented. This analysis involves to determining the significance of the interactions with respect to deterioration in stability robustness and performance, as well as critical frequency ranges where problems may occur due to these interactions. The analysis illustrated here investigates both the airframe's effects on the engine control loops and the engine's effects on the airframe control loops in two case studies. The second case study involves a multi-input/multi-output analysis of the airframe. Sensitivity studies are performed on critical interactions to examine the degradations in the system's stability robustness and performance. Magnitudes of the interactions required to cause instabilities, as well as the frequencies at which the instabilities occur are recorded. Finally, the analysis framework is expanded to include control laws which contain cross-feeds between the airframe and engine systems. Author

A91-49741#
PROPULSION SYSTEM REQUIREMENTS FOR PITCH AND VERTICAL-AXIS CONTROL OF A LIFT-PLUS-LIFT/CRUISE AIRCRAFT WITHOUT REACTION CONTROLS
E. J. TICH (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1652-1665. Research sponsored by USAF. refs
(AIAA PAPER 91-2795) Copyright

The concept for an advanced lift-plus-lift/cruise fighter aircraft that does not utilize reaction jets for pitch control in hover is presented. The vehicle instead relies on thrust modulation of the lift and life/cruise engines for control in both the pitch and vertical axes. Thrust response natural frequency and thrust-rate requirements for pitch control were found to be much more stringent than the requirements for vertical-axis control. P.D.

A91-49743#
ROBUSTNESS ANALYSIS OF FUZZY CONTROL SYSTEMS WITH APPLICATION TO AIRCRAFT ROLL CONTROL
SUJEET CHAND and STEPHEN CHIU (Rockwell International Science Center, Thousand Oaks, CA) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1676-1679. refs
(AIAA PAPER 91-2799) Copyright

A new method for robustness analysis of fuzzy logic-based, multi-input/multi-output controllers for linear time-varying dynamic systems is described. This method derives conservative bounds on parametric uncertainty in a linear plant model for stable operation of the fuzzy controller. These bounds are computed for individual cells of a partitioned state space of the fuzzy controller. The bounds also provide a measure of the relative robustness of each cell; this information can be used to redesign fuzzy rules and membership functions to make the fuzzy controller uniformly robust. The robustness analysis method is illustrated by applying it to a fuzzy roll controller for an aircraft model. Author

A91-49757#
DESIGN OF FAST-SAMPLING DIGITAL CONTROLLERS FOR ACTIVE FLUTTER SUPPRESSION
B. PORTER (Salford, University, England), Z. Q. GU (Nanjing Aeronautical Institute, People's Republic of China), and T. MERZOUGUI IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1798-1804. refs
(AIAA PAPER 91-2814) Copyright

A methodology for the design of fast-sampling digital controllers, developed for regular linear time-invariant multivariable plants is further generalized by the addition of inner feedback loops processing extra plant output measurements derived from acceleration as well as velocity transducers. A fast-sampling digital controller for a typical fluttering wing is designed, and the open-loop and closed-loop eigenvalues for a range of speeds of flight are discussed together with the time-domain behavior. The effectiveness of the controller is illustrated by comparing the unstable impulse response of an uncontrolled open-loop system at a speed of 750 ft/sec with the stable impulse response of a controlled closed-loop system at the same speed. V.T.

A91-49758#
THE DESIGN OF ROBUST MULTIRATE AIRCRAFT CONTROL USING OPTIMISED EIGENSTRUCTURE ASSIGNMENT
Y. PATEL, R. J. PATTON (York, University, England), and S. P. BURROWS IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1805-1813. Research supported by British Aerospace, PLC and SERC. refs
(AIAA PAPER 91-2815) Copyright

This paper presents a new method for constant gain controller design for digital aircraft systems monitored and updated at multiple frequencies. It addresses two main problems associated with such a scheme; adverse effects of intersample cross-coupling and high amplitude control signals that normally result from a multirate feedback structure. An examination of the problem indicates that the two objectives present conflicting design criteria. Thus, a solution must seek to achieve an acceptable compromise between the minimization of control effort and the assignment of a prescribed modal structure. An unconstrained numerical optimization procedure, based on eigenstructure assignment using full-state feedback, is developed to provide for this. A suitable choice of weighting factors, introduced into the scalar cost function defined for the optimization, allows for the computation of two alternative control laws for lateral motion control of an aircraft. The two controller differ only in the emphasis placed on the two conflicting design objectives. They are evaluated using a fully nonlinear simulation of the aircraft. The results fully demonstrate the robustness of the multirate feedback solution and the flexibility offered by the eigenstructure assignment optimization approach in both cases. Author

A91-49780#
DESIGN CHALLENGE IN AUTOMATIC FLIGHT CONTROL - THE SCT SOLUTION
JAMES H. VINCENT, ABBAS EMAMI-NAEINI, and NASSER M. KHRAISHI (Systems Control Technology, Inc., Palo Alto, CA) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 16 p. refs
(AIAA PAPER 91-2633) Copyright

The goal of this paper is to discuss SCT's approach for designing a flight control system in response to the AIAA Design Challenge in Automatic Flight Control. Desired flying qualities characteristics are implemented through the utilization of an explicit model-following flight control system. With the model-following control system, the pilot commands the desired response (e.g., lateral stick force commands roll rate, instead of aileron deflection). The control design is based on the notion of generalized actuators and the use of a control selector to distribute commands to the redundant effectors. A parallel design effort is being pursed for the regulators. Design considerations for using both regular synthesis methods are presented. Author

A91-49785#
THE EFFECT OF CLUTTER ON MISSILES AT A LOW ALTITUDE
TAKESHI KURODA, FUMIAKI IMADO (Mitsubishi Electric Corp., Central Research Laboratory, Amagasaki, Japan), and SUSUMU MIWA (Tokyo Denki University, Japan) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 7 p. refs
(AIAA PAPER 91-2697) Copyright

Clutter spectra in an airborne radar of a missile at a low altitude are calculated for several situations, and the effects of the missile altitude on clutter spectra are discussed. The results show that most of the clutter power distributed over all Doppler frequency, except for the return of the main lobe, consists of the reflected power from the sea surface right under the missile. When the off-boresight tracking is applied to the above geometries, the clutter power decreases about 11dBm on the main lobe frequency, and about 3dBm on other frequencies, while the signal power from the target decreases 4dBm. Author

A91-49793*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATION OF AN INTEGRATED FLIGHT/PROPULSION CONTROL DESIGN METHODOLOGY TO A STOVL AIRCRAFT
SANJAY GARG and DUANE L. MATTERN (NASA, Lewis Research Center, Cleveland, OH) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 11 p. refs
(AIAA PAPER 91-2792) Copyright

The application of an emerging Integrated Flight/Propulsion Control design methodology to a STOVL aircraft in transition flight is reported. The methodology steps consist of: (1) design of a centralized feedback controller to provide command tracking and stability and performance robustness considering the fully integrated airframe/propulsion model as one high-order system; (2) partition of the centralized controller into a decentralized, hierarchical form compatible with implementation requirements; and (3) design of command shaping prefilters from pilot control effectors to commanded variables to provide the overall desired response to pilot inputs. Intermediate design results using this methodology are presented, the complete point control design with the propulsion system operating schedule and limit protection logic included is evaluated for sample pilot control inputs, and the response is compared with that of an 'ideal response model' derived from Level I handling qualities requirements. C.D.

A91-49818#
DYNAMICS OF A TOWED SAILPLANE
GUIDO DE MATTEIS (Roma I, Universita, Rome, Italy) AIAA,

Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 12 p. refs
(AIAA PAPER 91-2862) Copyright

The longitudinal stability of the system represented by towing airplane, cable and sailplane, is investigated. The differential problem concerning the cable dynamics, the boundary conditions of which are the equations of motion of the two planes, is formulated. The resulting set of equations is linearized and the stability analysis is carried out. Strong interactions are shown to take place between cable, tow-plane and sailplane motions, leading to unstable situations in the considered range of practical flight conditions. Author

A91-49822#
X-31A MODEL EVALUATION AND VALIDATION VIA SYSTEM IDENTIFICATION
D. ROHLF, E. PLAETSCHKE, and S. WEISS (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) AIAA, Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 11 p. refs
(AIAA PAPER 91-2875) Copyright

The highly augmented X-31A experimental aircraft poses several challenges in aircraft system identification, mainly because the uncontrolled basic aircraft is aerodynamically unstable in distinct flight regimes and because the integrated flight control laws lead to correlated control surface defections (e.g. canard and trailing edge flaps which are additionally interrelated to thrust vectoring). Moreover, the flight test instrumentation and data handling system is not designed for parameter-identification requirements. In view of this background, the investigations pertaining to aerodynamic parameter estimation were focused in the preliminary stages on the analysis of simulated aircraft response data to determine appropriate model structures at conventional and post-stall flight test points, as well as to design-optimized control inputs. This is followed up by data compatibility checking and estimation of aerodynamic derivatives from initial flight tests carried out with the X-31A aircraft. This paper presents some selected results from both simulated and flight-test data obtained by using a maximum likelihood method for parameter estimation in nonlinear systems. Author

A91-49823#
THRUST CONTRIBUTIONS TO THE SPIN CHARACTERISTICS OF A MODEL FIGHTER AIRCRAFT
JAMES B. PLANEAUX (USAF, Institute of Technology, Wright-Patterson AFB, OH) and ROBERT J. MCDONNELL AIAA, Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 13 p. refs
(AIAA PAPER 91-2887)

Spin characteristics of a mathematical model of the F-15 aircraft are explored using bifurcation analysis and continuation methods. Equilibrium solutions to the nonlinear equations of motion are mapped out globally as they depend on variable thrust, asymmetric thrust, and thrust vectoring. The structure of flat spin equilibrium branches (both stable and unstable) is first established for three disparate thrust levels. Thrust asymmetries are introduced and their tendencies to encourage spins are quantified. Ideal thrust vectoring nozzles are then added to the model to evaluate both pitch and yaw vectoring capabilities. Appropriate pitch vectoring is shown to assist in spin recovery via inertial coupling. Yaw vectoring provides the most effective antispin moments, but some grounds for caution are identified. Selected simulations lend additional insight into the transient spin dynamics of the F-15 model. Author

A91-49824#
X-31A INITIAL FLYING QUALITIES RESULTS USING EQUIVALENT MODELING FLIGHT TEST EVALUATION TECHNIQUES
P. HUBER (MBB GmbH, Munich, Federal Republic of Germany), S. WEISS, and H. GALLEITHNER (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) AIAA, Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 12 p. refs
(AIAA PAPER 91-2891) Copyright

A review is presented of the characteristics of the X-31A flight control laws, the handling qualities flight test methods, and the data extraction and evaluation techniques. The equivalent modeling method is found to be useful for evaluating the X-31A characteristics in the pitch and roll/yaw axis. The model provides the dimensional derivatives and makes it possible to determine the response time delays attributed to the individual motion response variables. Conventional handling qualities parameters were calculated using the dimensional derivatives. These parameters are considered to be in good agreememnt with military specification requirements. The observed flying qualities are rated to be adequate in early pilot-in-the-loop task related evaluations. O.G.

A91-49825*# Systems Technology, Inc., Hawthorne, CA.
SIMULATION EVALUATION OF THE EFFECTS OF TIME DELAY AND MOTION ON ROTORCRAFT HANDLING QUALITIES
DAVID G. MITCHELL (Systems Technology, Inc., Hawthorne, CA), ROGER H. HOH (Hoh Aeronautics, Inc., Lomita, CA), ADOLPH ATENCIO, JR., and DAVID L. KEY (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991. 16 p. Research sponsored by U.S. Army. refs
(Contract NAS2-13127)
(AIAA PAPER 91-2892) Copyright

A study aimed at determining the effects of simulator characteristics on perceived handling qualities is discussed. Evaluations were conducted with a baseline set of rotorcraft dynamics, using a simple transfer-function model of an uncoupled helicopter, under different conditions of visual and overall time delays. As the visual and motion parameters were changed, differences in pilot opinion were found reflecting a change in the pilots' perceptions of handling qualities, rather than changes in the aircraft model itself. It is concluded that it is necessary to tailor the motion washout dynamics to suit the task, with reduced washouts for precision maneuvering as compared to aggressive maneuvering. Visual-delay data suggest that it may be better to allow some time delay in the visual path to minimize the mismatch between visual and motion, rather than eliminate the visual delay entirely through lead compensation. O.G.

A91-50082
ABORT LANDING IN THE PRESENCE OF WINDSHEAR AS A MINIMAX OPTIMAL CONTROL PROBLEM. II - MULTIPLE SHOOTING AND HOMOTOPY
R. BULIRSCH, F. MONTRONE, and H. J. PESCH (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) Journal of Optimization Theory and Applications (ISSN 0022-3239), vol. 70, Aug. 1991, p. 223-254. refs
Copyright

A multiple shooting method is applied to the multipoint boundary-value problem with jump conditions defined by Bulirsch et al. (1991) for the optimal control problem of a passenger-aircraft abort-landing trajectory in wind shear. An appropriate homotopy strategy based on natural homotopy parameters is proposed to overcome obstacles of indirect methods, requiring a good knowledge of an initial trajectory and an assumption on the switching structure. Consideration is also given to techniques for detecting bang-bang subarcs and singular subarcs. The treatment of state constraints is examined in detail, focusing on detection techniques for both touch points and boundary arcs caused by state variable inequality constraints. It is found that the transformation of the minimax performance index to a performance index of standard form requires consideration of an additional state constraint. O.G.

A91-50602
AIRCRAFT CONTROL UNDER CONDITIONS OF WINDSHEAR

GEORGE LEITMANN and SANDEEP PANDEY (California, University, Berkeley) IN: Control and dynamic systems. Vol. 34 - Advances in control mechanics. Pt. 1. San Diego, CA, Academic Press, Inc., 1990, p. 1-79. Research supported by USAF. refs
(Contract NSF ECS-86-02524)
Copyright

The optimal control problem of guiding an aircraft through wind shear is examined theoretically. The approach developed by Leitmann (1981 and 1989) on the basis of Liapunov stability theory is applied in the design of a deterministic controller for the relative path inclination and tested by means of numerical simulations on various published wind-shear models. The results are presented in extensive graphs, and the present approach is shown to be promising. T.K.

A91-50619* Yale Univ., New Haven, CT.
AIRCRAFT AUTOMATIC FLIGHT CONTROL SYSTEM WITH MODEL INVERSION
G. A. SMITH (Yale University, New Haven, CT) and GEORGE MEYER (NASA, Ames Research Center, Moffett Field, CA) IN: Control and dynamic systems. Vol. 38 - Advances in aeronautical systems. San Diego, CA, Academic Press, Inc., 1990, p. 1-40. refs
Copyright

A simulator study was conducted to verify the advantages of a Newton-Raphson model-inversion technique as a design basis for an automatic trajectory control system in an aircraft with highly nonlinear characteristics. The simulation employed a detailed mathematical model of the aerodynamic and propulsion system performance characteristics of a vertical-attitude takeoff and landing tactical aircraft. The results obtained confirm satisfactory control system performance over a large portion of the flight envelope. System response to wind gusts was satisfactory for various plausible combinations of wind magnitude and direction. O.C.

A91-50991
TRACKING DESIGN FOR A GUST-ALLEVIATION CONTROL SYSTEM FOR AIRCRAFT
ATHANASIOS D. SARANTOPOULOS and J. A. DE ABREU-GARCIA (Akron, University, OH) IN: IEEE International Conference on Systems Engineering, 2nd, Pittsburgh, PA, Aug. 9-11, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 292-295. refs
Copyright

A tracking capability design for the gust-alleviation control system for aircraft of McLean (1978) is proposed. The mathematical model, a 27th-order linearized model, describes the small perturbation motion of a rigid aircraft about its equilibrium. The system is decoupled into two independent subsystems: a 15th-order model describing the lateral motion and a 12th order model describing the longitudinal motion. The authors deal strictly with the case of longitudinal motion in which the control inputs used are the deflections of elevator and horizontal canards while the output is the normal acceleration measured at a location some meters away from the tip of the nose of the aircraft. Results obtained from two design approaches are analyzed and compared. I.E.

A91-51250
ARTIFICIAL STABILITY IN AIRCRAFT - FAILSAFE FLIGHT-CONTROL SYSTEMS CONSIDERABLY INCREASE PERFORMANCE
New-Tech News (ISSN 0935-2694), no. 2, 1991, p. 28-32.
Copyright

During 1975-1984, CCV technology-related flight tests were conducted with a suitably modified, three-lifting-surface (canard/wing/elevator) F-104G aircraft that was equipped with a novel, quadruplex digital control system. This comprehensive experimental program demonstrated the ability of a highly unstable fighter aircraft to be reliably restabilized by active control measures. The quadruplex control system is exemplified by four elevator segments' operation of four self-detecting simplex servocylinders each. If two faults occur, half of the elevator effect would still be available for control and stabilization. O.C.

A91-52014
DESIGN OF RESTRUCTURABLE FLIGHT CONTROL SYSTEMS USING FEEDBACK LINEARIZATION
YOSHIMASA OCHI and KIMIO KANAI (National Defense Academy, Yokosuka, Japan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 903-911. refs
Copyright

In this paper, a design method is presented for restructurable flight control system based on the feedback linearization method. Failures are identified indirectly by estimating parameters of the nonlinear aircraft model using the recursive least square algorithm. The aircraft is assumed to have many control surfaces that can be driven independently. In the design, actuator dynamics are taken into account and the control distributor, which reduces real inputs to generic inputs, is used. The imaginary actuators for generic inputs are introduced to generate input signals used in parameter identification. Pitch and roll angles are controlled indirectly by controlling pitch and roll rates, respectively, which is an approximate way but makes the control system simpler than applying the feedback linearization method straight to the control of the angles. To evaluate the performance of the restructurable flight control system, two failure cases are simulated on the six-degree-of-freedom nonlinear aircraft model. Author

A91-52015* Arizona State Univ., Tempe.
ERROR DYNAMICS AND PERFECT MODEL FOLLOWING WITH APPLICATION TO FLIGHT CONTROL
MARK R. ANDERSON (Systems Control Technology, Inc., Lexington Park, MD) and DAVID K. SCHMIDT (Arizona State University, Tempe) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 912-919. Research supported by McDonnell Aircraft Co. Previously cited in issue 22, p. 3540, Accession no. A87-50432. refs
(Contract NAG4-1)
Copyright

A91-52016
GENERALIZED TECHNIQUE FOR INVERSE SIMULATION APPLIED TO AIRCRAFT MANEUVERS
R. A. HESS, S. H. WANG (California, University, Davis), and C. GAO Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 920-926. Previously cited in issue 06, p. 811, Accession no. A91-19291. refs
Copyright

A91-52017* Martin Marietta Corp., Denver, CO.
DESIGN OF A TOTAL ENERGY CONTROL AUTOPILOT USING CONSTRAINED PARAMETER OPTIMIZATION
CHRISTOPHER VOTH (Martin Marietta Corp., Denver, CO) and UY-LOI LY (Washington, University, Seattle) (1990 American Control Conference, 9th, San Diego, CA, May 23-25, 1990, Proceedings. Vol. 2, p. 1332-1337) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 927-935. Previously cited in issue 11, p. 1707, Accession no. A91-30120. refs
(Contract NAG1-913)
Copyright

A91-52018* California Univ., Davis.
PRECISE FLIGHT-PATH CONTROL USING A PREDICTIVE ALGORITHM
R. A. HESS (California, University, Davis) and Y. C. JUNG Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 936-942. refs
(Contract NAG2-221)
Copyright

Generalized predictive control describes an algorithm for the control of dynamic systems in which a control input is generated that minimizes a quadratic cost function consisting of a weighted sum of errors between desired and predicted future system output

and future predicted control increments. The output predictions are obtained from an internal model of the plant dynamics. A design technique is discussed for applying the single-input/single-output generalized predictive control algorithm to a problem of longitudinal/vertical terrain-following flight of a rotorcraft. By using the generalized predictive control technique to provide inputs to a classically designed stability and control augmentation system, it is demonstrated that a robust flight-path control system can be created that exhibits excellent tracking performance. Author

A91-52019* Arizona State Univ., Tempe.
NUMERICAL AND LITERAL AEROELASTIC-VEHICLE-MODEL REDUCTION FOR FEEDBACK CONTROL SYNTHESIS
BRETT NEWMAN and DAVID K. SCHMIDT (Arizona State University, Tempe) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 943-953. refs
(Contract NAG1-758)
Copyright

The simplification of a high-order, literal model for large flexible aircraft is discussed. Areas of model fidelity that are critical if the model is to be used for control law synthesis are presented. Several simplification techniques, some new and some widely available, that can deliver the necessary model fidelity are presented and applied to a model from the literature. The techniques include both numerical and analytical approaches. An analytical approach, based on first-order sensitivity theory, is shown to lead not only to excellent numerical results, but also to closed-form analytical expressions for key system dynamic properties such as the pole/zero factors of the vehicle transfer-function matrix. The analytical results are expressed in terms of vehicle vibrational characteristics and rigid-body and aeroelastic stability derivatives, thus providing insight into the underlying causes for critical dynamic characteristics. Author

A91-52020* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLYING QUALITY ANALYSIS AND FLIGHT EVALUATION OF A HIGHLY AUGMENTED COMBAT ROTORCRAFT
MARK B. TISCHLER, JAY W. FLETCHER, PATRICK M. MORRIS, and GEORGE E. TUCKER (NASA, Ames Research Center, Moffett Field, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 954-963. refs
Copyright

This paper discusses implications of digital flight control system design for rotorcraft and illustrates the analysis of the resulting handling qualities obtained with the Advanced Digital Optical Control System demonstrator in the context of the proposed new handling-qualities specification for rotorcraft. Topics covered are digital flight control design and analysis methods, flight testing techniques, handling-qualities evaluation results, and correlation of flight test results with analytical models and the proposed handling-qualities specification. The evaluation of the demonstrator system indicates desirable response characteristics based on equivalent damping and frequency, but undersirably large effective time delays (exceeding 240 ms in all axes). Piloted handling qualities are found to be desirable or adequate for all low, medium, and high pilot gain tasks, but handling qualities are inadequate for ultrahigh gain tasks such as slope and running landings. Correlation of these results with the proposed handling-qualities specification indicates good agreement for the bandwidth boundaries, but suggests the need for more stringent limits on allowable phase delay. Analytical models based on emulation (s-plane) techniques compare favorably with flight-extracted frequency-domain characteristics of the overall (end-to-end) system responses. Author

A91-52033
MODERN GUIDANCE LAW FOR HIGH-ORDER AUTOPILOT
ILAN RUSNAK and LEVI MEIR (Rafael Armament Development Authority, Haifa, Israel) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 1056-1058. refs
Copyright

The homing intercept problem on a collision course for a linear time-invariant acceleration-commanded arbitrary-order autopilot is formulated. An explicit closed-loop closed-form solution for a quadratic performance index is obtained. The resulting guidance law has the structure of a guidance gain multiplied by the zero effort miss. For a third-order nonminimum phase autopilot, the derived guidance law gives improved performance with respect to a first-order guidance law. L.M.

A91-52190
SOME PROBLEMS ABOUT THE ATMOSPHERIC TURBULENCE SPECTRUM AND AIRCRAFT RESPONSE
KE XU (Xian Aircraft Industry Co., People's Republic of China), YELUN XIAO, and GUILIAN ZHANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A241-A248. In Chinese. refs

General expressions of the correlation and spectrum functions for turbulent velocities and velocity gradients for isotropic turbulence are derived. The odd-even nature of spectrum functions with regard to space frequency is analyzed. Some problems concerning atmospheric turbulence are discussed and clarified. Finally, an example of aircraft response to atmospheric turbulence is presented, and conclusions are drawn. Author

A91-52195
THE MODEL REFERENCE FAULT TOLERANT CONTROL IN AIRCRAFT
SHOUSONG HU (Nanjing Aeronautical Institute, People's Republic of China) and JIONG CHENG (Nanchang Aeronautical Industry Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, May 1991, p. A279-A286. In Chinese. refs

The detection filter theory is applied to the design of a fault detector and a fault parameter identifier for aircraft with an internal element or control element fault. Because Liapunov's stability theory is applied, the fault tolerant control law can ensure the stability of the flight control system. A model reference fault tolerant control system is designed and simulated using a short period longitudinal model of a certain aircraft. Because the flight range of the aircraft is very large, its parameter variation is very violent. When the aircraft is normal, a parameter robust controller in the system is designed in order to obtain good performances under every flight state. Author

A91-52212
A SIMULATION STUDY ON TAKEOFF AND LANDING DYNAMICS OF FLY-BY-WIRE CONTROL SYSTEM AIRCRAFT
YACHANG FENG, GANG CHEN, and PEIQIONG LI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B252-B258. In Chinese. refs

Based on the dynamic theory of rigid body systems and flying characteristics of aircraft during takeoff and landing, a six-degree-freedom aircraft equation for landing gears-aircraft fuselage rigid body system is formulated. The time domain step-target tracking pilot model is valuable to the analysis of flying qualities of pilot/vehicle system during takeoff and landing. The mathematical models of the mechanical control system and fly-by-wire control system are provided. The nonlinear time domain computer program provides a complete quantitative analysis of aircraft takeoff and landing dynamics, and the numerical simulation results agree well with the real flight test data. Author

A91-52281
RESPONSE OF AN AIRPLANE TO NON-GAUSSIAN ATMOSPHERIC TURBULENCE
F. POIRION (ONERA, Chatillon, France) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 579-583. refs
Copyright

Application of a novel method based on filtered Poisson fields

in a study of atmospheric turbulence model influences on the response of a nonrigid aircraft with nonlinear control systems, in order to build numerical simulations of non-Gaussian random fields, shows that the spectral density of the response, as well as such other characteristics as level-crossing or probabilistic moments, may substantially differ from those obtained when turbulence is modeled as a Gaussian process. This study is limited to the effects of the third- and fourth-order moments. O.C.

A91-52824
EFFECT OF A SAIL ON AUGMENTING ATTITUDE STABILITY OF HOVERING VTOL VEHICLE SUPPORTED BY ONE-DUCTED-FAN
SHIGENORI ANDO and MICHIYO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 450, 1991, p. 367-372. In Japanese. refs

This paper presents a simple device for augmenting attitude stability of a VTOL airplane supported by one-ducted-fan at hovering. It is based on an aerodynamic drag generated at a place higher than the vehicle center-of-gravity (CG). Since the problem becomes nonlinear, the time-marching technique is used. The effect is remarkable, even with a reasonable size of a sail and at a reasonable height over the CG. It is suggested that a gas-bag or windmill be used in place of a sail. Author

A91-52941
AUTOMATIC FLIGHT CONTROL SYSTEM HONEYWELL SPZ-7600 (AFCS) FOR SEARCH AND RESCUE HELICOPTERS
BRETT EDDY (Honeywell, Inc., Minneapolis, MN) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 9 p.
(SAE PAPER 911008) Copyright

The SPZ-7600 dual digital AFCS for single pilot IFR operation to a 50 foot hover is described. With a mark-on-target mode of the system guiding the aircraft from cruise flight to hover near a survivor's position, a pilot is able to spend more time with other tasks and more thoroughly evaluate the mission progress and safety. AFCS automatically guides the aircraft through various search and rescue (SAR) approach, hover, and climb maneuvers, making it possible to simply monitor the aircraft systems. The pilot workload during SAR operation is greatly decreased, which allows SAR work to be accomplished in conditions previously not possible due to visibility limitations or excessive pilot workload. O.G.

N91-29190# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research
AN INVESTIGATION INTO THE USE OF SIDE-ARM CONTROL FOR CIVIL ROTORCRAFT APPLICATIONS
S. W. BAILLIE and S. KERELIUK Jun. 1990 39 p
(AD-A226628; NRC-32133; IAR-AN-67; CTN-91-60100)
Copyright Avail: NTIS HC/MF A03

An evaluation of the handling qualities of civil rotocraft incorporating force or displacement sensing side arm controllers with varying levels of control integration was carried out on the Institute for Aeronautical Research of the National Research Council of Canada Bell 205 Airborne Simulator. Evaluators were certified pilots from the FAA or Transport Canada. Pilot workload level and performance for configurations with the force sensing 4 + 0 controller was as good or better than with conventional controls for most tasks and there is a good potential for improvement. The breakout gradient force characteristics and sensitivities of side arm controllers may dominate aircraft handling qualities. A systematic evaluation of a range of these characteristics for all representative tasks is required to establish satisfactory boundaries for both force sensing and deflection sensing controllers. Several certification issues are suggested. These include: fault failure analysis to ensure redundance, provision for monitoring coupled systems, and testing for electromagnetic interference. Overall, the force sensing 4 + 0 controller was preferred for most manoeuvres over the conventional configuration. CISTI

N91-29191*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
CONTROLLING CRIPPLED AIRCRAFT-WITH THROTTLES
FRANK W. BURCHAM, JR. and C. GORDON FULLERTON Sep. 1991 30 p Prepared for presentation at the 44th International Air Safety Seminar, Singapore, 12-14 Nov. 1991
(NASA-TM-104238; H-1747; NAS 1.15:104238) Avail: NTIS HC/MF A03 CSCL 01/3

A multiengine crippled aircraft, with most or all of the flight control system inoperative, may use engine thrust for control. A study was conducted of the capability and techniques for emergency flight control. Included were light twin engine piston powered airplanes, an executive jet transport, commercial jet transports, and a high performance fighter. Piloted simulations of the B-720, B-747, B-727, MD-11, C-402, and F-15 airplanes were studied, and the Lear 24, PA-30, and F-15 airplanes were flight tested. All aircraft showed some control capability with throttles and could be kept under control in up-and-away flight for an extended period of time. Using piloted simulators, landings with manual throttles-only control were extremely difficult. However, there are techniques that improve the chances of making a survivable landing. In addition, augmented control systems provide major improvements in control capability and make repeatable landings possible. Control capabilities and techniques are discussed. Author

N91-29192# Lawrence Livermore National Lab., CA.
FLUTTER CONSIDERATION OF A CRASH-TEST AIRCRAFT
T. F. CHEN 28 Feb. 1991 33 p
(Contract W-7405-ENG-48)
(DE91-015094; UCRL-ID-107239) Avail: NTIS HC/MF A03

The Plutonium Air Transport Certification (PATC) project is currently being conducted by the Nuclear Systems Safety Program (NSSP) for the US Nuclear Regulatory Commission. Developing aircraft crash test criteria is part of this effort. One objective is to assess whether a researcher can safely control the aircraft and to evaluate the likelihood that the aircraft can be successfully crash tested. Due to the extraordinarily high velocity of 925 fts required at aircraft impact, the likelihood for the crash test aircraft to undergo flutter in the final stages of flight is substantially increased. A fundamental understanding is gained of the aircraft flutter phenomenon in order to successfully determine the scope of and prepare for an aircraft crash test. This documentation includes: (1) a general description of the aircraft flutter phenomenon, its structural representation, and some of the commonly used unsteady oscillatory aerodynamic loading approximations; (2) a brief summary of the flutter equation solution techniques; (3) the input requirements for conducting a successful flutter prediction; (4) some of the main aircraft flutter characteristics and prevention considerations; and (5) an outline for future work on the aircraft flutter phenomenon. DOE

N91-29194*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A SIMULATION EVALUATION OF A FOUR-ENGINE JET TRANSPORT USING ENGINE THRUST MODULATION FOR FLIGHTPATH CONTROL
GLENN B. GILYARD, JOSEPH L. CONLEY, JEANETTE LE, and FRANK W. BURCHAM, JR. Washington Sep. 1991 22 p Presented at the AIAA/ASME/SAE/ASEE 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991
(NASA-TM-4324; H-1741; NAS 1.15:4324) Avail: NTIS HC/MF A03 CSCL 01/3

The use of throttle control laws to provide adequate flying qualities for flight path control in the event of a total loss of conventional flight control surface use was evaluated. The results are based on a simulation evaluation by transport research pilots of a B-720 transport with visual display. Throttle augmentation control laws can provide flight path control capable of landing a transport-type aircraft with up to moderate levels of turbulence. The throttle augmentation mode dramatically improves the pilots' ability to control flight path for the approach and landing flight condition using only throttle modulation. For light turbulence, the

average Cooper-Harper pilot rating improved from unacceptable to acceptable (a pilot rating improvement of 4.5) in going from manual to augmented control. The low frequency response characteristics of the engines require a considerably different piloting technique. The various techniques used by the pilot resulted in considerable scatter in data. Many pilots readily adapted to a good piloting technique while some had difficulty. A new viable approach is shown to provide independent means of redundancy of transport aircraft flight path control. Author

N91-30149# Aeronautical Research Labs., Melbourne (Australia).
F/A-18 1/9TH SCALE MODEL TAIL BUFFET MEASUREMENTS
C. A. MARTIN, M. K. GLAISTER, L. D. MACLAREN, L. A. MEYN, and J. ROSS (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) Jun. 1991 35 p
(ARL-FLIGHT-MECH-R-188; AR-006-149) Copyright Avail: NTIS HC/MF A03

Wind tunnel tests were carried out on a 1/9th scale model of the F/A-18 at high angles of attack to investigate the characteristics of tail buffet due to bursting of the wing leading edge extension (LEX) vortices. The tests were carried out at the Aeronautical Research Laboratory low-speed wind tunnel facility and form part of a collaborative activity with NASA Ames Research Center, organized by The Technical Cooperative Program (TTCP). Information from the program will be used in the planning of similar collaborative tests, to be carried out at NASA Ames, on a full-scale aircraft. The program covered the measurement of unsteady pressures and fin vibration for cases with and without the wing LEX fences fitted. Fourier transform methods were used to analyze the unsteady data, and information on the spatial and temporal content of the vortex burst pressure field was obtained. Flow visualization of the vortex behavior was carried out using smoke and a laser light sheet technique. Author

N91-30150*# Oregon State Univ., Corvallis. Dept. of Electrical and Computer Engineering.
NONLINEAR STABILITY AND CONTROL STUDY OF HIGHLY MANEUVERABLE HIGH PERFORMANCE AIRCRAFT Annual Report
R. R. MOHLER 12 Aug. 1991 82 p
(Contract NAG1-1081)
(NASA-CR-188721; NAS 1.26:188721; OSU-ECE-91-01) Avail: NTIS HC/MF A05 CSCL 01/3

The purpose was to develop and apply new nonlinear system methodologies to the stability analysis and adaptive control of high angle of attack (alpha) aircraft such as the F-18. Considerable progress is documented on nonlinear adaptive control and associated model development, identification, and simulation. The analysis considered linear and nonlinear, longitudinal, high alpha aircraft dynamics with varying degrees of approximation dependent on the purpose. In all cases, angle of attack or pitch rate was controlled primarily by a horizontal stabilizer. In most cases studied, a linear adaptive controller provided sufficient stability. However, it has been demonstrated by simulation of a simplified nonlinear model that certain large rapid maneuvers were not readily stabilized by the investigated linear adaptive control, but were controlled instead by means of a nonlinear time-series based adaptive control. Author

N91-30152*# Stanford Univ., CA. Joint Inst. for Aeronautics and Acoustics.
FOREBODY TANGENTIAL BLOWING FOR CONTROL AT HIGH ANGLES OF ATTACK Final Report
I. KROO, S. ROCK, and L. ROBERTS Jun. 1991 42 p
(Contract NCC2-55)
(NASA-CR-188773; NAS 1.26:188773; SU-JIAA-TR-101) Avail: NTIS HC/MF A03 CSCL 01/3

A feasibility study to determine if the use of tangential leading edge blowing over the forebody could produce effective and practical control of the F-18 HARV aircraft at high angles of attack was conducted. A simplified model of the F-18 configuration using a vortex-lattice model was developed to obtain a better understanding of basic aerodynamic coupling effects and the influence of forebody circulation on lifting surface behavior. The effect of tangential blowing was estimated using existing wind tunnel data on normal forebody blowing and analytical studies of tangential blowing over conical forebodies. Incorporation of forebody blowing into the flight control system was investigated by adding this additional yaw control and sideforce generating actuator into the existing F-18 HARV simulation model. A control law was synthesized using LQG design methods that would schedule blowing rates as a function of vehicle sideslip, angle of attack, and roll and yaw rates. M.G.

N91-30153*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
MODELING, SIMULATION, AND FLIGHT CHARACTERISTICS OF AN AIRCRAFT DESIGNED TO FLY AT 100,000 FEET
ALEX G. SIM Sep. 1991 44 p
(NASA-TM-104236; H-1731; NAS 1.15:104236) Avail: NTIS HC/MF A03 CSCL 01/3

A manned real time simulation of a conceptual vehicle, the stratoplane, was developed to study the problems associated with the flight characteristics of a large, lightweight vehicle. Mathematical models of the aerodynamics, mass properties, and propulsion system were developed in support of the simulation and are presented. The simulation was at first conducted without control augmentation to determine the needs for a control system. The unaugmented flying qualities were dominated by lightly damped dutch roll oscillations. Constant pilot workloads were needed at high altitudes. Control augmentation was studied using basic feedbacks. For the longitudinal axis, flight path angle, and pitch rate feedback were sufficient to damp the phugoid mode and to provide good flying qualities. In the lateral directional axis, bank angle, roll rate, and yaw rate feedbacks were sufficient to provide a safe vehicle with acceptable handling qualities. Intentionally stalling the stratoplane to very high angles of attack (deep stall) was studied as a means of enable safe and rapid descent. It was concluded that the deep stall maneuver is viable for this class of vehicle. Author

N91-30154*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
APPLICATION AND FLIGHT TEST OF LINEARIZING TRANSFORMATIONS USING MEASUREMENT FEEDBACK TO THE NONLINEAR CONTROL PROBLEM
ROBERT F. ANTONIEWICZ, EUGENE L. DUKE, and P. K. A. MENON (Georgia Inst. of Tech., Atlanta.) Sep. 1991 56 p
(NASA-TP-3154; H-1629; NAS 1.60:3154) Avail: NTIS HC/MF A04 CSCL 01/3

The design of nonlinear controllers has relied on the use of detailed aerodynamic and engine models that must be associated with the control law in the flight system implementation. Many of these controllers were applied to vehicle flight path control problems and have attempted to combine both inner- and outer-loop control functions in a single controller. An approach to the nonlinear trajectory control problem is presented. This approach uses linearizing transformations with measurement feedback to eliminate the need for detailed aircraft models in outer-loop control applications. By applying this approach and separating the inner-loop and outer-loop functions two things were achieved: (1) the need for incorporating detailed aerodynamic models in the controller is obviated; and (2) the controller is more easily incorporated into existing aircraft flight control systems. An implementation of the controller is discussed, and this controller is tested on a six degree-of-freedom F-15 simulation and in flight on an F-15 aircraft. Simulation data are presented which validates this approach over a large portion of the F-15 flight envelope. Proof of this concept is provided by flight-test data that closely matches simulation results. Flight-test data are also presented. Author

N91-30156*# McDonnell Aircraft Co., Saint Louis, MO.
AEROSERVOELASTIC STABILIZATION TECHNIQUES FOR HYPERSONIC FLIGHT VEHICLES

SAMUEL Y. CHAN, PETER Y. CHENG, DALE M. PITT, THOMAS T. MYERS, DAVID H. KLYDE, RAYMOND E. MAGDALENO, and DUANE T. MCRUER (Systems Technology, Inc., Hawthorne, CA.) Sep. 1991 95 p
(Contract NAS1-18763)
(NASA-CR-187614; NAS 1.26:187614) Avail: NTIS HC/MF A05 CSCL 01/3

The potential of Hybrid Phase Stabilization (HPS), particularly for highly unstable aircraft, using a hypersonic flight vehicle (HSV) as a relevant example, is discussed. The development of HPS is presented and the result is compared with that generated using a conventional gain stabilization technique. Since HPS was not addressed in the MIL-spec requirements, a preliminary residual response metric was developed to provide guidance in assessing HPS. 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.

A91-48601
AIRCRAFT AND SUBSYSTEM LEVEL HIRF TEST METHODS
DEAN C. MILLER (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p.
(SAE PAPER 901917) Copyright

Requirement-compliance is a major problem faced by high-intensity radiated-field (HIRF) engineering; an account is presently given of proper selection and scheduling practices for HIRF certification-related aircraft test methods at both the LRU and subsystems levels. Attention is given to low-level swept CW testing, which involves measurement of RF transfer functions from the external incident field to internal areas and has the unique advantage of not tying airframe test results to an external threat level. This method's main disadvantage is its assumption of linearity in airframe response times. O.C.

A91-48640* Boeing Commercial Airplane Co., Seattle, WA.
HYBRID LAMINAR FLOW CONTROL TESTS IN THE BOEING RESEARCH WIND TUNNEL
P. G. PARIKH, D. W. LUND, D. GEORGE-FALVY, and A. L. NAGEL (Boeing Commercial Airplane Group, Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 23 p. refs
(Contract NAS1-15325)
(SAE PAPER 901978) Copyright

The hybrid laminar flow control (HLFC) concept has undergone wind tunnel testing at near full-scale Reynolds number on an infinite wing of 30-deg sweep on which boundary-layer suction was furnished over the first 20 percent of chord of the upper surface. Depending on the external pressure distribution, the HLFC extended the laminarity of the boundary layer as far back as 45 percent of chord; this corresponds to a transition Reynolds number of about 11 million. The maximum chordwise extent of laminar run was found to be insensitive to the suction level over a wide range. O.C.

A91-50470
VISUAL DATABASE REQUIREMENTS TO SUPPORT A-6E MISSION TRAINING
JOE DE MAIO and PAMELA LUDWIG (Grumman Simulation/Trainer Products, Bohemia, NY) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 130-139. refs
Copyright

Grumman is developing an aircrew trainer suite for the A-6 and F-14 aircraft. The primary mission of the A-6 is ground/surface attack, while that of the F-14 is air superiority. A major part of the development is designing a visual simulation database that is correlated with a high resolution radar database. Analysis and evaluation were performed on alternative approaches to developing a terrain skin database. Costs and benefits of the alternative approaches are discussed. Author

A91-50472
TWO CREW DISPLAY
RICHARD J. SCHWARTZ (McDonnell Douglas Corp., Saint Louis, MO) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 155-162. refs
Copyright

An account is given of a tandem-seat cockpit projection-display system representative of the F/A-18D aircraft, whose design has been optimized according to customer requirements, current display technology limitations, physical limitations, and system-design considerations. A separate dome displays for each of the two crewmembers, in conjunction with two separate, three-field-of-view head-tracked display. Attention is given to the effects of diffuse screen contrast ratios vs reflectivity, the differences in acuity vs field-of-view performance for human vision and night vision goggles, and the gain lobe of Lambertian and Non-Lambertian reflectors. O.C.

A91-50474
VIDEO SWITCHING, RECORDING, AND DISTRIBUTION FOR ENGINEERING FLIGHT SIMULATION
RANDOLPH E. CRUTCHFIELD (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 175-182.
Copyright

The video switching, recording, and distribution requirements of engineering flight simulation efforts have been integrated by means of a Facility Video Switching and Distribution (FVSD) system. The FVSD allows the user to rapidly reconfigure the video system before and during a simulation, using touch screens. The FVSD also allows mission-related switching to be accomplished under computer control, as well as video recording of multiple video formats with such special effects as time-coding. O.C.

A91-50475
SYSTEM REQUIREMENTS FOR A HIGH GAIN DOME DISPLAY SURFACE
JOHN R. QUICK (McDonnell Aircraft Co., Saint Louis, MO) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 183-191.
Copyright

The use of a high-gain surface in the type of spherical-dome and multiple-projector screen employed in fighter cockpit simulators, the location of the projectors within the dome is restricted, resulting in poor coupling. As surface gain is increased, system sensitivity to observer location increases, restricting head motion and the dynamic response requirements for the electronic blending system. Attention is given to the reflection lobes of the spherical dome. O.C.

A91-51858* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN ELECTRONIC PRESSURE PROFILE DISPLAY SYSTEM FOR AERONAUTIC TEST FACILITIES
MARK R. WOIKE (NASA, Lewis Research Center, Cleveland, OH) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 117-124. Previously

announced in STAR as N90-15964. refs
Copyright

The NASA Lewis Research Center has installed an Electronic Pressure Profile Display system. This system provides for the real-time display of pressure readings on high resolution graphics monitors. The Electronic Pressure Profile Display system will replace manometer banks currently used in aeronautic test facilities. The Electronic Pressure Profile Display system consists of an industrial type Digital Pressure Transmitter (DPI) unit which interfaces with a host computer. The host computer collects the pressure data from the DPI unit, converts it into engineering units, and displays the readings on a high resolution graphics monitor in bar graph format. Software was developed to accomplish the above tasks and also draw facility diagrams as background information on the displays. Data transfer between host computer and DPT unit is done with serial communications. Up to 64 channels are displayed with one second update time. This paper describes the system configuration, its features, and its advantages over existing systems. Author

A91-51885* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
OVERVIEW OF THE NASA AMES-DRYDEN INTEGRATED TEST FACILITY
DALE MACKALL, DAVID MCBRIDE, and DOROTHEA COHEN (NASA, Flight Research Center, Edwards, CA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 667-681. refs
Copyright

An overview of the Integrated Test Facility (ITF) and the real-time systems being developed to operate it are outlined. The generic capabilities of the ITF real-time systems, the real-time data recording, and the remotely augmented vehicle (RAV) monitoring system are discussed. The benefits of applying simulation to aircraft-in-the-loop testing and the RAV monitoring system capabilities to the X-29A flight research program are considered. P.D.

A91-51887
AUTOMATED JET ENGINE TESTING
JUAN A. MOREJON (Pratt and Whitney Group, East Hartford, CT) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 691-706.
Copyright

A computer system utilized to automate test stand preparation, engine operation, health monitoring, and other test-related functions is presented. The hardware utilized in this system and the system's software and operation are described. Results that demonstrate the advantages of automated testing are presented. C.A.B.

A91-51888* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
AN AUTOMATED CALIBRATION LABORATORY - REQUIREMENTS AND DESIGN APPROACH
NORA O'NEIL-ROOD and RICHARD D. GLOVER (NASA, Flight Research Center, Edwards, CA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 707-719. Previously announced in STAR as N90-26564.
Copyright

NASA's Dryden Flight Research Facility (Ames-Dryden), operates a diverse fleet of research aircraft which are heavily instrumented to provide both real time data for in-flight monitoring and recorded data for postflight analysis. Ames-Dryden's existing automated calibration (AUTOCAL) laboratory is a computerized facility which tests aircraft sensors to certify accuracy for anticipated harsh flight environments. Recently, a major AUTOCAL lab upgrade was initiated; the goal of this modernization is to enhance productivity and improve configuration management for both software and test data. The new system will have multiple testing stations employing distributed processing linked by a local area network to a centralized database. The baseline requirements for the new AUTOCAL lab and the design approach being taken for its mechanization are described. Author

A91-52282
ANOTHER LOOK AT HIGH-ALPHA SUPPORT INTERFERENCE IN ROTARY TESTS
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 584-591. Previously cited in issue 06, p. 768, Accession no. A90-19729. refs
Copyright

A91-52283
SLOTTED-WALL BLOCKAGE CORRECTIONS FOR DISKS AND PARACHUTES
J. M. MACHA, ROBERT J. BUFFINGTON, JOHN F. HENFLING (Sandia National Laboratories, Albuquerque, NM), DAVID VAN EVERY, and JOHN L. HARRIS (DSMA International, Inc., Mississauga, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 592-597. Previously cited in issue 16, p. 2492, Accession no. A90-57946. refs
(Contract DE-AC04-76DP-00789)

A91-52776
ICAW 1991; INTERNATIONAL CONFERENCE ON ADAPTIVE WALL WIND TUNNEL RESEARCH AND WALL INTERFERENCE CORRECTION, XIAN, PEOPLE'S REPUBLIC OF CHINA, JUNE 10-14, 1991, PROCEEDINGS
JIA JU HE, ED. (Northwestern Polytechnical University, Xian, People's Republic of China) Conference sponsored by Chinese Aeronautics and Astronautics Establishment and Northwestern Polytechnical University. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, 290 p. For individual items see A91-52777 to A91-52805.

The present conference on adaptive-wall wind tunnel research and wind tunnel wall interference and correction discusses 2D wall adaptation for 3D flows, the integration of wall interference assessment with wall adaptation, a wall-interference investigation using variable-porosity wall segments, and studies of unsteady boundary pressure for adaptive wind tunnel wall interference. Also discussed are asymptotic methods for transonic slender body wind tunnel wall interference, the nonlinear evaluation of transonic wall interference corrections for semispan wing data, the effect of friction on sidewall interference in a 2D wind tunnel, and recent advancements in wind tunnel interference corrections for pressure measurements. O.C.

A91-52777
ADAPTIVE WALL TECHNOLOGY FOR MINIMIZATION OF WIND TUNNEL BOUNDARY INTERFERENCES - A REVIEW
STEPHEN W. D. WOLF (MCAT Institute, Moffett Field, CA) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A1-1 to A1-15. refs

This paper reviews adaptive wall technology for improving wind tunnel flow simulations. The technology relies on a tunnel/computer system to control the shapes of the test section boundaries. This powerful marriage of experiment and theory is used to minimize boundary interferences at the very source of the disturbances. The significant benefits of adaptive wall testing techniques are briefly discussed. A short historical overview describes the disjointed development and the status of these testing techniques from 1938 to present. Some of the currently operational Adaptive Wall Test Sections (AWTSs) for aerofoil and turbomachinery research are described. Some observations on the achievements and future directions of adaptive wall research are presented to stimulate round table discussion. Author

A91-52778
TWO-DIMENSIONAL WALL ADAPTATION FOR THREE-DIMENSIONAL FLOWS
M. C. LEWIS and M. J. GOODYER (Southampton, University, England) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A2-1 to A2-24. Research supported by Department of Trade and Industry of England and Royal Aerospace Establishment. refs

This paper summarizes recent research at the University of Southampton into adaptive wall technology for three-dimensional flows. The work is aimed at developing testing techniques for use in test sections with just two flexible walls. Two independently derived interference codes have been developed and both are used to assess the inevitable residual wall interference. A simple theoretical investigation concerning the proportions of the test section and the permissible model size is briefly outlined. The highlights of model tests with straight and adapted walls are also reported. While it is recognized that current testing experience with adapted walls is limited, all the evidence suggests that adaptive test sections with two flexible walls are all that is necessary to ensure correctable flows over typical wing models. Author

A91-52779
ADAPTIVE WALL WIND TUNNELS WITH ADJUSTABLE PERMEABILITY - EXPERIENCE OF EXPLOITATION AND POSSIBILITIES OF DEVELOPMENT
V. M. NEILAND (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A3-1 to A3-6. refs

Possibilities for wind tunnel flow-boundary interference effect reductions using adaptive (segmented and adjustable) test section wall permeability are presently evaluated in light of results from both theoretical and experimental investigations. It is shown that, at transonic speeds, the far flowfield is close to axisymmetric even if the wind tunnel model has not been area-ruled; in such a case, the wall-pressure distribution corresponding to free-flow conditions can be calculated in advance for the equivalent body-of-revolution. O.C.

A91-52780
THE CRYOGENIC ADAPTIVE WALL WIND TUNNEL T2 - QUALITY OF THE ADAPTATION WITH 2-D AND 3-D STRATEGIES, RESIDUAL CORRECTIONS, ASSESSMENT OF SIDEWALL EFFECT IN 2-D CASE
J. P. ARCHAMBAUD and A. MIGNOSI (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A4-1 to A4-6. refs

ONERA's T2 wind tunnel is one of the few extant facilities employing adaptive walls while operating under cryogenic conditions. The present consideration of T2's design features and operational capabilities gives attention to the wind tunnel's test section, the 2D and 3D adaptation processes, the qualification of the sidewall effects, and the means to active wind tunnel control. O.C.

A91-52781
FIRST EXPERIMENTAL RESULTS FROM THE ADAPTIVE-WALLS WIND-TUNNEL IN NAPLES
G. P. RUSSO, G. ZUPPARDI, and M. BASCIANI (Napoli, Universita, Naples, Italy) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A5-1 to A5-8. refs

The test section of the adaptive-wall wind tunnel operated by the University of Naples has undergone modifications associated not only with the resolution of previous problems but the incorporation of a computerized data-acquisition and control system. Adaptation is obtained by modification of the shape of the flexible upper and lower walls of the test chamber, to improve high-subsonic/low-transonic flow regimes. O.C.

A91-52782
INTEGRATION OF WALL INTERFERENCE ASSESSMENT AND WALL ADAPTATION
J. SMITH (National Aerospace Laboratory, Amsterdam, Netherlands) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A6-1 to A6-8. refs

The fact that the normal velocity distribution on the test section walls suffices to calculate the associated harmonic perturbation flow field inside it, is fully exploited for adaptive wall applications. In addition, wall adaptation is applied to obtain correctable, instead of zero, interference. Wall interference assessment is applied to determine, in succession, initial and residual interference. A major advantage of accepting correctability is that deviations of the center of the test section exit from the nominal test section centerline, which may give rise to unnecessarily high losses in the diffuser entry area, are avoided. Author

A91-52783
UNSTEADY BOUNDARY PRESSURE STUDIES FOR ADAPTIVE WIND TUNNEL WALL INTERFERENCE
S. KARASOY and M. S. KAVSAOGLU (Middle East Technical University, Ankara, Turkey) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A7-1 to A7-8. refs

In this study, unsteady pressure measurements made on an oscillating airfoil and on the walls of the test section in an incompressible wind tunnel (at various blockage ratios and reduced frequencies) showed that linear unsteady interference effects could be negligible in moderate size wind tunnels with steady adaptation. The measurements are also expected to provide data for related theoretical studies on correction methods, while highlighting some specific difficulties and requirements of unsteady wall pressure measurements for future experimental works. Author

A91-52784
RECENT DEVELOPMENTS IN TWO-DIMENSIONAL TESTING AT LOW SUPERSONIC SPEEDS IN AN ADAPTIVE FLEXIBLE-WALLED WIND TUNNEL
N. J. TAYLOR and M. J. GOODYER (Southampton, University, England) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A9-1 to A9-25. Research supported by SERC and Ministry of Defence Procurement Executive. refs

Current 2D adaptive wall research at the University of Southampton is directed toward producing interference-free wind tunnel data throughout the transonic speed range. This paper reviews the recent advances that have been made toward developing testing techniques for Mach numbers ranging from 1 to 1.4. Methods have been devised to overcome the problems associated with starting the tunnel, flow sensitivity, and wave reflections. The principles of three testing techniques are described and details of their implementation are provided. Various developments which promise more economical operation are also outlined. Highlights of initial testing experience at Mach 1.2 are presented, and the considerable potential advantages of testing

large models in relatively shallow test sections are discussed. While it is recognized that all three techniques are in the early stages of development, prospects for successful completion are considered to be good. Author

A91-52785
2-D WALL ADAPTATION FOR 3-D MODELS IN SUPERSONIC FLOW
A. HEDDERGOTT and E. WEDEMEYER (DLR, Goettingen, Federal Republic of Germany) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A10-1 to A10-6. refs

First experimental investigations regarding two-dimensional wall adaptation for three-dimensional supersonic flows are reported. It is shown that the wall interferences due to a reflected shock wave can be largely eliminated by suitable shaping of the flexible test section walls. Residual interferences are mainly due to imperfections of the experimental facility; the limited number of jacks and their wide spacing preclude an exact wall adaptation. Author

A91-52786
REDUCING SHOCK WAVE REFLECTION FOR 3-D MODELS TESTING IN 2-D ADAPTIVE FLEXIBLE WALL TEST SECTION AT M = 1.2
JIA J. HE, PEI C. ZUO, HUA X. LI, and MIN XU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A11-1 to A11-8. refs

China's Northwestern Polytechnical University has developed a trisonic, blow-down wind tunnel with adaptive walls. An iterative method has been developed for testing which takes fullest advantage of wall adaptability. Attention is given to initial efforts to reduce 3D wall interference in the case of low supersonic flow shack wave reflection. O.C.

A91-52787
PRELIMINARY COMPARATIVE ASSESSMENT ON 2-D AND 3-D WALL ADAPTATION FOR LOW SUPERSONIC 3-D FLOWS
H. X. LI, J. J. HE, P. C. ZUO, and M. XU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. A12-1 to A12. refs

This paper reports an exploration of the use of 2D flexible-walled test sections for 3D model testing at low supersonic speed. The wall adjusting strategy is outlined and the preliminary experimental results are presented. Through comparisons with the results of the 3D model tests in different current 2D and 3D adaptive wall test sections, it has been confirmed that, at the prerequisite of acceptable total numbers of the wall adjusting jacks in engineering application, the quality of the supersonic wall adaptation for 3D models does not absolutely depend on whether the 2D or 3D wall adaptations are performed. The spacing of the controlling jacks also plays an important role in control of the flow characteristics near the walls. A 2D adaptive wall test section with appropriate jack arrangement and wall adjusting strategy could greatly reduce the wall interferences in 3D model testing at low supersonic speeds. Author

A91-52788
TOWARDS FURTHER DEVELOPMENT OF ADAPTIVE WALL TECHNOLOGY
N. J. TAYLOR and M. J. GOODYER (Southampton, University, England) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. D1-1 to D1-14. Research supported by SERC and Ministry of Defence Procurement Executive. refs

There is general concern, which extends beyond the adaptive wall community, regarding the limited development of the adaptive wall test section as a tool for producing high quality wind tunnel test data. This paper outlines some of the major reasons for the current situation and attempts to assess the validity of various aspects in the debate. The unique potential of adaptive flexible-walled test sections to meet the combined needs of the aerodynamic community for reliable test data and an experimental platform for computational technique development is identified. A reevaluation of the current status of adaptive wall technology in the light of recent developments is recommended in order to stimulate further research interest. Author

A91-52789
HIGH SPEED WIND TUNNEL WALL INTERFERENCE CORRECTION RESEARCH AT NAI
QIWEI ZHANG (Nanjing Aeronautical Institute, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W3-1 to W3-8. refs

The wall-interference assessment/correction (WIAC) codes developed for the tunnel NH-I at Nanjing Aeronautical Institute have been used to assess or correct the wall-interference effects for 2-D airfoil tests and 3-D model tests in several high speed wind tunnels including the slotted wall, perforated wall, solid wall and adaptive wall test sections. The codes are briefly described and typical corrected results are shown in this paper. Author

A91-52790
RECENT RESEARCH ON WIND TUNNEL WALL INTERFERENCE AT THE NATIONAL RESEARCH COUNCIL OF CANADA
Y. Y. CHAN, Y. NISHIMURA, and M. MOKRY (National Research Council of Canada, Institute for Aerospace Research, Ottawa) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W4-1 to W4-5. refs

A brief account of two research programs on wall interference on a conventional tunnel and a tunnel with adaptive walls is presented. The first program has demonstrated that a conventional tunnel with proper interference corrections and an adaptive wall tunnel with proper streamline simulation can adequately eliminate the tunnel wall interference effects. In the second program, a method has been developed for correcting residual interference from imperfect wall adaption for adaptive wall tunnels. Author

A91-52792
ACOUSTIC FLUCTUATIONS IN TRANSONIC WIND TUNNEL TEST SECTIONS
V. LEBIGA and V. ZINOV'EV (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W8-1 to W8-4. refs

Using hot-wire equipment and special technique for data interpretation, intensity and spectra of fluctuations have been studied in the test sections of a transonic wind tunnel. Characteristics of fluctuations are compared for different types of walls: slotted, perforated, and smooth (solid), which correspond to adaptive walls. Author

A91-52793
NUMERICAL DESIGN AND ANALYSIS OF SLOTTED-WALLS IN A RECTANGULAR TRANSONIC TEST-SECTION
Y. C.-J. SEDIN (Saab-Scania, AB, Linkoeping, Sweden), N. ZHANG (Northwestern Polytechnical University, Xian, People's Republic of China), N. AGRELL, and B. A. PETTERSSON (Aeronautical Research Institute of Sweden, Bromma) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W9-1 to W9-9. refs

An approximate slotted-wall theory for inverse mode design of slot-shapes yielding low wall-interference in rectangular transonic test-sections has been applied to a relatively large low-aspect-ratio wind tunnel model blocking about 1.5 percent of cross-section. The approximate wall theory is based on slender cross-flow theory coupling the test-section flow to the flow through individual slots while taking into account slot geometry, plenum pressure and wall inclination. The obtained wall-interference is numerically checked in direct analysis mode runs with the designed slots using an existing computer code working with the same slot flow model, but with a somewhat different wall theory. The inviscid theories are corrected for viscous slot flow losses and wall boundary layers using certain loss factors and simple 2D wall boundary layers.
Author

A91-52794
EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF WALL INTERFERENCE IN SLOTTED TEST SECTIONS
S. R. MOHAN (City University, London, England), R. C. LOCK, and M. M. FREESTONE IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W10-1 to W10-13. Research supported by Ministry of Defence. refs

The method presently used to investigate the interference produced in a slotted-liner wind tunnel only requires that there should be a region of potential flow between the model flow and the wind tunnel walls. A theoretical method is developed for slotted-liner wind tunnels which allows the normal velocity component to be determined on the basis of a knowledge of the pressure difference between points on the wind tunnel wall and within the plenum chamber. Experiments have been conducted in a low speed wind tunnel, using a half-model NACA 0021 airfoil mounted opposite either a single-slot liner or a liner with four slots.
O.C.

A91-52795
A NUMERICAL ASSESSMENT OF WALL INTERFERENCE IN 2-D
R. GOPINATH, S. VISWANATHAN, and S. S. DESAI (National Aeronautical Laboratory, Bangalore, India) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W11-1 to W11-4. refs

A numerical method of assessing the interference due to tunnel walls on flow past an airfoil in a wind tunnel from measurements on a control surface using the full potential equation, has been tried out on a few airfoils in this study. The interference corrections are compared with those by the other methods and the agreement is very good. The calculation is quite rapid and can be used in a routine manner to correct the data from the wind tunnel. Author

A91-52796
COMBINED FOUR-WALL INTERFERENCE CORRECTION IN TWO-DIMENSIONAL TRANSONIC AIRFOIL TESTS
MIANCHUN ZHANG and HONGYING ZHANG (Chinese Academy of Sciences; Institute of Mechanics, Beijing, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W12-1 to W12-6. refs

A procedure is examined for combining the correction method for the effects of the sidewall-boundary layer with the correction method for the effects of the upper and lower tunnel walls. The model representation consists of a subsonic higher-order model representation and a 'transonic doublet'. The procedure can be used for transonic wind-tunnel-test on-line data reduction.
Author

A91-52797
WALL INTERFERENCE CORRECTIONS FOR HIGH SPEED WIND TUNNEL TESTS USING WALL PRESSURE METHOD
Z. L. FAN and N. M. CUI (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W13-1 to W13-8. refs

A linear procedure is described for the evaluation of wall-interference corrections for high-speed wind-tunnel tests at CARDC which requires pressure measurements on or near walls and measured aerodynamic forces of the tested model. The method has been applied to wall-interference corrections for test data of two models with a fighter configuration in the CARDC 0.6 x 0.6 m wind tunnel with perforated walls. The lift- and pitch-moment data can be corrected with reasonable accuracy at subcritical flow conditions near the walls. Application of the present method to wall-interference corrections at higher angles of attack is also investigated.
Author

A91-52798
INVESTIGATION FOR WALL INTERFERENCE OF SLOTTED WIND TUNNEL AT HIGH ANGLE OF ATTACK
RONXI YUAN and JIECHUAN FAN (Harbin Aerodynamics Research Institute, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W14-1 to W14-6. refs

The longitudinal test results of the DLR NWD slotted wind tunnel using DBM-01 calibration model at high angle of attack are given in this paper. The calculation of the wall-interference correction for test results is performed using the wall-pressure-signature method. The calculation results show that the wall-pressure-signature method is feasible for correction of residual wall interference of slotted wall and the quantity of wall interference does not change much and is not large near the optimum area ratio, and the suitable working open-area ratio can be given in the range of certain angles of attack for the same wind tunnel.
Author

A91-52800
A WALL PRESSURE CORRECTION METHOD FOR SUBSONIC WIND TUNNEL
W. H. ZHANG (Nanjing Aeronautical Institute, People's Republic of China) and G. SCHULZ (DLR, Cologne, Federal Republic of Germany) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W17-1 to W17-7. refs

A wall pressure correction method for closed rectangular subsonic test sections is presented. This paper calculates the wall interference by method of influence function. Experimental examinations of the method give good results on high lift measurements, as well as on the blockage correction in the presence of a large wake region behind the model.
Author

A91-52801
2D WALL INTERFERENCES OF THE TRANSONIC WIND TUNNEL OF DLR BRAUNSCHWEIG (TWB)
W. SCHROEDER (DLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W18-1 to W18-8. refs

Wall-interference assessment is applied to TWB for a variety of transonic airfoils for typical model sizes and flow conditions. The interference and correction procedure is based on the Cauchy integral method coupled with a 'model representation' routine for ventilated test-section walls and uses measured wall pressures. Its quality is shown by a comparison with test cases from the literature and with interference results based on experiments with measured boundary conditions within the flow field by a rail, a Calspan pipe and an angularity probe. The results indicate large interference gradients along the model chord. TWB tests presently fulfill the flow-quality requirements of AGARD-AR 184 only with moderate model sizes (of 0.15 m or less) and only at moderate lift conditions. Author

A91-52803
EFFECT OF WALL FRICTION ON SIDEWALL INTERFERENCE IN TWO-DIMENSIONAL WIND TUNNELS
KEMING CHENG and YIYI HUANG (Nanjing Aeronautical Institute, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W20-1 to W20-5. refs

A theoretical defect in Barnwell's (1980) analysis of sidewall interference is the inadmissibility of neglecting the friction term when dealing with the wind tunnel sidewall boundary layer. By investigating the effect of wall friction on the sidewall boundary layer, a novel correction for the Barnwell model is developed. Ways of more accurately determining the boundary-layer displacement thickness are discussed. O.C.

A91-52804
STUDY ON SIDEWALL SUCTION IN TWO-DIMENSIONAL WIND TUNNEL
KEMING CHENG (Nanjing Aeronautical Institute, People's Republic of China) and YAOXI SU (Northwestern Polytechnic University, Xian, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W21-1 to W21-6. refs

This paper studies sidewall suction in 2D wind tunnels. Because the analyses regarding the effect of sidewall suction have not been perfected, the present analysis further considers the effects of porosity and suction-orifice inclination and therefore more perfectly describes the influence of sidewall suction on the flow in a 2D wind tunnel. Moreover, the control of sidewall suction is explored theoretically so as to eliminate the interference from the sidewalls. Author

A91-52805
NEW ADVANCES IN WIND TUNNEL WALL INTERFERENCE CORRECTION FOR PRESSURE MEASUREMENTS
GUIQING JIANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) IN: ICAW 1991; International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Proceedings. Xian, People's Republic of China, Northwestern Polytechnical University, 1991, p. W15-1 to W15-8. refs

Two critical advances over the wall-pressure signature-correction method by J. E. Hackett are presented in this paper. First, an accurate and convenient method to determine the wake intensity of a tested model was developed. Secondly, an accurate correction method for pressure measurements was deduced. Those were demonstrated through force and pressure tests on two vertical disks of blockage 15 percent and 20 percent. The correction results were better than by original method, even in the cases of drag- and base-pressure corrections up to 90 percent and 260 percent of real value, respectively. The wall pressure distribution data are provided in the paper. Author

A91-52807
A METHOD FOR ASSESSING TRANSONIC WIND TUNNEL WALL INTERFERENCE - 2-D ASSESSING COMPUTATION USING WALL PRESSURE
ZHEN CHEN (CAE Shenyang Aerodynamics Research Institute, People's Republic of China) Chinese Aeronautics and Astronautics Establishment and Northwestern Polytechnical University, International Conference on Adaptive Wall Wind Tunnel Research and Wall Interference Correction, Xian, People's Republic of China, June 10-14, 1991, Paper . 8 p. refs

The optimum configuration for transonic wind-tunnel walls is examined by using the transonic x-direction strengthen perturbation method. The equation allows the calculation of the free-stream field with the optimum open area ratio for minimum interference. The results of the computation are compared to experimental values of wall-pressure distribution from two wind tunnels in which airfoils are placed to simultaneously study the blockage effect. One wind tunnel permits the variance of the open area ratio from 0-10 percent by means of four adjustable slots, and the other has a constant open area ratio of 15 percent. The magnitude of wall interference is found to relate generally to the test-section walls, the position of the mounted model, and the Mach number. The small airfoil creates negligible wall interference at open area ratios of 2-6 percent, and the condition of no interference from blockage is also discussed for different Mach numbers. C.C.S.

A91-52923
TECHNIQUE FOR AERODYNAMIC FORCE MEASUREMENT WITHIN MILLISECONDS IN SHOCK TUNNEL
K. W. NAUMANN, H. ENDE, and G. MATHIEU (Saint-Louis, Institut Franco-Allemand de Recherches, France) Shock Waves (ISSN 0938-1287), vol. 1, Aug. 1991, p. 223-232. refs
Copyright

A novel measurement technique is developed for aerodynamic force measurement in shock tunnels and similar short-duration aerodynamic testing facilities. Its key feature is a mounting support, which releases the test model and grips it again after a free flight duration of about 10 milliseconds. The model is equipped with small accelerometers and can contain additional installations. The short free flight allows the use of thin wires because the model travels only a few millimeters during this time. Validation experiments with a cone-cylinder of known drag coefficient show good accuracy with a response time of about half a millisecond. Pitot pressure measurement and suitable data processing allow for direct evaluation of aerodynamic coefficients in slowly changing flow. Author

A91-52959
LANDING AND TAXIING LIGHTS - DESIGN CRITERIA FOR INSTALLATION
SAE Aerospace Recommended Practice, ARP 693, Jan. 30, 1991, 15 p.
(SAE ARP 693) Copyright

Considerations and design issues are discussed with respect to a recommended method for installing lights for the night operation of several types of aircraft. Detailed recommendations are given for the landing lights used as ground reference or signaling indicator, and issues are discussed ranging from the impact of glare on visibility to minimum illumination to the number of required lights. Possible locations for the lights are listed, landing-light aiming is reviewed, and the control scheme for the lights is discussed. General provisions for runway turnoff/taxi lights

are presented, with particular attention given to the minimum illumination and requirements for different aircraft types. Installation issues are discussed in depth including environmental conditions, maintainability, light loss, and safety practices, and the operation parameters of retractable landing lights are detailed. C.C.S.

N91-29197# *National Aeronautical Lab., Bangalore (India). Flight* Mechanics and Controls Div.
INSTRUMENTATION FOR ASE EXPERIMENTS IN THE DYNAMIC WIND TUNNEL
L. POORNIMA and K. SESHADRI Jun. 1991 13 p
(PD-FC-9112) Avail: NTIS HC/MF A03

The instrumentation package developed for use with flexible wing models was tested in the dynamic wind tunnel for aeroservoelastic studies. This approach uses geometrically scaled elastic wings which are mounted with sensors to measure dynamic response. Strain gages and accelerometers were used. Author

N91-29198# Army Cold Regions Research and Engineering Lab., Hanover, NH.
PERFORMANCE OF ASPHALT CONCRETE AIRPORT PAVEMENTS DURING THAW WEAKENING PERIODS: A FIELD STUDY
VINCENT C. JANOO and RICHARD L. BERG Apr. 1991 70 p
(Contract DTFA-01-84-2-02038)
(AD-A237441; CRREL-91-7; DOT/FAA/RD-91/16) Avail: NTIS HC/MF A04 CSCL 11/2

It is accepted that in the winter the load-carrying capacity of pavements increases dramatically because of freezing of the pavement structure. This is more striking in asphalt concrete pavements because of the stiffening of the asphalt at low temperatures. In the spring, the pavement structure below the asphalt layer thaws and can become saturated with water from the melting ice lenses, reducing the strength of the bases subbase and subgrades. In the spring of 1986, CRREL conducted Falling Weight Deflectometer (FWD) measurements at an airfield in Wisconsin, which had pavements that were primarily asphalt concrete, to determine the change in the load bearing strength of these pavement structures in a seasonal frost area during thaw weakening periods. In addition to FWD measurements, surface and subsurface pavement temperatures were measured at selected sites. This report gives a general description of the airfield and the pavement structure and a comprehensive analysis of the FWD measurements. GRA

N91-29199*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CALCULATED PERFORMANCE OF THE NASA LEWIS ICING RESEARCH TUNNEL
LARRY A. VITERNA Aug. 1991 23 p
(NASA-TM-105173; E-6469; NAS 1.15:105173) Avail: NTIS HC/MF A03 CSCL 14/2

The Icing Research Tunnel is used extensively to test many classes of aircraft under atmospheric icing conditions. Because of the need to test models at higher Reynolds numbers, a new fan rotor was designed to increase test section wind speed. A preliminary study was made of the present fan rotor to suggest possible methods to increase tunnel wind speed. The results of that study are presented. Author

N91-30164# Aeritalia S.p.A., Turin (Italy). Centro di Simulazione.
ON-LINE ASSISTANCE IN FLIGHT SIMULATION
MICHELE VISCIOLA, ARMANDO ARMAND, and SEBASTIANO BAGNARA (Siena Univ., Italy) 1990 11 p Presented at the 5th Societa Europa Ergonomia Cognitiva, Urbino, Italy, Sep. 1990
(ETN-91-99772) Avail: NTIS HC/MF A03

Preliminary results of an explorative investigation of modalities of assistance during a training stage in a flight simulator are presented. Assistance modalities and communication patterns are studied in order to find error detection and correction conditions. Ways to assist the pilot in avoiding erroneous decisions and actions well before they happen are investigated. Ten consistent patterns of communication between pilots and instructors are found. These patterns can be used in developing a framework for the design of a data bank which takes into account both error episodes and modalities of assistance in learning activities. ESA

N91-30165# European Space Agency, Paris (France).
STUDY OF AN ELECTROTHERMAL DE-ICER: NUMERICAL SIMULATION AND MEASUREMENT OF THE SKIN TEMPERATURE BY INFRARED TECHNIQUE IN AN ICING WIND TUNNEL Ph.D. Thesis - Clermont-Ferrand Univ., 1989
ROBERT HENRY (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) May 1991 211 p Transl. into ENGLISH of Etude du Fonctionnement d'un Degivreur Electrique Modelisation et Mesure en Soufflerie Givrante de Temperature Parietale par Thermographie Infrarouge (Paris, France, ONERA), Dec. 1989 Original language document was announced as N91-11133
(ESA-TT-1231; ONERA-NT-1989-10; ETN-91-99808) Avail: NTIS HC/MF A10

Various protective measures taken against ice formation are presented. The method of measurement using infrared thermography in an icing wind tunnel and the measurements actually carried out are described. Particular emphasis is placed on the preliminary studies needed for thermographic measurement. The results of the measurement led to the development of a new numerical model for deicing taking into account the melting of a layer of ice. This model is described and compared with similar programs, as well as with a finite element program (ADIBAT). The results obtained experimentally with the infrared camera are compared with the numerical results arising from the developed program. This comparison reveals the present limitations of the model and possible improvements in it, such as taking into account the capture of droplets and the changes occurring in the ice layer. 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.

A91-48836* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RAREFIED-FLOW AERODYNAMICS MEASUREMENT EXPERIMENT ON THE AEROASSIST FLIGHT EXPERIMENT VEHICLE
ROBERT C. BLANCHARD (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 28, July-Aug. 1991, p. 368-375. Previously cited in issue 09, p. 1298, Accession no. A89-25504. refs

A91-49453
USING QUATERNION ALGEBRA TO DETERMINE THE COORDINATES AND ORIENTATION OF A FLIGHT VEHICLE USING DATA FROM AERIAL PHOTOGRAPHY AND NAVIGATION SYSTEM [PRIMENENIE ALGEBRY KVATERNIONOV DLIA OPREDELENIIA KOORDINANT I ORIENTATSII LA PO DANNYM AEROFOTOS'EMKI I NAVIGATSIONNOI SISTEMY]
L. I. ARAMANOVICH (Moskovskii Institut Inzhenerov Geodezii, Aerofotos'emki i Kartografii, Moscow, USSR) and L. V. POPOV (Moskovskii Institut Teplotekhniki, Moscow, USSR) Geodeziia i Aerofotos'emka (ISSN 0536-101X), no. 5, 1990, p. 102-111. In Russian. refs

The paper considers the problem of determining values of linear and angular kinematic parameters and orientation of a flight-vehicle equipped with a camera and a strapdown inertial navigational system (SINS), at an arbitrary initiation time of the motion integration, using the quaternion formalism described by Branetz and Shmyglevskii (1973). The solution is obtained in analytical form. It is shown that this solution, in conjunction with SINS data and two or more aerial photographs, makes it possible to obtain flight-vehicle parameters easily and accurately. I.S.

A91-49613*# Princeton Univ., NJ.
AEROSPACE PLANE GUIDANCE USING TIME-SCALE DECOMPOSITION - A GEOMETRIC APPROACH
MARK A. VAN BUREN and KENNETH D. MEASE (Princeton University, NJ) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 370-379. refs
(Contract NAG1-907)
(AIAA PAPER 91-2722) Copyright

A method is proposed for developing the necessary guidance logic to steer single-stage vehicles into orbit. The minimum-fuel ascent problem is first considered to analyze the effects of dynamic pressure, acceleration, and heating constraints on guidance systems to thereby develop the guidance logic. The optimal solution consists of behavior with two time scales, and the control law is used to develop near-optimal guidance. The solution uses the slow manifold to delineate the control for minimum-fuel reduced-order trajectory and a separate control for tracking the optimal reduced-order trajectory. A family of fast manifolds is then employed to resolve the tracking problem via the feedback linearization methodology from nonlinear geometric control theory. The two-time-scale decomposition is found to produce a near-optimal ascent by tracking the applicable state-constraint boundary, as well as to simplify the control-design task. C.C.S.

A91-51560
A STUDY OF AEROASSISTED ORBITAL TRANSFER VEHICLE
TSUTOMU IWATA (NASDA, Tokyo, Japan), SUMIO KATO, HIROSHI ODA, and NOBUYOSHI MUROI (Kawasaki Heavy Industries, Ltd., Kobe, Japan) IN: Workshop on Space Fluid Dynamics and Related Problems, Kurashiki, Japan, Nov. 22, 23, 1989, Proceedings. Fukuoka, Japan, Kyushu University, 1990, p. 68-75. refs

The effectiveness of the use of aerobraking by an aeroassisted OTV is demonstrated in light of thermal, loading, and strength analyses for the aerobrake feature. On the basis of the results thus obtained, a study was conducted for aerobrake weight characteristics, with a view to weight reduction. Attention is also given to the effects of such parameters as loads, diameter, thickness, etc., for a lift-generating aerobrake. Thermal-protection system weight is identified as a potentially problematic factor. O.C.

A91-51750
THE MHD ACCELERATOR
J. T. LINEBERRY and T. A. CRAWFORD (Tennessee, University, Tullahoma) Mechanical Engineering (ISSN 0025-6501), vol. 113, Sept. 1991, p. 70-74.
Copyright

An MHD principle-propelled wind tunnel is envisioned as a highly effective means for the ground testing of NASP-related configurational concepts at speeds up to hypervelocity. In such an MHD system, the fact that the fluid is accelerated by an intrinsic force results in a direct increase of kinetic energy. Both the magnitude of the MHD current and its distribution along the accelerator length are controllable by design to yield the most efficient operating point. The high-energy flow exhausted from the MHD accelerator is expanded by means of a hypersonic nozzle which converts the supersonic stream of the accelerator up to the simulation's required Mach number. The flow of the tunnel nozzle is exhausted as a free jet over the static wind tunnel model. O.C.

A91-52251
NUMERICAL INVESTIGATION OF HIGH-TEMPERATURE EFFECTS IN THE UTIAS-RPI HYPERSONIC IMPULSE TUNNEL
C. P. T. GROTH, J. J. GOTTLIEB, and P. A. SULLIVAN (Toronto, University, Downsview, Canada) Canadian Journal of Physics (ISSN 0008-4204), vol. 69, July 1991, p. 897-918. refs
Copyright

A generalized quasi-1D nonstationary flow analysis and associated TVD finite-difference solution schemes, including approximate Riemann solvers, are presented for predicting the high-temperature flows in short-duration blow-down experimental wind tunnels. The analysis is used to investigate the operation of the UTIAS-RPI facility and produce performance data that are not always easily determined or available from experimental measurements. The thermodynamic state of the nozzle-exit flow and high-temperature or real-gas effects are assessed for this facility under various operating conditions. The numerical results, coupled with additional comparisons with available experimental data, demonstrate the range of test-section flows that may be achieved. It is shown that for typical operating conditions, the air freezes in the nozzle very close to the throat and results in test-section flows with considerable energy bound in the vibrational modes of the N2 and O2 molecules. P.D.

A91-52322
FEASIBILITY STUDY OF AIR-BREATHING TURBOENGINES FOR HORIZONTAL TAKEOFF AND LANDING SPACE PLANES
M. MINODA, K. SAKATA (National Aerospace Laboratory, Chofu, Japan), T. TAMAKI, T. SAITOH, and A. YASUDA (Ishikawajima-Harima Heavy Industries, Ltd., Tanashi, Japan) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 821-827. Previously cited in issue 20, p. 313, Accession no. A90-46733. refs
Copyright

N91-29221*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL PROPULSION SYSTEM SIMULATION: AN INTERDISCIPLINARY APPROACH
LESTER D. NICHOLS and CHRISTOS C. CHAMIS 1991 16 p Presented at the Conference on Advanced Space Exploration Initiative Technologies, Clevelend, OH, 4-6 Sep. 1991; cosponsored by AIAA and OAI
(NASA-TM-105181; E-6359; NAS 1.15:105181; AIAA-91-3554)
Avail: NTIS HC/MF A03 CSCL 21/8

The tremendous progress being made in computational engineering and the rapid growth in computing power that is resulting from parallel processing now make it feasible to consider the use of computer simulations to gain insights into the complex interactions in aerospace propulsion systems and to evaluate new concepts early in the design process before a commitment to hardware is made. Described here is a NASA initiative to develop a Numerical Propulsion System Simulation (NPSS) capability. Author

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A91-48621
FLAMMABILITY OF AIRCRAFT FUELS
N. A. MOUSSA (BlazeTech Corp., Winchester, MA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p. refs
(SAE PAPER 901949) Copyright

This paper presents a brief review of the behavior of jet fuels

under simple ASTM-type tests and under the complex conditions of simulated fires. Then, focusing on the flammability of an aircraft fuel tank under ballistic threat conditions, it is shown that dynamic processes (associated with aircraft maneuvering, tank breathing, and projectile-impact) can alter significantly the equilibrium flammability envelope of a fuel. Differences in fuel properties that are apparent in small scale tests can be overshadowed under these conditions. Author

A91-48647
DEVELOPMENT OF SONIC DESIGN DATA FOR ENGINEERING PLASTICS USED FOR STRUT AND NACELLE APPLICATIONS
MICHAEL A. O'GRADY, KEITH A. EVANS, and DONALD P. MATHESON (Boeing Co., Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p.
(SAE PAPER 901985) Copyright

Engineering plastics are now available for use on lightly loaded aircraft structure. These materials have excellent cost benefits as well as producibility benefits over their hand laidup predecessors. They are especially useful in the strut and nacelle areas where many of the fairings are attached for aerodynamic purposes only and may have rather complicated contours. In addition to lower costs, the manufacturing process is consistent, unlike hand laidup parts, which often require rework. In the strut and nacelle area one of the major requirements for all parts is sonic durability. This paper is intended to explain the test setup and test procedure for sonic testing of thermoplastics and thermosets and the results of the testing up to this point. Included in the explanation will be the assumptions made, the test setup, results of the testing and conclusions drawn from the testing. Author

A91-49114
DEVELOPMENT OF A NEW LOW TOXICITY PMR-TYPE POLYIMIDE FOR ADVANCED COMPOSITE APPLICATIONS
N. D. HOYLE, N. J. STEWART (BP Research, Sunbury Research Centre, England), D. WILSON (BP Chemicals, Inc., Santa Ana, CA), M. BASCHANT (Dornier GmbH, Friedrichshafen, Federal Republic of Germany), J. GREENWOOD, G. D. SMALL (ERA Technology, Ltd., Leatherhead, England), H. MERZ, and S. SIKORSKI (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 198-212. refs
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A PMR-type polyimide has been developed whose properties resemble those of PMR-15 but do not include that resin's thermal cycling-induced microcracking, and methylene diamine comonomer (methylene dianiline) toxicity. The formulation identified as most promising employs a partially fluorinated four-ring diamine of low toxicity. Laminates of this resin have been fabricated by autoclave molding. Long-term use temperatures of the order of 250 C are envisioned; even at 300 C, the new resin's weight loss was significantly lower than that of PMR-15. O.C.

A91-49118
DESIGN TRADE-OFFS FOR CERAMIC/COMPOSITE ARMOR MATERIALS
STEPHEN M. ARNDT and JOSEPH W. COLTMAN (Simula, Inc., Phoenix, AZ) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 278-292.
Copyright

Armors designed to defeat small caliber projectiles, as are typically required for lightweight aircraft or vehicle protection, can vary greatly in design, weight, and cost depending upon the materials chosen. Where weight is a primary consideration, ceramic/composite armors provide the best performance. Typical materials used today for ceramic/composite armors include Spectra 900 and 1000, Kevlar 29 and 49, and S-2 Glass fibers as well as boron carbide silicon carbide, and aluminum oxide ceramics. Because there is such a range of materials available, an armor system can be tailored to meet the specific design requirements of any given application. These design requirements may include weight, cost, structural loading, thermal exposure, shock, vibration, flammability, and solvent resistance. This paper will examine typical design trade-offs for a number of ceramic/composite armor systems based on their exhibited properties and intended use. Author

A91-49119
EVALUATION OF LIGHTWEIGHT MATERIAL CONCEPTS FOR AIRCRAFT TURBINE ENGINE ROTOR PROTECTION
JOHN J. DELUCA and STEPHEN P. PETRIE (U.S. Army, Materials Technology Laboratory, Watertown, MA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 319-333. refs
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Aircraft turbine rotor failure is characterized by the release of high energy fragments capable of penetrating the engine casing. The fragments could cause fires, loss of aircraft control, hull damage, and occupant injury. Lightweight armor material technology has been proposed as a potential alternative to traditional steel containment technology. The materials investigated were: fiberglass/polyester, fiberglass/phenolic, Kevlar/phenolic, fiberglass/polyester-steel, fiberglass/phenolic-steel, Kevlar/phenolic-titanium, and titanium. and titanium. These materials were evaluated in a rotor spin-pit facility using the second stage power turbine rotor from the T53 turboshaft engine. Spin-pit testing has indicated that these materials were all successful in containing the high energy fragments produced by the failed turbine rotor. Author

A91-49128
INFLUENCE OF MATERIALS AND LAYUP PARAMETERS ON IMPACT DAMAGE MECHANISMS
WILLIAM B. AVERY and DODD H. GRANDE (Boeing Co., Seattle, WA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 470-483. refs
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The influence of stacking sequence, laminate stiffness, and material properties on impact damage mechanisms and post-impact compression strength was investigated for the IM7/8551-7 and T800H/3900-2 toughened epoxy systems. The effect of stacking sequence on damage resistance was investigated for three different stacking sequences. Damage resistance decreased with increasing laminate thickness when the number of interfaces favorable to delamination was kept constant. Stacking sequences with equal thickness exhibited different damage resistances when the number of favorable delamination sites varied. The relationship between sublaminate thickness and post-impact compression strength is discussed. Visual damage observations were correlated with damage area and the amount of broken fibers in the laminate. The intralaminar fracture toughness G(IC) and interlaminar fracture toughness G(IIC) were determined for both material systems. Post-impact compression strength increased with G(IIC) by reducing the amount of damage area created during the impact event. Author

A91-49953
FRACTOGRAPHIC OBSERVATIONS AND PREDICTIONS ON FATIGUE CRACK GROWTH IN AN ALUMINIUM ALLOY UNDER MINITWIST FLIGHT-SIMULATION LOADING
J. SIEGL, J. SCHIJVE, and U. H. PADMADINATA (Delft University of Technology, Netherlands) International Journal of Fatigue (ISSN 0142-1123), vol. 13, March 1991, p. 139-147. refs
Copyright

Sheet specimens from the 2024-T3 Al alloy were tested under two miniTWIST load histories and a special load sequence, which combines the most severe flights from miniTWIST and batches of constant-amplitude cycles. Fractographic observations were made

to determine the fatigue crack growth increments in the most severe flights. The bands caused by the severe flights could be distinguished on the fracture surface and an accurate reconstitution of the crack growth curve could be made. The crack increments occurring in the most severe flights were measured and compared with the values predicted by the modified CORPUS model.
Author

A91-50575
DESIGN, ANALYSIS, AND TEST OF A CERAMIC BARRIER TURBINE ELEMENT
G. D. SCHNITTGRUND and D. M. SHEA (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) SAMPE Journal (ISSN 0091-1062), vol. 27, Sept.-Oct. 1991, p. 39-47. refs
(Contract DAAG46-84-C-0002)
Copyright

Design features and fabrication processes for a ceramic barrier turbine blade (CBTB) are described. The capability of the CBTB design to withstand the thermal and loading environment of the F107 turbine engine is verified. It is demonstrated that airfoil-shaped, thin-walled Si3N4 shells can be fabricated to withstand the forces imposed upon them during engine operation. Spin tests of these shells show that the calculated load factor of safety (19) and the 99.5 percent probability of survival will provide a highly reliable, survivable component. The CBTB is proposed for applications in the next generation of turbine engines with operating temperatures up to 1600 C. O.G.

A91-52250
ALUMINUM ALLOY DEVELOPMENT
Aerospace Engineering (ISSN 0736-2536), vol. 11, Sept. 1991, p. 21-24.
Copyright

Development of an aluminum alloy which has higher strength than previous alloys while still showing acceptable levels of corrosion resistance and fracture is presented. Two different approaches to this goal are described; a final thermomechanical treatment method employed deformation and aging, while the second method depended solely on thermal practices to enhance the strength/corrosion resistance combination. Attention is given to a 7055 alloy that offers significant weight savings potential for applications requiring high compression strength combined with good corrosion resistance. It is indicated that structures including keel beams, horizontal tails, upper wings, cargo rails, and seat tracks on commercial transports are all candidate applications for this alloy. R.E.P.

A91-52320
MEASUREMENTS OF PARTICLES REBOUND CHARACTERISTICS ON MATERIALS USED IN GAS TURBINES
W. TABAKOFF (Cincinnati, University, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 805-813. Research supported by DOE. Previously cited in issue 18, p. 2790, Accession no. A89-43211. refs
Copyright

A91-52325
***IGNITION AND FLAMMABILITY CHARACTERISTICS OF SOLID* FUEL RAMJETS**
R. C. WOOLDRIDGE (U.S. Navy, Washington, DC) and D. W. NETZER (U.S. Naval Postgraduate School, Monterey, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 846-848. refs
(Contract N60530-87-WR-30009)

In order to achieve ignition, a solid-fuel ramjet requires a stable, high-temperature recirculation zone; after ignition is established, the entire fuel surface furnishes hot fuel vapor to the combustion process. The ignition and flammability characteristics of several fuel compositions are studied under various operating conditions and inlet geometries for the case of a windowed two-dimensional solid fuel ramjet. O.C.

A91-52509
ADVANCED BLADING
K. SCHNEIDER (ABB Kraftwerke AG, Mannheim, Federal Republic of Germany) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 935-954. refs
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The blading materials currently used by manufacturers of heavy-duty stationary gas turbines are reviewed. The potential of new materials and new processing methods is described from the viewpoint of large component size and long operating times. Particular attention is given to nickel-based alloys. Directional solidification and single-crystal technologies are assessed, and the potential of ODS materials, and advanced metals and ceramics for use in stationary gas turbines is evaluated. L.M.

A91-52519
AN EVALUATION OF CREEP BEHAVIOURAL MODELS FOR GAS TURBINE ALLOYS
L. W. CANDLER and M. R. WINSTONE (Royal Aerospace Establishment, Farnborough, England) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1077-1086. refs
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This study examines the use of the Theta Projection method for the analysis of creep data used in the design of aero gas turbines and compares the overall accuracy of life prediction and curve modeling to that of an established manual technique, devised by Graham and Walles. The single crystal superalloy SRR 99 has been creep tested for a range of temperatures and stresses and the data analyzed to derive constitutive equations. It was found that both the modeling techniques give similar creep life predictions with the manual method yielding slightly more accurate results. The limitations of each technique are discussed and examples of their regenerative ability are illustrated. Author

A91-52527
DAMAGE MECHANISMS IN AN ODS-SUPERALLOY DURING ISOTHERMAL AND THERMAL-MECHANICAL FATIGUE
R. JOOS, D. M. ELZEY, and E. ARZT (Max-Planck-Institut fuer Metallforschung, Stuttgart, Federal Republic of Germany) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1173-1184. refs
Copyright

Results are reported from thermal-mechanical fatigue (TMF) tests of oxide-dispersion-strengthened (ODS) superalloy MA 6000. Failure under TMF conditions is found to be similar to that under creep-fatigue conditions, with transverse-grain-boundary cavitation resulting in nucleation of internal microcracks which then grow and coalesce until fracture occurs. T.K.

A91-52529
INFLUENCE OF ENVIRONMENT ON HIGH TEMPERATURE *LOW CYCLE FATIGUE OF AN OXIDE DISPERSION* STRENGTHENED NICKEL BASE SUPERALLOY
M. MARCHIONNI, D. RANUCCI, and E. PICCO (CNR, Istituto per la Tecnologia dei Materiali Metallici non Tradizionali, Cinisello Balsamo, Italy) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1195-1204. refs
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The influence of air and vacuum on low-cycle fatigue (LCF) of an ODS superalloy at 850-1050 C was studied. LCF results in air showed a reduction of fatigue life when temperature increased. No influence of test temperature on fatigue life and a longer endurance were observed in vacuum. The fatigue damage

mechanisms were analyzed by SEM and TEM. Generally fatigue cracks occurred at the surface and propagated toward the interior in transgranular mode. Author

A91-52533
BURNER RIG TESTS OF COATED SINGLE CRYSTAL SUPERALLOYS AT 1100 C
K. FRITSCHER, H.-J. RAETZER-SCHEIBE, G. WIRTH (DLR, Institut fuer Werkstoff-Forschung, Cologne, Federal Republic of Germany), and M. R. WINSTONE (Royal Aerospace Establishment, Propulsion Dept., Farnborough, England) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1239-1248. refs
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Uncoated and differentially coated alloys (single-crystal SX60A, SRR99, CMSX-2, CMSX-6, MMT143, and directionally solidified MAR-M002) were cyclically tested in a Mach-0.3 burner rig at 1100 C for 100 h, both with and without injection of 5 ppm synthetic sea salt into the JP4 combustion gas. The uncoated alloys had oxidation resistance inferior to that of conventional polycrystalline alloys. When tested with a simple aluminide diffusion coating the results were still significantly worse than those obtained for the same coating on the polycrystalline alloy. The addition of 5 ppm sea salt to the combustion gas accelerated corrosion but did not alter the ranking of the substrate/coating systems. Overall the best performance was achieved with two overlay coating versions. The interdiffusion between substrate and overlay coating also affected the corrosion resistance and the potential lifetime of the coatings. Author

A91-52536
PROCESS AND ALLOY OPTIMIZATION FOR CMSX-4 SUPERALLOY SINGLE CRYSTAL AIRFOILS
D. J. FRASIER, J. R. WHETSTONE (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN), K. HARRIS, G. L. ERICKSON, and R. E. SCHWER (Cannon-Muskegon Corp., Muskegon, MI) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1281-1300. refs
Copyright

Maximum advance in turbine-blade stress and temperature capability is possible when alloy chemistry optimization is combined with process innovation and development. The material selected for this program is CMSX-4, a second-generation rhenium-containing ultra-high-strength single-crystal superalloy. Casting, solution and aging heat treatment, and bonding process optimization results are reviewed for a variety of single-crystal airfoil configurations. Optimized creep-rupture data are shown for CMSX-4 alloy. Author

A91-52541
RAISING THE HIGH TEMPERATURE LIMIT OF IN718 - DESIGNING TICOLLOY
J. K. TIEN, J. P. COLLIER, P. L. BRETZ, and B. C. HENDRIX (Texas, University, Austin) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1341-1356. Research supported by Niobium Products Co., Wyman Gordon Co., and Special Metals Corp. refs
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The objective of the study was to enhance the temperature capabilities of the nickel-iron-base superalloy IN718 by increasing the stability of the gamma, gamma prime, and gamma double prime phases and thus reducing the amount of the brittle delta phase. It is found that the microstructural and thermal stability of IN718 can be improved by increasing the (Al+Ti)/Nb ratio while maintaining the Fe and Nb concentrations. Increasing the Al/Ti ratio while maintaining a high (Al+Ti)/Nb ratio and Fe content produces an even more stable alloy. The strongest and most stable alloy, Ticolloy, contains the largest amount of Nb. Ticolloy shows an improvement in 0.2-percent yield and ultimate tensile strengths at all testing temperature. V.L.

A91-52543
THERMAL STABILITY OF SUPERALLOY 718 FROM A COMPOSITIONAL VIEWPOINT
EDWARD A. LORIA (Niobium Products Co., Pittsburgh, PA) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1367-1375. refs
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The strength of the alloy 718 must be improved beyond 650 C in order to meet the design needs for advanced aeroengines. Minor compositional modifications in three separate investigations which increase the (Al + Ti)/Nb and Al/Ti ratios, as well as the (Al + Ti + Nb) total hardener content, do so by decreasing the amount of delta phase and increasing the stability of the gamma-double-prime and gamma-prime precipitates that form during extended exposures. Hence, a significant improvement in mechanical properties beyond 650 C is realized with either the conventional noncompact precipitate or the compact precipitate morphology obtained by appropriate heat treatment. Author

A91-52547
N18, A NEW GENERATION PM SUPERALLOY FOR CRITICAL TURBINE COMPONENTS
G. RAISSON (Tecphy, Imphy, France) and J. H. DAVIDSON (Imphy, S.A., Imphy, France) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1405-1416. refs
Copyright

The relationships between the processing, microstructure, and mechanical properties of N18, a new P/M disk alloy, are examined in order to more clearly define the potential fields of application. The alloy is now produced via gas atomization and extrusion consolidation carried out below the gamma prime solvus. This process produces a fine-grained material suitable for superplastic forming. Both the gamma prime distribution and grain size are shown to strongly affect the yield stress and creep rupture behavior. By modifying the processing and final heat treatment conditions to obtain various tradeoffs between the tensile and creep strengths, the alloy can be adapted for particular applications. V.L.

A91-52554
SUPERCLEAN MATERIALS NEEDS AND OPPORTUNITIES
I. W. HUSSEY, R. A. VENABLES, and A. C. PICKARD (Rolls-Royce, PLC, Derby, England) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1493-1505. refs
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An approach is outlined which examines the design process when the presence of defects in the material is assumed and the ramifications of using superclean materials. The inherent nature of defects and related methods of component-life prediction are discussed including process control, representative component tests, and damage tolerance. The control of material cleanliness is examined in conjunction with risk-of-failure analyses. Refined manufacturing techniques are listed for nickel-based superalloys which include electron-beam cold-hearth refining, clean powder routes, and the assessment of superclean materials. Assessment techniques include electrolytic dissolution, electron-beam button melting, and ultrasonics such as porosity and soft inclusion. Superclean materials are characterized by increased performance and lower failure rates, particularly as processing and modeling techniques become more advanced. C.C.S.

A91-52558
COMPARISON OF THE CLEANLINESS ASSESSMENT TECHNIQUES IN P.M. SUPERALLOYS

T. PAUCOD, F. SCHWARTZ, C. DUCROCQ, and A. LASALMONIE (SNECMA, Evry, France) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1629-1641. refs
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A process used to produce a P/M alloy containing a homogeneous dispersion of ceramic particles is described. Several cleanliness assessment techniques are then evaluated in quantitative terms. Water elutriation and EB button melting are shown to be capable of detecting most of the ceramic inclusions in P/M Astroloy. X-ray microfocus radiography is capable of detecting particles larger than a minimum size (175 microns in the present study), the detection limit being dependent on the slice thickness and particle chemistry. V.L.

A91-52562
OXIDATION AND HOT CORROSION OF INTERMETALLICS
L. SINGHEISER, H. W. GRUENLING, and K. SCHNEIDER (ABB Kraftwerke AG, Mannheim, Federal Republic of Germany) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1687-1702. refs
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Results of oxidation and hot corrosion experiments are presented for NiAl and TiAl intermetallics and MoSi2 silicide. NiAl intermetallics containing up to 17 percent Cr exhibit high oxidation resistance. TiAl intermetallics are characterized by high oxidation rates due to the formation of Al2O3 and TiO2, which limits the high-temperature capability to about 850 C. The highest oxidation resistance and therefore the highest temperature capability (up to 1000 C) is obtained in the case of MoSi2. V.L.

A91-52564
DEVELOPMENT OF HIGH TEMPERATURE TI-BASE DISC MATERIALS IN COMPETITION TO NI-BASE SUPERALLOYS
M. A. DAEUBLER and D. HELM (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1717-1726. refs
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The mechanical properties of two titanium alloys, Ti 6242 and IMI 834, are compared with those of IN 718 nickel superalloy, with particular reference to aircraft engine compressor disc applications. It is found that the high-temperature tensile strength, creep strength, and low-cycle fatigue strength of IMI 834 significantly exceed those of Ti 6242, a commonly used high-temperature titanium alloy. Up to 550 C, the specific high-temperature tensile, creep, and low-cycle fatigue strengths of IMI 834 compare with those of IN 718. V.L.

A91-52934
THE MODERNIZATION OF MILITARY PISTON ENGINE AVIATION OIL SPECIFICATIONS
JOHN T. SHIMSKI (U.S. Navy, Naval Air Propulsion Center, Trenton, NJ) and DOUGLAS F. MEARNS (U.S. Navy, Naval Air Systems Command, Washington, DC) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 17 p.
(SAE PAPER 910999) Copyright

The introduction of gas turbine aircraft propulsion disrupted the evolutionary development of reciprocating aircraft engines' oil lubricants. Attention is presently given to the rationale of recent efforts to modernize the MIL-L-6082 and MIL-L-22851 specifications governing these lubricants. A tabulation is presented of the similarities and differences between the old and new versions of the oil specifications. O.C.

A91-52935
NEW 150-HOUR TEST FOR SAE AND MIL SPECIFICATION APPROVAL OF AIRCRAFT PISTON-ENGINE LUBRICANTS
CHARLES F. ZIEGLER, JR. (Illinois, University, Savoy) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 11 p. refs
(SAE PAPER 911000) Copyright

Aviation piston engine lubricating oils undergo extensive testing prior to their approval for use. During the revision of MIL-L-22851/J-1966 specifications, it was determined that a standardized engine test would be utilized. A Textron-Lycoming TIO-540-J2BD engine was selected as the engine for the 150-hour endurance test. Federal Aviation Regulation Part 33 served as the guideline for development of a standardized test specifically aimed at lubricating oil evaluation. This paper discusses this new 150-hour endurance test for piston engine lubricants used to gain SAE and MIL approval. This new test was conducted at the University of Illinois-Institute of Aviation during 1990. Author

A91-52936
ASTM ACTIVITIES RELATED TO FUTURE FUELS FOR GENERAL AVIATION
CESAR GONZALEZ (Cessna Aircraft Co., Wichita, KS) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 18 p. refs
(SAE PAPER 911001) Copyright

An account is given of American Society for Testing and Materials activities involving the development of new specifications or revisions for current and prospective general aviation (GA) fuels. Attention is given to the prospects for aviation gasoline, which is required by most reciprocating-engined GA aircraft, and advanced powerplant studies conducted to date. It is strongly recommended that future GA propulsion systems avail themselves of fuels already being used in large quantities by other aviation and/or ground transportation systems. O.C.

N91-29236# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
ASSESSMENT OF IMPACT DAMAGE IN TOUGHENED RESIN COMPOSITES
C. POON, T. BENAK, and R. GOULD 8 Mar. 1989 42 p Presented at CAARC Specialists Symposium, Melbourne, Australia, 18-19 May 1988
(NAE-LTR-ST-1695; CTN-91-60025) Copyright Avail: NTIS HC/MF A03

Low energy impact can produce internal delaminations in carbon/epoxy composites with little visible surface damage. This barely visible impact damage is of major concern in the design of composite aircraft structures from a damage tolerance viewpoint because it causes a significant reduction in compressive strength and it reduces fatigue strength as a result of delamination growth under compression cyclic loading. An evaluation of the impact performance of three commercial toughened resin systems against the baseline T300/5208 material was performed using an instrumented dropweight impact method. The following conclusions were reached: (1) The toughened resin systems can absorb a much higher level of elastic energy than the baseline system; (2) Toughened resin systems absorb inelastic energy by a damage process that involves delaminations and intralaminar transverse shear cracks (The baseline system absorbs inelastic energy by fiber and matrix fractures that coalesce to form a major through-the-thickness crack with extensive delaminations in every ply of the laminate); (3) Toughened resin systems have better resistance to impact loading as evidenced by the production of barely visible impact damage in contrast to the production of easily visible impact damage in the baseline system for the same impact energy; (4) Results of the compression-after-impact tests have indicated that the residual compressive properties for the toughened resin systems are higher than those for the baseline system. Author (CISTI)

N91-29253*# Lockheed Aeronautical Systems Co., Burbank, CA.

COMPOSITE TRANSPORT WING TECHNOLOGY DEVELOPMENT: DESIGN DEVELOPMENT TESTS AND ADVANCED STRUCTURAL CONCEPTS

CHARLES F. GRIFFIN and WILLIAM E. HARVILL Washington NASA Sep. 1988 111 p

(Contract NAS1-17699)

(NASA-CR-4177; NAS 1.26:4177) Avail: NTIS HC/MF A06 CSCL 11/4

Numerous design concepts, materials, and manufacturing methods were investigated for the covers and spars of a transport box wing. Cover panels and spar segments were fabricated and tested to verify the structural integrity of design concepts and fabrication techniques. Compression tests on stiffened panels demonstrated the ability of graphite/epoxy wing upper cover designs to achieve a 35 percent weight savings compared to the aluminum baseline. The impact damage tolerance of the designs and materials used for these panels limits the allowable compression strain and therefore the maximum achievable weight savings. Bending and shear tests on various spar designs verified an average weight savings of 37 percent compared to the aluminum baseline. Impact damage to spar webs did not significantly degrade structural performance. Predictions of spar web shear instability correlated well with measured performance. The structural integrity of spars manufactured by filament winding equalled or exceeded those fabricated by hand lay-up. The information obtained will be applied to the design, fabrication, and test of a full-scale section of a wing box. When completed, the tests on the technology integration box beam will demonstrate the structural integrity of an advanced composite wing design which is 25 percent lighter than the metal baseline. Author

N91-29254*# Douglas Aircraft Co., Inc., Long Beach, CA.

TEST RESULTS FOR COMPOSITE SPECIMENS AND ELEMENTS CONTAINING JOINTS AND CUTOUTS Final Report

P. T. SUMIDA, R. C. MADAN, and A. V. HAWLEY Aug. 1988 100 p

(Contract NAS1-17701)

(NASA-CR-178246; NAS 1.26:178246; ACEE-30-FR-3610) Avail: NTIS HC/MF A05 CSCL 11/4

A program was conducted to develop the technology for joints and cutouts in a composite fuselage that meets all design requirements of a large transport aircraft for the 1990s. An advanced trijet derivative of the DC-10 was selected as the baseline aircraft. Design and analysis of a 30-foot-long composite fuselage barrel provided a realistic basis for the test effort. The primary composite material was Hexcel F584 resin on 12 K IM6 fiber, in tape and broadgoods form. Fiberglass broadgoods were used in E-glass and S-glass fiber form in the cutout region of some panels. Additionally, injection-molded chopped graphite fiber/PEEK was used for longeron-to-frame shear clips. The test effort included four groups of test specimens, beginning with coupon specimens of mono-layer and cross-piled laminates, progressing through increasingly larger and more complex specimens, and ending with two 4- by 5-foot curved fuselage side panels. One of the side panels incorporated a transverse skin splice, while the second included two cabin window cutouts. Author

N91-29317# California Univ., Berkeley. Dept. of Materials Science and Mineral Engineering.

MICROMECHANISMS OF MONOTONIC AND CYCLIC SUBCRITICAL CRACK GROWTH IN ADVANCED HIGH MELTING POINT LOW-DUCTILITY INTERMETALLICS Annual Report No. 1, 15 Apr. 1990 - 14 Apr. 1991

K. T. RAO, L. MURUGESH, and L. C. DEJONGHE 1 May 1991 49 p

(Contract AF-AFOSR-0167-90; AF PROJ. 2306)

(AD-A238151; UCB/R/91/A1072; AFOSR-91-0576TR) Avail: NTIS HC/MF A03 CSCL 11/6

The next generation of high-performance jet engines will require markedly stiffer materials, operating at higher stress levels and capable of withstanding temperatures of up to 1650 C. Prime candidates for such applications include ordered intermetallics, ceramics and composites based on metal, intermetallic and ceramic or carbon matrices, all of which are currently of limited use due to their low ductility and fracture properties. Moreover, there is a lack of fundamental understanding on the micromechanisms influencing crack growth in these materials, particularly intermetallics. Accordingly, the present study is aimed at exploring the potential of intermetallic alloys and their composites as advanced structural materials by identifying the critical factors influencing the crack-propagation resistance under monotonic and cyclic loads. Attention is focused on the Nb3Al and TiAl intermetallic systems. In both cases, the principal mechanism of toughening is to impede crack advance from crack bridging by ductile second phase particles. Reactive sintering and vacuum hot pressing techniques are successful is processing Nb3Al intermetallics and duplex Nb/Nb3Al microstructure with a stringy niobium phase can be achieved through thermal treatments. Characterization of mechanical properties will commence in the second year. GRA

N91-29326# Materials Research Labs., Ascot Vale (Australia).

A NOVEL EPOXY LACQUER FOR HIGH STRENGTH STEEL IN F-111 AIRCRAFT DURING OVERHAUL

L. V. WAKE May 1991 11 p

(AD-A236828; MRL-TN-590; DODA-AR-006-362) Avail: NTIS HC/MF A03 CSCL 01/3

The corrosion inhibiting paint used on high strength steel (D6AC) components of RAAF F-111 aircraft is removed from the wing carry thru box and lower trap tank during deseal/reseal of integral fuel tanks and from the fuel flow holes and stiffener runouts during crack inspection of the wing pivot fittings. Following paint removal, a protective lubricant is applied to the exposed components during overhaul to inhibit corrosion and pitting of the D6AC steel. Adhesive paint failures have subsequently occurred following recoating of this steel in a number of F-111 aircraft as a result of incomplete removal of the lubricant. This report describes the development of an alternative temporary corrosion prevention coating to replace the protective grease. The replacement coating is an inhibited uncured epoxy resin system which is smear resistant, solvent removable and chemically compatible with the D6AC protective coating. Coating problems associated with the overhaul procedures are no longer being experienced since introduction of the epoxy lacquer into service by RAAF. GRA

N91-30268# Massachusetts Inst. of Tech., Cambridge. Lab. for Advanced Composites.

STATIC AND DYNAMIC PROPERTIES OF COMPOSITE BLADES WITH STRUCTURAL COUPLINGS Final Report, 1 Feb. 1987 - 30 Jun. 1990

JOHN DUGUNDJI 27 Aug. 1990 10 p

(Contract DAAL03-87-K-0024)

(AD-A229318; TELAC-90-15; ARO-24023.5-EL) Avail: NTIS HC/MF A02 CSCL 11/4

The static and dynamic behavior of helicopter rotor blades made of composite materials is studied experimentally and analytically. A new analytic model was developed for handling arbitrarily large deflections of composite blades based on an Euler angle representation. Results for both large static deflections and small amplitude vibrations about the large static deflections, agreed well with experimental results from a series of structurally coupled composite blade models constructed to verify the analysis. The analytical model was later extended to include large amplitude, nonlinear vibrations about the large static positions. It was found that both static deflections and large amplitudes influenced greatly the fore-and-aft (lead-lag) and torsion modes, but had little effect on the bending modes. GRA

N91-30286# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Zentrallab.
MANUFACTURING AND MECHANICAL PROPERTIES OF FIBER COMPOSITE MATERIALS WITH TEXTILE PREFORMS [FERTIGUNG UND MECHANISCHE EIGENSCHFTEN VON FASERVERBUNDWERKSTOFFEN MIT TEXTILEN VORFORMLINGEN]
J. BRANDT, K. DRECHSLER, H. F. SIEGLING, and F. J. ARENDTS (Stuttgart Univ., Germany, F.R.) 1990 23 p In GERMAN Presented at the 23rd Internationale AVK-Tagung, Mainz, Fed. Republic of Germany, 5-7 Nov. 1990
(MBB-Z-0325-90-PUB; OTN-030839; ETN-91-99453) Avail: NTIS HC/MF A03

The potential of different fiber structures is shown, using examples from various fields. An automobile engine bearer was obtained with a three dimensional glass fiber tissue, by which a marked improvement of crash behavior and a more rational fabrication were obtained. A carbon/carbon airfoil leading edge for a hypersonic aircraft was realized with integral stiffening ribs, using a three dimensional carbon fiber tissue. The problems raised by the joining of deck coating and stiffening ribs were solved. It is shown that textile fiber preforms offer a great potential for the optimization of the mechanical properties and the simplification of the fabrication of fiber composite materials. ESA

N91-30288# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Zentrallab.
THERMAL ANALYSIS FOR THE EXAMINATION AND DETERMINATION OF PROCESSING CONDITIONS FOR STRUCTURAL FIBER COMPOSITE MATERIALS AND BONDING AGENTS IN AIR AND SPACE NAVIGATION [THERMOANALYSE ZUR UNTERSUCHUNG UND FESTLEGUNG VON VERARBEITUNGSBEDINGUNGEN FUER STRUKTURPREPREGS UND -KLEBER IN DER LUFT- UND RAUMFAHRT]
K. SCHMIDTKE, A. KELLER, and D. FEULNER 1990 13 p In GERMAN Presented at Fachtagung FH-Wuerzburg 'Angewandte Instrumentelle Analytik fuer Formmassen aus polymeren Werkstoffen, Wuerzburg, Fed. Republic of Germany, 17-21 Sep. 1990
(MBB-Z-0344-90-PUB; OTN-030932; ETN-91-99456) Avail: NTIS HC/MF A03

The utilization fields of thermoanalytic methods for synthetic material processing of high performance structural components made of fiber composite materials in air and space flight are described using selected examples: Differential Scanning Calorimetry (DSC) for checking the shelf/shop life, and for determining cure cycle and post cure; a combination of DSC and Thermal Gravimetric Analysis (TGA) results for determining temperature limits. High loaded primary structural components made of composite materials with synthetic matrix are used in a series of products: Airbus rudder unit, helicopter cabin and rotor system, solar generator for satellites and fighter wings. ESA

N91-30316 Toronto Univ. (Ontario). Dept. of Mechanical Engineering.
INVESTIGATION OF THE FATIGUE CRACK GROWTH CHARACTERISTICS OF TI-17
D. MCCAMMOND and M. NUMMI Jun. 1989 127 p
(Contract DREP-W7708-6700-01-SB)
(DREP-89-32; CTN-91-60181) Avail: NTIS HC A07

This report summarizes test results of fatigue crack growth rate experiments on corner crack specimens taken from a Ti-17 compressor disc forging. Ti-17 is a near beta titanium alloy developed for use in engine discs at intermediate operating temperatures. The data forms part of the Canadian contribution to the AGARD Structures and Materials Panel Program on damage tolerance of gas turbine engine discs. The test program consisted of low-cycle fatigue tests on corner crack specimens. Constant amplitude loading sequences involved ten different loading waveforms with two specimens being tested for each waveform. Tests were conducted from an initial crack length of 0.5 mm to a final length of 5 mm. The TURBISTAN spectrum, a standard load sequence for cold aircraft engine discs, was used to investigate fatigue crack growth under spectrum loading. In addition to the test program, a literature review on Ti-17 was carried out and the microstructure of seven compressor disc forging samples was investigated. The samples were found to be composed of about 70 percent Widmanstatten alpha-plates and 30 percent elongated primary alpha grains embedded in the Widmanstatten structure.
CISTI

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.

A91-48527
WHAT IS WAT? WRAP AROUND TEST - MAXIMIZING AVIONICS BIT UTILIZATION TO MINIMIZE FLIGHTLINE ARMAMENT SYSTEM TEST EQUIPMENT REQUIREMENTS
CHRISTOPHER D. WILLIAMS (U.S. Navy, Naval Avionics Center, Indianapolis, IN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 15 p. refs
(SAE PAPER 901787) Copyright

An evolutionary extension of military aircraft Built-In-Test has been developed for armament systems. This extension, Wrap-Around-Test shows promise in replacing conventional support equipment currently used to test aircraft interfaces prior to weapons loading and during system maintenance. Wrap-Around-Test offers the ability to verify weapon system integrity at a reduced cost, improved operational readiness and enhanced ergonomics.
Author

A91-48528
ELECTRONIC CHASSIS/PWB STRUCTURES - VIBRATION RESPONSE LEVEL NONLINEARITIES IN RELIABILITY GROWTH TESTING
RICHARD RAWLINGS (Sundstrand Aviation, Rockford, IL) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p.
(SAE PAPER 901788) Copyright

Current practices used in reliability and development growth testing (RDGT) are discussed, and emphasis is placed on the use of fatigue analyses relating RDGT and qualification test vibration levels to equipment requirements. RDGT level derivation, usage of the fatigue relationship from MIL-STD-810D, and printed-wire-board measured responses are reviewed against predicted responses for given vibration inputs. An approach involving a continuous monitoring of selected station responses throughout the test for recording accumulated damage suffered by the test article is suggested. V.T.

A91-48534
REDUNDANT, THIN-WING, HIGH-PRESSURE, DIRECT-DRIVE VALVE ACTUATION SYSTEM
KENT R. BOYER (H.R. Textron, Inc., Valencia, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p.
(SAE PAPER 901796) Copyright

A smart actuation system for a hypothetical aircraft fast-aileron application is presented. The system comprises high-pressure (8000 psi), direct-drive, parallel servoactuators with multichannel analog control and multiprocessor digital redundancy management. Laboratory demonstration revealed that these systems are capable of providing solutions to the space constraints of thin-wing, trailing surface control applications. It is recommended that the high actuation system dynamic performance be accompanied with fast,

precise fault detection and fault isolation to control failure transients. Digital redundancy management is considered to provide great power and dimension for the formulation of simulation models used in the fault detection process. Its benefits include accuracy, repeatability, nonlinear numerical operations, and convenience of a software-based system. O.G.

A91-48547
SERVOACTUATORS FOR FLIGHT SIMULATOR MOTION SYSTEMS
MARK A. BALZER (Moog, Inc., East Aurora, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 9 p. refs
(SAE PAPER 901815) Copyright

Linear hydraulic servoactuators are used in flight simulator motion systems to provide platform motion cues. Accurate reproduction of commanded motion while simultaneously insuring aircrew safety requires a departure from conventional servoactuator design approaches. This paper will discuss the unique features found on servoactuators for flight simulator motion systems and their performance testing. These features include hydrostatic bearings, low friction seals, asymmetric servovalves, abort valves and hydraulic cushions. Author

A91-48577
FILTER LINE WIRING DESIGNS IN AIRCRAFT
RICHARD M. ROWE SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p. refs
(SAE PAPER 901875) Copyright

The paper presents a harness design using a filter-line wire technology and appropriate termination methods to help meet high-energy radiated electromagnetic field (HERF) requirements for protection against the adverse effects of EMI on electrical and avionic systems. Filter-line interconnect harnessing systems discussed consist of high-performance wires and cables; when properly wired they suppress conducted and radiated EMI above 100 MHz. Filter-line termination devices include backshell adapters, braid splicers, and shield terminators providing 360-degree low-impedance terminations and enhancing maintainability of the system. V.T.

A91-48598
ELECTROMAGNETIC ENVIRONMENT FOR CIVIL AIRCRAFT
RONALD J. ROGERS (Air Line Pilots Association, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 8 p.
(SAE PAPER 901914) Copyright

Pursuant to an FAA request, the SAE established the AE4R Subcommittee for evaluating the hazard to airborne electronic systems posed by the EM environment. After deriving a list of detailed assumptions regarding the known emitter population, a set of histograms was derived which depicts the EM environment under various operational conditions. The histograms depict the highest degree of granularity (segments of frequency bands) allowed, considering the need for security, and reflect conservative field-intensity levels; on a daily basis, most aircraft would not experience the field intensity levels indicated by the histograms. O.C.

A91-48629
VAPOR CYCLE COMPRESSORS FOR AEROSPACE VEHICLE THERMAL MANAGEMENT
PETER F. DEXTER, ROLAND J. WATTS, and WILLIAM L. HASKIN (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p. Research sponsored by USAF. refs
(SAE PAPER 901960) Copyright

An overview is given of approaches to achieving high reliability and long life in vapor cycle compressor design for aerospace vehicles. The requirements peculiar to aircraft and spacecraft cooling systems are described. Piston, rotary vane, rolling piston, helical screw, scroll, and centrifugal compressors being developed for aerospace applications are discussed. C.D.

A91-48630
TECHNOLOGY REVIEW - UTILIZING ROTATING THERMOSYPHON TECHNOLOGY IN AIRCRAFT THERMAL MANAGEMENT AND CONTROL
KIRK L. YERKES (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 13 p. Research supported by USAF. refs
(SAE PAPER 901961) Copyright

An evaluation is made of the development status and performance benefits of rotating thermosyphon aircraft thermal management control applications. Rotating two-phase thermosyphons furnish reliable, low maintenance cooling for such rotating systems as electric motors, compressors, and generators. Thermosyphons are uniquely suited for aircraft applications in their insensitivity to operating environments involving high G-loads, vibration, and multiple orientations. O.C.

A91-48644
CARBON EPOXY PERFORATED SKIN FOR NACELLE ACOUSTIC TREATMENT
R. HERSEN and D. VIGNERON (Hispano-Suiza, Saint-Cloud, France) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 11 p.
(SAE PAPER 901982) Copyright

The acoustic treatment requirement for jet engine nacelle inner flowpath leads to using perforated skin. Formerly in light alloy these skins are now composite and new techniques have been developed to achieve the perforation. After reviewing different possible techniques (mandrel tool, abrasion, stamping, mechanical drilling,...) one process is chosen and described in terms of skin mechanical properties, cost, and production facilities. Author

A91-48665
DATA ACQUISITION AND CONTROL FOR COMPLEX PULTRUSIONS
LEE A. CARVELL, CYNTHIA L. T. LAMBING, RICHARD A. MANZINI, MARK R. MCLAUGHLIN, and SHARON D. DICKENSON (Alcoa Laboratories, Alcoa Center, PA) Society of Manufacturing Engineers, Conference on Composites in Manufacturing, 10th, Anaheim, CA, Jan. 7-10, 1991. 20 p. refs
(SME PAPER EM91-102) Copyright

Pultrusion process control, as it exists today, is limited to pull speed and two or three heating zones within the die. However, as pultruded products become more complicated in both shape and materials processing, more sophisticated process control is required to achieve high-quality hardware and increase manufacturing producibility. A complex missile airframe shape to be pultruded out of thermoplastic matrix composite materials was selected as the baseline problem for a computerized pultrusion data acquisition and control (PDAC) system. The requirements, design, fabrication, and operation of the PDAC system are described along with the missile airframe pultrusion program. Author

A91-48673
LEADING-EDGE METHODS OF MAKING NEAR-NET SHAPE AIRFRAME PARTS
HORST E. FRIEDRICH (MBB GmbH, Augsburg, Federal Republic of Germany) and PETER-J. WINKLER (MBB GmbH, Ottobrunn, Federal Republic of Germany) Advanced Materials and Processes (ISSN 0882-7958), vol. 140, Aug. 1991, p. 16-22.
Copyright

An evaluation is presented of the development status and performance and economic advantages of the superplastic forming (SPF), incremental forging, and investment casting processes that can be used to obtain light-weight, complex-geometry near-net shape aerospace structural components. Although component production-run quantities are intrinsically low, SPF is projected to be important to hypersonic airframe structures requiring Ti alloys.

Incremental forging has been found to require about 23 percent less starting material than conventional forging. Integrally stiffened aircraft parts having ribs and webs are attractive candidates for investment casting of Al-Li alloys. O.C.

A91-48788
PERIPHERAL POLAR-GRAPHIC DISPLAYS FOR SIGNAL/FAILURE DETECTION
DENNIS B. BERINGER and STEVEN E. CHRISMAN (New Mexico State University, Las Cruces) International Journal of Aviation Psychology (ISSN 1050-8414), vol. 1, no. 2, 1991, p. 133-148. refs
Copyright

The object of this series of studies was to examine the utility of multivariate polar-graphic iconic displays, placed in the parafoveal or near-peripheral regions of the visual field, for the presentation of multiple indices of subsystem performance in an aircraft system context. Results of the first study suggest that (1) such a display, circumscribed about a primary flight instrument, could be used readily to detect performance deviations that exceeded defined 'normal' bounds; and (2) polygons are more effective than polar histograms. The second study examined the hypothesis that the superior performance obtained with polar formats was not merely a function of reductions in visual scanning requirements, but stemmed from the organization and symmetry found in the iconic display. Index markings lacking in the first study were added to the polar histograms to determine if these would materially affect speed and accuracy of judgments. Performance using polar histograms in the second study was found superior to that obtained using needle indicators of similar spatial distribution, polar-graphic iconic displays ranking between the other two display types. The results suggest that order-of-merit of displays may be altered by small format changes, and that the performance benefits of polar-graphic iconic displays stem from factors beyond the simple physical proximity of the component indicators. Author

A91-48825
SUPERSONIC FLUTTER OF LAMINATED CIRCULAR CYLINDRICAL SHELL PANELS
R. S. SRINIVASAN and B. J. C. BABU (Indian Institute of Technology, Madras, India) Journal of Aircraft (ISSN 0021-8669), vol. 28, Aug. 1991, p. 543, 544. refs
Copyright

The present flutter analysis gives attention to circular cylindrical shell panels of rectangular planform whose edges are clamped laterally and free from in-plane stresses. The panel is acted upon by supersonic flow parallel to the generator on one of its sides. The aerodynamic forces are approximated by means of two-dimensional quasi-steady aerodynamic theory, and the solution is obtained by means of the integral equation technique. O.C.

A91-48899* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A RESISTANCE STRAIN GAGE WITH REPEATABLE APPARENT STRAIN TO 800 C
J.-F. LEI (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) Experimental Techniques (ISSN 0732-8818), vol. 15, July-Aug. 1991, p. 23-27. refs
Copyright

Experimental PdCr temperature-compensated resistance static-strain gages are described. The gages are developed in both fine-wire and thin-film forms. It is found that a PdCr wire strain gage coated with a flame-sprayed mixture of alumina and 4 wt pct zirconia demonstrates the smallest variation in and the best repeatability of apparent strain among the existing gages used at temperatures up to 800 C. Results of preliminary tests indicate uncompensated uncoated thin-film gages have potential usefulness at temperatures up to 1000 C. O.G.

A91-49064
A DISTRIBUTED FIVE-HOLE PROBE RAKE ON STATOR BLADES FOR ROTOR EXIT MEASUREMENT OF A COMPRESSOR
QIXUN LIN, CHUNYING SHI, and GENGSEN PAN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 137, 138. In Chinese. refs

Each tube of five-holes probe will be placed at the same radius on five different stator blades. The diameter of the probe and the wall proximity effect are decreased. The distributed five-hole probe rake has been verified experimentally. Its dynamical frequency response is enhanced seven times and its characteristics are improved. The parameter measurement of each rotor exit in a multistage compressor becomes practicable. Author

A91-49072
EXPERIMENTAL INVESTIGATION ON LIQUID-COOLING MECHANISM FOR TURBINE VANE
DEZHANG LIU and NING OUYANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 175-179. In Chinese. refs

A experimental investigation of the liquid cooling mechanism was carried out with water through an even-heated adiabatic straight pipe. The flow pattern, the heat transfer coefficient along full-flow-path, and the correlation between them have been studied. In order to imitate the actual working conditions of the cooling passage of turbine vane, the heat transfer flux, the coolant inlet parameters, and the pipe angle are changeable. Some empirical formulas for coome-to-saturated point and come-annular point have been derived and several useful conclusions have been drawn for engineering application. Author

A91-49124
COMPUTERIZED ADHESIVES BONDING TECHNOLOGY
ANTHONY T. DESMOND and JOSEPH A. BRESCIA (U.S. Army, Armament Research, Development, and Engineering Center, Picatinny Arsenal, NJ) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 393-403. refs
Copyright

The U.S. Army's Armaments Research, Development and Engineering Center has developed an adhesives data base for engineering information relevant to aircraft structures. This data base encompasses three major sections: (1) adhesives properties, (2) 'lessons learned', and (3) design and manufacturing encyclopedia. The data contained range over adhesive compositions; laboratory test data; trade identifications; adhesive resins, fillers, curing agents; surface preparations; adherend properties; and test methods. O.C.

A91-49131
IMPACT DAMAGE TOLERANCE TESTING OF BONDED SANDWICH PANELS
M. S. CALDWELL, P. W. BORRIS, and R. FALABELLA (Hexcel Corp., Dublin, CA) IN: International SAMPE Technical Conference, 22nd, Boston, MA, Nov. 6-8, 1990, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1990, p. 509-520. refs
Copyright

Impact tests at 5.4 and 8.1 J were performed on sandwich panels made with a variety of different core materials as part of an impact damage tolerance test development program. Panel shear in three-point bending was used to differentiate the strength retention after impact of standard honeycomb products and newly developed cores. Damage area, plate shear strength and modulus, compressive strength and modulus, and facing performation after impact were also studied. The results show that the damage tolerance of honeycomb core may be increased by using tough matrix resins and changing fiber orientation from 0-90 to +/- 45. Nomex paper cores are also shown to be more impact damage tolerant than glass fabric cores. Author

A91-49182
APPLICATION OF THE AERONAUTICAL MOBILE SATELLITE SERVICE (AMSS) AND THE PROVIDERS OF THE SERVICE [LES APPLICATIONS DU SERVICE MOBILE AERONAUTIQUE PAR SATELLITES /AMSS/ ET LES FOURNISSEURS DU SERVICE]
FRANCIS BRANGIER (Direction Generale de l'Aviation Civile, Centre d'Etudes de la Navigation Aerienne, Orly, France) Navigation (Paris) (ISSN 0028-1530), vol. 39, July 1991, p. 370-378. In French. refs
Copyright

The paper describes the different potential users of the AMSS, their requirements, and foreseen applications. The AMSS will be provided by several satellite-communication organizations, including INMARSAT, ARINC, SITA, and various national companies. Consideration is given to air-traffic-control services, aircraft operations communication, administrative communication, passenger communication services, and the problem of compatibility among these components. L.M.

A91-49273
TECHNIQUES FOR AIRCRAFT QUALITY CNC TUBE BENDING AND INSPECTION
JAMES WENCK (Eaton Leonard Technologies, Inc., Carlsbad, CA) Society of Manufacturing Engineers, Conference on Aircraft Tubing Fabrication Technology, Seattle, WA, Feb. 27-Mar. 1, 1991. 11 p.
(SME PAPER MF91-236) Copyright

This paper presents the most recent advances in techniques for high-precision tube bending and inspectrion. The design requirements for the positioning axes of an aircraft-quality CNC tube bender are reviewed. Other factors affecting the bending process are discussed, including automatic tooling setup. In addition to eliminating the variables introduced by an operator, an automated setup provides faster changeover to increase the efficiency of small quantity runs. The paper also reviews the advantages of using PC controls to operate bending machines. The latest developments in vector measuring machines has improved inspection accuracy an order of magnitude. This is achieved through the use of rigid joints, precision spindle bearings, ultrahigh resolution encoders, temperature compensation, laser noncontact probes, and statistical averaging scanning techniques. A review is presented of the types of calculation algorithms used to inspect tube shapes. Author

A91-49274
BENDING OF TITANIUM TUBES
ROLF-D. STUTZ (Deutsche Airbus GmbH, Bremen, Federal Republic of Germany) Society of Manufacturing Engineers, Conference on Aircraft Tubing Fabrication Technology, Seattle, WA, Feb. 27-Mar. 1, 1991. 11 p.
(SME PAPER MF91-237) Copyright

To reduce the weight of the A320 aircraft, the normally used steel hydraulic-pressure tubes should be replaced by titanium tubes. The weight reduction in this case would be about 47 Kg/ac. With a special test program the feasibility of this material change was proved. With the agreement of the design departments to some changes in their tolerance requirements and some technical changes the production rate of 6000 titanium tubes/month is attained. Author

A91-49702*# Illinois Univ., Chicago.
TIME VARIANT ANALYSIS OF LARGE SCALE CONSTRAINED ROTORCRAFT SYSTEMS DYNAMICS - AN EXPLOITATION OF IBM-3090 VECTOR-PROCESSOR'S PIPE-LINING FEATURE
F. M. L. AMIROUCHE, N. H. SHAREEF, and M. XIE (Illinois, University, Chicago) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1307-1319. Research supported by U.S. Army. refs
(Contract NAG3-1092)
(AIAA PAPER 91-2745) Copyright

A generalized algorithmic procedure is presented for handling the constraints in transmissions, which are treated as a multibody system of interconnected rigid/flexible bodies. The type of constraints are classified based on the interconnection of the bodies, assuming one or more points of contact to exist between them. The method is explained through flow charts and configuration/interaction tables. A significant increase in speed of execution is achieved by vectorizing the developed code in computationally intensive areas. The study of an example consisting of two meshing disks rotating at high angular velocity is carried out. The dynamic behavior of the constraint forces associated with the generalized coordinates of the system are plotted by selecting various modes. Applications are intended for the study of dynamic and subsequent prediction of constraint forces at the gear teeth contacting points in helicopter transmissions with the aim of improving performance dependability. P.D.

A91-49799
PHOTONICS TECHNOLOGY FOR AEROSPACE APPLICATIONS
LUIS FIGUEROA, C. S. HONG, GLEN E. MILLER, CHARLES R. PORTER, and DAVID K. SMITH (Boeing High Technology Center, Bellevue, WA) Photonics Spectra (ISSN 0731-1230), vol. 25, July 1991, p. 117, 118, 120, 122, 124.
Copyright

Key technologies required for implementation of future fly-by-light systems are reviewed. These technologies include fiber optic position sensors, multiplexers, fiber optics data bases, and transceivers. C.D.

A91-50240
STABILITY ANALYSIS OF INTERSHAFT SQUEEZE FILM DAMPERS
A. EL-SHAFEI (Cairo University, Giza, Egypt) Journal of Sound and Vibration (ISSN 0022-460X), vol. 148, Aug. 8, 1991, p. 395-408. refs
Copyright

Intershaft squeeze film dampers have been investigated for damping of dual rotor aircraft jet engines. It was thought that the intershaft damper would enhance the stability of the rotor-bearing system. Unfortunately, it was determined both theoretically and experimentally that the intershaft squeeze film damper was unstable above the engine's first critical speed. In this paper, a stability analysis of rotors incorporating intershaft squeeze film dampers is performed. A rotor model consisting of two Jeffcott rotors with two intershaft squeeze film dampers is investigated. Examining the system characteristic equation for the conditions at which the roots indicate an ever-growing unstable motion results in the stabibity conditions. The cause of the instability is identified as the rotation of the oil in the damper clearance. Several proposed configurations of intershaft squeeze film dampers are discussed, and it is shown that the intershaft dampers are stable supercritically only with a configuration in which the oil film does not rotate.
Author

A91-50348
EFFECTS OF IN-PLANE LOAD ON NONLINEAR PANEL FLUTTER BY INCREMENTAL HARMONIC BALANCE METHOD
S. L. LAU (Hong Kong Polytechnic, Hung Hom) and S. W. YUEN AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1472-1479. refs
Copyright

The dynamical behavior of a hinged-hinged two-dimensional plate excited by supersonic flow is presented in this paper. The geometrical nonlinearity is considered using the large deflection plate theory, whereas the supersonic piston theory is employed to account for the effects of the aerodynamic force. A four-mode expansion has been used to reduce the original partial differential equation into a set of ordinary differential equations, which is then solved by the incremental harmonic balance method. In this study, the effects of the in-plane load are emphasized on the fluttering plate problem. The solution diagrams show that for a moderately high post-buckling load, several limit cycle oscillations are possible

which have not yet been found beforehand. In addition, comparison of numerical results with other articles are made whenever data are available. Author

A91-50651* Virginia Polytechnic Inst. and State Univ., Blacksburg.
DESIGN OF A BLADE-STIFFENED COMPOSITE PANEL WITH A HOLE
S. NAGENDRA, R. T. HAFTKA, Z. GURDAL (Virginia Polytechnic Institute and State University, Blacksburg), and J. H. STARNES, JR. (NASA, Langley Research Center, Hampton, VA) Composite Structures (ISSN 0263-8223), vol. 18, no. 3, 1991, p. 195-219. refs
(Contract NAG1-168; NAG1-643)
Copyright

A procedure is developed analytically to design and produce an optimized stiffened panel with a centrally located hole. The PASCO panel-buckling analysis and sizing code is employed with the Engineering Analysis Language (EAL) code for finite-element analysis to optimize the design variables. Important design considerations are stiffener height and ply thicknesses in the skin and the stiffener laminates. The EAL code calculates the maximum strains around the hole boundary, and the resulting constraints are combined with the buckling constraint developed by the PASCO code. Cooptimization of the two codes is effected until convergence on the optimal solution is achieved. Results of the analytical procedure are experimentally verified by applying a compressive end-load to graphite-fiber laminated plates with center holes. The experimental results support the analytical procedure, and it is found that for the same weight, the soft-skin designs tested are found to have the best tolerance characteristics and resistance to failure. C.C.S.

A91-50655
DAMPED COMPOSITE STRUCTURES
DAVID J. BARRETT (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Warminster, PA) Composite Structures (ISSN 0263-8223), vol. 18, no. 3, 1991, p. 283-294. refs
Copyright

The effect of damping applications on the static and dynamic response of structures is studied parametrically to consider the use of damped composites in aircraft construction. A beam with damping material and a load is considered analytically by means of a laminated anisotropic form of the damped-plate theory by Abdulhadi (1969) and the 'damped forced vibration-mode method.' Resonant frequencies, loss factors, and responses to loads are derived for aluminum and graphite/epoxy stiffeners. The main results are that commercially available damping materials generally have a low modulus and that the performance of the composites is linked to environmental conditions. It is shown, however, that damping can be employed in a wide variety of design applications to simultaneously increase the vibration resistance and reduce the weight of aircraft structures. C.C.S.

A91-50765
SIMULATION OF REDUCTION CHARACTERISTICS OF SCATTERING FROM AIRCRAFT MODEL COATED WITH THIN-TYPE ABSORBER BY SPATIAL NETWORK METHOD
TATSUYA KASHIWA, NORINOBU YOSHIDA, and ICHIRO FUKAI (Hokkaido University, Sapporo, Japan) IN: EMC '89 - International Symposium on Electromagnetic Compatibility, Nagoya, Japan, Sept. 8-10, 1989, Proceedings. Vol. 2. Tokyo/New York, Institute of Electronics, Information and Communications Engineers/Institute of Electrical Engineers of Japan and IEEE, 1989, p. 792-797. refs
Copyright

The reduction characteristics of scattering from an aircraft model having a thin-type absorber was simulated by the spatial network method (SNM). The fundamental treatment of a thin-type absorber as the boundary condition in the SNM is presented. The scattering far field is calculated from the near-field distributions by using the equivalent theorem. Results for the cases with and without coating absorber show a significant reduction in the scattering from the aircraft. The results are of interest in connection with reducing scattering from structures, which causes problems such as ghost images on TV and radar displays. I.E.

A91-51002
A COMPARISON OF RADAR SIGNAL CLASSIFIERS
STANLEY C. AHALT, TZYY-PING JUNG, and ASHOK K. KRISHNAMURTHY (Ohio State University, Columbus) IN: IEEE International Conference on Systems Engineering, 2nd, Pittsburgh, PA, Aug. 9-11, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 609-612. refs
Copyright

The performances of two neural network classifiers are compared with those of two conventional information theoretic pattern classifiers for the classification of radar returns. Each of the classifiers is applied to the problem of discriminating between the radar signal returns of five commercial aircraft at various azimuth angles. The neural netowrk classifiers studied are frequency-sensitive competitive learning (FSCL) and FSCL learning vector quantization (FSCL-LVQ), a variation on Kohonen's LVQ classifier (1988). These are compared to the nearest-neighbor and maximum-likelihood classifiers. It is shown that the performance of the neural classifier is close to that of the maximum-likelihood and the nearest-neighbor classifiers. The results indicate that the neural classifiers are relatively insensitive to the noise level of the training data. I.E.

A91-51153
MILITARIZED, 0.120 INCH TALL, CONNECTORIZED OPTOELECTRONIC DEVICES FOR AVIONIC APPLICATIONS
GARY L. NELSON, GREGORY J. COSIMINI, DANIEL J. BARTNIK, ROGER W. HONEBRINK, and DENNIS D. LONG (Unisys Corp., Electronic Information Systems Group, Saint Paul, MN) IN: Optical and digital GaAs technologies for signal-processing applications; Proceedings of the Meeting, Orlando, FL, Apr. 16-18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 250-259. refs
Copyright

Ultra low profile (ULP) fiber optic transmitters and receivers have been developed which meet the 0.120 inch height requirement of military avionic applications. Field usable fiber optic connectors have been developed which provide highly efficient fiber coupling from -55 to +125 C. These devices are fabricated using soldering and laser welding techniques to produce packages which contain no organic materials. Both 1300 and 850 nm devices have been built which operate at 1.3 gigabits per second. Author

A91-51157
DIGITAL GALLIUM ARSENIDE INSERTION INTO THE OH-58D SCOUT HELICOPTER
TIMOTHY MISKO and NORM ANDRADE (McDonnell Douglas Electronic Systems Co., Huntington Beach, CA) IN: Optical and digital GaAs technologies for signal-processing applications; Proceedings of the Meeting, Orlando, FL, Apr. 16-18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 290-298. Research sponsored by DARPA.
(Contract DAAJ09-89-C-0715)
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A very-high-speed sensor processor subsystem (MSPS) is described in terms of its design, fabrication techniques, and applications to fielded military systems. Incorporated in the design are high-speed GaAs and Si integrated circuits and an algorithm for aided target recognition and multiple target tracking. The existing Mast Mounted Sight (MMS) system is described, and the MSPS system is described in detail to permit a comparison of the two system processors. The speed of the proposed system is 100 million instructions/s, and the system operates in parallel and offers 24-bit floating point multiplies and ALU operations and 16 bit integer multiplies internal with 24-bit integer operations and external memory access. The processor employs existing form factor, power supply, operational software, and interfaces, and can be operated at about the same cost with reduced operator workload. C.C.S.

A91-51354
PRELIMINARY TESTS OF AN ULTRASONIC THERMOANEMOMETER FOR AIRCRAFT MEASUREMENTS
A. MARILLIER, M. CABANE, and D. CRUETTE (Paris VI, Universite, France) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 8, Aug. 1991, p. 597-605. Research supported by DRET. refs

A prototype of an ultrasonic thermoanemometer, specially designed for aircraft measurements, has been developed. By measuring the transit time of ultrasonic pulses, one can deduce the speed of sound and then the air temperature (or the aircraft speed) at hundredth of a second intervals. In order to avoid the problems inherent to vibrations and to reduce the number of measurement paths, the flow has been channeled so as to be unidirectional. Wind tunnel studies made it possible to define a convenient geometry. Preliminary flight tests (up to 200 km/h) have been conducted. Author

A91-51447
AUGMENTED HEAT TRANSFER IN SQUARE CHANNELS WITH PARALLEL, CROSSED, AND V-SHAPED ANGLED RIBS
J. C. HAN, Y. M. ZHANG (Texas A & M University, College Station), and C. P. LEE (General Electric Co., Cincinnati, OH) ASME, Transactions, Journal of Heat Transfer (ISSN 0022-1481), vol. 113, Aug. 1991, p. 590-596. Research supported by General Electric Co. refs
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The effect of the rib angle orientation on the local heat transfer distributions and pressure drop in a square channel with two opposite in-line ribbed walls was investigated for Reynolds numbers from 15,000 to 90,000. The square channel composed of ten isolated copper sections has a length-to-hydraulic diameter ratio of 20; the rib height-to-hydraulic diameter ratio is 0.0625; the rib pitch-to-height ratio equals 10. Nine rib configurations were studied: 90 deg rib, 60 and 45 deg parallel ribs, 60 and 45 deg crossed ribs, 60 and 45 deg v-shaped ribs, and 60 and 45 deg inverted-v-shaped ribs. The results show that the 60 deg (or 45 deg) v-shaped rib performs better than the 60 deg (or 45 deg) parallel rib and, subsequently, better than the 60 deg (or 45 deg) crossed rib and th 90 deg rib. The v-shaped rib produces the highest heat transfer augmentation, while the inverted-v-shaped rib generates the greatest pressure drop. The crossed rib has the lowest heat transfer enhancement and the smallest pressure drop penalty. Author

A91-51511
THE DEVELOPMENT OF A RANGE OF SMALL MECHANICAL CRYOCOOLERS FOR SPACE AND AVIONIC APPLICATIONS
BARRY HOCKING (Lucas Aerospace, Ltd., Engine Systems Div., Birmingham, England) IN: Infrared technology and applications; Proceedings of the Meeting, London, England, June 26-28, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 126-138.
Copyright

The design features of a mechanical cryocooler, including a compressor, displacer, connecting pipe, and electronic controller are described. The complete system is filled with helium gas to a pressure of 10 bar. Long life, low exported vibration, and good refrigeration within the defined temperature range are emphasized as the main requirements. A number of improvements with regard to the reliability required for long-life space coolers are outlined, and emphasis is placed on the improved sealing for the helium gas and the outgassing properties of all components. Scaling up of the cryocooler design for increased refrigeration is reviewed as well as a space-system interface. Testing of space-rated cryocooler systems producing nominal 0.5 W and 1 W cooling at 65 K from a single system is discussed. V.T.

A91-51581
TRANSIENT THERMOGRAPHIC NDE OF TURBINE BLADES
X. MALDAGUE, D. POUSSART, R. BOURRET (Universite Laval, Quebec, Canada), P. CIELO (National Research Council of Canada, Industrial Materials Research Institute, Boucherville), and D. CRAIG (Pratt and Whitney Canada, Longueil) IN: Thermosense XII; Proceedings of the International Conference on Thermal Sensing and Imaging Diagnostic Applications, Orlando, FL, Apr. 18-20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 161-171. refs
Copyright

A method is proposed for the automatic inspection of jet engine turbine blades using transient infrared thermography. The blades are thermally stimulated using internal flow (water) at different temperatures. By looking on the pressure (or suction) side of the blade, it is possible to detect and locate blocked cooling passages. Differential time-resolved image analysis methods are shown to effectively improve the visibility of obstruction defects in the presence of strong temperature fluctuations across the blade. Examples of such analyses are presented. Author

A91-51753
COMPUTATIONAL FLUID DYNAMICS
G. A. HASEN (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Critical technologies for national defense. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 27-40. refs
Copyright

The primary consequence of CFD methodologies for future weapons systems involves the reduction of design risks and development costs for aircraft that cannot be fully tested in flight. CFD will accordingly be one of the critical enabling technologies for the National Aerospace Plane and X-30 hypersonic test vehicle. CFD is also useful in submarine and surface naval vessel design for minimization of expensive model testing. CFD has also begun to be applied to the design of high-performance parachutes. Flight vehicles operating at very low speeds present unique flow problems which are readily addressed through the application of CFD. Useful CFD applications also exist in artillery internal and external ballistics investigations. O.C.

A91-51764
SIGNATURE CONTROL
VITTAL P. PYATI (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Critical technologies for national defense. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 215-228.
Copyright

The reduction of vehicle radar signature is accomplished by means of vehicle shaping, the use of microwave frequencies-absorbent materials, and either passive or active cancellation techniques; such techniques are also useful in the reduction of propulsion system-associated IR emissions. In some anticipated scenarios, the objective is not signature-reduction but signature control, for deception, via decoy vehicles that mimic the signature characteristics of actual weapons systems. As the stealthiness of airframes and missiles increases, their propulsion systems' exhaust plumes assume a more important role in detection by an adversary. O.C.

A91-51794
MATHEMATICAL MODELLING OF DAMAGE TO AIRCRAFT SKIN PANELS SUBJECTED TO BLAST LOADING
S. K. SINGH and V. P. SINGH (Centre for Aeronautical Systems Studies and Analyses, Bangalore, India) Defence Science Journal (ISSN 0011-748X), vol. 41, July 1991, p. 305-316. refs
Copyright

A mathematical model for assessing the damage to an aircraft due to blast from conventional ammunition has been developed. The minimum distance of the point of explosion from the aircraft for its permanent damage for a reference explosion has been obtained depending upon the dimensions (thin plate or thin cylindrical shell) of the structural elements. Author

A91-51862
COAXIAL SURFACE THERMOCOUPLES - ANALYTICAL AND EXPERIMENTAL CONSIDERATIONS FOR AEROTHERMAL HEAT-FLUX MEASUREMENT APPLICATIONS

C. T. KIDD (Calspan Corp., Arnold AFB, TN) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 203-211. refs
Copyright

Practices regarding the use of coaxial surface thermocouples are evaluated and the application of the finite difference code is appraised in terms of heat-transfer measurement. Analytical data are presented regarding temperature histories for different coaxial sensor set-ups by means of a finite-element model of the thermocouples. Heat-flux data are generated from the analytical temperature histories with a finite-difference heat-conduction code. An experimental application of varying time periods and different thermocouple lengths is presented and the results are compared to the analytical work. The effective time period of use for the thermocouples is found to be extended beyond that of the semiinfinite solid time constraints. The results also demonstrate that the coaxial sensor can be applied effectively in a number of configurations and not exclusively when it is the length of the model wall. C.C.S.

A91-51864* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GROUNDING, BONDING AND SHIELDING FOR SAFETY AND SIGNAL INTERFERENCE CONTROL
T. J. FORSYTH and AL BAUTISTA (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 295-309.
Copyright

Aircraft models and other aerodynamic tests are conducted at the NASA Ames Research Center National Full Scale Aerodynamics Complex (NFAC). The models, tested in NFAC's wind tunnels, are sometimes heavily instrumented and are connected to a data acquisition system. Besides recording data for evaluation, certain critical information must be monitored to be sure the model is within operational limits. The signals for these parameters are for the most part low-level signals that require good instrumentation amplification. These amplifiers need to be grounded and shielded for common mode rejection and noise reduction. The instrumentation also needs to be grounded to prevent electrical shock hazards. The purpose of this paper is to present an understanding of the principles and purpose of grounding, bonding, and shielding. Author

A91-51873
RECENT DEVELOPMENTS IN HIGH HEAT-FLUX MEASUREMENT TECHNIQUES AT THE AEDC
C. T. KIDD (Calspan Corp., Arnold AFB, TN) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 477-492. refs
Copyright

Recent developments in the techniques of measuring very high heat-transfer rates are described. These advances include thermal analyses applied to transducer concepts used to make these measurements, improved heat-flux sensor fabrication techniques, experimental methods of determining time responses of sensors, performing absolute calibrations at heat-flux levels above 2000 Btu/sq ft-sec, and novel methods of run-to-run characterizations of the indicated heat-flux levels from the transducers. Results of extensive thermal analyses of the null-point calorimeter concept with application to measurements in arc-heated aerothermal test environments are graphically illustrated. Results of experimental time-response checks and absolute calibrations of null-point calorimeters at different heat-flux levels are shown. Author

A91-51875
AERODYNAMIC PRESSURE MEASUREMENTS ON A ROTATING WIND TURBINE BLADE
C. P. BUTTERFIELD, M. JENKS, D. A. SIMMS, and W. MUSIAL (SERI, Golden, CO) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 517-524. Previously announced in STAR as N90-24256. refs
(Contract DE-AC02-83CH-10093)
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A microprocessor-controlled measurement system was designed and built to make accurate measurements of low pressures on a rotating wind turbine blade. This Pressure System Controller (PSC) is capable of simultaneously operating four pressure scanners (128 channels total) while rotating on a wind turbine blade. Calibrations and purge sequences are performed automatically on all 128 channels while the turbine is rotating. Data are fed to a Pulse Code Modulation (PCM) data-acquisition system and recorded on magnetic tape for later processing. Accurate measurements were made down to pressures of 11 microbars (0.00018 psi) for low Reynolds Number tests. These rotating blade pressure measurements are used to compare with wind tunnel data to see how blade rotation alters airfoil performance. A description of the test setup and instrumentation design is given along with examples results. Recommendations for future work and changes in the design approach are also discussed. Author

A91-51877
A MODULAR 64 CHANNEL PRESSURE SCANNER FOR AEROSPACE TEST
D. JUANARENA (Pressure Systems, Inc., Hampton, VA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 539-545. refs
Copyright

The pressure scanner is described in terms of accuracy and three major improvements, including modular design, transducer density improvements, and a selectable pressure reference. The transducer carriers, amplifier subassembly, and calibration valve are described, and pressure evaluations are reported for the scanners. The modular scanner permits the adjustment of pressure ranges for particular applications and facilitates the field repair of system components. C.C.S.

A91-51878
PERFORMANCE OF A 600-CHANNEL AERODYNAMIC PRESSURE MEASUREMENT SYSTEM FOR TURBINE ENGINE TESTING
J. W. THOMPSON, JR. and P. E. MCCARTY (Sverdrup Technology, Inc., Arnold AFB, TN) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 547-560. refs
Copyright

Altitude simulation testing of turbine engines in ground test facilities requires the steady-state measurement of up to 600 channels of aerodynamic pressures over the range of 0.5 to 500 psia. The time required to acquire the data and the data quality have a significant influence on total test time, hence cost, and turbine engine performance measurements, respectively. Traditionally, these large quantities of measurements have been accomplished by mechanically multiplexing 10 to 20 pneumatic signals to a single strain-gage pressure transducer. A new approach using a dedicated piezoresistive pressure transducer per cahnnel, electronic multiplexing, and rapid on-line calibration provides improved capabilities. The electronic versus pneumatic multiplexing reduces the steady-state acquisition time per test condition from a nominal 80 to 10 s and improves performance from a nominal 0.25 percent FS to 0.05 percent FS. The new system is described, with emphasis on operational characteristics, measurement uncertainty assessment, and the approach to system design and validation. Author

A91-51881
FEASIBILITY STUDY FOR ELECTRON BEAM AND LASER RAMAN NON-INTRUSIVE DIAGNOSTIC MEASUREMENTS IN HYPERSONIC BLOWDOWN WIND TUNNELS
HOMER M. POWELL, CARL A. VENTRICE (Tennessee Technological University, Cookeville), WILLIAM YANTA, ERIC

HEDLUND (U.S. Navy, Naval Surface Weapons Center, White Oak, MD), and RICHARD L. MOYERS IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 585-599. Research supported by U.S. Navy. refs
Copyright

Calculations based upon density measurements are presented for assessing the feasibility of electron beam and laser Raman flow diagnostic techniques for hypersonic blowdown wind tunnels of the Naval-Surface-Weapons-Center class. It is concluded that the electron beam technique is applicable only for flow visualization purposes, even at the low end of the test envelope. P.D.

A91-51884* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SYSTEMS SAFETY MONITORING USING THE NATIONAL FULL-SCALE AERODYNAMIC COMPLEX BAR CHART MONITOR
OSCAR JUNG (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 661-666.
Copyright

Attention is given to the Bar Chart Monitor system designed for safety monitoring of all model and facility test-related articles in wind tunnels. The system's salient features and its integration into the data acquisition system are discussed. P.D.

A91-51895
ARTIFICIAL INTELLIGENCE IN THE EDDY CURRENT INSPECTION OF AIRCRAFT ENGINE COMPONENTS
C. E. CHAPMAN, A. FAHR (National Research Council Canada, Structures and Materials Laboratory, Ottawa), A. PELLETIER, and D. R. HAY (Tektrend International, Inc., Montreal, Canada) Materials Evaluation (ISSN 0025-5327), vol. 49, Sept. 1991, p. 1090-1092, 1094. Research supported by DND. refs
Copyright

An integrated system is described which uses eddy current signals to detect and characterize cracks in the boltholes of aircraft compressor disks. The automated real-time intelligence eddy current system (ARIES) includes a standard eddy current instrument, an automated XYZ table, and an advanced pattern recognition software package. With the ARIES system, service-induced fatigue cracks as small as 0.05 mm deep in the boltholes can be detected in real time. V.L.

A91-51896
SHEAROGRAPHIC INSPECTION OF AIRCRAFT STRUCTURE
JOHN W. NEWMAN (Laser Technology, Inc., Norristown, PA) Materials Evaluation (ISSN 0025-5327), vol. 49, Sept. 1991, p. 1106-1109.
Copyright

The theory of shearographic nondestructive testing and aircraft applications of shearography are discussed. In particular, it is shown that the use of a portable shearography system offers a unique NDT capability for the on-aircraft inspection of the following maintenance areas: crack detection in skins with pressurization loading to 0.27 kPa differential; detection of debonds in lap joints; detection of corroded aluminum honeycomb; detection of poor or improper repairs to aluminum, composite honeycomb, and composite laminates; and detection of impact damage in graphite/epoxy of thermoplastic aircraft structures. Some test results are presented for illustration. V.L.

A91-51912
THE APPLICATION OF PHOTOELASTICITY TO THE ANALYSIS OF SHAFT SPLINES
D. G. SALYARDS and H. J. MACKE (GE Aircraft Engines, Evendale, OH) IN: 1990 SEM Spring Conference on Experimental Mechanics, Albuquerque, NM, June 4-6, 1990, Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1990, p. 117-124. refs
Copyright

A photoelastic investigation of a shaft spline is employed to analyze the stresses, torque distribution, and tooth-load distribution of the element and thereby improve the stress distributions of the element. Epoxy-resin models of the shaft spline are mounted in a torsion-test framework to conduct stress-freezing, and the photoelastic analysis is conducted on thin transverse slices cut perpendicular to the spline axis. The changes in stresses calculated from successively measured fringe orders show that the fully defined stress distributions can be determined, and stress-concentration factors can be calculated for the torsional and bending stresses. C.C.S.

A91-51923
COMPARISON OF THE X-RAY DIFFRACTION METHOD AND THE HOLE DRILLING METHOD FOR THE MEASUREMENT OF RESIDUAL STRESS ON THE AERONAUTICAL MATERIALS
X. SOUDAN, D. GILLEREAU (Aerospatiale, Toulouse, France), J. LU, and J. F. FLAVENOT (Centre Technique des Industries Mecaniques, Senlis, France) IN: 1990 SEM Spring Conference on Experimental Mechanics, Albuquerque, NM, June 4-6, 1990, Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1990, p. 263-270. refs
Copyright

The two methods for determining residual stress are examined with a titanium alloy, martensitic stainless steel, and a nickel alloy to determine relative advantages of the techniques. Several parameters are considered to compare the methods including surface measurement, grain size, geometry, and the ability to study microstresses, multiphase material, and textured materials. Both methods are found to be suitable for determining residual stresses and are complementary techniques; one notable difference is that hole-drilling measures the mean stress of both phases of the Ti alloy and X-ray diffraction can separate the stresses into corresponding phases. C.C.S.

A91-51926* Technology Integration and Development Group, Inc., Billerica, MA.
IN-SERVICE HEALTH MONITORING OF COMPOSITE STRUCTURES
GINO A. PINTO, C. S. VENTRES (Technology Integration and Development Group, Inc., Billerica, MA), CAROL A. GINTY, and CHRISTOS C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) IN: 1990 SEM Spring Conference on Experimental Mechanics, Albuquerque, NM, June 4-6, 1990, Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1990, p. 304-309. refs
Copyright

The aerospace industry is witnessing a vast utilization of composites in critical structural applications and anticipates even more use of them in future aircraft. Therefore, a definite need exists for a composite health monitoring expert system to meet today's current needs and tomorrow's future demands. The primary goal for this conceptual health monitoring system is functional reliably for in-service operation in the environments of various composite structures. The underlying philosophy of this system is to utilize proven vibration techniques to assess the structural integrity of a fibrous composite. Statistical methods are used to determine if the variances in the measured data are acceptable for making a reliable decision on the health status of the composite. The flexible system allows for algorithms describing any composite fatigue or damage behavior characteristic to be provided as an input to the system. Alert thresholds and variances can also be provided as an input to this system and may be updated to allow for future changes/refinements in the composite's structural integrity behavior. Author

A91-51942
ECCENTRICITY EFFECTS OF A SQUARE CUTOUT ON THE RESONANT FREQUENCIES AND MODE SHAPES OF A CURVED COMPOSITE PANEL
V. J. LEVRAEA, JR., A. N. PALAZOTTO (USAF, Institute of Technology, Wright-Patterson AFB, OH), and G. E. MADDUX (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: 1990 SEM Spring Conference on Experimental Mechanics, Albuquerque, NM, June 4-6, 1990,

Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1990, p. 462-469. refs
Copyright

An investigation of the effects of eccentrically located square cutouts on the natural frequencies and mode shapes of circular, cylindrical panels was conducted. A video-holographic-interferometry technique was used to experimentally determine the first five natural frequencies and mode shapes of the panels. Numerically, predictions for the same data were obtained using a finite element method. A clamped-free-clamped-free boundary condition was selected for this study. Cutouts were eccentrically located in both the circumferential and axial directions. The experimental and numerical results for both the natural frequencies and mode shapes correlated well. The percent differences between the experimental and numerical frequencies averaged around 7 percent and were in all cases less than 10 percent. It was observed that, in general, panels with eccentrically located cutouts experienced only small frequency deviations from those with centered cutouts. The amount of variation observed tended to increase with cutout size. Author

A91-52221
THE SELECTION OF IMPELLER PARAMETERS FOR SMALL CENTRIFUGAL REFRIGERATING COMPRESSOR

DEXIONG CHEN and TENG XU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B304-B306. In Chinese. refs

On the basis of thermal calculation, using the flow-path loss method, the selection of impeller's geometric and aerodynamic parameters is proposed for small centrifugal refrigerating compressor, and the influence on its parameters and the performance of the compressor is analyzed. It provides a basis for the selection of the optimum design program of that type compressor. Author

A91-52305* California Univ., Irvine.
GAS AND DROP BEHAVIOR IN REACTING AND NON-REACTING AIR-BLAST ATOMIZER SPRAYS

VINCENT G. MCDONELL and SCOTT SAMUELSEN (California, University, Irvine) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 684-691. Research supported by General Motors Corp. refs
(Contract NAS3-24350)
Copyright

A detailed study of the two-phase flow produced by a gas-turbine air-blast atomizer is performed with the goal of identifying the interaction between the two phases for both nonreacting and reacting conditions. A two-component phase Doppler interferometry is utilized to characterize three flowfields produced by the atomizer: (1) the single-phase flow, (2) the two-phase nonreacting spray, and (3) the two-phase reacting spray. Measurements of the mean and fluctuating axial and azimuthal velocities for each phase are obtained. In addition, the droplet size distribution, volume flux, and concentration are measured. The results reveal the strong influence of the dispersed phase on the gas, and the influence of reaction on both the gas and the droplet field. The presence of the spray significantly alters the inlet condition of the atomizer. With this alteration quantified, it is possible to deduce that the inertia associated with the dispersed phase damps the fluctuating velocities of the gas. Reaction reduces the volume flux of the droplets, broadens the local volume distribution of the droplets in the region of the reaction zone, increases the axial velocities and radial spread of the gas, and increases the anisotropy in the region of the reaction zone. Author

A91-52321
HIGH-TEMPERATURE SOLID-LUBRICATED BEARING DEVELOPMENT - DRY POWDER-LUBRICATED TRACTION TESTING

HOOSHANG HESHMAT (Mechanical Technology, Inc., Latham, NY) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Sept.-Oct. 1991, p. 814-820. Research supported by USAF. Previously cited in issue 18, p. 2896, Accession no. A90-41998. refs
Copyright

A91-52490*# Pennsylvania State Univ., University Park.
ROBUST AND REAL-TIME ROTOR CONTROL WITH MAGNETIC BEARINGS

A. SINHA, K. W. WANG, and K. L. MEASE (Pennsylvania State University, University Park) AIAA, NASA, and OAI, Conference on Advanced SEI Technologies, Cleveland, OH, Sept. 4-6, 1991. 13 p. refs
(Contract NAGW-1356)
(AIAA PAPER 91-3626) Copyright

This paper deals with the sliding mode control of a rigid rotor via radial magnetic bearings. The digital control algorithm and the results from numerical simulations are presented for an experimental rig. The experimental system which has been set up to digitally implement and validate the sliding mode control algorithm is described. Two methods for the development of control softwares are presented. Experimental results for individual rotor axis are discussed. Author

A91-52510
INTELLIGENT PROCESSING, A KEY FACTOR TO PERFORMANCE AND QUALITY

THIERRY HURTES (SNECMA, Paris, France) and PIERRE E. MOSSER (SNECMA, Laboratoire Materiaux et Procedes, Gennevilliers, France) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 955-974. refs
Copyright

With reference to engine manufacturing it is emphasized that it is necessary to implement new engineering and production methodologies based on phenomenological analysis and simulation to reduce the number of experiments. Intelligent processing signifies not only the implementation of analytical methods to avoid production quality drifts and scrapping, but essentially requires that the process be considered as a system and aims at life-cycle cost optimization. Using SNECMA examples, it is shown how it is possible to improve the performance and quality of the processes through the use of these methodologies. L.M.

A91-52565
ACOUSTIC-EMISSION MONITORING OF CERAMIC TURBINE BLADE STRENGTH

A. V. SUDAREV, I. S. GILEV, and S. G. NIKOL'SKII (Vsesoiuznyi Nauchno-Issledovatel'skii Tekhnologicheskii Institut Energeticheskogo Mashinostroeniia, Leningrad, USSR) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1737-1745. refs
Copyright

A nondestructive method is developed for monitoring the strength characteristics of ceramic gas-turbine blades so that off-the-shelf blade grading is facilitated. The technique is based on the acoustic-emission (AE) method employed to determine the strength of brittle material specimens, in which the signals of continuous AE are examined for a specimen undergoing continuous monotonic loading and off-loading. The technique is applied to turbine blades constructed from Al2O3 with Mn, Cr, and Si-oxide added, with blade-loading conducted by means of the three-point bending circuit. Results of the examinations of oscillogram data from the loading and AE counting-rate records indicate that the strengths and grades of ceramic blades during static loading can be ascertained accurately. The effects of various factors in strength decline can be assessed with the method including heat shock, oxidation, and corrosion. C.C.S.

A91-52566
A CO2 LASER APPROACH TO REMANUFACTURING OF TURBINE VANES AND BLADES
V. REGIS, D. D'ANGELO (Ente Nazionale per l'Energia Elettrica, Milan, Italy), M. BRACCHETTI (Milano, Politecnico, Milan, Italy), W. CERRI, and G. P. MOR (Centro Informazioni Studi Esperienze, Milan, Italy) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1747-1756. refs
Copyright

In order to avoid the adverse effects of conventional repair methods for gas-turbine vanes and blades, a method is presented which incorporates a laser beam to perform surface modifications. An experimental device is described for testing the technique, and the cladding tests are carried out and reported. The morphological aspects of laser cladding depend primarily on absorbed laser power, laser-spot dimension, workpiece-advancing speed, and the power-feed rate. Microstructural examination of the experimental blade surfaces shows cladding ranging from 0.6 to 1.0 mm in thickness with dendritic features. The microstructure also shows metallurgical continuity which is noted at the critical cladding-substrate interface, suggesting that the laser-cladding process is an effective technique for the restoration of missing metal in high temperature components. C.C.S.

A91-52567
TRENDS IN CLEAN MELTING TECHNOLOGY FOR NI-BASED SUPERALLOYS
S. J. PATEL and I. C. ELLIOTT (Inco Alloys, Ltd., Hereford, England) IN: High temperature materials for power engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1757-1766. refs
Copyright

The driving forces behind historical developments in cleaner melting technology for Ni-based superalloys are discussed, and future trends and needs in the area of Ni-base alloy processing are indicated. Special attention is given to early vacuum melting as a method for improving forgeability of alloys, and to the techniques of duplex treatments, cold hearth refining by electron beam and plasma arc melting, and vacuum induction melting (VIM). Among future trends, the use of complex vacuum processing routes VIM + electroslag refining, and triple melt combinations for critical components is expected to replace the established VIM + vacuum arc remelting route. I.S.

A91-52808
GEARBOX NOISE AND VIBRATION; PROCEEDINGS OF THE 1ST IME INTERNATIONAL CONFERENCE, UNIVERSITY OF CAMBRIDGE, ENGLAND, APR. 9-11, 1990
Conference sponsored by IME. Bury Saint Edmunds, England, Mechanical Engineering Publications, Ltd., 1990, 190 p. For individual items see A91-52809 to A91-52818.
Copyright

The papers presented in this volume provide a summary of the available experience in gearbox noise and vibration control in various fields, including aerospace, automotive, mining, and steel industries. Topics discussed include a review of the theory and measurement of gear transmission error; optimum profile relief and transmission error in spur gears, and helicopter gearcase structure-borne noise studies using statistical energy analysis modeling. Papers are also presented on source identification of automotive gearbox noise; decoupling measures of rattling noise in gearboxes; and an expert system for vibration diagnostics. V.L.

A91-52810
GEARBOX NOISE AND VIBRATION - REVIEW OF OPPORTUNITIES FOR IMPROVING SAFETY AND RELIABILITY
D. G. ASTRIDGE (Derek Astridge and Associates, Langport, England) IN: Gearbox noise and vibration; Proceedings of the 1st IME International Conference, Cambridge, England, Apr. 9-11, 1990. Bury Saint Edmunds, England, Mechanical Engineering Publications, Ltd., 1990, p. 11-18. refs
Copyright

Problems and opportunities relating to the enhancement of the safety and reliability of systems employing gearboxes are briefly examined. It is noted that noise and vibration may contribute both negatively (as a potential hazard) and positively to safety and reliability. In particular, noise and vibration can be beneficial when used in the quality assurance testing of gearboxes. Recommendations are given concerning the improvement of safety and reliability at different stage of the design-development-service life cycle of machines. V.L.

A91-52811* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GEAR NOISE, VIBRATION, AND DIAGNOSTIC STUDIES AT NASA LEWIS RESEARCH CENTER
J. J. ZAKRAJSEK, F. B. OSWALD, D. P. TOWNSEND, and J. J. COY (NASA, Lewis Research Center, Cleveland, OH) IN: Gearbox noise and vibration; Proceedings of the 1st IME International Conference, Cambridge, England, Apr. 9-11, 1990. Bury Saint Edmunds, England, Mechanical Engineering Publications, Ltd., 1990, p. 27-34. Previously announced in STAR as N90-18041. refs
Copyright

The NASA Lewis Research Center and the U.S. Army Aviation Systems Command are involved in a joint research program to advance the technology of rotorcraft transmissions. This program consists of analytical as well as experimental efforts to achieve the overall goals of reducing weight, noise, and vibration, while increasing life and reliability. Recent analytical activities are highlighted in the areas of gear noise, vibration, and diagnostics performed in-house and through NASA and U.S. Army sponsored grants and contracts. These activities include studies of gear tooth profiles to reduce transmission error and vibration as well as gear housing and rotordynamic modeling to reduce structural vibration and transmission and noise radiation, and basic research into current gear failure diagnostic methodologies. Results of these activities are presented along with an overview of near-term research plans in the gear noise, vibration, and diagnostics area. Author

A91-52815
HELICOPTER GEARCASE STRUCTURE-BORNE NOISE STUDIES USING STATISTICAL ENERGY ANALYSIS MODELLING
J. S. POLLARD (Anthony Best Dynamics, Ltd., Bradford on Avon, England) IN: Gearbox noise and vibration; Proceedings of the 1st IME International Conference, Cambridge, England, Apr. 9-11, 1990. Bury Saint Edmunds, England, Mechanical Engineering Publications, Ltd., 1990, p. 69-81. Research supported by Ministry of Defence of England. refs
Copyright

Statistical energy analysis modeling has been applied to the main gearbox, the principal source of helicopter cabin noise, with a view to developing a helicopter noise prediction model and providing suitable design tools. The model used in this study consists of elements for panels, cone, circular top plate, cavity, and receiver space. Model predictions are compared against theoretical and experimentally determined coupling loss factors across the cone interfaces. V.L.

A91-52818
HELICOPTER GEARBOX VIBRATION ANALYSIS IN THE CANADIAN FORCES - APPLICATIONS AND LESSONS
J. F. A. LEBLANC (DND, Ottawa, Canada), J. R. F. DUBE (National Research Council of Canada, Ottawa), and B. DEVEREUX (Aerospace Maintenance Development Unit, Trenton, Canada) IN: Gearbox noise and vibration; Proceedings of the 1st IME International Conference, Cambridge, England, Apr. 9-11, 1990. Bury Saint Edmunds, England, Mechanical Engineering

Publications, Ltd., 1990, p. 173-177. refs
Copyright

The results of a vibration analysis program used by the Canadian Forces as an element of aircraft condition monitoring are summarized. The program was originally developed to deal with unusual tail vibrations which affected the entire Sea King helicopter fleet. The program has produced reliable detection and diagnosis of transmissions despite the limitations imposed by the equipment at the early stages of the program. It has been demonstrated that vibration analysis alone can be used reliably to detect and diagnose faults within gear boxes. It is recommended, however, that vibration analysis be used in conjunction with other condition monitoring techniques to ensure that all possible failure modes within gear boxes are detected and properly diagnosed. V.L.

A91-52960
METHOD - PRESSURE DROP TESTS FOR FUEL SYSTEM COMPONENTS
SAE Aerospace Recommended Practice, ARP 868, Dec. 18, 1990, 9 p.
(SAE ARP 868) Copyright

Techniques are presented for testing components and improving the accuracy of such tests to meet the requirements of MIL-F-8615 or equivalent specifications. Pressure-drop tests for individual components are described generally including the single and double piezometer-tube methods, and many of the suggested improvements apply to these techniques. The test setup is presented graphically, and the procedural conditions are described. The suggestions for improving the test results include notes regarding air bubbles, pumping-source pulsations, attachment fittings, overshooting the flow rate, and the importance of precise calibration. Diagrams are given for the double piezometer-tube, the mercury-manometer, and the fuel-manometer tests, and the arithmetic computation is described for the data-reduction equation. C.C.S.

N91-29412# Environmental Research Inst. of Michigan, Ann Arbor.
P-3 SAR CALIBRATION ACTIVITY AT ANDROS ISLAND
DAN SHEEN, DENISE GINERIS, and ERIC KASISCHKE Feb. 1991 57 p
(Contract N00014-90-C-0117)
(AD-A237357; ERIM-226900-1-T) Avail: NTIS HC/MF A04 CSCL 17/9

From 26 May 1990 through 9 June 1990 the NADC/ERIM P-3/SAR collected calibration data over Andros Island. Several calibration reflectors were deployed on the ground at Andros town. The P-3/SAR typically imaged the reflectors during one pass at the start of each day's flight and one pass at the end of the day. These images were quickly processed to verify focussing and linearity of the SAR. The calibration activity demonstrated that the P-3/SAR was operating properly during the mission and that the data is calibratable. Author (GRA)

N91-29508# United Technologies Research Center, East Hartford, CT.
EXPERIMENTAL AND ANALYTICAL STUDY OF RIPPLED TRAILING EDGE AIRFOILS FOR COMPRESSOR APPLICATION Final Report
BRUCE L. MORIN and THOMAS J. BARBER May 1991 95 p
(Contract N00014-86-C-0663)
(AD-A237425; UTRC/R89-957707) Avail: NTIS HC/MF A05 CSCL 13/7

Research was conducted to assess potential benefits of using the Rippled Trailing Edge (RTE) concept on compressor airfoils for separation alleviation and wake mixing enhancement. An empirically designed RTE was tested in a highly loaded, simulated compressor cascade that had demonstrated large scale suction side separation with a baseline circular trailing edge. The original RTE design resulted in a 50 percent increase of the chordwise extent of the separated flow compared to the baseline trailing edge. Extensive modifications to the RTE resulted in a fairing that eliminated separation, indicating that RTEs have potential for separation alleviation on compressor trailing edges. However, failure of the first design shows the weaknesses of the empirical RTE design procedure that was used, and that many unknowns still exist regarding the 3-D boundary layer relief concept. Further testing of ripples on more basic, isolated airfoils is suggested to develop further understanding of the 3-D boundary layer relief mechanism, without having to consider the inherent problems associated with the cascade testing. After developing such a data base, RTEs can then be evaluated for application to the more complex case where curvature and three-dimensional effects are significant. GRA

N91-29509# Naval Postgraduate School, Monterey, CA.
NEAR-STALL LOSS MEASUREMENTS IN A CD COMPRESSOR CASCADE WITH EXPLORATORY LEADING EDGE FLOW CONTROL M.S. Thesis
JEFFREY H. ARMSTRONG Jun. 1990 166 p
(AD-A237497) Avail: NTIS HC/MF A08 CSCL 20/4

Loss measurements were conducted using a five-hole conical pneumatic probe in a subsonic wind tunnel containing a modeled cascade of controlled diffusion (CD) stator blades. Following reference measurements at high incidence one blade was modified (slotted at the leading edge) in an attempt to (passively) reduce the size of the leading edge separation bubble and thereby improve performance. Prior to the surveys, the acquisition and reduction software was modified to provide loss calculations using both mass-averaged and fully-mixed-out conditions for the upstream and downstream flows. Results showed that the mass-averaged method provided the more consistent results, and this was explained. The slotted leading edge blade was found to produce less loss than the reference blade, and it was concluded that the control concept should be explored in more detail. GRA

N91-29515# Pennsylvania State Univ., University Park. Applied Research Lab.
UNSTEADY FORCE CALCULATIONS IN TURBOMACHINERY
WILLIAM C. ZIERKE Jul. 1991 57 p Sponsored by Naval Sea Systems Command
(AD-A237937; ARL/PSU/TR-91-008) Avail: NTIS HC/MF A04 CSCL 20/4

This report gives a review of the various types of unsteady flow phenomena that occur within a turbomachine and examines existing methods for computing several of these flows. Then, we discuss a method for applying two-dimensional, unsteady, thin airfoil theory in a stripwise manner to compute the unsteady forces and moments on the shaft of a rotor operating within a nonuniform inflow. Techniques for computing these unsteady forces and moments on a rotor blade row with rake and skew are included. GRA

N91-29519# Naval Postgraduate School, Monterey, CA.
NUMERICAL STUDY OF NON-IMPULSIVELY STARTED FLOW AROUND A CIRCULAR CYLINDER M.S. Thesis
KENT A. FREDRICKSON Sep. 1990 78 p
(AD-A238051) Avail: NTIS HC/MF A05 CSCL 20/4

The effect of constant acceleration, prior to the establishment of a steady uniform flow, on some of the characteristics of the resulting time-dependent flow about a circular cylinder has been investigated numerically. It is shown that the occurrence of a local maximum drag is dependent on the parameters characterizing the non-impulsive nature of the ambient flow. However, the onset of the wake asymmetry and the evolution of the lift and drag forces during the transient period depend on the characteristics of the numerical perturbation used to initiate the asymmetric vortex shedding. It is concluded that the numerical methods can predict, to varying degrees of accuracy, the behavior of the symmetric state and the quasi-steady-state, but not of the intermediate state. GRA

N91-29521# Naval Postgraduate School, Monterey, CA.
CONTROL OF FLOW OVER A BACKWARD FACING STEP M.S. Thesis

J. V. HEALEY Sep. 1990 92 p
(AD-A238638) Avail: NTIS HC/MF A05 CSCL 20/4

The poor aerodynamic design of the superstructures of today's Navy ships create a highly turbulent airwake that can make shipboard helicopter operations quite hazardous. This study is part of a longer-term project to tailor airflow over a ship's helicopter deck in order to improve the poor quality of the airflow. This airflow is thought to be largely responsible for several costly blade strike mishaps involving H-46 helicopters during start-up and shut down. Numerous computer simulations were conducted using the Phoenics Computational Fluid Dynamics code to simulate airflow over a backward-facing-step. The latter represents a simple 2-d model of flow behind a typical hangar/flight deck combination. In each run a deflector of different size, orientation or porosity was placed in a specific location in an attempt to reduce the size of the recirculation zone, the velocities and the turbulence levels. Of the studies involved, a vertical deflector offset downstream with its lower edge at the top of the step produced the best overall results. GRA

N91-29533# National Aeronautical Establishment, Ottawa (Ontario). Unsteady Aerodynamics Lab.
LABORATORY EVALUATION OF PORTABLE AND WALK-THROUGH EXPLOSIVES VAPOUR DETECTORS
LORNE ELIAS and PAVEL NEUDORFL Mar. 1990 26 p
Presented at the 3rd Symposium on Analysis and Detection of Explosives, Mannheim, Fed. Republic of Germany, 10-13 Jul. 1989 Sponsored in part by Transport Canada
(NAE-LTR-UA-104; CTN-91-60015) Copyright Avail: NTIS HC/MF A03

Thirteen different explosives vapor detectors (EVD) were quantitatively tested for their response to certain nitroorganics, particularly ethylene glycol dinitrate (EGDN), as part of an assessment of their overall efficacy in field use. Eleven of these instruments are housed in carrying cases for portability, two are designed as fixed-installation portals for personal screening. Instruments tested were of two types: (1) continuous, fast acting devices based on electron capture detection (ECD) or ion mobility spectrometry (IMS), usually in conjunction with semi-permeable membranes; and (2) slower, batch sampling, gas chromatographic equipment with ECD using vapor preconcentrators. Sensitivity was measured by subjecting the instrument under test to known controllable levels of exposives vapors from a dynamic vapor source. The continuous EVDs had response times of a few seconds, poor to good selectivity, and a lower detection limit in the 1 to 100 ppb range; the GC based instruments were 100 times more sensitive, considerably more specific, but required 0.5 to 3 minutes per analysis. CISTI

N91-29534# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
STRAIN GAUGE CABLING, CONDITIONING, AND SENSITIVITY CALCULATIONS FOR THE CT-114 (TUTOR) AIRCRAFT AFT FUSELAGE AND EMPENNAGE FULL-SCALE FATIGUE TEST
P. A. ADAMS and R. A. BRACKETT 22 Feb. 1990 36 p
Sponsored by Department of National Defense
(NAE-LTR-ST-1758; CTN-91-60021) Copyright Avail: NTIS HC/MF A03

The monitoring of strain on the aft fuselage and empennnage of the CT-114 is accomplished by the cabling, conditioning and sensitivity calculations described. Gauge types and locations simulate a subset of those which formed part of the CL-41 flight load survey strain gauge report by Canadair. Eighty-eight bridges are monitored. Eight of those include original flight load survey gauges. The effect of lead resistances are figured into the calculations of shunt strain simulation. Two data acquisition systems were employed. Sixty out of a 64 channel system manufactured by MTS Systems Corp QUAD system were used along with 30 channels on a Hewlett Packard system. Cabling and calculations spreadsheets as well as schematics of quarter, half and full bridge set-ups are included for each system. Author (CISTI)

N91-29609# Netrologic, Inc., San Diego, CA.
NEURAL NETWORKS AND ROBOTICS APPLIED TO THE NON-DESTRUCTIVE INSPECTION OF AIRCRAFT Status Report
DAN GREENWOOD 1 Jul. 1991 2 p
(Contract N00014-91-C-0095)
(AD-A238312) Avail: NTIS HC/MF A01 CSCL 12/9

We are converting the in phase and quadrature measurements into an image and then using the image to classify fault or no fault eddy current. This has been done using old OCR features developed to recognize handwritten numerical characters which are applicable to this situation. The raw data was first smoothed out by taking the average of the nearest 10 measurements, then plotted on a 50 by 50 grid. The X axis is the in phase measurement normalized to accommodate the maximum and minimum in phase values in the data set. The same was done for quadrature values on the Y axis. An efficient path planning method for collision avoidance has been developed. Fast path planning is achieved by decomposing the 3-dimensional space into a number of 2-dimensional subspaces. A method is devised to work directly with arm postures (configurations) instead of dealing with individual joint angles. These two aspects, namely decomposition and posture control, greatly speed up the path finding procedure and make it possible to perform near real-time planning in a moderately cluttered environment. Meetings were held at McDonnell Douglas, McClelland AFB, and Physical Research Inc., manufacturers of Magneto-Optic Crack Detectors, to assess the utility of our research and plans for prototyping during Phase 2. Discussions have begun with United Technologies concerning the use of our research for a large Air Force NDI program. Prospects for Phase 3 follow-on look promising. GRA

N91-29615 Virginia Polytechnic Inst. and State Univ., Blacksburg.
MODELING AND RESPONSE ANALYSIS OF THIN-WALLED BEAM STRUCTURES CONSTRUCTED OF ADVANCED COMPOSITE MATERIALS Ph.D. Thesis
OHSEOP SONG 1990 194 p
Avail: Univ. Microfilms Order No. DA9116645

The objective is to incorporate several essential effects which have a considerable importance for the rational design of composite thin-walled beam structures. These effects are the transverse shear deformation, the warping constraint, the secondary warping as well as the hygrothermal and the dynamic ones. The field equations of laminated composite thin-walled beams of either open or closed single and multicell cross-sections are derived through the application of Hamilton's variational principle. The Laplace Transform technique is used to obtain exact solutions. The aeroelastic divergence instability of aircraft wings modelled as thin-walled beams as well as the eigenfrequency problem of cantilevered composite thin-walled beams of closed cross-section are considered in the framework of a refined theory incorporating non-classical effects. Author

N91-30383# Royal Aerospace Establishment, Farnborough (England).
DOPPLER-MULTIPATH TOLERANT VOICE COMMUNICATION
R. M. HARRIS *In* AGARD, Use or Reduction of Propagation and Noise Effects in Distributed Military Systems 11 p 1990
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Line of sight communication between high performance aircraft has been found to be subject to a peculiar form of multipath radio wave propagation - Doppler multipath. It degrades analogue voice reception on the standard fit ultrahigh frequency radio, producing low frequency random noise and warbling. Various modifications were carried out on the aircraft's communications system, but the problem remained. All the evidence points to a natural phenomenon. The reported observations are corroborated by theoretical studies and laboratory simulations of multipath radio wave propagation between two points moving relative to a diffusely scattering reflector. Theoretical predictions of Rician fading have explained the disruption of speech transmitted using conventional

dsb(am) modulation. This also indicated suppressing the carrier as a radical cure. Double sideband suppressed carrier radios have been developed for airborne evaluation in comparison with standard dsb(am). The air to air flying trials proved the superior performance of the suppressed carrier system under conditions of Doppler multipath. Author

N91-30384# Federal Aviation Administration, Atlantic City, NJ.
EVALUATION OF DESIRED TO UNDESIRED SIGNAL PROTECTION RATIOS OF 14 DB VERSUS 20 DB WITH FREQUENCY OFFSET
ARTHUR CUSHNAN, KIEM VANHOANG, and Y. TRUONG Aug. 1991 15 p
(DOT/FAA/CT-TN91/15) Avail: NTIS HC/MF A03

This evaluation describes tests performed on eight avionics receivers at the Federal Aviation Administration (FAA) Technical Center to compare receiver performance when exposed to 14 and 20 decibel (dB) desired/undesired (D/U) co-channel interference. Testing was done with the undesired signal offset in frequency by small amounts to simulate real-world conditions. Test results indicate that at both D/U ratios, the receivers were able to reproduce clear, audible, and intelligible speech with or without the undesired frequency slightly offset. Author

N91-30431# European Space Agency, Paris (France).
PHYSICAL MECHANISMS AND DISTURBANCES RELATED TO THE ATTACHMENT OF AN ELECTRIC ARC TO A CONDUCTIVE CYLINDER Ph.D. Thesis - Paris VI Univ., 1988
PATRICK LEVESQUE (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) May 1991 189 p Transl. into ENGLISH of Etude des Mecanismes Physiques Lies a l'Attachement d'un Arc Electrique sur un Cylindre Conducteur (Paris, France, ONERA), 1988 193 p Original language document was announced as N89-29698
(ESA-TT-1168; ONERA-NT-1988-2; ETN-91-99794) Avail: NTIS HC/MF A09

The physics of the interaction between medium length electric arcs (5 to 35 cm) and a structure simulating an aircraft fuselage on a small scale is discussed. The classical physical analysis of electrical discharges is recalled, and a certain number of typical discharge configurations in air, over short and long distances are described. The electrical characteristics of the experimental device are given and various electrical and optical diagnostic systems used are described. The main experimental results are given, along with a critical analysis and a physical interpretation of the different phases of the phenomena. In particular, the special role of high current streamers and of the propagation of high conductivity leaders are revealed. An analysis of the correlations between the different phases of the arc-over and the voltages induced inside the simulated aircraft structure are given. ESA

N91-30454 Stanford Univ., CA.
HEAT TRANSFER WITH HIGH INTENSITY, LARGE SCALE TURBULENCE: THE FLAT PLATE TURBULENT BOUNDARY LAYER AND THE CYLINDRICAL STAGNATION POINT Ph.D. Thesis
FORREST EDWARD AMES 1991 250 p
Avail: Univ. Microfilms Order No. DA9115734

The influence of high intensity, large scale turbulence on heat transfer from the zero velocity gradient turbulent boundary layer and the cylindrical stagnation region is examined. This research is relevant to the development of gas turbine engines where high levels of turbulence exist and are believed to be responsible for large uncertainties in assessing gas path heat transfer. High intensity, large scale turbulence was generated in a simulated combustor. Turbulence levels of up to 19 percent were reached. Heat transfer from a flat plate turbulent boundary layer was determined using three constant temperature cylinders with a 4 to 1 diameter range. Baseline tests demonstrate the ability to determine local flat plate heat transfer within +/- 2.5 percent, and cylindrical region heat transfer within +/- 4 percent. Hot wire anemometry using a single wire was used to survey the velocity and turbulence distributions as well as to take velocity-time records in order to characterize the longitudinal integral and energy scales of the flow. An orthogonal axis triple wire was used to survey the mean and fluctuating velocities in the X,Y, and Z directions. The thermal boundary layer was examined using a thermocouple probe. An outer layer eddy diffusivity model was developed for use in the STAN7 finite difference boundary layer code, which predicts the heat transfer results within +/- 5 percent. A correlating parameter was developed which collects the present data within +/- 3 percent. Dissert. Abstr.

N91-30473*# National Aeronautics and Space Administration. *Lewis Research Center, Cleveland, OH.*
A QUALITATIVE VIEW OF CRYOGENIC FLUID INJECTION INTO HIGH SPEED FLOWS
R. C. HENDRICKS, J. SCHLUMBERGER, and M. PROCTOR 1991 8 p Presented at the 18th International Congress of Refrigeration, Montreal, 10-17 Aug. 1991
(NASA-TM-105139; E-6410; NAS 1.15:105139) Avail: NTIS HC/MF A02 CSCL 20/4

The injection of supercritical pressure, subcritical temperature fluids, into a 2-D, ambient, static temperature and static pressure supersonic tunnel and free jet supersonic nitrogen flow field was observed. Observed patterns with fluid air were the same as those observed for fluid nitrogen injected into the tunnel at 90 deg to the supersonic flow. The nominal injection pressure was of 6.9 MPa and tunnel Mach number was 2.7. When injected directly into and opposing the tunnel exhaust flow, the observed patterns with fluid air were similar to those observed for fluid nitrogen but appeared more diffusive. Cryogenic injection creates a high density region within the bow shock wake but the standoff distance remains unchanged from the gaseous value. However, as the temperature reaches a critical value, the shock faded and advanced into the supersonic stream. For both fluids, nitrogen and air, the phenomena was completely reversible. Author

N91-30478# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Entwurfsaerodynamik.
A MULTIPLE-BLOCK MULTIGRID METHOD FOR THE SOLUTION OF THE THREE-DIMENSIONAL EULER AND NAVIER-STOKES EQUATIONS
HAROLD ATKINS (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Sep. 1991 34 p
(DLR-FB-90-45; ISSN-0171-1342; ETN-91-99788) Avail: NTIS HC/MF A03; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 12.50 DM

A multiple block multigrid method for the solution of the three dimensional Euler and Navier-Stokes equations is presented. The basic flow solver is a cell vertex method which employs central difference spatial approximations and Runge-Kutta time stepping. The use of local time stepping, implicit residual smoothing, multigrid techniques and variable coefficient numerical dissipation results in an efficient and robust scheme is discussed. The multiblock strategy places the block loop within the Runge-Kutta Loop such that accuracy and convergence are not affected by block boundaries. This has been verified by comparing the results of one and two block calculations in which the two block grid is generated by splitting the one block grid. Results are presented for both Euler and Navier-Stokes computations of wing/fuselage combinations. ESA

N91-30480# Royal Aerospace Establishment, Farnborough (England). Propulsion Dept.
UNSTEADY VISCOUS FLOW IN A HIGH SPEED CORE COMPRESSOR
M. A. CHERRETT and J. D. BRYCE 10 Dec. 1990 14 p Presented at the 36th ASME International Gas Turbine and Aeroengine Congress and Exposition, Orlando, FL, 3-6 Jun. 1991
(RAE-TM-P-1198; BR116642; ETN-91-99854) Copyright Avail: NTIS HC/MF A03

A probe incorporating a miniature high frequency response pressure transducer traversed behind the first three stages of a

high speed multistage compressor operating at throttle settings corresponding to near choke, peak efficiency and near surge, is described. A novel method of compensating for transducer temperature sensitivity was employed. Consequently, time averaged pressures derived from the transducer were found to be in good agreement with pneumatic pressure measurements. Analysis of the unsteady pressure measurements revealed both the periodic and random fluctuations in the flow field. This provided information on rotor-rotor interaction effects and the nature of viscous blade wake and secondary flows in each stage. ESA

N91-30488# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
NUMERICAL DEFINITION DOCUMENT FOR THE ISNAS TIME-IMPLICIT FLOW SOLVER
D. DIJKSTRA and J. G. M. KUERTEN Feb. 1991 55 p (MEMO-935; ISSN-0169-2690; ETN-91-99733) Avail: NTIS HC/MF A04

Two applications of ISNaS project related to compressible viscous flow are discussed. The first application is the flow about a multi element airfoil. The second is the flow about a wing/body transport combination. For the second application, a time implicit monoblock is chosen. The way in which the equations are discretized and solved for this time implicit solver is outlined. Attention is paid to vectorization aspects. Stability analysis indicates that the maximum possible time step for three dimensional calculations is the same as in the time explicit flow solver. Vectorization of the proposed method is possible. ESA

N91-30492# Aeritalia S.p.A., Turin (Italy). Flight Test Dept.
AUTOMATIC TREATMENT OF FLIGHT TEST IMAGES USING MODERN TOOLS: SAAB AND AERITALIA JOINT APPROACH
A. KAELLDAHL (Saab-Space A.B., Linkoeping, Sweden) and P. DURANTI 1990 11 p Presented at the 3rd European SFTE Mini-Symposium, Linkoeping, Sweden, 7-8 Jun. 1990 Prepared in cooperation with Saab-Space A.B., Linkoeping, Sweden (ETN-91-99773) Avail: NTIS HC/MF A03

The use of onboard cine cameras, as well as that of on ground cinetheodolites, is very popular in flight tests. The high resolution of film and the high frame rate of cinecameras are still not exceeded by video technology. Video technology can successfully enter the flight test scenario once the availability of solid-state optical sensors dramatically reduces the dimensions, and weight of TV cameras, thus allowing to locate them in positions compatible with space or operational limitations (e.g., HUD cameras). A proper combination of cine and video cameras is the typical solution for a complex flight test program. The output of such devices is very helpful in many flight areas. Several sucessful applications of this technology are summarized. Analysis of the large amount of data produced (frames of images) requires a very long time. The analysis is normally carried out manually. In order to improve the situation, in the last few years, several flight test centers have devoted their attention to possible techniques which allow for quicker and more effective image treatment. ESA

N91-30519 Bath Univ. (England).
CONTROL OF VIBRATION IN A FLEXIBLE ROTOR-BEARING SYSTEM Ph.D. Thesis
M. A. BASEER 1990 321 p
Avail: Univ. Microfilms Order No. BRDX91984

The historical development in the study of vibration problems in rotating machinery is traced. The main causes of vibration in rotor-bearing systems are summarized. Different methods of vibration control and their optimum areas of application are discussed. Both passive and active vibration control devices are described. A review of analytical methods in rotor dynamics is presented. A comprehensive discussion of lumped parameter representations of distributed systems furnishes the basic modeling knowledge of flexible rotor-bearing systems. Modeling rules for attaining optimum accuracy with lumped-parameter modeling are discussed in detail. Analytical methods commonly used for the determination of the critical speeds and steady state response to imbalance are described. Various numerical methods available for computing the transient response of flexible rotor-bearing systems, subjected to a sudden change in imbalance are described. Nonlinearities arising at the journal bearings are discussed. A method is introduced for performing a nonlinear transient analysis of a flexible rotor-bearing system, operating under simulated blade loss conditions. The formulation of a suitable control strategy for the active control of vibration in a flexible rotor-bearing system caused by steady as well as sudden changes in imbalance is described. The experimental set up and data acquisition system are also described, and the essential features of the test rotor-bearing systems are summarized. The microcomputer-based data acquisition system used to implement the control strategy is discussed. The test results are presented, and the purpose was to obtain experimental data on the use of an electromagnetic actuator for active control of synchronous as well as transient vibration in a flexible rotor-bearing system under conditions simulating those which might occur in a rotating machine in case of a component loss. A description of the blade loss mechanism is included. Dissert. Abstr.

N91-30521 Council for National Academic Awards (England).
VIBRATION CONTROL IN ROTATING MACHINERY USING VARIABLE DYNAMIC STIFFNESS HYDROSTATIC SQUEEZE-FILMS Ph.D. Thesis
M. P. ROACH 1990 271 p
Avail: Univ. Microfilms Order No. BRDX91965

The development and testing of a support design for use with rotating machinery is discussed. The support design is based on the centralized squeeze-film currently in use with aircraft engines. To allow the dynamic load support stiffness value to be varied between high hydrostatic support values and near-zero values during machine operation, capillary flow restrictors and remote-controlled solenoid values were introduced between the accumulators and the hydrostatic recesses. The support system was tested experimentally with a multi-mass flexible rotor running on rolling element bearings which modeled a General Electric TF 34 turbofan engine compressor shaft. The static and dynamic characteristics of the supports were modeled theoretically using fluid-flow continuity equations which accounted for fluid inertia and compressibility effects, with the circumferential land squeeze-film effects assumed to be acting in parallel with the hydrostatic effects. The shaft and rotor steady-state response to unbalance was determined theoretically using a transfer matrix method, and the stability of the system was determined by examining the complex roots of the system characteristic equations. Both the theoretical and experimental results show that the introduction of the accumulator-modified hydrostatic squeeze-film supports can result in significant improvements to a machine's stability, steady-state vibration levels and support force transmission in comparison with conventional support designs. Support stiffness and damping values were identified which maximize both the machine stability and the steady-state response to unbalance attenuation and are shown to be dependent upon certain machine parameters. Hydrostatic support instability was shown to be possible with high fluid compressibility values or with the introduction of the accumulators; however, such instability was found to be suppressed by the squeeze-film damping forces generated by the circumferential lands resulting in stability levels significantly above those achieved with conventional support systems. Dissert. Abstr.

N91-30533*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TRANSMISSION OVERHAUL ESTIMATES FOR PARTIAL AND FULL REPLACEMENT AT REPAIR
M. SAVAGE (Akron Univ., OH.) and D. G. LEWICKI 1991 8 p Presented at the International Conference on Motion and Power Transmissions, Hiroshima, Japan, 24-26 Nov. 1991; sponsored by the Japan Society of Mechanical Engineers with the participation of ASME, I. Mech. E., VDI, I.E.T., CSME and other societies
(Contract DA PROJ. 1L1-62211-A-47A)
(NASA-TM-104395; E-6211; NAS 1.15:104395; AVSCOM-TR-91-C-010) Avail: NTIS HC/MF A02 CSCL 13/9

Timely transmission overhauls increase in-flight service reliability greater than the calculated design reliabilities of the individual aircraft transmission components. Although necessary for aircraft safety, transmission overhauls contribute significantly to aircraft expense. Predictions of a transmission's maintenance needs at the design stage should enable the development of more cost effective and reliable transmissions in the future. The frequency is estimated of overhaul along with the number of transmissions or components needed to support the overhaul schedule. Two methods based on the two parameter Weibull statistical distribution for component life are used to estimate the time between transmission overhauls. These methods predict transmission lives for maintenance schedules which repair the transmission with a complete system replacement or repair only failed components of the transmission. An example illustrates the methods. Author

N91-30539*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PM200/PS200: SELF-LUBRICATING BEARING AND SEAL MATERIALS FOR APPLICATIONS TO 900 C
HAROLD E. SLINEY Jul. 1991 17 p Sponsored in part by DOE Original contains color illustrations
(NASA-TM-103776; E-6043; NAS 1.15:103776) Avail: NTIS HC/MF A03; 13 functional color pages CSCL 13/9

The development of the PS/PM200 class of self-lubricating material is described. The composition of the materials and their performance under temperature conditions from minus 160 degrees to 900 C (minus 250 to 1650 F) are examined. Applications in areas such as cylinder liner coatings, shaft seals, gas bearings, and airframe thermal expansion joints are proposed. Graphs and tables are provided to show service temperature limits, mechanical strength, linear thermal expansion, and thermal conductivity parameters. M.G.

N91-30543# Analytic Engineering Co., Lincoln, NE.
SURFACE ACOUSTIC WAVE TECHNIQUE FOR CRAZE DETECTION AND STRESS MEASUREMENT OF AIRCRAFT TRANSPARENCIES Final Report, Sep. 1989 - Mar. 1990
NISAR SHAIKH Feb. 1991 42 p
(Contract F33615-89-C-3402)
(AD-A235943; WRDC-TR-90-3082) Avail: NTIS HC/MF A03 CSCL 11/9

A nondestructive testing technique that employs surface acoustic waves was developed for detecting and characterizing flaws and degradation in transparent enclosures of fighter aircraft. The focus of research has been acoustic measurement of craze and stresses (i.e. residual stress) in the acrylic top layer of laminated transparencies. The craze severely degrades the optical performance of the transparent enclosure and is one of the major causes of the limited service life. The stress accelerates the incipience of craze in addition to causing eventual fracture. The acoustic detection technique uses silicone rubber wedges to launch and receive surface acoustic waves. Both Rayleigh surface wave and critical angle longitudinal (L-cr) wave transducers were developed and produced favorable test results. L-cr waves are recommended for stress measurement and Rayleigh surface waves are recommended for craze detection. GRA

N91-30558 Southampton Univ. (England).
WAVE PROPAGATION IN PERIODICALLY STIFFENED PLATES AND SHELLS Ph.D. Thesis
NICHOLAS SIMON BARDELL 1990 331 p
Avail: Univ. Microfilms Order No. BRDX92315

It is investigated how the vibration-transmission characteristics of periodically stiffened plates and shells might be exploited to reduce propfan-induced noise and vibration in the fuselage cabins of civil aircraft. Initially, steady state harmonic wave propagation is considered in stringer-stiffened and frame-stiffened cylinders. Generality of stringer and frame section is allowed. Both types of structure are analyzed as one-dimensional periodic systems. Exact, closed-form relationships are established between the frequency and the propagation constants. Computed values are presented in graphical form, and clearly show the existence of distinct frequency stop and pass bands. The phase constant part of these curves is used to deduce the natural frequencies and normal modes for a number of specific structures. Provision is made for the inclusion of hysteretic damping. Steady state harmonic wave propagation is then considered in orthogonally stiffened plates and shells. Although the vibration modes and waves of these structures do not admit closed-form, exact solutions, approximate modes and frequencies can be deduced using energy methods. Both types of structure are therefore analyzed as two-dimensional periodic systems by using wave propagation techniques in conjunction with the hierarchical finite element method. Results are presented in the form of phase constant surfaces plotted against frequency. Experimental work conducted on two differently stiffened cylinders provides additional substantiation to the theoretical analyses. Dissert. Abstr.

N91-30562*# Sverdrup Technology, Inc., Brook Park, OH.
ASTROP3 USER'S GUIDE Final Report
RICHARD AUGUST Aug. 1991 34 p
(Contract NAS3-25266)
(NASA-CR-187180; E-6477; NAS 1.26:187180) Avail: NTIS HC/MF A03 CSCL 20/11

ASTROP3 (Aeroelastic Stability and Response of Propulsion Systems) is a FORTRAN computer code developed for calculating the performance and dynamic stability (classical flutter) of single rotation propfans. Three-dimensional, subsonic aerodynamics with constant pressure panel discretization and MSC/NASTRAN finite element analysis of the blade are used to calculate the steady and unsteady aerodynamic forces. The flutter analysis is a modal based technique using motion dependent aerodynamic forces based on in-vacuum frequencies and normal modes of the individual propfan blades. The execution of ASTROP3 is illustrated through the calculation of blade performance and blade aeroelastic stability for the SR7L rotor. These calculations are representative of applications for ASTROP3. All input and output files necessary for program execution are discussed, as well as other appropriate information to aid the user in applying the program. Author

N91-30564 Royal Military Coll. of Canada, Kingston (Ontario).
DEVELOPMENT OF STRUCTURAL OPTIMIZATION CAPABILITY AT RMC
C. T. SHYU, N. K. POPE, and J. S. ELLIS 31 Mar. 1989 257 p
(Contract DREA-FE-311F121)
(DREA-CR-89-413; CTN-91-60194) Avail: NTIS HC A12

This report describes the implementation, on the Royal Military College (RMC) Honeywell Computer, of the constrained structural optimization programming systems PROSS, PROSS-2, and PVC04. PROSS and PROSS-2 were developed at the NASA Langley Research Center by combining in a modular manner a production level structural analysis program (SPAR), a state-of-the-art optimization program (CONMIN) and user supplied and problem dependent interface programs. PVC04 was developed at RMC by replacing, in PROSS-2, SPAR by the Defence Research Establishment Atlantic sponsored vibration and strength analysis program VAST04. During the implementation of the three programming systems, code for many component parts was converted from CDC and VAX systems to run on the RMC Honeywell system. Test runs were made in order to ensure that the converted component parts were functioning correctly. Finite element models of a fuselage, a 35 member latticed frame and two stiffened cylinders were used as test or demonstration problems for the three constrained optimization programs. All the problems involved weight minimization. Up to 16 design variables were used and up to four types of constraint were considered. Reasonable solutions were obtained for all constrained optimization problems attempted. The report contains a user's manual which describes in detail the minimization of the weight of a constrained latticed frame structure. Author (CISTI)

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

N91-29651# National Aeronautical Establishment, Ottawa (Ontario).
NAE TWIN OTTER OPERATIONS IN THE 1988 EULERIAN MODEL EVALUATION FIELD STUDY
J. I. MACPHERSON Apr. 1989 90 p
(NAE-LTR-FR-107; CTN-91-60027) Copyright Avail: NTIS HC/MF A05

From July 18 to August 31, 1988, the NAE Twin Otter Atmospheric Research Aircraft was operated from Muskoka, Ontario in an experiment designed to test a new computer model for the long range transport of atmospheric pollutants. The 1988 Eulerian Model Evaluation Field Study was a collaborative effort with the Atmospheric Environment Service of Canada and the Ontario Ministry of the Environment. The Twin Otter flew 50 flights and 122.8 hours in support of this study. Scientists using Twin Otter data will find this a working reference. Flight summaries, atmospheric profile data, and details on the instrumentation, software, and flight procedures used is included. A discussion is presented on tests conducted on the wind measuring systems on the aircraft and recommendations are given for improvements in instrumentation and operational procedures for the next in this series of atmospheric pollution experiments. During this flight program the instrumentation computed and recorded three wind estimates, the Doppler/inertial wind measure which uses a National Aeronautical Establishment accelerometer and gyro package, and 3-axis Doppler radar; Litton winds which used inertial components taken directly from the Litton inertial reference system in earth-fixed axes; and Litton/Doppler winds using the 3-axis Doppler data with the Litton system supplying accelerometer and gyro data, and the Litton heading and attitude data to resolve the computed wind component into earth-axis. The best results were obtained from the Litton/Doppler system with the Doppler/inertial system only slightly less accurate. The Litton winds values were unacceptable. Author (CISTI)

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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.

A91-48546
MINICOMPUTER PART-TASK SIMULATION FOR HELICOPTER DEVELOPMENT - AN ECONOMICAL APPROACH
JEFFREY DORMAN (McDonnell Douglas Helicopter Co., Mesa, Az) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p.
(SAE PAPER 901814) Copyright

An economical part-task simulator for providing quantitative optimization of helicopter cockpit layout and displays has been built. The steps followed to confer real-time minicomputer application of a simplified flight model (FLYRT) is outlined, as is the control law development needed for 4-axis sidearm controller application. Instrument display variable synthesis, based on calculated variables is discussed. Author

A91-48548
REPLICATED SHARED-MEMORY NETWORKS APPLIED TO AIRCRAFT SIMULATORS
STAN CHILCOTT (Boeing Co., Military Airplanes Div., Seattle, WA) and TOM GUSTIN (Systran Corp., Dayton, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 7 p.
(SAE PAPER 901816) Copyright

This paper discusses the real-time networking experience and future plans at the Boeing Wichita Flight Simulation Facility. Boeing selected a replicated shared-memory network utilizing fiber optic cable. This network was designed specifically for high-speed, real-time applications. Author

A91-48723
THE FINITE ELEMENT SOLUTION OF ELLIPTICAL SYSTEMS ON A DATA PARALLEL COMPUTER
SCOTT HUTCHINSON, EDWARD HENSEL, STEVEN CASTILLO, and KIM DALTON (New Mexico State University, Las Cruces) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 32, Aug. 5, 1991, p. 347-362. refs
(Contract NSF EET-88-12958; F30602-88-C-0031)
Copyright

A study is conducted of the finite element solution of elliptic partial differential equations on a data parallel computer. A nodal assembly technique is introduced which maps a single node to a single processor. The system of equations is first assembled and then solved in parallel using a conjugate gradient algorithm for unsymmetric, nonpositive definite systems. Using this technique and a massively parallel machine, problems in excess of 100 k nodes are solved. Results of electromagnetic scattering, governed by the 2-d scalar Helmholtz equation, are presented for both an infinite cylinder and an airfoil cross-section. Solutions are demonstrated for a wide range of object sizes. A summary of performance data is given for a set of test problems. Author

A91-49645*# Princeton Univ., NJ.
COMPUTER-AIDED DESIGN OF FLIGHT CONTROL SYSTEMS
ROBERT F. STENGEL (Princeton University, NJ) and SUBRATA SIRCAR IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 677-683. Research supported by FAA. refs
(Contract NGL-31-001-252; DAAL03-89-K-0092)
(AIAA PAPER 91-2677) Copyright

A computer program is presented for facilitating the development and assessment of flight control systems, and application to a control design is discussed. The program is a computer-aided control-system design program based on direct digital synthesis of a proportional-integral-filter controller with scheduled linear-quadratic-Gaussian gains and command generator tracking of pilot inputs. The FlightCAD system concentrates on aircraft dynamics, flight-control systems, stability and performance, and has practical engineering applications. C.C.S.

A91-49662#
TOWARDS ROBUST TRACKING OF MANEUVERING TARGETS
STEPHAN A. HEPNER, LUCA BAGNASCHI, and HANS P. GEERING (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 837-844. refs
(AIAA PAPER 91-2699) Copyright

The low observability combined with the unknown target maneuver invariably results in state estimates that are corrupted by substantial estimation errors. The linearization around these estimates causes the sensitivity problems which are typical for extended Kalman filters. Because the information contents of the measurements cannot be influenced by the designer of a filter, the only way to improve the tracking performance is to increase the robustness of the tracking algorithm with respect to the

modeling errors. A new tracking filter with enhanced robustness is presented, which combines nonlinear estimation techniques with limited memory filtering and time-scale separation. Author

A91-49675#
APPLICATION OF FEEDBACK LINEARIZATION METHOD IN A DIGITAL RESTRUCTURABLE FLIGHT CONTROL SYSTEM
YOSHIMASA OCHI (National Defense Academy, Yokosuka, Japan) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 984-992. refs
(AIAA PAPER 91-2714) Copyright

The feedback linearization method is applied to accommodation of aircraft failures occurring at the control effectors or the airframe. The failures are identified as parameter changes in the six-degree-of-freedom nonlinear equations of motion by the recursive least square algorithm. The control parameters are updated using the latest estimated system parameters. In order to allow one to use digital computer in implementation, a discrete time servo controller is designed for the surface actuators and the engine, where the reference inputs are given by the continuous time control law. The performance of the RFCS is demonstrated through computer simulation using the nonlinear model of an aircraft which has half of the right wing broken off. Author

A91-49685*# Washington State Univ., Pullman.
CLOSED-LOOP TRANSFER RECOVERY WITH OBSERVER-BASED CONTROLLERS. I - ANALYSIS
BEN M. CHEN, ALI SABERI (Washington State University, Pullman), and UY-LOI LY (Washington, University, Seattle) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1095-1109. Research supported by Boeing Commercial Airplane Group. refs
(Contract NAG1-1210)
(AIAA PAPER 91-2727) Copyright

The description of a novel problem in loop transfer recovery is presented. The problem of closed-loop recovery (CLTR) is examined using a measurement feedback-control law where the closed-loop transfer function from the external signal to the controlled output can be made either exactly equal or approximately close to the so-called target closed-loop transfer function achieved under full-state feedback. The analysis of CLTR applies specifically to the general class of observer-based controllers and focuses on three fundamental issues. The first issue is concerned with what can and cannot be achieved for a given system and for an arbitrary target closed-loop transfer function. The second issue is to develop necessary and/or sufficient conditions for a target closed-loop transfer function to be recoverable either exactly or approximately. The third issue deals with the necessary and/or sufficient conditions on a given system such that it has at least one recoverable target closed-loop transfer function. The result is applied to the lateral autopilot design for a commercial transport airplane. Author

A91-49687#
APPROXIMATE RECOVERY OF H-INFINITY LOOP SHAPES USING FIXED ORDER DYNAMIC COMPENSATION
EDWARD V. BYRNS, JR. and ANTHONY J. CALISE (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1127-1135. refs
(AIAA PAPER 91-2729) Copyright

This paper presents a method or designing fixed order dynamic compensators which approximate the H-infinity full state feedback closed loop transfer function properties from disturbance inputs to controlled outputs. This formulation uses the observer canonical form to represent the dynamic compensator which allows the design to be treated as a modified constant gain output feedback problem. The approximate recovery is accomplished through a unique selection of the quadratic performance index weighting matrices. This design procedure is demonstrated by two design examples. The first example is a simple second-order model used to demonstrate the procedure. The second example is a longitudinal flight controller for the F-18/HARV 'supermaneuverable' aircraft. This flight controler is compared to both a full and reduced order H-infinity compensator. Author

A91-49754*# Washington Univ., Seattle.
OPTIMAL DISCRETE-TIME DYNAMIC OUTPUT-FEEDBACK DESIGN - A W-DOMAIN APPROACH
CHEOLKEUN HA and UY-LOI LY (Washington, University, Seattle) IN: AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1769-1781. refs
(Contract NAG1-1210)
(AIAA PAPER 91-2811) Copyright

An alternative method for optimal digital control design is described in this paper. The method is based on the usage of the w-transform and has many attractive design features. One of these is its immediate connection with frequency loop-shaping techniques that are now popular and effective for multivariable control synthesis in continuous-time domain. Furthermore, any design algorithms originally developed for continuous-time systems can now be immediately extended to the discrete-time domain. The main results presented in this paper are the exact problem formulation and solution of an optimal discrete-time dynamic output-feedback design in the w-domain involving a quadratic performance index to random disturbances. In addition, necessary conditions for optimality are obtained for the numerical solution of the optimal output-feedback compensator design. A numerical example is presented illustrating its application to the design of a low-order dynamic compensator in a stability augmentation system of a commercial transport. Author

A91-49786#
ELICITING 'FUTURE KNOWLEDGE' FOR LARGE SCALE INTELLIGENT SYSTEMS
DOUGLAS I. HOLMES, JR. (ISX Corp., Westlake Village, CA) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 12 p. refs
(AIAA PAPER 91-2760) Copyright

This paper describes a case-based approach to knowledge acquisition for a large-scale multifunction intelligent system for aircraft. The system uses a high-fidelity, relatively low-cost digital simulation to focus and extend existing expertise into a projected future environment. The need for such a process is discussed, and an approach to developing, acquiring, and testing 'future knowledge' is described. C.D.

A91-49788#
PILOT'S ASSOCIATE - AN INTEGRATION ARCHITECTURE FOR DECISION AIDING
K. J. KELLER and K. C. STANLEY (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991. 11 p. refs
(AIAA PAPER 91-2759) Copyright

The Pilots Associate (PA) is a system of cooperating knowledge-based systems that will improve the mission effectiveness of the tactical fighter pilot by supporting the pilot in performing mission tasks. This paper describes the characteristics of the PA domain, and the functional and architectural requirements of the PA system are discussed. The components of a task network architecture developed to support the PA system development are outlined. Finally, the features of the architecture and how they relate to the development of a real-time decision support system are discussed. C.D.

A91-49868
A NEW ALGORITHM OF FIXED-INTERVAL SMOOTHER AND ITS APPLICATION TO FLIGHT TEST
ZHONGKE SHI (Northwestern Polytechnical University, Xian,

People's Republic of China) Acta Automatica Sinica (ISSN 0254-4156), vol. 17, May 1991, p. 323-329. In Chinese. refs

A new information filter and fixed-interval smoother algorithms based on Kalman filter and Rauch-Tung-Striebel smoother are presented, and U-D factorization is use both in the new filter and the smoother to get high computational efficiency. These new algorithms exhibit excellent numerical accuracy and stability, and the number of operations of both the filter and the smoother are decreased greatly since the structures of the new estimators are rearranged. A comparison of operation numbers shows that the new information filter and the fixed-interval smoother is more than 1.7 times as fast as Bierman's sequential smoother and Watanabe's (1986) forward-pass smoother. Author

A91-49985
USING KNOWLEDGE-BASED TECHNIQUES IN SYSTEMS FOR STRUCTURAL DESIGN

K. ORSBORN (Linkoping University, Sweden) (International Conference on Computational Structures Technology, 1st, Heriot-Watt University, Edinburgh, Scotland, Aug. 20-22, 1991) Computers and Structures (ISSN 0045-7949), vol. 40, no. 5, 1991, p. 1203-1211. Research supported by STU. refs

Copyright

A subdomain of structural design - damage tolerance design - has been implemented in a prototype system presented in this paper. The system consists of a knowledge-based generic shell which uses a FORTRAN program for fracture mechanics calculations. There is an explicit representation of both structure and process in the generic shell which also distinguishes between generic and specific knowledge. The prototype is implemented in the KEE environment on an Apollo 3500 workstation. Currently, the system contains about 900 objects, 350 of which are rules. Author

A91-50405
AN INVESTIGATION OF NEURAL NETWORKS FOR F-16 FAULT DIAGNOSIS. II - SYSTEM PERFORMANCE

RICHARD J. MCDUFF and PATRICK K. SIMPSON (General Dynamics Corp., Electronics Div., San Diego, CA) IN: Applications of artificial neural networks; Proceedings of the Meeting, Orlando, FL, Apr. 18-20, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 42-55. Research supported by General Dynamics Corp. refs

(Contract F33615-87-G-0015)

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With a view to the use of neural networks as a means of solving the multiple-fault diagnostics problem, an evaluation is made of the performance of a symptom-pattern that has been classified to an appropriate output class corresponding to a detected fault in an F-16's systems. An extension of binary adaptive-resonance theory, designated ART1, is developed whose implementation of an on-line-learning, multiple-fault diagnostic system improves in performance with use. ART1 is found to be capable of handling noisy and missing data, as well as of furnishing immediate responses. O.C.

A91-50471
HIGH PERFORMANCE COMPUTER IMAGE GENERATION - A MARRIAGE OF COMPUTER GRAPHICS AND IMAGE PROCESSING

R. L. FERGUSON (GE Aerospace, Simulation and Control Systems Dept., Daytona Beach, FL) IN: Cockpit displays and visual simulation; Proceedings of the Meeting, Orlando, FL, Apr. 17, 18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 140-154.

Copyright

Computer-image generation (CIG) systems have progressed to the point where their data bases are extremely dense, with near-continuous scene density for both 2D (photographic) and 3D (polygonal) features. The Rapidly Reconfigurable Data Base Project is devoted to the development of a data base generation system capable of constructing a data base in 72 hours. An account is presently given of how conventional CIG architectures have been affected by the addition of photo-based visual technology, as well as by the emergence of such mission-rehearsal applications as the Special Operation Forces' Aircrew Training System, which requires a 48-hour data base turnaround requirement. O.C.

A91-50601
CONTROL AND DYNAMIC SYSTEMS. VOL. 34 - ADVANCES IN CONTROL MECHANICS. PT. 1

C. T. LEONDES, ED. (California, University, Los Angeles; Washington, University, Seattle) San Diego, CA, Academic Press, Inc., 1990, 348 p. For individual items see A91-50602 to A91-50604.

Copyright

Recent advances in dynamic-system control theory and its applications are discussed in chapters contributed by leading experts. Topics addressed include aircraft control under conditions of wind shear, controllers for uncertain mechanical systems with robustness in the presence of unmodeled flexibilities, and the control and observation of uncertain systems. Consideration is given to discretization chaos (feedback control and the transition to chaos) and singularity issues for a class of nonstandard dynamical systems. T.K.

A91-50618
CONTROL AND DYNAMIC SYSTEMS. VOL. 38 - ADVANCES IN AERONAUTICAL SYSTEMS

C. T. LEONDES, ED. (California, University, Los Angeles; Washington, University, Seattle) San Diego, CA, Academic Press, Inc., 1990, 419 p. For individual items see A91-50619 to A91-50626.

Copyright

The present volume discusses an aircraft automatic flight control system with model inversion, an information system supporting the design of complex human-machine systems, and the formulation of a minimum-variance deconvolution technique for compensation of pneumatic distortion in pressure-sensing devices. Also discussed are the synthesis and validation of feedback guidance laws for air-to-air interceptions, multistep matrix integrators for real-time simulations, the role of image interpretation for tracking and guidance, inflight alignment of inertial navigation systems, and an analysis of continuous-time parameter estimation via a limiting ODE. O.C.

A91-50621* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FORMULATION OF A MINIMUM VARIANCE DECONVOLUTION TECHNIQUE FOR COMPENSATION OF PNEUMATIC DISTORTION IN PRESSURE SENSING DEVICES

STEPHEN A. WHITMORE (NASA, Flight Research Center, Edwards, CA) IN: Control and dynamic systems. Vol. 38 - Advances in aeronautical systems. San Diego, CA, Academic Press, Inc., 1990, p. 101-151. refs

Copyright

Increasingly, aircraft system designs require that aerodynamic parameters derived from pneumatic measurements be employed as control-system feedbacks. Such high frequency pressure measurements' accuracy is compromised by pressure distortion due to frictional attenuation and pneumatic resonance within the sensing system. A pneumatic distortion model is here formulated and reduced to a low-order state-variable model which retains most of the full model's dynamic characteristics. This reduced-order model is coupled with standard results from minimum variance estimation theory to develop an algorithm to compensate for pneumatic-distortion effects. O.C.

A91-50934
TOWARD A DISTRIBUTED DATA ARCHITECTURE FOR THE INDUSTRY

DAVID P. SANFORD (Aeronautical Radio, Inc., Annapolis, MD) IN: Annual International Aeronautical Telecommunications Symposium on Data Link Integration, 3rd, McLean, VA, May 20-23, 1991, Proceedings. Annapolis, MD, Aeronautical Radio, Inc., 1991,

p. 55-58. refs
Copyright

This paper takes three well known air-transport industry initiatives and redefines them as distributed data base problems. The problems of crew scheduling, air terminal information service, and maintenance are described. An argument is then posed as to why the most efficient solution to these problems requires a distributed data architecture approach. Architectural approaches to support these three industry initiatives and any distributed data problems are also summarized. Author

A91-51187
TRADITIONAL AND AUTOMATED APPROACHES FOR ACQUIRING EXPERT KNOWLEDGE
JEFFREY P. ROSENKING (Grumman Data Systems, Bethpage, NY), JAMES EILBERT (Grumman Corporate Research Center, Bethpage, NY), and IRIS C. HAYSLIP (Ford Aerospace Corp., Colorado Springs, CO) IN: Applications of artificial intelligence VIII; Proceedings of the Meeting, Orlando, FL, Apr. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 170-180. refs
Copyright

Combinations of techniques for optimizing the acquisition of expert knowledge are discussed within the framework of a pilot's threat response, which includes both motor responses and expert knowledge. The acceleration of the acquisition is discussed in relation to improving both expert interviewing and the knowledge-encoding processes and to using expert interpretations of specific comparable cases. A full-mission flight simulator is employed to maximize recorded information relevant to pilot responses. The responses can then be used to train a neural network (NN) system (essentially a learning algorithm) thereby eliminating sensory classifications and the selection of sensory-guided behavior. The NN approach provides rapid responses and can be used complementarily with approaches designed to improve the interview process. C.C.S.

A91-51204
CONTROL LAWS EXPERT ASSISTANT FOR ROTORCRAFT (CLEAR)
RONALD C. UNTERBERGER, JR., BRIAN P. BUTZ, NEIL F. PALUMBO (Temple University, Philadephia, PA), and DAVID G. MILLER (Boeing Helicopters, Inc., Philadelphia, PA) IN: Applications of artificial intelligence VIII; Proceedings of the Meeting, Orlando, FL, Apr. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 494-505. Research supported by Commonwealth of Pennsylvania's Ben Franklin Partnership. refs
Copyright

A Control Laws Expert Assistant for Rotorcraft (CLEAR) which will assist flight control engineers design a specific set of flight control systems is described. This interactive knowledge-based system, when complete, will analyze rotorcraft and design the compensator necessary to achieve the system specifications. This paper discusses the system architecture, describes the knowledge-base modules developed or are being developed, and presents an example of how the present system functions. Author

A91-51214
DYNAMIC SCHEDULING OF ACTIONS IN A PLAN GUIDED AIRCRAFT
DAN STROMBERG and GORAN PETTERSSON (National Defense Research Establishment, Linkoping, Sweden) IN: Applications of artificial intelligence VIII; Proceedings of the Meeting, Orlando, FL, Apr. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 758-766. Research supported by Linkoping Artificial Intelligence Consortium. refs
Copyright

The way high-level, i.e. tactical, pilot knowledge can be represented, managed and used for real time decision making in a hostile environment is described. A software system was designed to make real time decisions for an autonomous aircraft that operates in a simulated combat environment. The system consists of a planning agent that communicates with the outside world through different software hierarchies for perception and motion. High-level abilities of the system are supposed to reflect human decision making. The corresponding qualitative knowledge is represented as facts, goals, plans and actions, the dynamic management of which have been refined in terms of a set of relations feasible both for the complexities of the application and a rigorous formal treatment. The system, primarily designed for an autonomous aircraft, can also be used as an aid for a pilot in stressfull situations. V.I.

A91-51861
USING A DATA ACQUISITION SYSTEM FOR CLOSED LOOP POSITION CONTROL OF A THERMOCOUPLE RAKE
JAMES P. STRONSKI and ROBIN D. BECKER (Solar Turbines, Inc., San Diego, CA) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 183-192.
Copyright

Temperature-profiling thermocouple rakes are used to measure combustor performance in gas turbine development and production. A data-acquisition system (DAS) with limited logic capability is used in place of a host computer to control the position of such a rake. The DAS provides faster response time, twice the position accuracy, and four times the travel speed of the previous system. The programming techniques used in this project demonstrate the versatility of modern intelligent data-acquisition systems. Author

A91-51882
A NEAR REAL-TIME ENGINE/AIRFRAME DATA ACQUISITION AND PROCESSING SYSTEM
ROBERT S. HAUSER (USAF, Arnold Engineering Development Center, Arnold AFB, TN), MICHAEL R. BENNETT, and J. M. HODGES (Sverdrup Technology, Inc., Arnold AFB, TN) IN: International Instrumentation Symposium, 36th, Denver, CO, May 6-10, 1990, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1990, p. 639-647. refs
Copyright

Consideration is given to an MIL-STD-1553B and RS422 data acquisition and processing system built and currently in use during the altitude ground testing of advanced turbine engine designs. The system has demonstrated a capability to acquire an aggregate rate of 40,000 samples per second from multiple 1553B and RS422 data streams, store the data continuously on tape, and transmit selected portions to the data processing system. P.D.

A91-52026* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED STRUCTURE/CONTROL LAW DESIGN BY MULTILEVEL OPTIMIZATION
MICHAEL G. GILBERT (NASA, Langley Research Center, Hampton, VA) and DAVID K. SCHMIDT (Arizona State University, Tempe) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 1001-1007. Previously cited in issue 23, p. 3703, Accession no. A89-52564. refs
Copyright

A91-52041* Houston Univ., TX.
LINEAR QUADRATIC REGULATOR APPROACH TO THE STABILIZATION OF MATCHED UNCERTAIN LINEAR SYSTEMS
L. S. SHIEH (Houston, University, Texas), J. W. SUNKEL (NASA, Johnson Space Center, Houston, TX), and Y. J. WANG Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Sept.-Oct. 1991, p. 1074-1077. Previously cited in issue 21, p. 3435, Accession no. A90-47755. refs
(Contract DAAL03-87-K-0001; NAG9-380; NAG9-385)
Copyright

A91-52159
A PRE-RUN-TIME SCHEDULING ALGORITHM FOR HARD REAL-TIME SYSTEMS

TERRY SHEPARD (Royal Military College of Canada, Kingston) and J. A. M. GAGNE (Canadian Forces, Weapons System Software Unit, Cold Lake, Canada) IEEE Transactions on Software Engineering (ISSN 0098-5589), vol. 17, July 1991, p. 669-677. refs
Copyright

Process scheduling, an important issue in the design and maintenance of hard real-time systems, is discussed. A pre-run-time scheduling algorithm that addresses the problem of process sequencing is presented. The algorithm is designed for multiprocessor applications with preemptable processes having release times, computation times, deadlines, and arbitrary precedence and exclusion constraints. The algorithm uses a branch and bound implicit enumeration technique to generate a feasible schedule for each processor. The set of feasible schedules ensures that the timing specifications of the processes are observed and that all the precedence and exclusion constraints between pairs of processes are satisfied. The algorithm was tested using a model derived from the F-18 mission computer operational flight program. I.E.

A91-52209
YIDOYU AND ITS APPLICATION AIRCRAFT DESIGN
XIANXUE SUN, QIHAO LONG, BINGCHEN PAN, and WENPU CHEN (YIDOYU Service Group, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, June 1991, p. B231-B237. In Chinese. refs

A multiconstraint optimization system, termed YIDOYU, for designing aircraft structures is described. The YIDOYU uses mathematical programming techniques to optimize the structural design under a variety of constraints, including stress, displacement, natural frequency, flutter speed, static aeroelasticity, and minimum size. It also has the functions for the displacement and stress analysis, the natural vibration analysis, the flutter analysis, the static aeroelastic analysis, and the fully-stressed design. The YIDOYU was successfully used in designing several wing-type structures. The system is presently being integrated into a CAD/CAM software. I.S.

A91-52277
MODIFIED EXPONENTIAL SERIES APPROXIMATION FOR THE THEODORSEN FUNCTION
W. EVERSMAN (Missouri-Rolla, University, Rolla) and A. TEWARI Journal of Aircraft (ISSN 0021-8669), vol. 28, Sept. 1991, p. 553-557. refs
Copyright

An improved method is developed for the approximation of unsteady aerodynamics in the time domain by a series of decaying exponentials. The new method is different from the previous procedures in that it consistently accounts for the case when the optimum values of the lag parameters in the exponential series are close to one another. This is achieved by introducing a time-weighted exponential series for the repeated pole case. The method uses a nongradient optimizing procedure. Approximations are presented for Theodorsen's lift deficiency function and results are compared with those of a gradient-based method that was published recently. Author

A91-52557
EXPERT SYSTEMS FOR MATERIALS RELATED PROBLEMS
W. HOFFELNER and M. VITINS (ABB Power Generation, Ltd., Baden, Switzerland) IN: *High temperature materials for power* engineering 1990; Proceedings of the 4th Conference, Liege, Belgium, Sept. 24-27, 1990. Pt. 2. Dordrecht, Netherlands, Kluwer Academic Publishers, 1990, p. 1599-1626. refs
Copyright

AI and expert systems are discussed in terms of applications to knowledge regarding materials. The concept of frames is emphasized in a list of knowledge-based representation techniques which also includes rule-based systems, mathematical logic, and semantic nets. Problems related to materials are set forth with example applications, and the structure of a proposed knowledge-base is developed based on the data. Material data proposed for inclusion are material properties, microstructural information, uncertainties, and life-prediction models. The Matexpert expert system is introduced to give examples of solutions for materials problems related to gas turbines. The system is capable of judging the condition of compressor blades and making accept/reject decisions about materials deviating from standard. C.C.S.

A91-52831* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MDO CAN HELP RESOLVE THE DESIGNER'S DILEMMA
JAROSLAW SOBIESZCZANSKI-SOBIESKI (NASA, Langley Research Center, Hampton, VA) and JAN R. TULINIUS (Rockwell International Corp., El Segundo, CA) Aerospace America (ISSN 0740-722X), vol. 29, Sept. 1991, p. 32-35, 63.
Copyright

Multidisciplinary design optimization (MDO) is presented as a rapidly growing body of methods, algorithms, and techniques that will provide a quantum jump in the effectiveness and efficiency of the quantitative side of design, and will turn that side into an environment in which the qualitative side can thrive. MDO borrows from CAD/CAM for graphic visualization of geometrical and numerical data, data base technology, and in computer software and hardware. Expected benefits from this methodology are a rational, mathematically consistent approach to hypersonic aircraft designs, designs pushed closer to the optimum, and a design process either shortened or leaving time available for different concepts to be explored. R.E.P.

N91-29742# National Aeronautical Establishment, Ottawa (Ontario). Structures and Material Lab.
QBDATAMT: A COMPUTER PROGRAM TO READ DATAMYTE RECORDER DATA INTO AN IBM PC OR COMPATIBLE COMPUTER Preliminary Report
COLIN W. MACKENZIE 1 Mar. 1989 56 p Revised
(NAE-LTR-ST-547; CTN-91-60023) Copyright Avail: NTIS HC/MF A04

A description of QBDATAMT: a QuickBASIC based computer program designed to read Datamyte recorder data into an IBM PC and for initializing the memory packs is given. Datamyte can do several types of recording, depending on the plug-in program pack installed in the recorder. QBDATAMT has been written and tested for the 451 and 458 Rainflow packs. Program pack 451 is used to handle data from an accelerometer mounted vertically at the center of gravity of a fixed wing aircraft, and pack 458 is used for data collected from a strain gage bridge mounted in the longitudinal pitch link of both the forward and the aft main rotor heads of the CH-113 Voyageur helicopter. The code itself and abbreviated installation instructions are included. CISTI

N91-29744# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
DESCRIPTION OF COMPUTER PROGRAMS USED TO ANALYZE AND PLOT SPECTRAPOT DATA FILES
C. W. MACKENZIE 13 Jun. 1989 30 p
(NAE-ST-557; CTN-91-60047) Copyright Avail: NTIS HC/MF A03

A program designed to plot Spectrapot data files is described. Four CL-41 Tutor aircraft were instrumented with strain gages located in the aft-fuselage upper longeron, horizontal stabilizer rear spar cap, and the vertical stabilizer rear spar cap. The aircraft were then flown through various maneuvers while recording strain gage data. The Spectrapot data collector was used to record and process data from the strain gages in one of two formats: rainflow or sequential peak valley (SPV). The internal SPV program of the data collector collects peak and valley points which are separated by a specified hysteresis value that is set during initialization of the memory module. Two computer programs, QBSPEC and SPECPM, were developed to provide a means of plotting strain gage data gathered by the Spectrapot-1C data collection system. QBSPEC is written in QuickBASIC and allows the user to: plot sequential valleys and peaks; calculate and print class average; edit a data file; and select a printer. SPECPM, written in GWBASIC,

is similar to QBSPEC except that it plots only one point in a 30 second interval, while QBSPEC plots a complete data set. The programs, although written for use by the Tutor fatigue test spectrum development teams, can be used with any Spectrapot data processed using the SPV method. Computer coding for these programs is provided. CISTI

N91-29770# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A COMMON INTERFACE REAL-TIME MULTIPROCESSOR OPERATING SYSTEM FOR EMBEDDED SYSTEMS M.S. Thesis
MICHAEL S. ROTTMAN 4 Mar. 1991 227 p
(AD-A238445; AFIT/GCE/ENG/91M-04) Avail: NTIS HC/MF A11 CSCL 12/5

Large real time applications such as aerospace avionics systems, battle management, and factory automation place many demands and constraints on the computing system not found in other applications. Software development is hindered by software dependence on the computer architecture and the lack of portability between systems. This thesis specifies and designs a real time multiprocessor operating system (RTMOS) that implements a consistent programming model, enabling the development of real time parallel software independent of the target architecture. The RTMOS defines the core functionality required to demonstrate the programming model. The RTMOS functional requirements are specified using Structured Analysis and Design Technique (SADT). A hybrid of the Design Approach for Real-Time Software (DARTS) is used to perform the preliminary and detailed designs. The preliminary design is architecture-independent; the detailed design phase maps the design to a specific parallel system, the Intel iPSC/2 hypercube. The modular RTMOS design partitions operating system operations and data structures from hardware-dependent functions for portability. GRA

N91-29778*# ORA Corp., Ithaca, NY.
VERIFICATION OF THE FTCAYUGA FAULT-TOLERANT MICROPROCESSOR SYSTEM. VOLUME 1: A CASE STUDY IN THEOREM PROVER-BASED VERIFICATION Final Report
MANDAYAM SRIVAS and MARK BICKFORD Washington Jul. 1991 61 p
(Contract NAS1-18972)
(NASA-CR-4381; NAS 1.26:4381) Avail: NTIS HC/MF A04 CSCL 09/2

The design and formal verification of a hardware system for a task that is an important component of a fault tolerant computer architecture for flight control systems is presented. The hardware system implements an algorithm for obtaining interactive consistancy (byzantine agreement) among four microprocessors as a special instruction on the processors. The property verified insures that an execution of the special instruction by the processors correctly accomplishes interactive consistency, provided certain preconditions hold. An assumption is made that the processors execute synchronously. For verification, the authors used a computer aided design hardware design verification tool, Spectool, and the theorem prover, Clio. A major contribution of the work is the demonstration of a significant fault tolerant hardware design that is mechanically verified by a theorem prover. Author

N91-29808# Charles River Analytics, Inc., Cambridge, MA.
AN EXPERT SYSTEM APPROACH TO GLOBAL FAULT DETECTION AND ISOLATION DESIGN Final Report, 26 Jun. - 26 Dec. 1989
S. M. ALLEN and A. K. CAGLAYAN Jan. 1990 50 p
(Contract F33615-89-C-3606)
(AD-A238494; R9004; WL-TR-91-3007) Avail: NTIS HC/MF A03 CSCL 09/2

The primary objective of this research is the development and demonstration of a global Failure Detection and Identification (FDI) Design Assistant (DA) prototype based on expert system technology. A global FDI algorithm performs its detection, isolation and estimation function by assessing the global effects of a hardware fault and surface damage on the closed-loop aircraft dynamics. Since changes in the flight control law affect the signature of a hardware fault and surface damage, the design of a global FDI algorithm is dependent on the flight control law performance characteristics. Ideally, the flight control law and global FDI designs should be accomplished simultaneously, especially for a new aircraft design rather than the current practice of serial iterations on the two designs. Hence, automation of the global FDI design process is desirable in order to reduce development time, cost and risk for advanced flight control systems. A secondary study objective is to investigate how expert systems and neural networks can be integrated into the implementation of a global FDI system. We describe the implementation of the detection and isolation logic portions of the CRCA global FDI algorithm as a rule-based expert system so that symbolic knowledge representation and reasoning can be incorporated into the design. GRA

N91-30761# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
UTILIZATION OF COMPUTER AIDED DESIGN (CAD)/COMPUTER AIDED ENGINEERING (CAE) SYSTEMS IN AN AIRCRAFT INDUSTRIAL PLANT [PRAXISBERICHT UEBER DEN OPTIMIERTEN EINSATZ VON CAD-/CAE- IN EINEM WERK DER FLUGZEUGINDUSTRIE]
MANFRED SEILER 1990 24 p In GERMAN Presented at the 19th International Finite Elemente Kongress FEM 1990, Baden-Baden, Fed. Republic of Germany, 19-20 Nov. 1990
(MBB-UD-0583-90-PUB; OTN-030805; ETN-91-99445) Avail: NTIS HC/MF A03

It is shown that proper optimization and adaptation between the different systems are necessary for an efficient configuration of all processes, from model construction to complete documentation. The increasing use of CAE systems necessitates an increasing electronic data processing specific control within the utilization field. The use of a personal computer with host emulation proved to be efficient. The process chain required the control of up to ten systems for dependable tasks. This aspects and the necessary qualification of the workers is not to be underrated, in the intensification of the CAE system utilization. ESA

N91-30785# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
VALIDATION OF DIGITAL SIMULATION METHODS IN CAE
M. A. M. SOMERS and J. VDVOOREN 10 Feb. 1989 32 p Presented at Conference on Computer Applications in Production and Engineering, Amsterdam, Netherlands, 9-11 May 1991
(NLR-TP-89026-U; ETN-91-99633) Avail: NTIS HC/MF A03

The validation of digital simulation methods in CAE (Computer Aided Engineering) is discussed in general terms, independent of specific areas of application or technical disciplines. Validation is considered as making an assessment of the physical relevance and the accuracy of the method involved through carefully controlled comparisons with results of other digital as well as physical simulation methods. This requires, in general, full understanding of all sources of discrepancies between the methods used in the comparison, and physical reality. Emphasis is placed on the informatics aspects of validation. This concerns the point of view that validation is to be considered a crucial, integral step in the development cycle of digital simulation methods, if these are to be given to the end user in the form of complete information systems. Attention is given to the policy and to the infrastructure required for the (internationally) competitive in house development of todays complex and highly sophisticated digital simulation methods, and to how this reflects on the validation process. Appropriate examples from computational aerodynamics are given throughout. ESA

N91-30841# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
URV MULTIPROCESSOR CONTROL SYSTEM AND GROUND STATION CONTROLLER SOFTWARE DESIGN Final Report, Aug. - Oct. 1990
MICHAEL S. ROTTMAN, THOMAS F. DERMIS, and AMY R.

HARTFIELD May 1991 57 p
(Contract AF PROJ. 2403)
(AD-A237532; WL-TR-91-3015) Avail: NTIS HC/MF A04 CSCL 12/5

The design and implementation of the core controller software is documented for the Multiprocessor Control System (MCS) and Ground Station Core (GSC) for the new Lambda and Gamma Unmanned Research Vehicle (URV) aircraft. Included are the high level design issues and goals; a description of the real time multiprocessor operating system (RTMOS) being used; and a complete discussion of the software objects needed for both the MCS and GSC. GRA

N91-30844# Loughborough Univ. of Technology (England). Dept. of Mathematical Sciences.
POLE ASSIGNMENT BY OUTPUT FEEDBACK: A REVIEW
MYUNGHO OH Jan. 1991 58 p
(MATHS-REPT-A-142; ETN-91-99780) Avail: NTIS HC/MF A04

Some of the existing algorithms for pole assignment by output feedback control are reviewed and compared for a selection of test problems. Some possible modifications and the required research direction of a new algorithm are suggested. It is concluded that the Minimis algorithm assigns poles sufficiently close to those desired provided no two poles are too close to each other. The Nichols et al algorithm does not have restrictions on the dimension of system matrices. It provided good conditioning but it is not always possible to assign the poles sufficiently close to those desired. Development of an algorithm incorporating the ideas of both the algorithms is suggested. This new algorithm could be tested by considering the design of controllers for a generic vertical takeoff and landing aircraft. A nonlinear model of the aircraft which will enable a realistic assessment to be performed is available. ESA

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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.

A91-48608* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SUPERSONIC JET NOISE - ITS GENERATION, PREDICTION AND EFFECTS ON PEOPLE AND STRUCTURES
J. S. PREISSER, R. A. GOLUB, J. M. SEINER, and C. A. POWELL (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 17 p. refs
(SAE PAPER 901927) Copyright

This paper presents the results of a study aimed at quantifying the effects of jet source noise reduction, increases in aircraft lift, and reduced aircraft thrust on the take-off noise associated with supersonic civil transports. Supersonic jet noise sources are first described, and their frequency and directivity dependence are defined. The study utilizes NASA's Aircraft Noise Prediction Program in a parametric study to weigh the relative benefits of several approaches to low noise. The baseline aircraft concept used in these predictions is the AST-205-1 powered by GE21/J11-B14A scaled engines. Noise assessment is presented in terms of effective perceived noise levels at the FAA's centerline and sideline measuring locations for current subsonic aircraft, and in terms of audiologically perceived sound of people and other indirect effects. The results show that significant noise benefit can be achieved through proper understanding and utilization of all available approaches. Author

A91-49062
AN ACOUSTIC METHOD FOR MEASURING CHARACTERISTICS OF ROTATING STALL IN A COMPRESSOR
XIAOFENG SUN, XONGAN HU, YUCHENG FENG, and SHENG ZHOU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 129, 130. In Chinese. refs

According to analysis of the characteristics of frequency and propagation of the sound generated by the rotating stall, an acoustic measuring method is developed in which the characteristic parameters such as the number and propagation speed of stall cells are measured. Primary experimental results obtained on a transonic axial-flow compressor facility demonstrate the feasibility of this method. Author

A91-49063
EXPERIMENTAL INVESTIGATION ON JET NOISE
KEYANG ZHENG and XINGMIN GUI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 6, April 1991, p. 131-133. In Chinese. refs

The correlation of sound power with jet velocity is studied in this paper. It is indicated that both Lighthill's and Lilley's formulas fit experimental data very well when Mach number of jet Maj is greater than 0.4, but the deviation between the results obtained from the formulas and experimental data is not so negligible as Maj is less than 0.4. Substituting sixth power of the jet velocity instead its eight power in the formulas is proposed. The direction sensitiveness and the frequency spectrum of jet noise have been investigated enperimentally. Author

A91-50238
LONG-DISTANCE SOUND PROPAGATION OVER AN IMPEDANCE DISCONTINUITY
J. N. B. HARRIOTT, S. N. CHANDLER-WILDE, and D. C. HOTHERSALL (Bradford, University, England) Journal of Sound and Vibration (ISSN 0022-460X), vol. 148, Aug. 8, 1991, p. 365-380. refs
Copyright

A calculation method is presented for sound propagation over an impedance discontinuity which is an improvement over previous methods, being particularly efficient for long distances. A homogeneous, still atmosphere and flat ground are assumed. The starting point is to make an approximation in a two-dimensional boundary integral equation formulation of the problem. This leads to an expression of the solution as the solution for homogeneous ground plus an integral over part of the boundary. This integral is recognized as a generalized Fourier integral, to which standard techniques of asymptotic analysis can be applied. An asymptotic approximation is found which can replace the part of the integral which is most expensive to evaluate by numerical quadrature. The remaining integral is evaluated by numerical quadrature. Monofrequency excess attenuation results for propagation from a point source above rigid ground to a receiver above absorbing ground are discussed. When the source and receiver are low enough, very orderly trends are observed. The results are applied, with air attenuation and A-weighting, to a notional jet engine noise source; simple trends are noted. Author

A91-50336*
ASYMPTOTIC/NUMERICAL ANALYSIS OF SUPERSONIC PROPELLER NOISE
M. K. MYERS and R. WYDEVEN (George Washington University, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Sept. 1991, p. 1374-1382. Previously cited in issue 13, p. 2049, Accession no. A89-33722. refs
(Contract NCC1-14)
Copyright

A91-52931* Texas A&M Univ., College Station.
APPLICATION OF COMPUTATIONAL AEROACOUSTIC METHODOLOGIES TO ADVANCED PROPELLER CONFIGURATIONS - A REVIEW
KENNETH D. KORKAN, LISA A. EAGLESON, and ROBERT C. GRIFFITHS (Texas A & M University, College Station) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 18 p. refs
(Contract NAG3-354)
(SAE PAPER 910996) Copyright

Current research in the area of advanced propeller configurations for performance and acoustics are briefly reviewed. Particular attention is given to the techniques of Lock and Theodorsen modified for use in the design of counterrotating propeller configurations; a numerical method known as SSTAGE, which is a Euler solver for the unducted fan concept; the NASPROP-E numerical analysis also based on a Euler solver and used to study the near acoustic fields for the SR series propfan configurations; and a counterrotating propeller test rig designed to obtain an experimental performance/acoustic data base for various propeller configurations. O.G.

N91-29863# Arcon Corp., Waltham, MA.
ACOUSTIC BACKGROUND NOISE VARIATION IN AIR FORCE PLATFORMS AND ITS EFFECT ON NOISE REMOVAL ALGORITHMS Interim Report, Aug. 1988 - Feb. 1990
PHILIP A. LAFOLLETTE Jun. 1991 110 p
(Contract F19628-88-C-0190)
(AD-A238279; RL-TR-91-97) Avail: NTIS HC/MF A06 CSCL 01/2

In this study of short-term noise variation in Air Force platforms, we followed two avenues of investigation. First, we applied quantitative measures of variation to individual noise recordings, and compared the results across various aircraft. Some measures used were simple descriptive statistics, but we also measured attenuation obtained by spectral restoration (spectral subtraction), applied to the noise signal alone. The noise attenuation obtained for real aircraft environments was in most cases about the same as predicted theoretically for white Gaussian noise, but in some instances was considerably higher, especially in the presence of propeller noise. Second, we applied the nonparametric Mann-Whitney statistic to test the stationarity of power spectrum estimates on time scales of 200 to 800 ms. There was little or no evidence of nonstationarity in large jet or turboprop aircraft. In fighter aircraft and helicopters, there was some evidence of nonstationarity confined to more or less narrow frequency ranges. The nonstationarity found did not appear to limit the performance of special restoration algorithms. The noise recordings used were taken from the RADC/EEV database of field recordings made in the E-3A, E-4B, EC-135, E-130, P-3C, F-15, F-16, F-4, A-10, HH-53 and Tornado aircraft. GRA

N91-30902 Houston Univ., TX.
APPLICATION OF COHERENT STRUCTURE AND VORTEX SOUND THEORIES TO JET NOISE Ph.D. Thesis
JAMES EDWARD BRIDGES 1990 293 p
Avail: Univ. Microfilms Order No. DA9110813

Coherent structures (CS) are used to illustrate how, within its strict assumptions, aeroacoustic theory can indeed predict jet noise. Velocity and sound pressure fields were measured in an excited, subsonic cold jet with low freestream turbulence located in a large anechoic chamber. Several instances of stabilized, nearly periodic, pairing were educed. Coherent vorticity was measured over the region 0 less than or = y/D less than or = 1.2, 0 less than or = x/D less than or = 5, while the coherent sound pressure was measured over polar angles 20 degree less than or equal to phi less than or equal to 125 degrees for the radial range 10 less than or = r/D less than or = 50. The interactions and sound of 3-D vortex rings were simulated using vortex filaments and free-space vortex sound theory (VST) and compared with experiments. The difference between experimental and theoretical sound fields was a dipole field which appears to come from the neglected surface integrals over the nozzle body. The importance of the nozzle body was studied, and the results are presented. The sensitivity of the sound field to variations in the vortical structures was investigated using simulations of vortex rings with 3-D perturbations and temporal jitter. Incoherence in the vorticity field was highly magnified in the sound field; only in a very clean facility, such as the one built for this work, can the coherent sound be measured well. In addition, the first full-field, time-resolved measurements of CS in an intermittently pairing jet were made, launching studies of subharmonic resonance and feedback in jets. The effect of excitation on the evolution of the first two azimuthal instability modes was measured to observe tilting of CS. Finally, a general theory was proposed which can predict the evolution of noncircular vortex rings such as squares, ellipses, and triangles. Dissert. Abstr.

N91-30903*# Lockheed Engineering and Sciences Co., Hampton, VA.
THE NASA AIRCRAFT NOISE PREDICTION PROGRAM IMPROVED PROPELLER ANALYSIS SYSTEM
L. CATHY NGUYEN Washington NASA Sep. 1991 102 p
(Contract NAS1-19000)
(NASA-CR-4394; NAS 1.26:4394) Avail: NTIS HC/MF A06 CSCL 20/1

The improvements and the modifications of the NASA Aircraft Noise Prediction Program (ANOPP) and the Propeller Analysis System (PAS) are described. Comparisons of the predictions and the test data are included in the case studies for the flat plate model in the Boundary Layer Module, for the effects of applying compressibility corrections to the lift and pressure coefficients, for the use of different weight factors in the Propeller Performance Module, for the use of the improved retarded time equation solution, and for the effect of the number grids in the Transonic Propeller Noise Module. The DNW tunnel test data of a propeller at different angles of attack and the Dowty Rotol data are compared with ANOPP predictions. The effect of the number of grids on the Transonic Propeller Noise Module predictions and the comparison of ANOPP TPN and DFP-ATP codes are studied. In addition to the above impact studies, the transonic propeller noise predictions for the SR-7, the UDF front rotor, and the support of the enroute noise test program are included. Author

N91-30906 Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
EVALUATING THE EFFECTIVENESS OF ACTIVE NOISE REDUCTION IN FLIGHT HELMETS
S. E. FORSHAW, J. M. RYLANDS (Army Personnel Research Establishment, Farnborough, England), and R. B. CRABTREE Aug. 1988 43 p
(DCIEM-88-RR-34; CTN-91-60217) Avail: NTIS HC A03

The advent of high powered fixed- and rotary-wing aircraft and tracked armoured fighting vehicles has increased the level of noise to which crews are exposed. Active noise reduction (ANR) offers a means of increasing the attenuation at low and mid frequencies. It relies on sensing the sound inside a circumaural device and cancelling it by means of negative feedback through a miniature speaker inside the enclosed volume. This study was carried out to investigate laboratory procedures appropriate for measuring the effectiveness of ANR devices. The procedures were: ear-canal measurements using an acoustic test fixture (an objective procedure), and masked threshold and loudness balance tests (psycho-physical procedures). In addition, the effect of ANR on signal detection and speech reception was investigated. The results do not clearly permit one procedure to be recommended for the evaluation of ANR systems. Signal detection performance and speech intelligibility may be used, but the results are specific to the acoustic environment of the listener and the detection task or speech-system parameters of the evaluation. When the attenuation of the ANR system is measured objectively with a transducer inside the earmuff/ear-canal volume, the location of the transducer affects the observed ANR attenuations. Author (CISTI)

N91-30908# European Space Agency, Paris (France).
TRANSMISSION OF SOUND INSIDE AN AXISYMMETRIC STRUCTURE Ph.D. Thesis - Paris VI Univ., 1986
D. BRENOT (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) May 1991 248 p Transl. into ENGLISH of Transmission du Son a l'Interieur d'une Structure Axisymetrique (Paris, France, ONERA), 1987 215 p
(ESA-TT-1218; ONERA-P-1987-1; ETN-91-99800) Avail: NTIS HC/MF A11

A method which solves the problem of the transmission of sound along the axis of an axisymmetric, closed elastic structure is proposed. The method solves the Neumann problem associated with the acoustic pressure by the stationary phase method and the structural problem by a finite element method whose implementation is always possible since only the axisymmetric eigenmodes of the structure are necessary. The method is always applicable for high frequencies, and generally is so applicable, whatever the frequency, for conventional aeronautical structures. ESA

N91-30910# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Technische Akustik.
COMPARISON OF THE ICAO ANNEX 16 CHAPTER 10 AND CHAPTER 6 NOISE CERTIFICATION PROCEDURES ON THE BASIS OF FLIGHT NOISE MEASUREMENTS OF TEN LIGHT PROPELLER-DRIVEN AEROPLANES
HELMUT DAHLEN and HANNO HELLER Nov. 1990 52 p
(DLR-MITT-90-17; ISSN-0939-298X; ETN-91-99542) Avail: NTIS HC/MF A04; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 11 Deutsche marks

Noise certification procedures were developed by the International Civil Aviation Organization (ICAO) for light propeller driven aeroplanes (with a take off mass not exceeding 9000 kg). The established procedure following ICAO Annex 16 chapter 6 requires the aeroplane to conduct four level flyers at a height of 300 m above a microphone with a maximum continuous power setting. This procedure is now replaced by a new procedure documented in Annex 16 as chapter 10 where the aircraft must conduct six take offs with maximum continuous power and fly over a microphone positioned 2.5 km past the point of brake release. In both procedures, the maximum A weighted flyover noise level is to be compared to an (aircraft mass dependent) noise limit; however, both procedures have different noise limits. A study was conducted where 10 propeller driven aeroplanes were measured according to both chapter 6 and chapter 10 in order to evaluate the relative practicability and noise stringency of both procedures. 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.

A91-48650
STUDY OF THE ECONOMIC FEASIBILITY OF COMPOSITE (= STAGED) SST CONFIGURATIONS
JAN ROSKAM and DAN ROGERS (Kansas, University, Lawrence) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 21 p. refs
(SAE PAPER 901989) Copyright

An economic analysis is presented of a composite ('staged') configuration option for a supersonic transport with transatlantic range. It is shown that the staged approach offers economic advantages over a conventional SST. A staged SST offers the possibility of 'optimizing' the configuration for the cruise flight condition, does not require flaps (nor landing gear), does not carry any penalty for meeting FAR 36 takeoff and landing noise requirements, and causes up to 30 percent less stratospheric pollution. Therefore, despite the potential for operational problems with launch and recovery, the staged SST option may have to be taken seriously. Author

A91-50176
THE ROLE OF THE FEDERAL AVIATION ADMINISTRATION IN THE CONTROL OF AVIATION DRUG-TRAFFICKING
KAREN M. HANCHETT (Administrative Office of U.S. Courts, Washington, DC) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 56, Summer 1991, p. 999-1025. refs
Copyright

The FAA's role in aviation drug trafficking is examined, arguing that the 1984 and 1988 Drug Acts, if properly implemented, will make it more difficult and costly for drug traffickers to continue using general aviation aircraft in their operations. The specific requirements and ramifications of the 1984 Act are reviewed, and those actions taken by the FAA against drug smuggling pilots from 1984 to 1988 are addressed. The 1988 Act's effect on aircraft registration, air personnel certification, and law enforcement activity are examined. Finally, the FAA's implementation of the 1988 Act is discussed. C.D.

A91-52754
AVIATION LIABILITY LAW DEVELOPMENTS IN 1990
RANDAL R. CRAFT, JR. (Haight, Gardner, Poor and Havens, New York) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 57, Fall 1991, p. 1-172. refs
Copyright

Court decisions in aviation law in 1990 and late 1989 that are considered the most significant by the authors are reviewed, along with some other decisions that may indirectly affect aviation law. The general areas covered by these decisions include general procedural issues, liability of air carriers in Warsaw Convention Carriage, liability of operators of aircraft in non-Warsaw carriage, liability of manufacturers and suppliers, liability of the United States under the Federal Tort Claims Act, liability of foreign states under the Foreign Sovereign Immunities Act, liability of airports, and liability of insurers. C.D.

A91-52755
ANTITRUST IRRELEVANCE IN AIR TRANSPORTATION AND THE RE-DEFINING OF PRICE DISCRIMINATION
LAURENCE E. GESELL and MARTIN T. FARRIS (Arizona State University, Tempe) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 57, Fall 1991, p. 173-197. refs
Copyright

It is argued that the consolidation of the airline industry into an oligopoly has not enhanced the need for effective antitrust enforcement. Oligopolistic companies tend not to engage in predatory pricing because they know that their competitors will meet the price, lowering profits for all. Instead of more antitrust enforcement, what is needed is a new adaptive law to protect the consumer from unfair price discrimination. C.D.

N91-31020# Wichita State Univ., KS. National Inst. for Aviation Research.
A BRIEF EXAMINATION AND COMPARISON BETWEEN THE FEDERAL MOTOR VEHICLE SAFETY STANDARDS AND THE FEDERAL AVIATION REGULATIONS
BRIAN STEELE and HAMID LANKARANI 1991 78 p
(NIAR-91-25) Avail: NTIS HC/MF A05

A brief examination of the National Highway Traffic Safety Administration's (NHTSA) and the Federal Aviation Administration's (FAA) standards regarding passenger safety restraint systems. The HNTSA's standards are contained in the Federal Motor Vehicle Safety Standards (FMVSS) and those of the FAA are in the Federal Aviation Regulations (FAR). A comparison of the two agencies' regulations and some general recommendations to improve them are included. Author

N91-31022*# Garrett Turbine Engine Co., Phoenix, AZ.
ADVANCED TURBINE TECHNOLOGY APPLICATIONS PROJECT (ATTAP) Annual Report, 1990
Mar. 1991 187 p
(Contract DEN3-335)
(NASA-CR-187146; DOE/NASA/0335-3; NAS 1.26:187146; GARRETT-31-8071(3)) Avail: NTIS HC/MF A09 CSCL 21/5

This report summarizes work performed in support of the development and demonstration of a structural ceramic technology for automotive gas turbine engines. The AGT101 regenerated gas turbine engine developed under the previous DOE/NASA Advanced Gas Turbine (AGT) program is being utilized for verification testing of the durability of next-generation ceramic components and their suitability for service at reference powertrain design conditions. Topics covered in this report include ceramic processing definition and refinement, design improvements to the test bed engine and test rigs, and design methodologies related to ceramic impact and fracture mechanisms. Appendices include reports by ATTAP subcontractors addressing the development of silicon nitride and silicon carbide families of materials and processes. Author

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GENERAL

A91-52722
AIRCRAFT CARRIERS [AVIANESUSHCHIE KORABLI]
NIKOLAI I. BELAVIN Moscow, Izdatel'stvo Patriot, 1990, 216 p. In Russian. refs
Copyright

The history, recent developments, and the current status of aircraft carriers is reviewed in a popular manner with emphasis on the aircraft carriers in possession of the U.S. Navy. In particular, the book covers aircraft carrier classification, the principal technical and tactical specifications of large modern carriers, seaworthiness of aircraft carriers, and types of aircraft and flight support equipment. Attention is also given to carrier powerplants, combat missions, and aircraft carrier operations in recent wars. V.L.

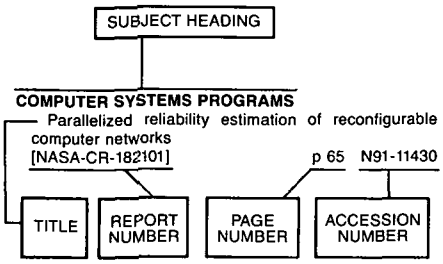
A91-52929
THE EVOLUTION OF AN AIRLINE - PIEDMONT AIRLINES 1948-1989
R. S. MACKLIN and H. A. POITZ SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 10 p. refs
(SAE PAPER 910994) Copyright

Attention is given to the evolution of Piedmont Airlines from a small feeder airline in 1948 to an international airline operating into Canada and England with an all-jet powered fleet in 1989. To date, it has merged into US Air and lost its identity as Piedmont Airlines. O.G.

A91-52930
PETROLEUM HELICOPTERS INC. - A SUCCESS STORY
C. L. TYSDAL and H. A. POITZ SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 7 p.
(SAE PAPER 910995) Copyright

This paper covers the rise of a helicopter company (i.e., Petroleum Helicopters Inc.) from a small beginning to a major factor in the helicopter world. It tells of a company's struggle to overcome the problems of a new and untested method of transportation. This presentation covers only a few of the major problems a new company in a new industry faced beginning in February 1949. Author

Typical Subject Index Listing



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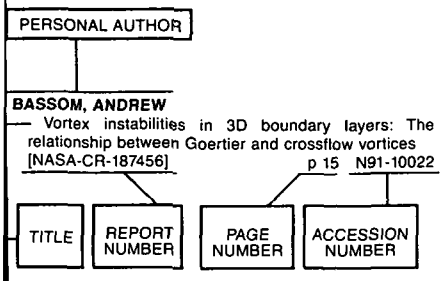

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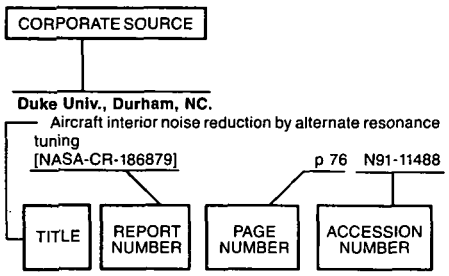

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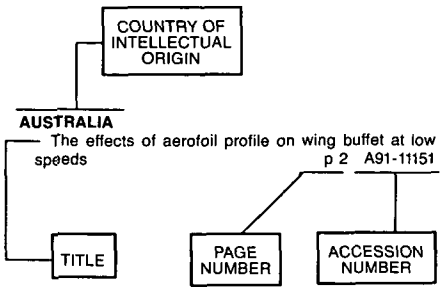

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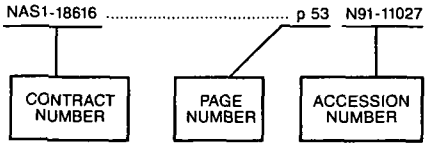

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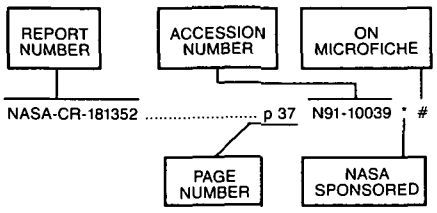

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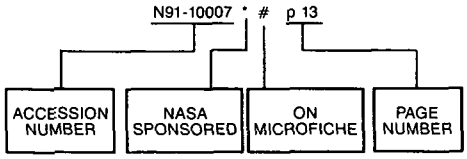

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