

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 661 reports, journal articles, and other documents originally announced in January 1993 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

Accession numbers cited in this issue are:

STAR (N-10000 Series) N93-10001 — N93-12543
IAA (A-10000 Series) A93-10001 — A93-13740

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

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

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

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

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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED
ON MICROFICHE

ACCESSION NUMBER → **N93-10098*** # Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics. ← CORPORATE SOURCE

TITLE → **NAVIER-STOKES DYNAMICS AND AEROELASTIC COMPUTATIONS FOR VORTICAL FLOWS, BUFFET AND AEROELASTIC APPLICATIONS** Progress Report, 1 Oct. 1991 - 30 Sep. 1992

AUTHOR → OSAMA A. KANDIL Sep. 1992 38 p

CONTRACT NUMBER → (Contract NAG1-648) ← PUBLICATION DATE

REPORT NUMBERS → (NASA-CR-190692; NAS 1.26:190692) Avail: CASI HC A03/MF ← PRICE CODE

← AVAILABILITY SOURCE

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

L.R.R.

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → **A93-12007*** National Aeronautics and Space Administration. ← CORPORATE SOURCE
Langley Research Center, Hampton, VA.

TITLE → **NUMERICAL SIMULATIONS OF HIGH-SPEED FLOWS ABOUT WAVERIDERS WITH SHARP LEADING EDGES**

AUTHORS → KEVIN D. JONES and F. C. DOUGHERTY (Colorado Univ., Boulder) ← AUTHORS' AFFILIATION

JOURNAL TITLE → Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 661-667. Research supported by Univ. of Colorado and DLR refs

CONTRACT NUMBER → (Contract NAG1-880)
Copyright

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

I.S.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 288)

February 1993

01

AERONAUTICS (GENERAL)

A93-10733

ICAO ANALYSES TRENDS IN FUEL CONSUMPTION BY WORLD'S AIRLINES

BORIS BALASHOV and ANDREW SMITH (ICAO, Air Transport Bureau, Montreal, Canada) *ICAO Journal* (ISSN 0018-8778) vol. 47, no. 8 Aug. 1992 p. 18-21. refs

Copyright

Projections of world aircraft fuel consumption and growth into 2010 are summarized with attention given to the improvements in fuel productivity in the period 1976-90. Without increases in fuel productivity it is expected that fuel consumption can increase by about 180 percent, and the forecast suggests total annual jet-fuel consumption of about 220 million tons in 2010. C.C.S.

A93-11020

JEPPESEN WORLDWIDE ELECTRONIC NOTAM SERVICE

DAVID J. GOEHLER (Jeppesen Sanderson, Inc., Englewood, CO) *In IEEE PLANS '92 - Position Location and Navigation Symposium*, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 353-356. refs

Copyright

The author examines the capabilities of current NOTAM (notice to airmen) services, presents user requirements for a reliable worldwide source for official NOTAM information, and gives an overview of the design concept for the Jeppesen Worldwide Electronic NOTAM Service now under development. A discussion of planned future enhancements is included to demonstrate the potential of the electronic NOTAM service to supplement existing Jeppesen paper charts, computer flight plan services, and navigation databases, as well as advanced electronic chart display systems. I.E.

A93-11027

REAL TIME DGPS SERVICE FOR PRECISE POSITIONING - ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY

WOLFGANG LECHNER (Avionics Center, Braunschweig, Germany) *In IEEE PLANS '92 - Position Location and Navigation Symposium*, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 398-402.

Copyright

Based on a strong user request for precise real-time satellite based positioning systems, the German Institute of Navigation has started an initiative within its commission Space Techniques to work on the topic of precise real-time DGPS. The aim of these activities is to develop a concept for a real-time DGPS service providing an accuracy better than 3 m up to the centimeter level. The author presents the current status of the project and its first results, and provides an overview of the work on precise DGPS and GLONASS in Germany. In addition, the outcome of the DGPS '91 symposium in Braunschweig is discussed. I.E.

A93-11250

UNORTHODOXY RISING

GRAHAM WARWICK *Flight International* (ISSN 0015-3710) vol. 142, no. 4331 Aug. 12, 1992 p. 70-72.

Copyright

Some of the imaginative concepts for the U.S. military VTOL unmanned reconnaissance aircraft requirement, involving many strange aerodynamic designs, are examined. Attention is given to a multimission intermediary rotor aircraft, a coaxial rotor UAV, a canard rotor/wing aircraft, and a slaved free-wing concept. R.E.P.

A93-11365*

National Aeronautics and Space Administration.

Wallops Flight Facility, Wallops Island, VA.

STATUS OF THE NASA BALLOON PROGRAM

H. C. NEEDLEMAN, R. S. NOCK (NASA, Wallops Flight Facility, Wallops Island, VA), and D. W. BAWCOM (New Mexico State Univ., Palestine, TX) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 69-76. refs

Copyright

The NASA Balloon Program (BP) is examined in an overview of design philosophy, R&D activities, flight testing, and the development of a long-duration balloon for Antarctic use. The Balloon Recovery Program was developed to qualify the use of existing films and to design improved materials and seals. Balloon flights are described for studying the supernova SN1987a, and systems were developed to enhance balloon campaigns including mobile launch vehicles and tracking/data-acquisition systems. The technical approach to long-duration ballooning is reviewed which allows the use of payloads of up to 1350 kg for two to three weeks. The BP is responsible for the development of several candidate polyethylene balloon films as well as design/performance standards for candidate balloons. Specific progress is noted in reliability and in R&D with respect to optimization of structural design, resin blending, and extrusion. C.C.S.

A93-11368

REVIEW AND PROSPECT OF CHINESE SCIENTIFIC BALLOON ACTIVITIES

G. YIDONG, J. LUHUA, and L. BIN (Chinese Academy of Sciences, Inst. of High Energy Physics, Beijing, China) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 101-105. refs

Copyright

An overview is presented of scientific ballooning under Chinese auspices including a recent collaborative effort with the former Soviet Union. The Chinese program is discussed indicating research in such fields as launching facilities, flight electronics, and balloon fabric research and production. Scientific balloon observational programs include: (1) two detectors for hard X-ray and Gamma-ray astronomy; (2) far-IR astronomy; and (3) a drop-capsule system for microgravity experiments. Projects under consideration are based on long-duration balloon flights and increased payload capabilities. It is expected that the balloons under development will have volumes of 500-600,000 cu m that could support payloads of up to 1500 kg. The collaborative effort with Japan on a long-duration transoceanic balloon flight is mentioned as an important effort. C.C.S.

ABSTRACTS

01 AERONAUTICS (GENERAL)

A93-11370* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
NASA LONG DURATION BALLOON CAPABILITY DEVELOPMENT PROJECT

D. STUHLIK (NASA, Wallops Flight Facility, Wallops Island, VA) and W. CRADDOCK (New Mexico State Univ., Las Cruces) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 115-118.
Copyright

A NASA development program is described for establishing near-global long-duration balloon (LDB) capabilities for both Antarctic and midlatitude applications. The program is intended to evaluate, research, and develop the balloon structures and systems needed for scientific payloads of over 1500 lbs for periods of up to three weeks. The systems examined include: control functions, data processing, power, navigation/positioning, and telecommunications. Test flights of the LDB Development Project in Antarctica are reported in which a 28 million cu ft balloon was launched with 3611 lbs of suspended weight. The subsystems under development are reported to work effectively for the test flights. Planned flights for the LDB based on these developments include gamma-ray and X-ray campaigns, a long-duration test in Antarctica, and an experiment based on magnetic passive isotopes. C.C.S.

A93-11374
A JOINT SOVIET-BULGARIAN SCIENTIFIC PROGRAM FOR FREE-FLIGHT AND TETHERED AEROSTAT OBSERVATIONS

B. BONEV, L. FILIPOV, P. GENOV, and A. KHRISTOV (Bulgarian Academy of Sciences, Space Research Inst., Sofia, Bulgaria) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 131-133.
Copyright

A Soviet-Bulgarian project based on the use of balloons and tethers is described which is based on the use of aerostats to conduct scientific experiments in the upper atmosphere. The experiments for free-flight aerostats include the study of ozone dynamics, electromagnetic-field morphologies, and astrophysical phenomena. Tethered aerostats are expected to be used for the study of regional atmospheric electrodynamics, the distribution of anthropogenic pollutants, and remote sensing. C.C.S.

A93-11621
ONERA MAKES PROGRESS IN ROTOR AERODYNAMICS, AEROELASTICITY, AND ACOUSTICS

JEAN-JACQUES PHILIPPE (ONERA, Chatillon, France) *Vertiflite* (ISSN 0042-4455) vol. 38, no. 5 Sept.-Oct. 1992 p. 48-53. refs
Copyright

An overview is presented of the research being conducted at ONERA in the study of a technologically optimal aeroacoustical helicopter rotor. Attention is focused on the interactions between the rotor wake, the fuselage, the empennage, and the fin section that require sophisticated aerodynamic calculations in which the rotor and the rest of the aircraft are coupled, and the complex 3D, unsteady wakes of the rotor are left free. Consideration is given to the performance-vibration tradeoff, rotor noise at high velocities, and blade-vortex interaction noise. R.E.P.

A93-12233
A CIVIL AIRCRAFT INDUSTRY FOR INDIA

R. NARASIMHA (National Aeronautical Lab., Bangalore, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 3-18. refs

The paper argues in favor of a national policy for the growth of a civil aircraft industry in India, which would exploit the aeronautical technology for solving some of existing infrastructural inadequacies in transport and at the same time help to create national wealth in high-technology areas. The arguments rest on an analysis of the potential for aviation, the capabilities available in the country to exploit it, and the means by which the aeronautical development can add to the economical well-being of Indian population. I.S.

A93-12234
EVOLUTION OF HELICOPTERS AND THE STATUS OF TECHNOLOGY IN INDIA

C. G. K. NAIR and K. S. SUDHEENDRA (Hindustan Aeronautics, Ltd., Bangalore, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 19-27. refs

The history of evolution of the helicopter, from the 15th century model of Leonardo Da Vinci, is traced with emphasis on the evolution of particular technologies, such as rotor blades, the rotor head, crashworthiness, antitorque devices, and the tilt rotor. Consideration is also given to the manufacture of light helicopters in India and, in particular to the technology used in the Advanced Light Helicopter, which is currently being developed in India. I.S.

A93-12235
THE APPROACH TO AIRWORTHINESS CLEARANCE WITH THE INTRODUCTION OF ADVANCED MATERIALS AND MANUFACTURING TECHNOLOGIES INTO THE DESIGN OF AEROSPACE STRUCTURES

S. J. LEWIS (British Aerospace Military Aircraft, Ltd., Preston, United Kingdom) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 29-39. refs

The paper describes issues which have been addressed by British Aerospace in obtaining airworthiness clearance of new advanced materials and associated manufacturing technologies introduced into design of aerospace structures. Particular attention is given to the effects of the introduction of fiber-reinforced composites over the past decade, particularly in superplastic forming and diffusion bonding, from the viewpoint of airworthiness. I.S.

A93-12726
AEROSPACE - COLLECTED TRANSLATIONS OF SELECTED PAPERS, 1992

Xian, China Northwestern Polytechnical University 1992 108 p. Translation.

Consideration is given to nonlinear multi-point modeling and parameter estimation DO28 research aircraft; research on a discharge coefficient of cooling holes on feeder tube; calculation of an ablative 'step effect' in a nozzle divergent section; an analytical method for subsonic cascade profile; prediction of the inception of rotating stall for multistage axial flow compressors; and a maximum likelihood method for flight data compatibility check. Attention is also given to an experimental investigation of a hydrogen-fueled supersonic combustor; compressible laminar and turbulent boundary layer computation for a 3D wing; a hub treatment effect on performance of an axial flow compressor; and a laser Ti-6Al-4V coating. (For individual items see A93-12727 to A93-12738) O.G.

A93-13368#
DESIGN FOR GLOBAL COMPETITION - THE BOEING 777

J. R. LOREN (Boeing Co., Seattle, WA) Aug. 1992 11 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4190) Copyright

An overview is presented of some major new initiatives and business processes being implemented on the new 777 commercial transport program. This new aircraft is meant to replace the 1970s period DC-10 and L-1011 fleet, as well as both regional and international market, early model 747s. Attention is given to interdisciplinary cooperation, concurrency during the development phase, recognition of new and evolving market forces and factors, and understanding and incorporating customer needs and requirements. R.E.P.

A93-13409
ADVANCED COCKPIT TECHNOLOGY IN THE REAL WORLD

HARRY W. ORLADY (Orlady Associates, Los Gatos, CA) *In Human factors on advanced flight decks; Proceedings of the Conference, London, United Kingdom, Mar. 14, 1991* London Royal Aeronautical Society 1991 p. 2.1-2.14. Copyright

The aircrew-training implications of currently available levels of intracockpit communication and crew coordination are of considerable concern throughout the airline industry. Pilots believe that there is a greater need for operational communication between crewmembers flying advanced cockpit technology aircraft than was previously the case; in addition, virtually all pilots with advanced systems experience believe that they should receive more training in the use of flight guidance and flight management systems. Moving map displays typical of the most advanced 'glass cockpits' are noted to be universally liked by pilots. O.C.

A93-13448

COMPOSITES ROLL SEVENS

RICHARD PIELLISCH Aerospace America (ISSN 0740-722X) vol. 30, no. 10 Oct. 1992 p. 26-29, 43. Copyright

Novel applications of composite materials on the 777-200 widebody aircraft are reviewed demonstrating the effectiveness of composite materials and fabrication techniques. The aircraft is designed with plastic primary structures including an all-composite empennage using carbon fiber and toughened epoxy plastic. Automated lay-up technologies and 'linear-flow' factory design facilitate the manufacture and fabrication of the materials. The composites are argued to provide corrosion resistance, indefinite fatigue life, and weight savings. Estimated weight savings are about 25 percent as compared to Al structures, and the composite surfaces are shown to be significantly smoother than those of conventional designs. Technologies are described for enhancing the manufacturing process including computer-activated 3D interactive design, automated tape lay-up for skin panels, and automated material placement and compaction. C.C.S.

A93-13627

STRUCTURAL INTEGRITY CHALLENGES

R. M. BADER (USAF, Wright Lab., Wright-Patterson AFB, OH) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 1-23. refs Copyright

The past success of the U.S. Air Force Structural Integrity Program is illustrated by the reduction in the number of catastrophic structural failures over the past thirty years. However, there are still many challenges that face the structures engineer. Several challenges are discussed that appear to be the most dominant for current aircraft as well as for future aircraft. There are aging aircraft issues, aircraft exposed to buffet environments, hypersonic vehicles structures, 'smart' technology and affordability. Some current activities are described to illustrate progress toward solutions to these challenges. Author

A93-13628

AIRCRAFT TRACKING OPTIMIZATION OF PARAMETERS SELECTION

R. J. CAZES and P. DEFOSSE (Dassault Aviation, Structure Div., Saint-Cloud, France) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 25-42. refs Copyright

The relative influence of flight parameters and loadings is modeled numerically to study their implications for aircraft static and fatigue design. Finite-element analysis is used to derive local structural stress responses that are developed into a grid for defined speeds, altitudes, and flight conditions. Aerodynamic and mass effects are determined for specific maneuvers, and computed values are compared to typical flight data for a tactical aircraft. The load/stress calculations are given by a structural load/stress time history based on flight conditions, pilot inputs, and local load responses. Percentage structural responses are given for the case of a 0.1 deg angle change, and the results are said to correspond

to experimental results. The technique can be used to assess fatigue and damage in the aircraft with attention to stress, Mach number, incidence, and pitch and roll angles. C.C.S.

A93-13632

MAINTAINING THE SAFETY OF AN AGING FLEET OF AIRCRAFT

A. W. HOGGARD (Douglas Aircraft Co., Long Beach, CA) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 113-136. Previously announced in STAR as N92-30108 refs Copyright

The current status of the Douglas Aging Fleet is examined in light of increasing concern for the possibility of the onset of widespread cracking and recent industry activity to minimize the concern. A fleet monitoring program together with an augmented maintenance program is proposed as a possible means to reduce the concern. Six candidate options for maintenance program augmentation are examined which have been shown to be effective in detection of widespread fatigue damage. A brief example of how this system might be applied to the DC-9 Fleet is presented. Author

A93-13633

FLEET FATIGUE CRACKING THRESHOLD PREDICTION

I. C. WHITTAKER (Boeing Commercial Airplane Group, Seattle, WA), P. B. STILWELL, and D. R. SIZEMORE *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 137-158. refs Copyright

The analysis procedure presented predicts the number of cracked airplanes in an aircraft fleet at a future date as a function of service life and the number of cracks per airplane. This information can be used for planning the timing and extent of corrective fleet action. Author

A93-13634

A REVIEW OF AGING AIRCRAFT TECHNOLOGY - AN I.A.I. PERSPECTIVE

A. BROT and A. NATHAN (Israel Aircraft Industries, Tashan Engineering Center, Lod) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 159-174. Previously announced in STAR as N92-20500 refs Copyright

Considerations in the maintenance of aging aircraft are reviewed and discussed, including the use of a logistics computer program for optimal maintenance scheduling, quantitative ranking of critical locations for maintenance, a comparative evaluation of proof testing and preloading as a means of life extension. The primary cause of increasing costs of repair and replacement of parts has been found to be corrosion damage. This causes maintenance costs eventually to rise to the point where the aircraft has to be retired. Israel Aircraft Industries (IAI) has developed non-destructive inspection procedures, based on low-frequency eddy-current methods, to detect potential cracking problems, to enable spares to be ordered and stocked in advance. Considerations in critical-location ranking include corrosion susceptibility, stress level, accessibility, geometry and past experience. Tests have indicated that preloading to 1.33-1.5 times the normal operating load can extend service life by a factor of 1.2-4.6. Preloading is recommended before the aircraft enters service and on 1-3 occasions during its service life. This treatment should be paralleled by non-destructive inspection at appropriate intervals. Author

01 AERONAUTICS (GENERAL)

N93-10647*# National Academy of Sciences - National Research Council, Washington, DC.

AERONAUTICAL TECHNOLOGIES FOR THE TWENTY-FIRST CENTURY

1992 311 p

(Contract NASW-4003)

(NASA-CR-190918; NAS 1.26:190918; LC-92-64197;

ISBN-0-309-04732-3) Avail: CASI HC A14/MF A03

This study gives an overview of the future technologies in aeronautics. This collaborative effort relies upon the input of numerous experts from around the country. Specific issues covered include subsonic transport aircraft, high-speed civil transport aircraft short-haul aircraft, environmental issues, operational issues, aerodynamics, propulsion, materials and structures, avionics and control, and cognitive engineering. The appendices include bibliography, abbreviations and acronyms, and NASA fiscal year 1992 aeronautics funding (table) and participants. The forward states that over the last decade, foreign aircraft manufacturers have made significant inroads into the global aircraft market, to the detriment of U.S. interests. Recommendations are made to counter that trend. R.L.B.

02

AERODYNAMICS

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

A93-10079

EXTREME VALUE HEAT TRANSFER PROBLEMS FOR THREE-DIMENSIONAL BODIES MOVING AT HYPERSONIC VELOCITIES [EKSTREMAL'NYE ZADACHI PRI TEPLOOBMENE PROSTRANSTVENNYKH TEL, DVIZHUSHCHIKHSIA S GIPERZVUKOVYMI SKOROSTIAMI]

M. A. ARGUCHINTSEVA and N. N. PILIUGIN Prikladnaia Matematika i Mekhanika (ISSN 0032-8235) vol. 56, no. 4 July-Aug. 1992 p. 643-657. In Russian. refs
Copyright

Variational problems are formulated for determining the optimal shape of three-dimensional bodies characterized by minimum heating during the entry into a dense planet atmosphere. Formulas are presented for the wave and friction resistance and convective and radiant fluxes toward three-dimensional bodies moving in the dense layers of planet atmospheres. The formulas are shown to be explicitly dependent on the conditions of the entry into a planet atmosphere and body geometry, which makes it possible to state variational problems for determining the three-dimensional body shape based on the minimum combined (convective and radiation) surface heating along the trajectory. V.L.

A93-10080

APPROXIMATE METHODS FOR HEAT FLOWS TOWARD THE SURFACE OF THREE-DIMENSIONAL BODIES [PRIBLIZHENNYE FORMULY DLIA TEPLOVYKH POTOKOV K POVERKHNOSTI PROSTRANSTVENNYKH TEL]

I. G. BRYKINA, V. V. RUSAKOV, and V. G. SHCHERBAK Prikladnaia Matematika i Mekhanika (ISSN 0032-8235) vol. 56, no. 4 July-Aug. 1992 p. 658-662. In Russian. refs
Copyright

Steady-state three-dimensional flow of a homogeneous gas past blunt bodies is investigated within the framework of a model of a hypersonic viscous shock layer. The integral method of successive approximations is used to obtain analytical formulas for heat flow distribution on the side surface in relation to the heat flow at the stagnation point. It is shown that, at moderate and large Reynolds numbers, the distribution of the relative heat flux depends only slightly on the Reynolds number and other gasdynamic flow parameters. The accuracy of the formulas obtained here is

estimated by comparing the results with those of numerical solutions of equations of a three-dimensional viscous shock layer for bodies of different shapes. V.L.

A93-10137

VISCOUS INSTABILITY OF HYPERSONIC FLOW PAST A WEDGE [O VIAZKOI NEUSTOICHIVOSTI GIPERZVUKOVOGO OBTEKANIIA KLINA]

I. V. SAVENKOV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 55-60. In Russian. refs

Copyright

The effect of a shock wave on the propagation of two-dimensional viscous modes under conditions of hypersonic interaction is analyzed by considering uniform hypersonic flow of a viscous gas past a sharp cone. These modes are characterized by greater growth increments (at Mach number scales) than the three-dimensional unstable modes studied by Crowley and Hall (1990) and thus considered more hazardous from the standpoint of the laminar-turbulent transition. V.L.

A93-10138

INTENSIFICATION OF FLOW MIXING BEHIND AN OBLIQUE SHOCK WAVE [OB INTENSIFIKATSII SMESHENIIA POTOKOV ZA KOSYM SKACHKOM UPLOTNENIIA]

V. I. VASIL'EV and S. N. ZAKOTENKO Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 61-68. In Russian. refs

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The paper is concerned with the possibility of flow mixing in the case where a wake jet passes through a stationary oblique shock. It is shown that the oblique shock leads to jet deformation, and the effect of jet deformation on mixing can be substantial. This effect is analyzed numerically. An approximate expression is proposed which describes the change of the maximum concentration of the admixed component in the jet behind the shock. V.L.

A93-10139

AN ASYMPTOTIC MODEL OF A CLOSED SEPARATION REGION IN SUPERSONIC FLOW [ASIMPTOTICHESKAIA MODEL' ZAMKNUTOI SRYVNOI ZONY V SVERKHZVUKOVOM POTOKE]

V. I. ZHUK Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 76-84. In Russian. refs

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An asymptotic solution is presented for Navier-Stokes equations with a closed separation region. A characteristic feature of the solution is that it separates into a stationary component downstream (near the reattachment) and a nonstationary component propagating upstream in the form of a separated wave. Details of the analysis are presented. V.L.

A93-10140

VARIATIONAL PROBLEM OF THE PROFILING OF THE SIDE WALLS OF THE SUPERSONIC SECTION OF A NARROW THREE-DIMENSIONAL NOZZLE [VARIATSIONNAIA ZADACHA PROFILIROVANIIA 'BOKOVYKH' STENOK SVERKHZVUKOVOI CHASTI 'UZKOGO' PROSTRANSTVENNOGO SOPLA]

A. N. KRAIKO, A. R. POLIANSKII, and N. I. TILLIAEVA Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 102-112. In Russian. refs

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The problem of the profiling of the side walls of the supersonic section of a three-dimensional nozzle with two planes of symmetry is solved by using the approximation of a narrow channel model whereby the three-dimensional flow is reduced to a two-dimensional one. In the general case, the approximate solution of the variational problem is obtained by the indefinite control contour method. For nozzles with nonexpanding end sections of the lower and upper

walls, this solution is rigorous. The method of characteristics is used to develop numerical algorithms for designing optimal side walls and calculating narrow channel flows. V.L.

A93-10141

NUMERICAL MODELING OF SUPERSONIC FLOWS PAST WINGS OF DIFFERENT ASPECT RATIOS OVER A WIDE RANGE OF ANGLES OF ATTACK WITHIN THE FRAMEWORK OF THE PLANE SECTION LAW [CHISLENNOE MODELIROVANIE SVERKHZVUKOVYKH TECHENII OKOLO KRYL'EV RAZNYKH UDLINENII V SHIROKOM DIAPAZONE UGLOV ATAKI V RAMKAKH ZAKONA PLOSKIKH SECHENII]
N. V. VOEVODENKO and I. M. PANTELEEV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 113-120. In Russian. refs

Copyright

A method and a program are developed for solving the problem of flow near bodies of various shapes in high supersonic flow at arbitrary angles of attack. Equations of the plane section law are integrated using the Godunov method. It is shown that the applicability region of the theory developed by Sychev (1960) is much greater than originally thought. V.L.

A93-10142

A METHOD FOR DETERMINING THE AERODYNAMIC COEFFICIENTS OF ASYMMETRIC BODIES WITH ALLOWANCE FOR NONLINEAR INFLUENCE FACTORS OF THE BODY SHAPE [METOD OPREDELENIIA AERODINAMICHESKIKH KOEFFITSIENTOV ASIMMETRICHNYKH TEL S UCHETOM NELINEINYKH FAKTOROV VLIIANIIA FORMY TELA]

G. G. SKIBA and V. M. IUROV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 121-128. In Russian. refs

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A numerical method is proposed which makes it possible to determine the aerodynamic coefficients of asymmetric bodies of arbitrary shape for small spatial angles of attack. The method provides for an aerodynamically justified transition from a three-dimensional system of gasdynamic equations to a two-dimensional system, which significantly simplifies the problem and reduces the computational effort by an order of magnitude. The method allows for nonlinear influence factors due to the body shape, which improves the accuracy of the calculations. The efficiency and robustness of the method are demonstrated by comparing calculation results with results of the numerical solution of the three-dimensional problem. V.L.

A93-10143

CALCULATION OF A THREE-DIMENSIONAL BOUNDARY LAYER AT THE LEE SIDE OF A FINITE-SPAN DELTA WING IN THE CASE OF VISCOUS INTERACTION WITH HYPERSONIC FLOW [RASCHET TREKHMERNOGO POGRANICHNOGO SLOIA NA PODVETRENNOI STORONE TREUGOL'NOGO KRYLA KONECHNOI DLINY NA REZHIME VIAZKOGO VZAIMODEISTVIA S GIPERZVUKOVYM POTOKOM]

G. N. DUDIN Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 129-136. In Russian. refs

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Hypersonic flow of a viscous gas past a finite-span slender delta wing at small angles of attack is investigated analytically. The analysis is based on the assumption of viscous interaction between a three-dimensional boundary layer and external nonviscous flow. The boundary condition is prescribed at the trailing edge of the wing. Calculations of the parameters of the three-dimensional boundary layer at the lee side of the wing and aerodynamic characteristics of the wing are presented. V.L.

A93-10144

REGIMES OF SUPERSONIC FLOW PAST THE WINDWARD SIDE OF V-SHAPED WINGS [O NEKOTORYKH REZHIMAKH SVERKHZVUKOVOGO OBTEKANIIA NAVETRENNOI STORONY V-OBRAZNYKH KRYL'EV]

M. A. ZUBIN and N. A. OSTAPENKO (Moskovskii Gosudarstvennyi Univ., Moscow, Russia) Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 137-150. In Russian. refs

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Aerodynamic experiments were carried out on three models of V-shaped wings with sharp leading edges and an anhedral angle of 40 deg at free-stream Mach 3. The laminar-turbulent transition occurred at a distance of 10 mm from the leading edge of the models at a local Reynolds number of $(1.5-2) \times 10^6$. The experiments focused on regimes discovered in ideal gas theory which involve buoyancy of the Ferry point and breakdown of conical flow in the case of turbulent boundary layer separation. It is found that the results of ideal gas theory relating to the region of existence of conical flow are not applicable in this case. V.L.

A93-10147

EFFECT OF LONGITUDINAL MICRORIBBING ON THE DRAG OF A BODY OF REVOLUTION [VLIANIE PRODOL'NOGO MIKROOREBRENIIA NA SOPROTIVLENIE TELA VRASHCHENIIA]

S. F. KONOVALOV, IU. A. LASHKOV, V. V. MIKHAILOV, I. V. FADEEV, and G. K. SHAPOVALOV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 174-178. In Russian. refs

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The use of riblet coatings is investigated as a possible way of reducing the turbulent friction of subsonic aircraft. In particular, results of comparative weight measurements are presented for an axisymmetric body with smooth and ribbed sections of the cylindrical surface. The tests were carried out in a wind tunnel at Mach 0.15-0.85, angles of attack 0-12 deg, and Reynolds numbers $(4-30) \times 10^6$. It is found that microribbing provides an 8-percent decrease in total drag. V.L.

A93-10150

A STUDY OF THE EFFECT OF NONSTATIONARY PERTURBATIONS ON FLOW IN THE FRONT SEPARATION REGION [ISSLEDOVANIE VLIIANIIA NESTATSIONARNYKH VOZMUSHCHENII NA TECHENIE V PEREDNEI OTRYVNOI ZONE]

V. S. KHLEBNIKOV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 185-188. In Russian. refs

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Results of a large series of experiments were analyzed in a systematic manner to determine how the low-frequency perturbations of the three-dimensional separation region formed in supersonic flow past a sphere with a needle terminated by a wedge tip affect flow in the front separation region. The experiments were carried out in a supersonic wind tunnel with an axisymmetric test section at Mach 3 and $Re (1.5-1.6) \times 10^6$. An analysis of the results suggests that, by using a rotating tip, it is possible to significantly reduce the total force acting on the front surface of the sphere. V.L.

A93-10187

THREE-DIMENSIONAL FLOW OF VISCOUS GAS IN THE BLADE PASSAGE OF A STRAIGHT COMPRESSOR CASCADE [PROSTRATVENNOE TECHENIE VIAZKOGO GAZA V MEZHLOPATOCHNOM KANALE PRIAMOI KOMPRESSORNOI RESHETKI]

IU. G. GUREVICH, E. B. SHUBIN, M. B. KRAVETS, and A. M. STARTSEV *In* The boundary layer Moscow Tsentral'nyi Institut Aviatsonnogo Motorostroeniia 1991 p. 25-42. In Russian. refs

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Results of an experimental study of the general pattern of

three-dimensional flow are presented for a straight compressor cascade with a blade height/chord ratio of 1 in the presence of a three-dimensional corner separation zone. The flow is calculated numerically near the end wall. The effect of the interaction of the boundary layer and separation with external flow on the accuracy of flow parameter determinations is estimated in quantitative terms. V.L.

A93-10188
BOUNDARY LAYER SEPARATION IN A CORNER FORMED BY TWO PLANES [OB OTRYVE POGRANICHNOGO SLOIA V UGLE, OBRAZOVANNOM DVUMIA PLOSKOSTIAMI]

G. M. BAM-ZELIKOVICH *In* The boundary layer Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 43-65. In Russian. refs
 Copyright

Flow in a boundary layer formed in flow past a corner between two planes is investigated analytically. It is found that the separation condition for a two-dimensional boundary layer is inapplicable to the boundary layer in corner flow; a new separation condition is formulated. By assuming the validity of the local flow hypothesis, a separation criterion is derived in terms of the angle and thickness ratio of the boundary layers on the planes at a distance from the corner edge. V.L.

A93-10189
EFFECT OF A LARGE-SCALE INHOMOGENEITY OF THE INCOMING FLOW ON FLOW IN A PLANE TURBINE CASCADE [VLIANIE KRUPNOMASSHTABNOI NERAVNOMERNOSTI NABEGAIUSHCHEGO POTOKA NA TECHENIE V PLOSKOI TURBINNOI RESHETKE]

IU. G. GUREVICH and E. IU. SHAL'MAN *In* The boundary layer Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 66-72. In Russian. refs
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Results of an experimental study of the effect of radial inhomogeneity on the flow structure and losses in a plane turbine cascade are reported. It is shown that a large-scale radial inhomogeneity may produce qualitative changes in boundary layer flow on a blade. The radial inhomogeneity may also lead to the formation of a corner separation zone at the point of intersection between the blade and the end surface. V.L.

A93-10192
CALCULATION OF THREE-DIMENSIONAL TURBULENT JETS PROPAGATING BEHIND NOZZLES OF RECTANGULAR CROSS SECTION [RASHET TREKHMERNYKH TURBULENTNYKH STRUI, RASPROSTRANIAIUSHCHIKHSIA ZA NASADKAMI PRIAMOUGOL'NOGO SECHENIIA]

V. I. VASIL'EV, S. N. ZAKOTENKO, and S. IU. KRASHENINNIKOV *In* The boundary layer Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 90-97. In Russian. refs
 Copyright

Results of numerical studies of free jets of an incompressible fluid issuing from nozzles of rectangular cross section are reported. The analysis allows for the different mechanisms of transverse flow formation in these jets. The effect of secondary flows on the integral jet characteristics is determined. The calculation results are compared with the available experimental data. V.L.

A93-10402
SELF-EXCITED OSCILLATIONS AT SUPERSONIC OFF-DESIGN JET OUTFLOW

V. N. GLAZNEV (Russian Academy of Sciences, Inst. of Theoretical and Applied Mechanics, Novosibirsk, Russia) *Russian Journal of Theoretical and Applied Mechanics* (ISSN 1051-8045) vol. 2, no. 1 March 1992 p. 29-40. refs
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We consider self-excited oscillations during underexpanded jet outflow to a resting medium and its flow to a plane obstacle. Experimental results concerned with the detailed investigations of spatial-temporal oscillation field structure in both jets and their

external acoustic fields are presented. We demonstrate that self-excited oscillations are implemented via a 'chain' of acoustic vortex interactions. Author

A93-10404
ON IMPROVING ADEQUACY OF MODELING IN WIND TUNNEL PROBLEMS

A. M. KHARITONOV (Russian Academy of Sciences, Inst. of Theoretical and Applied Mechanics, Novosibirsk, Russia) *Russian Journal of Theoretical and Applied Mechanics* (ISSN 1051-8045) vol. 2, no. 1 March 1992 p. 65-77. refs
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Approaches for enhancing wind-tunnel aerodynamics simulations are discussed that are compatible with numerical models for facilitating cross-verification. Specific problems related to wind-tunnel experiments include: (1) testing Re numbers up to flight conditions; (2) maintaining controlled turbulence at supersonic velocities; (3) simulating the thermochemicokinetic effects of hypersonic flight; and (4) providing contactless measurement methods. The simulation of flows at the bottom of aircraft is also found to be an area for improvement, and magnetic suspension of models is reviewed. General improvements for wind tunnels are identified in: (1) expanding the variation of flow parameters; (2) assessing the boundary conditions for each experiment; and (3) determining average and pulsating flow properties with complex measurements. Other techniques are reviewed for providing numerical and physical studies that reflect the complex applications of aeromechanics being pursued. C.C.S.

A93-10533 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN EFFECTIVE MULTIGRID METHOD FOR HIGH-SPEED FLOWS

R. C. SWANSON (NASA, Langley Research Center, Hampton, VA), E. TURKEL (Tel Aviv Univ., Israel; ICASE, Hampton, VA), and J. A. WHITE (Analytical Services and Materials, Inc., Hampton, VA) *Communications in Applied Numerical Methods* (ISSN 0748-8025) vol. 8, no. 9 Sept. 1992 p. 671-681. Previously announced in STAR as N91-30096 refs
 (Contract NAS1-18605; RTOP 505-90-52-01)
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The use is considered of a multigrid method with central differencing to solve the Navier-Stokes equations for high speed flows. The time dependent form of the equations is integrated with a Runge-Kutta scheme accelerated by local time stepping and variable coefficient implicit residual smoothing. Of particular importance are the details of the numerical dissipation formulation, especially the switch between the second and fourth difference terms. Solutions are given for 2-D laminar flow over a circular cylinder and a 15 deg compression ramp. Author

A93-10534* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN IMPLICIT MULTIGRID SCHEME FOR HYPERSONIC STRONG-INTERACTION FLOWFIELDS

JAMES L. THOMAS (NASA, Langley Research Center, Hampton, VA) *Communications in Applied Numerical Methods* (ISSN 0748-8025) vol. 8, no. 9 Sept. 1992 p. 683-693. refs
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An implicit multigrid method for the compressible Navier-Stokes equations is applied to a series of two-dimensional, steady, laminar hypersonic flows over a compression ramp, including both attached and separated flow conditions. The algorithm uses upwind-biased differencing for the convective and pressure terms and central differencing for the shear-stress and heat-transfer terms. An implicit spatially factored scheme is used to advance the solution in terms on a given mesh, and a V-cycle multigrid strategy is used to accelerate convergence. The multigrid algorithm provided an order of magnitude decrease in the computational time required to obtain a converged position of the separation location and enabled a substantially grid-independent result to be obtained for each of the flows considered. Author

A93-10778

TRANSONIC PROFILE DESIGN IN CURVILINEAR COORDINATES USING AN APPROXIMATE FACTORIZATION ALGORITHM

B. S. DE MATTOS, S. WAGNER (Stuttgart Univ., Germany), and J. L. F. AZEVEDO (Inst. de Aeronautica e Espaco, Sao Jose dos Campos, Brazil) *Zeitschrift fuer Flugwissenschaften und Weltraumforschung* (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 217-225. refs
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An efficient technique for profile aerodynamic design in general curvilinear coordinates was developed and implemented. This is an inverse method coupled to an analysis code, which solves the transonic full potential equation in conservative form. The method is based on the determination of a normal blowing velocity component at the airfoil surface, which is obtained from the difference between the current and the desired surface pressure distributions. This, in turn, allows the computation of the required changes in the airfoil geometry in order to recover the zero normal velocity component condition. The scheme has good convergence characteristics, especially in comparison with those that employ mathematical optimization routines, which can be credited to the fact that it deals directly with the flow physics. Results that establish the robustness of the method are presented, and possible extensions of the present research are discussed. Author

A93-10779

BREAKDOWN ANALYSIS ON DELTA WING VORTICES

G. GUGLIERI (CNR, Centro per lo Studio della Dinamica dei Fluidi, Turin, Italy), M. ONORATO, and F. QUAGLIOTTI (Torino Politecnico, Turin, Italy) *Zeitschrift fuer Flugwissenschaften und Weltraumforschung* (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 226-230. refs
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An experimental investigation of the breakdown phenomenon in delta wings conducted in a low-speed wind tunnel is reported. The program consists of flow visualization and measurements of aerodynamic loads in both static and dynamic conditions. The effects of Reynolds number, angle of attack, and oscillation frequency are studied. C.D.

A93-11267#

SHIP AIRWAKE MEASUREMENT AND FLOW VISUALIZATION

WILLIAM D. REDDY, JR. (U.S. Navy, Naval Air Warfare Center, Patuxent River, MD) *in* AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 118-131. refs
(AIAA PAPER 92-4088)

Ship airwake is an important factor in defining rotorcraft/ship operational limitations and in predicting those limitations using analysis and simulation. Accurate real-time ship airwake models are required to support pilot shipboard landing training in aviation training devices. Increased emphasis must be placed on obtaining quantitative full scale airwake data and in quantitatively evaluating ship airwake simulation models. Equipment used to measure ship airwake ranges from hand-held mechanical sensors and mast mounted propeller anemometers, to laser velocimeters. Wind tunnel and computational fluid dynamics (CFD) options are also possible candidates for ship airwake data generation. The focus of this paper is to compare the various techniques for obtaining full scale ship airwake data and to evaluate the utility and strengths and weaknesses of each. Author

A93-11302

TRANSPORT PROCESSES IN HYPERSONIC FLOWS [TRANSPORTVORGAENGE IN HYPERSCHALLSTROEMUNGEN]

ANGELA ZEROUALI *Luft- und Raumfahrt* (ISSN 0173-6264) vol. 13, no. 4 July-Aug. 1992 p. 21-23. In German.
Copyright

Research on hypersonic flow processes being carried out at

the Rhein-Westphalia Technical College is briefly reviewed. The main lines of study in which doctoral theses and working groups are concentrating are pointed out. C.D.

A93-11362* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

DETERMINATION OF BALLOON GAS MASS AND REVISED ESTIMATES OF DRAG AND VIRTUAL MASS COEFFICIENTS

E. ROBBINS and M. MARTONE (New Mexico State Univ.; NASA, Wallops Flight Facility, Wallops Island, VA) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 55-57. refs
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In support of the NASA Balloon Program, small-scale balloons were flown with varying lifting gas and total system mass. Instrument packages were developed to measure and record acceleration and temperature data during these tests. Top fitting and instrument payload accelerations were measured from launch to steady state ascent and through ballast drop transients. The development of the small lightweight self-powered Stowaway Special instrument packages is discussed along with mathematical models developed to determine gas mass, drag and virtual mass coefficients. Author

A93-11497

EXPERIMENTS ON SPACE SHUTTLE ORBITER MODELS IN A FREE PISTON SHOCK TUNNEL

R. M. KREK and R. J. STALKER (Queensland Univ., Brisbane, Australia) *Aeronautical Journal* (ISSN 0001-9240) vol. 96, no. 957 Aug.-Sept. 1992 p. 249-259. Research supported by Australian Research Council refs
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Heat transfer and pressure measurements were made on a model of the United States Space Shuttle Orbiter in the University of Queensland's T4 shock tunnel at three angles of attack, with stagnation enthalpies which varied by a factor of 11, from 2.1 MJ/kg to 23 MJ/kg, and normal shock Reynolds numbers which varied by a factor of 38, from 2.1×10^4 to 8.1×10^5 . Leeward pressure results were obtained for comparison with flight data and equilibrium calculations, but the majority of the experiments were conducted to investigate the heat transfer distributions around the shuttle model. Both the windward and the leeward heat transfer results exhibit the onset of transition to turbulent flow. The leeward results were compared with flight data as well as with conventional wind tunnel data, and were used to establish trends associated with variation in the major flow and geometry parameters. It was found that, although high enthalpy effects could be important, Reynolds number effects played a dominant role in determining the flow. Author

A93-11499

WING PRESSURE LOADS IN CANARD CONFIGURATIONS - A COMPARISON BETWEEN NUMERICAL RESULTS AND EXPERIMENTAL DATA

G. BURESTI, G. LOMBARDI (Pisa Univ., Italy), and P. PETAGNA (ARIA - Aerodynamic Research for Industrial Applications, Italy) *Aeronautical Journal* (ISSN 0001-9240) vol. 96, no. 957 Aug.-Sept. 1992 p. 271-279. refs
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A comparison between computed and experimental pressure distributions on straight and forward-swept wings placed in interference with a force canard surface at $M = 0.3$ and Re of about 2.8×10^6 is presented. It is shown that a numerical code, based on a nonlinear vortex lattice method and expressly developed for the analysis of interfering lifting surfaces, is capable, in spite of its simplicity, of very accurate predictions in all configurations which do not correspond to sufficiently high angles of attack and to a close interference between the fore wake and the wing surface. Furthermore, even in the latter cases, the predictions are acceptable, and the code is shown to be extremely robust as regards the variation of all its free parameters. Author

A93-11500

A LOW-SPEED AERODYNAMIC MODEL FOR HARMONICALLY OSCILLATING AIRCRAFT CONFIGURATIONS

N. SINGH and S. BHATTACHARYA (Indian Inst. of Technology, Kharagpur, India) *Aeronautical Journal* (ISSN 0001-9240) vol. 96, no. 957 Aug.-Sept. 1992 p. 280-285. Research supported by Ministry of Defence of India refs

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An economical numerical method has been developed to calculate unsteady aerodynamic characteristics of aircraft configurations, undergoing small amplitude simple harmonic motion in various laterally symmetric modes of oscillation, in inviscid incompressible flow, by taking advantage of the computational inefficiency of internal distribution of singularities. The only approximation introduced in the method is the linearization of the problem with respect to the amplitude of oscillation. A number of comparisons have been made to demonstrate the effects of different aircraft components on wing or tail pressure, and lift distributions. Author

A93-11527* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

DIRECT NUMERICAL SIMULATION OF LAMINAR BREAKDOWN IN HIGH-SPEED, AXISYMMETRIC BOUNDARY LAYERS

C. D. PRUETT (Analytical Services and Materials, Inc., Hampton, VA) and T. A. ZANG (NASA, Langley Research Center, Hampton, VA) *Theoretical and Computational Fluid Dynamics* (ISSN 0935-4964) vol. 3, no. 6 1992 p. 345-367. refs

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The compressible Navier-Stokes equations are solved using spectral collocation and high-order compact-difference techniques to simulate the laminar breakdown in high-speed, axisymmetric boundary-layer flow. Mach 4.5 flow along a hollow cylinder and Mach 6.8 flow along a sharp cone are considered. Data obtained replicate two previously unexplained phenomena, namely, the appearance of so-called 'rope-like waves' and 'the precursor transition effect', in which transitional flow originates near the critical layer well upstream of the transition location at the wall. The numerical data also reveal that neither of these effects can be explained, even qualitatively, by linear stability theory alone. It is shown that rope-like appearance arises from secondary instability. Certain features of the precursor transition effect also emerge from secondary instability but its nature is revealed to be fundamentally nonlinear. O.G.

A93-11553

ON THE USE OF THE METHOD OF MATCHED ASYMPTOTIC EXPANSIONS IN PROPELLER AERODYNAMICS AND ACOUSTICS

H. H. BROUWER (National Aerospace Lab., Amsterdam, Netherlands) *Journal of Fluid Mechanics* (ISSN 0022-1120) vol. 242 Sept. 1992 p. 117-143. refs

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The applicability of the method of matched asymptotic expansions to both propeller aerodynamics and acoustics is investigated. The method is applied to a propeller with blades of high aspect ratio, in a uniform axial flow. The first two terms of the inner expansion and the first three terms of the outer expansion are considered. The matching yields an expression for the spanwise distribution of the downwash velocity. A numerical application shows that the first two terms of the inner solution do not yield an acceptable approximation for the downwash velocity. However, recasting the analytical expressions into an integral equation, similar to Prandtl's lifting line equation for wings, yields results for both aerodynamic and acoustic quantities, which agree well with experimental results. The method thus constitutes a practical analysis method for conventional propellers. Author

A93-11872

WEIGHTED AVERAGE METHOD FOR EVALUATING THE AERODYNAMIC PROPERTIES OF TRANSITION FLOW

QIFEN WU, YUZHONG SHI, and BING REN (National Univ. of

Defense Technology, Changsha, China) Chinese Society of Astronautics, *Journal* (ISSN 1000-1328) no. 1 1992 p. 84-89. In Chinese. refs

Under the assumption of localization, the formulas of pressure and tangential stress in the transition flow regions are presented using the weighted average method over continuous flow and free molecular flow. The undetermined constants of the weighted functions are obtained by regression analysis to evaluate the aerodynamic properties of the flow over a blunt body. The results obtained by the engineering evaluating method presented in this paper are compared with experimental results. Author

A93-11920

NUMERICAL SOLUTION OF A FREE-BOUNDARY PROBLEM IN HYPERSONIC FLOW THEORY - NONEQUILIBRIUM VISCOUS SHOCK LAYERS

BRUNO LABOUDIGUE (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France), VINCENT GIOVANGIGLI (Ecole Polytechnique, Palaiseau, France), and SEBASTIEN CANDEL (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France) *Journal of Computational Physics* (ISSN 0021-9991) vol. 102, no. 2 Oct. 1992 p. 297-309. Research supported by Dassault Aviation refs

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The present viscous shock layer problem for hypersonic flow is transformed from a free-boundary one to a nonlinear eigenvalue problem through the introduction of a reduced coordinate; the resulting two-point boundary-value problem is then solved by means of Newton iterations and adaptive gridding. The new boundary conditions derived at the shock replace the classical thin, viscous shock layer relations, and lead to an improved calculation of the shock shape. This method couples all components of the dependent solution. O.C.

A93-11921

A SPLIT-MATRIX RUNGE-KUTTA TYPE SPACE MARCHING PROCEDURE

C. WEILAND (MBB GmbH, Munich, Germany) *Journal of Computational Physics* (ISSN 0021-9991) vol. 102, no. 2 Oct. 1992 p. 319-335. refs

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The robust space-marching method presented for the integration of Euler equations uses a split-matrix scheme in order to apply a suitable upwind discretization. Attention is given to (1) eigenvalue and eigenvector results for the complex hyperbolic system in space, where the bow shock is fitted through the use of the Rankine-Hugoniot equations in conjunction with the suitable characteristic compatibility equation, and (2) the calculation of the flow variables at the wall, using a postcorrection technique. Validation of the method is approached via detailed comparisons with the results of other methods. O.C.

A93-12002* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

VISCOUS EQUILIBRIUM COMPUTATIONS USING PROGRAM LAURA

FRANCIS A. GREENE and ROOP N. GUPTA (NASA, Langley Research Center, Hampton, VA) *Journal of Spacecraft and Rockets* (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 627-632. refs

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Modifications have been made to the Langley Aerothermodynamic Upwind Relaxation Algorithm (LAURA) that enable it to compute viscous airflows under the assumption of thermal and chemical equilibrium. Equilibrium thermodynamic and transport property information are input to the code via curve fits. The periodic updating of this information enables the equilibrium algorithm to perform at a computational rate that is only a small percentage larger than the rate associated with the perfect-gas algorithm. Presented in this article are the results of the initial validation of the modified code. Solutions for surface pressure and heating are presented for the flow over slender and blunt cones at realistic reentry conditions. LAURA solutions are

compared with those produced by a viscous shock-layer method, and, for one case considered, with heat transfer data from a flight experiment. For both pressure and heating, the agreement is good. In general, differences in pressure of a few percent were noted, while differences in heating rates were in the 5-10 percent range. Author

A93-12007* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NUMERICAL SIMULATIONS OF HIGH-SPEED FLOWS ABOUT WAVERIDERS WITH SHARP LEADING EDGES

KEVIN D. JONES and F. C. DOUGHERTY (Colorado Univ., Boulder) *Journal of Spacecraft and Rockets* (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 661-667. Research supported by Univ. of Colorado and DLR refs
(Contract NAG1-880)
Copyright

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

A93-12010* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

NUMERICAL DISSIPATION IN F3D THIN-LAYER NAVIER-STOKES SOLUTION FOR FLOWS WITH WALL TRANSPIRATION

M. KANDULA (Lockheed Engineering & Sciences Co., Houston, TX) and F. W. MARTIN, JR. (NASA, Johnson Space Center, Houston, TX) *Journal of Spacecraft and Rockets* (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 678-684. Previously cited in issue 23, p. 3997, Accession no. A91-53729 refs
(Contract NAS9-17900)
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A93-12011* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC DESIGN OF AXISYMMETRIC HYPERSONIC WIND-TUNNEL NOZZLES USING A LEAST-SQUARES/PARABOLIZED NAVIER-STOKES PROCEDURE

JOHN J. KORTE (NASA, Langley Research Center, Hampton, VA) *Journal of Spacecraft and Rockets* (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 685-691. Previously cited in issue 09, p. 1351, Accession no. A92-25779 refs
Copyright

A93-12020* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH ANGLE-OF-ATTACK INVISCID SHUTTLE ORBITER COMPUTATION

WILLIAM L. KLEB and K. J. WEILMUNSTER (NASA, Langley Research Center, Hampton, VA) *Journal of Spacecraft and Rockets* (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 746-748. refs
Copyright

Results are presented of a comparison between the pressure distributions predicted by the perfect-gas computational fluid dynamics and the Shuttle Orbiter wind-tunnel data for high angles of attack, using the LAURA (for Langley Aerothermodynamic Upwind Relaxation Algorithm) as applied to the wind-tunnel condition to predict the flow over the vehicle. It is shown that the calculated pressures compare well with the wind tunnel data for both the windward and the leeward sides, indicating that the salient inviscid flow features were properly modeled. I.S.

A93-12156

CONTROL OF NUMERICAL DIFFUSION IN COMPUTATIONAL MODELING OF VORTEX FLOWS

ALEXANDRA LANDSBERG (U.S. Navy, Naval Research Laboratory, Washington) and EARLL MURMAN (MIT, Cambridge, MA) *In Computational nonlinear mechanics in aerospace engineering* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 205-243. refs
Copyright

A comparative study is conducted for various methods of controlling numerical diffusion in vortex flow calculations; where the diffusion is due to artificial viscosity and finite grid resolution, it exerts a significant influence on the vortical structures in the flow. Attention is given to the effectiveness of the perturbation method, a Eulerian/Lagrangian particle-tracking scheme, higher-order accurate schemes, zonal grid-refinement methods, and adaptive grid-refinement methods. While the adaptive methods are extremely effective in the reduction of numerical diffusion errors, vortices still suffer from numerical diffusion over long distances. O.C.

A93-12158

BOUNDARY INTEGRAL EQUATION METHODS FOR AERODYNAMICS

LUIGI MORINO and MASSIMO GENNARETTI (Roma I, Univ., Rome, Italy) *In Computational nonlinear mechanics in aerospace engineering* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 279-320. refs
Copyright

The present review of boundary-integral-equation (BIE) methods for the potential aerodynamics of aircraft and rotary wings emphasizes the 'direct velocity-potential formulation'. The formulation is presented at levels of increasing complexity, beginning with incompressible nonlifting problems and ending with such recent developments as a BIE formulation for the velocity potential equation of compressible flows in a frame of reference in arbitrary motion. The formulation is given in terms of the velocity potential, for which an explicit treatment of the wake is required. Emphasis is given to the formulation for the wake transport. O.C.

A93-12163

COMPUTATION OF VISCOUS COMPRESSIBLE FLOWS USING AN UPWIND ALGORITHM AND UNSTRUCTURED MESHES

M. VAHDATI (Imperial College of Science, Technology, and Medicine, London, United Kingdom), K. MORGAN (Univ. College, Swansea, United Kingdom), and J. PERAIRE (Imperial College of Science, Technology, and Medicine, London, United Kingdom) *In Computational nonlinear mechanics in aerospace engineering* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 479-505. Research supported by British Aerospace, PLC refs
Copyright

The implicit upwind cell vertex code whose numerical performance is presently assessed in the solution of compressible viscous flows on general, unstructured meshes is found to be capable of yielding predictions that are in good agreement with experimental observations conducted over a wide range of flow regimes. It is noted, however, that developments in automated mesh generation and adaptations for viscous flows are required before a general unstructured mesh facility becomes available for the analysis of the range of flows that is of current industrial interest. O.C.

A93-12177* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THREE-DIMENSIONAL BOUNDARY-LAYER TRANSITION ON A CONE AT MACH 3.5

R. A. KING (NASA, Langley Research Center, Hampton, VA) *Experiments in Fluids* (ISSN 0723-4864) vol. 13, no. 5 1992 p. 305-314. refs
Copyright

A boundary-layer transition study on a sharp, 5 deg half-angle

02 AERODYNAMICS

cone at various angles of attack was conducted at Mach 3.5. Transition data were obtained with and without significantly reduced freestream acoustic disturbance levels. A progressive downstream and upstream motion of the transition front on the windward and leeward rays, respectively, of the cone with angle of attack was observed for the high noise level data in agreement with data trends obtained in conventional ('noisy') wind tunnels. However, the downstream movement was not observed to the same degree for the low noise level data in the present study. Transition believed to be crossflow dominated was found to be less receptive to freestream acoustic disturbances than first-mode (Tollmien-Schlichting) dominated transition. The previously-developed crossflow transition Reynolds number criterion was found to be inadequate for the current case. An improved criterion is offered, which includes compressibility and flow-geometry effects. Author

A93-12273

TRANSONIC FLUTTER/DIVERGENCE CHARACTERISTICS OF AEROELASTICALLY TAILORED AND NON-TAILORED HIGH-ASPECT-RATIO FORWARD-SWEPT WINGS

K. ISOGAI (National Aerospace Lab., Chofu, Japan) *Journal of Fluids and Structures* (ISSN 0889-9746) vol. 6, no. 5 Sept. 1992 p. 525-537. refs
Copyright

In order to see whether the divergence phenomenon of a transport-type high-aspect-ratio forward-swept wing can be effectively eliminated by aeroelastic tailoring, experimental studies have been performed focusing attention especially on the transonic regime. The transonic flutter/divergence boundaries of the two wing tunnel models, one of which simulates the tailored full-scale wing and the other of which simulates the non-tailored one, have been determined. The tailored model has experienced flutter as predicted by linear theory which employs the Doublet Lattice Method; i.e., the divergence phenomenon is suppressed by aeroelastic tailoring. The non-tailored model has experienced flutter, contrary to theoretical prediction, which is conjectured as shock stall flutter; in which the shock induced flow separation plays the dominant role. By comparing the nondimensional flutter boundaries of the two models, it is shown that, by aeroelastic tailoring, the transonic flutter characteristics of this particular wing can be improved about 60-80 percent over that of the non-tailored wing. Author

A93-12317

REVIEW OF THE NORMAL FORCE FLUCTUATIONS OF AEROFOILS WITH SEPARATED FLOW

D. G. MABEY (Imperial College of Science, Technology, and Medicine, London, United Kingdom) *Progress in Aerospace Sciences* (ISSN 0376-0421) vol. 29, no. 1 March 1992 p. 43-80. refs
Copyright

The comprehensive measurements on many different aerofoils made by Pollentz, Page and Levy (1955), as well as later measurements, are reviewed. Then an empirical law is proposed to predict the normal force fluctuations on aerofoils with trailing-edge separations at subsonic speeds from $C(L) - \alpha$ curves. It is based on an equivalent separation position as deduced from the Kirchoff free-streamline flow for flat plates. The law is developed from the concept of bubble similarity and can also be extended to aerofoils with leading-edge separations if the reattachment position is known. It predicts that the maximum level of normal force fluctuations will be higher for a leading-edge separation than for a trailing-edge separation: this is in accord with the limited experiments available. Some suggestions are made for further research to investigate the application of these laws to modern aerofoils and 2D high lift configurations. Author

A93-12324

DYNAMIC CHARACTERISTICS OF AN AIRFOIL AT HIGH SPEED CHANGE OF PITCH ANGLE

MANABU SANO, TOMOAKI MORINAGA, and HIDEYUKI

MATSUSHIMA Japan Society for Aeronautical and Space Sciences, *Journal* (ISSN 0021-4663) vol. 40, no. 458 1992 p. 157-164. In Japanese. refs

Dynamic forces on an airfoil which changes pitch angle with constant speed in uniform air flow are measured. In a previous work, we could not measure these forces for high speed change of pitch angle because of resonance on the actuating and sensing systems. Pitching mechanism is improved: an actuator, which changes pitch angle speed, is exchanged from a pulse motor to a servomotor and a sensor is exchanged from an optical displacement meter to a load cell. Two dynamic characteristics are measured as follows: transient properties for quick increase of pitch angle and dynamic ones for triangular motion of an airfoil (saw-toothwise change of pitch angle). We obtain the following results: for triangular pitching motion, clockwise hysteresis loops are formed in the lift and the drag curves. Then, the transition of those loops can be described. Maximum lift coefficient and dynamic stall angle of the airfoil tend to be saturated with increasing angular velocity of the pitching motion. Author

A93-12361

TURBINE BLADE CASCADE FLOWS

S. S. GOKHALE (Indian Inst. of Technology, Madras, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 2 May 1992 p. 77-85. refs

A modification of Clines (1978) VNAP program is developed and used to model both viscous and inviscid flows in a 2D blade cascade for flow visualization on a PC-based system. The VNAP code is modified to study blade-to-blade flows without the effects of leading- and trailing-edge flows, and the scheme is prepared for application with a graphics package. Experimental data for a rotor blade at the mean are used for the visualization which give the geometrical coordinates of the blade and inlet conditions. Inviscid and viscous flow calculations are performed at two different grid spacings, and the iso plots and velocity vector plots are given with graphs showing the relationships of pressure ratio and Mach number to distance. The computationally efficient technique provides good descriptions of blade-cascade internal flows for a number of boundary conditions. C.C.S.

A93-12366

AN AERODYNAMIC MODEL OF MULTIPLE LIFTING SURFACES INCLUDING WAKE DEFORMATION AND TIP EFFECT

KAUSHIK SINHA and MANAS KUMAR LAHA (Indian Inst. of Technology, Kharagpur, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 2 May 1992 p. 117-121. refs

The classical vortex lattice method for calculating aerodynamic effects of thin wings has been extended to include wake deformation and tip effect. Interaction of lifting surfaces with each other and with an infinite ground plane have been studied. Comparison with results obtained from methods established in design practice reveal significant differences, attributable to the inclusion of wake deformation and tip effect. Author

A93-12427

NUMERICAL SIMULATION OF COMPRESSIBLE MIXING ZONES [SIMULATION NUMERIQUE DES ZONES DE MELANGE COMPRESSIBLES]

P. COMTE, Y. FOUILLET, and M. LESIEUR (Grenoble, Inst. de Mecanique, France) *Revue Scientifique et Technique de la Defense* (ISSN 0994-1541) no. 17 1992 p. 43-63. In French. refs
(Contract DRET-88-150; DRET-89-174; DRET-89-2045; ONERA-21336-SAT-2-CDC)
Copyright

By means of direct numerical simulation, we study the influence of compressibility on the development of instabilities and transition to turbulence in the case of mixing layers and jets. These effects are well quantified by the convective Mach number alone. With the help of simple inviscid and 2D reasoning we propose an explanation for the progressive inhibition of the large-scale vortices

by compressibility and account for their asymmetry when the mixing streams are not of the same density or temperature. In three dimensions, we show, using color visualizations of isobaric and isopycnal surfaces together with vortex lines, how vortices form and evolve for different values of the convective Mach number. We also check that intense turbulent activity persists in the small scales, even for high convective Mach numbers, when large-scale vortices are inhibited. Author

A93-12428
EXPERIMENTAL ANALYSIS OF TURBULENCE WITHIN SUPERSONIC MIXING LAYERS [ANALYSE EXPERIMENTALE DE LA TURBULENCE DANS LES COUCHES DE MELANGE SUPERSONIQUES]

J. P. BONNET and J. R. DEBISSCHOP (Poitiers Univ., France) *Revue Scientifique et Technique de la Defense* (ISSN 0994-1541) no. 17 1992 p. 65-84. In French. refs (Contract DRET-90-068) Copyright

Three experimental mixing layers, with one supersonic side, are investigated with convective Mach numbers of 0.525, 0.535 and 0.64. Several measurement techniques are applied: pressure and mean temperature measurements, laser Doppler anemometry, impulsional laser planogram visualizations, and a twelve hot-wires rake. Conventional measurements point out the main effects of convective Mach number on the mixing-layer growth rates with a high sensitivity to initial conditions. The fluctuation rates decrease with convective Mach number particularly for the transverse component. The Reynolds tensor seems to be affected by the distribution of energy among the components of kinetic energy. The high-order moments (skewness and flatness) are also affected, but the effects are only a contraction of the turbulent part with no important change of the global structuration. Turbulent structures observed for the convective Mach number of 0.525 are less noticeable for the highest one. The supersonic effects are mainly on the distribution of correlation levels inside the layers for small time and space shifts. Author

A93-12429
EFFECT OF WALL HEATING ON A SUPERSONIC TURBULENT BOUNDARY LAYER [INFLUENCE D'UN APPORT PARIETAL DE CHALEUR SUR UNE COUCHE LIMITE TURBULENTE SUPERSONIQUE]

P. DUPONT, N. AUDIFFREN, M. ELENA, and J. F. DEBIEVE (Inst. de Mecanique Statistique de la Turbulence, Marseille, France) *Revue Scientifique et Technique de la Defense* (ISSN 0994-1541) no. 17 1992 p. 85-94. In French. Research supported by DRET and ONERA refs Copyright

Experiments carried out in a supersonic turbulent boundary layer reaching a strongly heated wall are presented. This problem is considered in terms of the adaptation of a boundary layer to boundary conditions which are different from the classical adiabatic ones. Mean and turbulent fields concerning velocity and temperature are described. The heat influence on these fields and the flow characteristics are examined. The connection between the velocity and temperature fields are approached. Author

A93-12432
FLOW PROBLEMS POSED BY REENTRY IN PLANETARY ATMOSPHERES [PROBLEMES D'ECOULEMENT POSES PAR LA RENTREE DANS LES ATMOSPHERES PLANETAIRES]

R. BRUN (Aix-Marseille I, Univ., Marseille, France) *Revue Scientifique et Technique de la Defense* (ISSN 0994-1541) no. 17 1992 p. 123-132. In French. refs Copyright

Hypersonic flows around space vehicles during their reentry phase in planetary atmospheres are characterized by intense aerothermal phenomena. Physicochemical processes, dissociation, ionization, gas-wall interaction attend the energies and high thermal transfer generated at the gas-vehicle interface. Modeling the physicochemical phenomena and the numerical approach of the

determination of the flowfields and the test facilities and diagnostic tools are analyzed. The problems of the reentry in the atmospheres of earth, Mars and Titan are examined in particular. Author

A93-12433
ROTATION AND CAVITATION OF A MARGINAL VORTEX [ENROULEMENT ET CAVITATION DE TOURBILLON MARGINAL]

D. H. FRUMAN, C. DUGUE (Ecole Nationale Supérieure de Techniques Avancées, Palaiseau, France), and P. CERRUTTI (Ecole Navale, Brest-Naval, France) *Revue Scientifique et Technique de la Defense* (ISSN 0994-1541) no. 17 1992 p. 133-141. In French. Research supported by DRET refs Copyright

The local intensity and the radius of the inner solid body rotation region of a tip vortex issued from an elliptical planform hydrofoil are determined using the values of the tangential (vertical) component of the velocity. The local intensity of the vortex at the tip of the wing is 25 percent of the total circulation over the wing (as computed from the lift coefficient), and it increases moderately downstream. The characteristic radius of the solid body rotation region (defined as the one corresponding to the maximum tangential velocity) has a minimum at a distance from the tip of about one eighth of the maximum chord, and it increases sharply from there to the trailing edge and more slowly thereafter as a result of viscous diffusion. The location of the minimum local pressure coefficient on the vortex axis coincides with the minimum of the vortex core radius, and its value compares favorably to the critical cavitation number for the same operating conditions. The effect of Reynolds number on cavitation is interpreted by considering the modification of the boundary layer on the hydrofoil in the transition regime. Author

A93-12453
THREE-DIMENSIONAL FLOW CALCULATIONS IN TURBOMACHINERY USING THE STREAM FUNCTION FORMULATION

C. W. GU and J. Z. XU (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China) *Journal of Engineering Thermophysics* (ISSN 0253-231X) vol. 13, no. 2 May 1992 p. 150-155. In Chinese. refs

The principal equations of the three-dimensional stream functions in an arbitrary nonorthogonal curvilinear coordinate system are derived. Because the two principal equations include the second-order partial derivatives of both stream functions, some difficulties arise in the calculation. Based on the analysis of the stream functions and their principal equations, to overcome the difficulties, the discretized equations of these equations are adopted as the simultaneous difference equations of solving two stream functions. The numerical results show that the method is effective and the stream function formulation can be used conveniently in the three-dimensional flow calculations in turbomachinery. Author

A93-12454
EXPERIMENTAL RESEARCH FOR THE DISCHARGE FLOW OF A CENTRIFUGAL IMPELLER AND THE FLOWFIELD IN THE VANELESS DIFFUSER

GUANG XI, SHANGJIN WANG, MINJIAN YUAN, and DUJUAN LI (Xian Jiaotong Univ., China) *Journal of Engineering Thermophysics* (ISSN 0253-231X) vol. 13, no. 2 May 1992 p. 156-160. In Chinese. refs

Using three-hole and five-hole probes, the discharge flow of a modern centrifugal compressor impeller and the flowfield in the vaneless diffuser were measured and analyzed at three operating conditions, and the distributions of the velocity and pressure from hub to shroud at three radial locations are presented. The measurement results show that the variation of the discharge flow angle from hub to shroud is still large even for high performance 3D impellers, so only 3D twisted diffusers can match the discharge flow perfectly. Author

02 AERODYNAMICS

A93-12558

DYNAMIC STABILITY OF BODIES OF REVOLUTION IN COMPRESSIBLE FLOW [ESTABILIDAD DINAMICA DE CUERPOS DE REVOLUCION EN FLUJO COMPRESIBLE]

P. GARCIA-FOGEDA and G. GARCIA JULIAN (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) *Ingenieria Aeronautica y Astronautica* (ISSN 0020-1006) no. 329 Oct. 1992 p. 18-28. In Spanish. refs
Copyright

A method is presented for determining the dynamic stability of sharp-pointed axially symmetric bodies in compressible flow based on an asymptotic expression for the flows about the bodies. Equations are developed for the contours of the body, pressure and force coefficients, and solution for dynamic instability for subsonic flow. Nonlinear terms are retained in the potential equation for small perturbations to express the dynamic stability of bodies in transonic flow. A solution is also given for the case of supersonic flow that is similar to the procedure by Von Karman and Moore (1932) for flows in which small frequency oscillations are present. Dynamic coefficients are derived for the normal and moment forces on various bodies of revolution in the subsonic and supersonic regimes. The method uses relatively efficient computation times and is effective and accurate for a range of Mach numbers.

C.C.S.

A93-12651

VISCOUS SHOCK-LAYER NUMERICAL CALCULATIONS OF THREE DIMENSIONAL NONEQUILIBRIUM FLOWS OVER HYPERSONIC BLUNT BODIES AT HIGH ANGLE OF ATTACK

SHUIWU QUANG and YUHONG SU (Beijing Inst. of Aerodynamics, China) *Chinese Society of Astronautics, Journal* (ISSN 1000-1328) no. 3 1992 p. 1-12. In Chinese. refs

This paper describes hypersonic, nonequilibrium, viscous shock-layer equation numerical calculation procedures for a multi-component mixture of reacting gases. 3D flowfields over the re-entry blunt bodies at high angle of attack, chemical specie mass fractions, skin-friction coefficient, and heat transfer rates are discussed. The viscous gas flows are considered to be seven-component ionizing air. It is assumed that the chemical reactions proceed at finite rate. The present numerical method uses a general orthogonal curve-coordinate computational grid system to treat 3D blunt body flowfields. The equations, including xi-momentum, zeta-momentum, energy and species conservation equations, are solved by a finite-difference scheme. Author

A93-12659

COF2 RADIATION FROM AN AIR-TEFLON WAKE

XUEHUA ZHOU (Chinese Academy of Sciences, Inst. of Mechanics, Beijing, China) *Chinese Society of Astronautics, Journal* (ISSN 1000-1328) no. 3 1992 p. 57-64. In Chinese. refs

A finite explicit difference method which has been applied to the axisymmetric boundary layer equation of a hypersonic air wake in chemical nonequilibrium behind a slightly blunted cone is expanded into an air-teflon wake boundary layer and the boundary conditions are revised. The infrared radiations from COF2 and NO in the air-teflon wake are calculated in detail, especially for four spectral band - 2.4, 2.9, 5.2 and 8.0 microns from COF2 radiation. The calculations show that the radiation from COF2 increase with increase of the C2F4 concentration in wake, if only C2F4 concentration more than 1000 ppm COF2 infrared radiation is stronger than the NO radiation. The calculations confirm COF2 is major radiator in the air-teflon wake over the 4-10 microns spectral region. Author

A93-12730

ANALYTICAL METHOD FOR SUBSONIC CASCADE PROFILE

BO LIU (Northwestern Polytechnical Univ., Xian, China) *In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 8 p.* Translation. Previously cited in issue 19, p. 3231, Accession no. A91-46154 refs

A93-12731

PREDICTION OF THE INCEPTION OF ROTATING STALL FOR MULTISTAGE AXIAL FLOW COMPRESSORS

JIUNQIANG ZHU and ZHIWEI LIU (Northwestern Polytechnical Univ., Xian, China) *In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 7 p.* Translation. Previously cited in issue 09, p. 1316, Accession no. A91-25879 refs

A93-12735

COMPRESSIBLE LAMINAR AND TURBULENT BOUNDARY LAYER COMPUTATION FOR THE THREE-DIMENSIONAL WING

QIN E and FENGWEI LI (Northwestern Polytechnical Univ., Xian, China) *In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 p.* Abridged. Translation. Previously cited in issue 22, p. 3813, Accession no. A91-52208 refs

A93-12760

EFFECT OF HEAT SUPPLY ON THE GASDYNAMIC PARAMETERS OF GAS FLOW IN LAVAL NOZZLES [O VLIANII TEPLOPODVODA NA GAZODINAMICHESKIE PARAMETRY TECHENIIA GAZA V SOPLAKH LAVALIA]

A. A. FROLOVA *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669) vol. 32, no. 3 March 1992 p. 472-477. In Russian. refs
Copyright

The quasi-one-dimensional flow model is used to determine the causes of pressure stabilization in the subsonic part of the gas flow in a Laval nozzle with heat supply. This model is used to study the dependence of the gasdynamic parameters (pressure, density, discharge rate, and velocity modulus) on the heat supply, and to determine the factors that affect pressure stabilization in the subsonic and transonic regions. L.M.

A93-12764

A FLOW CALCULATION AND AERODYNAMIC DESIGN METHOD FOR TURBOMACHINE CASCADES [OB ODNOM METODE RASCHETA OBTEKANIIA I AERODINAMICHESKOGO PROEKTIROVANIIA PROFILEI RESHETOK TURBOMASHIN]

P. M. BYVAL'TSEV *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669) vol. 32, no. 4 April 1992 p. 598-612. In Russian. refs
Copyright

An efficient method is proposed for the aerodynamic design of cascades of turbomachinery blades. The calculation of flow past a plane cascade is based on the numerical integration of the full velocity potential equation using a modified implicit relaxation method. Characteristic numerical results are presented to demonstrate the capabilities of the method. V.L.

A93-12766

CALCULATION OF THE THREE-DIMENSIONAL INTERACTION OF A SHOCK WAVE WITH A BOUNDARY LAYER ON A CYLINDER [RASCHET TREKHMERNOGO VZAIMODEISTVIA UDARNOI VOLNY S POGRANICHNYM SLOEM NA TSILINDRE]

M. IA. IVANOV and V. G. KRUPA *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669) vol. 32, no. 4 April 1992 p. 623-634. In Russian. refs
Copyright

Results of the three-dimensional interaction of a plane shock wave with a turbulent boundary layer on a cylinder are presented. The numerical integration of Reynolds-averaged three-dimensional Navier-Stokes equations is carried out by using a high-accuracy implicit monotonic Godunov scheme. A computational grid adapted to the flow structure is used which provides good agreement between the calculations and the experimental results. V.L.

A93-12768

NUMERICAL SOLUTION OF THE INTEGRAL EQUATIONS OF THE AERODYNAMICS OF POROUS SURFACES [K CHISLENNOMU RESHENIU INTEGRAL'NYKH URAVNENII AERODINAMIKI PRONITSAEMYKH POVERKHNOSTEI]

A. F. MATVEEV and N. M. MOLIAKOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669) vol. 32, no. 5 May 1992 p. 788-801. In Russian. refs
Copyright

An integral equation of the second kind is obtained for problems of the aerodynamics of a porous profile and a wing of finite span. The first problem is reduced to a 1D equation with an integral understood in the sense of the principal value according to Cauchy, while the second problem is reduced to a 2D equation with an integral understood in the sense of a finite value according to Hadamard. Solution schemes are developed for these equations, and numerical results are presented. L.M.

A93-12805

COMPUTATIONAL STUDIES OF THE CHARACTERISTICS OF AXIAL COMPRESSOR CASCADES AND STAGES IN UNSTEADY INCOMING FLOW [RASCHETNYE ISSLEDOVANIYA KHARAKTERISTIK RESHETOK I STUPENI OSEVOGO KOMPRESSORA V NESTATSIONARNOM NABEGAIUSHCHEM POTOKE]

V. N. KOTOVSKII, R. M. FEDOROV, and A. S. MATVIENKO Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 24-28. In Russian. refs
Copyright

The effect of the one-dimensional unsteadiness of the incoming flow on the characteristics of the cascades of an axial compressor rotor is investigated analytically. The effect of such flow unsteadiness on the characteristics of an axial stage as a whole is estimated in an approximate manner. The results are compared with experimental data. V.L.

A93-12807

A METHOD FOR CALCULATING FLOW PAST AN ARBITRARY AIRFOIL PROFILE IN THE PRESENCE OF FLOW SEPARATION [METOD RASCHETA OBTEKANIIA PROIZVOL'NOGO PROFILIA PRI NALICHII OTRYVA POTOKA]

E. I. LATYPOVA, S. R. LEVSHIRBANOV, Z. KH. NUGMANOV, and V. A. OVCHINNIKOV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 33-37. In Russian. refs
Copyright

An approximate method is proposed for calculating the aerodynamic characteristics of an airfoil profile in flow of an incompressible fluid with diffuser separation of the boundary layer. Results of calculations of the pressure, lifting force, and drag coefficients using this method are found to be in satisfactory agreement with experimental data. Details of the method, which involves an iteration procedure, are briefly described. V.L.

A93-12808

GRID-CHARACTERISTIC METHOD FOR CALCULATING A THREE-DIMENSIONAL BOUNDARY LAYER ON THE BOUNDING SURFACES OF THE BLADE PASSAGE OF A TURBOMACHINE [SETOCHNO-KHARAKTERISTICHESKII METOD RASCHETA PROSTRANSTVENNOGO POGRANICHNOGO SLOIA NA OGRANICHIVAIUSHCHIKH POVERKHNOSTIAX MEZHLOPATOCHNOGO KANALA TURBOMASHINY]

M. L. UGRUMOV, V. A. MEN'SHIKOV, and V. V. BELIK Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 38-41. In Russian. refs
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An approach to the calculation of the integral parameters of a three-dimensional boundary layer on the bounding surfaces of a blade passage is proposed whereby smooth solutions are obtained by using the method of grid characteristics to solve the integral relations of the three-dimensional compressible turbulent boundary layer. The results obtained by the method are compared with

experimental data and results obtained by other analytical methods. V.L.

A93-12839

SHOCK WAVE INTERFERENCE ON A WING WITH A PARTITION AT HYPERSONIC VELOCITIES [INTERFERENTSIIA SKACHKOV UPLOTNENIIA NA KRYLE S PEREGORODKOI PRI GIPERZVUKOVYKH SKOROSTIAXH]

V. N. GOLUBKIN and V. I. MIKHAILOV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 3 May-June 1992 p. 135-140. In Russian. refs
Copyright

In accordance with the exact solution to the problem of supersonic flow past a delta wing with a side partition, the deflection of the head shock from the partition leads to the formation of a high-pressure region. As a result, the lifting force of the wing increases by a magnitude comparable with the force acting on the peripheral part between the partition and the leading edge. The objective of the study reported here was to investigate this effect experimentally to see to what extent it is realized in the presence of various factors that are not considered in the theoretical analysis. High-pressure regions are identified on the wing which result from the interference between the reflected shocks. The effect of shock interference on the aerodynamic characteristics of the wing is assessed. V.L.

A93-12841

MAXIMIZING THE CRITICAL MACH NUMBER FOR LIFTING WING PROFILES [MAKSIMIZATSIIA KRITICHESKOGO CHISLA MAKHA DLIA NESUSHCHIKH KRYLOVYKH PROFILEI]

F. G. AVKHADIEV, A. M. ELIZAROV, and D. A. FOKIN Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 3 May-June 1992 p. 155-162. In Russian. refs
Copyright

By using the approximate Chaplygin method, the problem of maximizing the free-stream Mach number for a selected class of lifting wing profiles is reduced to that of solving a minimax problem of a special kind. An exact solution for the latter is obtained for a wide class of flows. Profiles are identified which are characterized by higher critical Mach numbers than the existing ones. V.L.

A93-12932

MONOTONICITY CHARACTERISTICS OF SOME PLANE VORTEX FLOWS OF INCOMPRESSIBLE FLUIDS AND SUBSONIC GAS FLOWS [O SVOISTVAKH MONOTONNOSTI NEKOTORYKH VIKHREVYKH PLOSKIKH TECHENII NESZHIMAEMOI ZHIKOSTI I DOZVUKOVYKH TECHENII GAZA]

A. I. RYLOV Prikladnaia Matematika i Mekhanika (ISSN 0032-8235) vol. 56, no. 3 May-June 1992 p. 386-391. In Russian. refs
Copyright

The monotonicity of pressure changes along certain sections of a body and flow region boundaries as well as the absence of isobar bifurcation points (saddle points) in flows past convex bodies are demonstrated. The analysis employs the method of isobars which is based on the monotonic change of the velocity vector along the constant-pressure line. V.L.

A93-12933

INCREASING THE LIFT-DRAG RATIO OF WINGS OF SMALL ASPECT RATIO AT HYPERSONIC VELOCITIES [O POVYSHENII AERODINAMICHESKOGO KACHESTVA KRYL'EV MALOGO UDLINENIIA PRI GIPERZVUKOVYKH SKOROSTIAXH]

V. N. GOLUBKIN and V. V. NEGODA Prikladnaia Matematika i Mekhanika (ISSN 0032-8235) vol. 56, no. 3 May-June 1992 p. 392-403. In Russian. refs
Copyright

The variational problem of determining the shape of thin lifting surfaces with a high hypersonic lift-drag ratio is formulated by using an analytical solution describing flow past wings of small

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aspect ratio. Solutions to this problem yields shapes of the lower wing surface and of the leading edge that provide for a noticeable increase in the lift-drag ratio in comparison with the limiting Newtonian value for a given lifting force or useful volume. V.L.

A93-12973

EFFECT OF THE DRAG OF THE FRONT BODY ON THE RESTRUCTURING OF FLOW BETWEEN TWO BODIES IN THE PATH OF SUPERSONIC FLOW, WITH ONE BODY LOCATED IN THE WAKE OF THE OTHER [VLIANIE SOPROTVLENIIA PEREDNEGO TELA NA PERESTROIKU TECHENIIA MEZHDU DVUMIA TELAMI, ODNO IZ KOTORYKH NAKHODITSIA V SLEDE DRUGOGO PRI SVERKHZVUKOVOM OBTEKANII]

P. G. TSYGANOV TsAGI, Trudy no. 2494 1991 p. 3-12. In Russian. refs

Copyright

For direct and inverse flow restructuring, a relationship is established between the critical distance of flow restructuring and a correlation parameter for two bodies in the path of supersonic flow, with one body located in the wake of the other. The limiting flow lines on the surface of bodies located in the wake are analyzed for separated flow and for flow with a head shock in front of the rear body. V.L.

A93-12974

A STUDY OF THE LAMINAR-TURBULENT TRANSITION IN A BOUNDARY LAYER AND SEPARATION ON CONES AT SUPERSONIC VELOCITIES [ISSLEDOVANIE PEREKHODA LAMINARNOGO POGRANICHNOGO SLOIA V TURBULENTNYI I OTRYVA NA KONUSAKH PRI SVERKHZVUKOVYKH SKOROSTIAXH]

IU. G. SHVALEV TsAGI, Trudy no. 2494 1991 p. 13-21. In Russian. refs

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The laminar-turbulent transition in a boundary layer and flow separation on a sharp cone with a half-angle of taper of 5, 10, and 20 degrees were investigated experimentally for flow velocities corresponding to Mach 3.35 and 4 at Re numbers varying over the range $(3-3.5) \times 10 \exp 6$. Data are obtained on the position of the separation line as a function of the angle of attack (0-30 deg), cone taper angle, and Mach number. The effect of the Re number on the formation and evolution of the boundary layer separation region is investigated. V.L.

A93-12975

CALCULATION OF SEPARATED AXISYMMETRIC FLOW PAST BODIES BY SOLVING EULER EQUATIONS IN THE INNER VORTEX REGION [RASCHET OTRYVNOGO OSESIMMETRICHNOGO OBTEKANIIA TEL NA OSNOVE RESHENIIA URAVNENII EILERA VO VNUTRENNEI VIKHREVOI OBLASTI]

V. V. VYSHINSKII and S. A. KRAVCHENKO TsAGI, Trudy no. 2494 1991 p. 22-41. In Russian. refs

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By using a nonstationary model based on Euler equations in the separation region, a numerical method is developed for calculating transonic axisymmetric flow past bodies, including the backflow region near the rear section of the body. Solutions are obtained for separated flow past bodies with a rear step, a sphere, and a body of revolution with an elliptical generatrix of the rear section. Various mechanisms of vorticity generation in the flow are examined. V.L.

A93-12980

AN EXPERIMENTAL STUDY OF DC DISCHARGES IN SUPERSONIC AND SUBSONIC AIR FLOWS [EKSPERIMENTAL'NOE ISSLEDOVANIE ELEKTRICHESKIKH RAZRIADOV POSTOIANNOGO TOKA V SVERKHZVUKOVYKH I DOZVUKOVYKH POTOKAKH VOZDUKHA]

V. V. VITKOVSKII, L. P. GRACHEV, N. N. GRITSOV, Z. M. EGOROVA, IU. E. KUZNETSOV, V. V. LEBEDENKO, V. V. SKVORTSOV, K. V. KHODATAEV, and V. P. IANKOV TsAGI,

Trudy no. 2505 1991 p. 3-27. In Russian. refs
Copyright

The parameters of dc discharges in air flows were studied experimentally in the Mach number range 0.-2.5. The breakdown and pulsation characteristics of the discharges are determined. It is found that discharges in which the current is shorted across the gas flow are characterized by current pulsations associated with the downstream drift of the discharge channel and repeat breakdowns with pulsation amplitudes up to 50 percent of the mean value. To obtain discharges with a low pulsation level (less than 3 percent), a discharge scheme is proposed where current passes along the gas flow. Conditions under which such a discharge is characterized by low pulsations are examined. V.L.

A93-13303*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNSTRUCTURED GRID SOLUTIONS TO A WING/PYLON/STORE CONFIGURATION USING VGRID3D/USM3D

PARESH PARIKH, SHAHYAR PIRZADEH (Vigyan, Inc., Hampton, VA), and NEAL T. FRINK (NASA, Langley Research Center, Hampton, VA) Aug. 1992 21 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs

(Contract NAS1-18585)

(AIAA PAPER 92-4572)

The purpose of this paper is to validate an inviscid flow solution package based on a new unstructured grid methodology using experimental data on a wing/pylon/store configuration. The solution package consists of an advancing front unstructured grid generator, VGRID3D, and an efficient Euler equation solver, USM3D. Comparisons of computed data versus experimental data are made for two free-stream Mach numbers at five store locations relative to the wing. Both rigid body aerodynamics and mutual interference effects are explored. A very good agreement is observed between computed and wind tunnel data. Author

A93-13304*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECT OF CANARD POSITION ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A CLOSE-COUPLED CANARD-WING-BODY CONFIGURATION

EUGENE L. TU (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 14 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs
(AIAA PAPER 92-4632) Copyright

The thin-layer Navier-Stokes equations are solved numerically to investigate the effects of canard vertical position on a close-coupled canard-wing-body configuration at a transonic Mach number of 0.90 and angles of attack ranging from -2 to 12 degrees. Canard-wing interactions are investigated for high-, mid- and low-canard positions. The computational results show favorable canard-wing interactions for the high- and mid-canard configurations. The unfavorable lift and drag characteristics for the low-canard configuration are examined by analyses of the low-canard flowfield structure. Author

A93-13305*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE NUMERICAL STUDY OF 3-D FLOW PAST CONTROL SURFACES

DENNY S. CHAUSSEE and GOETZ H. KLOPFER (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 15 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs
(AIAA PAPER 92-4650) Copyright

The computation of a steady 3D viscous flow past a slender delta wing-body configuration with trailing edge control surfaces is presented. For the numerical simulation, a cell centered finite volume Navier-Stokes zonal method was used and, besides the standard nonplanar zonal interfacing techniques, a new zonal capability, called a 'virtual zone', was implemented. This capability

enables the end caps of the wings or flaps to be gridded and interfaced with the rest of the flowfield in a natural and straightforward manner. The computational results for 0-, 10-, and 24-deg angles-of-attack were found to agree with experimental results qualitatively and quantitatively. I.S.

A93-13306* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A COMPARISON OF UPWIND SCHEMES FOR COMPUTATION OF THREE-DIMENSIONAL HYPERSONIC REAL-GAS FLOWS

R. A. GERBSCH and R. K. AGARWAL (McDonnell Douglas Research Labs., Saint Louis, MO) Aug. 1992 23 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 Research supported by NASA refs (AIAA PAPER 92-4350) Copyright

The method of Suresh and Liou (1992) is extended, and the resulting explicit noniterative upwind finite-volume algorithm is applied to the integration of 3D parabolized Navier-Stokes equations to model 3D hypersonic real-gas flowfields. The solver is second-order accurate in the marching direction and employs flux-limiters to make the algorithm second-order accurate, with total variation diminishing in the cross-flow direction. The algorithm is used to compute hypersonic flow over a yawed cone and over the Ames All-Body Hypersonic Vehicle. The solutions obtained agree well with other computational results and with experimental data. I.S.

A93-13308#

NONLINEAR AERODYNAMIC PARAMETER ESTIMATION AND MODEL STRUCTURE IDENTIFICATION

GARY T. CHAPMAN (California Univ., Berkeley) and LESLIE A. YATES (Eloret Inst., Palo Alto, CA) Aug. 1992 32 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (AIAA PAPER 92-4502)

An overview of nonlinear aerodynamic model identification and parameter estimation is presented. This includes the modeling of flight dynamic and measurement systems and algorithms to identify aerodynamic models and to estimate the parameters therein. Modeling of the flight dynamic system is considered in a comprehensive manner and includes the effects of propulsion, controls, elasticity, and winds. Aerodynamic modeling is considered in detail. The major issues in measurement system modeling, including noise, biases, and unmodeled effects, are considered for two widely different types of systems: the ballistic range and flight testing. Finally, two classes of algorithms are reviewed: the estimation before modeling approach, EBM, and modeling before estimation approach, MBE. Author

A93-13309#

GEOMETRY BASED DELAUNAY TETRAHEDRALIZATION AND MESH MOVEMENT STRATEGIES FOR MULTI-BODY CFD

S. R. KENNON, J. M. MEYERING, C. M. BERRY, and J. T. ODEN (Computational Mechanics Co., Inc., Austin, TX) Aug. 1992 12 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (Contract F33615-90-C-3001) (AIAA PAPER 92-4575) Copyright

The development of a software system for the analysis and design of multi-body CFD is described. The system incorporates unstructured mesh generation based on typical CAD surface geometry descriptions, mesh movement to follow bodies in relative motion, and mesh restructuring to maintain quality, into an interactive software environment. Delaunay methods are used to generate and restructure meshes due to their versatility, and the minimization of interpolation due to mesh movement. Examples are given for a generic wing-pylon-store configuration. Author

A93-13342* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF STOL OPERATIONS USING THRUST-VECTORING

KALPANA CHAWLA and W. R. VAN DALSEM (NASA, Ames

Research Center, Moffett Field, CA) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4254) Copyright

The flow field about a delta wing equipped with thrust reverser jets in slow speed flight near the ground has been computed. Results include the prediction of the flow about the delta wing at four fixed heights above the ground, and a simulated landing, in which the delta wing descends towards the ground. Comparison of computed and experimental lift coefficients indicates that the simulations can capture at least the qualitative trends in lift-loss encountered by thrust-vectoring aircraft operating in ground effect. Author

A93-13356#

AERODYNAMIC CHARACTERISTICS OF A NEXT GENERATION HIGH-SPEED CIVIL TRANSPORT

HIKARU TAKAMI and EIJI KAWASHIMA (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan) Aug. 1992 7 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4229) Copyright

The aerodynamic characteristics of a candidate for the configuration of a high-speed civil-transport aircraft were evaluated using results of wind tunnel tests on the transport model. Results demonstrated that the proposed configuration has inherently good longitudinal- and lateral-directional characteristics. The value of the lift-to-drag ratio at supersonic cruise was 7.1. I.S.

A93-13361#

A STUDY OF THE EFFECT OF A MOVING GROUND BELT ON THE VORTEX CREATED BY A JET IMPINGING ON THE GROUND IN A CROSS FLOW

V. R. STEWART (KSA Technology, Columbus, OH) and W. B. BLAKE (USAF, Wright-Patterson AFB, OH) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4250)

The investigation of the ground vortex created when a jet impinges on the ground in a cross flow is continued in this paper. The results of an experimental program to investigate the effects of a moving ground belt on the ground vortex is discussed. The characteristics of the ground vortex created on a moving ground belt are compared to the vortex created on a fixed ground board in a wind tunnel and to the vortex created by a moving jet over a stationary ground board. The results indicate that the moving belt will reduce the forward penetration, the reduction of the vortex penetration with the moving belt does not duplicate the moving model vortex. The penetration of the vortex from the moving model is less than that produced over the moving belt. This effort was done under contract to the Air Force WPAFB/FIGC and supported by NASA, Langley Research Center. It was part of a study which included static testing at NASA, Ames Research Center. Author

A93-13377#

'WINGWAKE' - A COMPUTATIONAL MODEL FOR PRELIMINARY ASSESSMENT OF WAKE VORTEX ATTENUATION SCHEMES

VOJIN NICOLIC, ROBERT C. NELSON, and ERIC J. JUMPER (Notre Dame Univ., IN) Aug. 1992 12 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4209) Copyright

An invicid, first order, quasi-steady model based on the point vortex approximation is presented for development of vortex wakes behind lift generating wings. The validation of the model indicates that the method is a valuable tool, well suited for screening of various wake vortex attenuation schemes. The fundamental invariants of vortical flows are satisfied. It is shown that injection of discrete mid-span vortices hold significant promise as a means for vortex attenuation. It appeared to be beneficial to locate the vortex injecting device as far inboard as possible, to achieve the

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highest reduction of the spanwise coordinate of the centroid of vorticity. O.G.

A93-13380#

IMPROVING THE LIFT TO DRAG CHARACTERISTICS OF LOW BOOM CONFIGURATION

KENJI YOSHIDA and AYANO TOKUYAMA (Kawasaki Heavy Industries, Ltd., Gifu Technical Inst., Kakamigahara, Japan) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4218) Copyright

This paper presents a discussion about the aerodynamic design of a SST which has both low boom and low drag characteristics, by using numerical studies based on a method developed by Darden and supersonic linear theory. The results are as follows: (1) the weight of an aircraft cruising at Mach number 2.5 and at altitude of 60,000 ft must be less than about 500,000 lb in order to suppress the boom strength below 1.0 lb/sq ft; (2) a low boom configuration using a very slender and warped arrow wing and a slightly relaxed blunt nose has the great advantage of improving the lift to drag ratio (L/D), and the small disadvantage of increasing the boom strength (pressure rise). For example, the improvement of L/D is about 12 percent, but the increase of pressure rise is about 7 percent. Author

A93-13382#

MULTI-POINT DESIGN OF TRANSONIC AIRFOILS USING OPTIMIZATION

J. O. HAGER, S. EYI, and K. D. LEE (Illinois Univ., Urbana) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4225) Copyright

An aerodynamic design method is developed which couples flow analysis and numerical optimization to find an airfoil geometry with improved aerodynamic performance at multiple (two) design-points. The flow analysis is based on the Euler equations in order to model the rotational physics of transonic flows. The numerical optimization is based on minimizing an objective function subject to certain constraints. The method is applied to several transonic flow design points, and the results are compared to single-point design results. Author

A93-13434* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

TAKING THE MEASURE OF AERODYNAMIC TESTING

PETER J. ERBLAND (USAF, Wright-Patterson AFB, OH) and RODNEY K. BOGUE (NASA, Flight Research Center, Edwards, CA) Aerospace America (ISSN 0740-722X) vol. 30, no. 11 Nov. 1992 p. 16-19, 25. Copyright

A review is presented of the major challenges for aerodynamic measurement created by advanced aircraft systems that range from turbulence modeling to scramjet engines. Three diverse examples typically challenge current capabilities: modeling of compressible turbulence, validation of complex 3D flow predictions, and thermochemical characterization of chemically active high-enthalpy flows. Various techniques being explored and under development to realize the aerodynamic measurements required are discussed. R.E.P.

A93-13649

COMPUTER AIDED AERODYNAMIC DESIGN OF HIGH PRESSURE AXIAL FLOW FAN BLADE ELEMENT

P. K. SEN (Voltas, Ltd., Mining Equipment Design and Manufacturing Centre, Calcutta, India) and B. N. CHANDA (Jadavpur Univ., Calcutta, India) Institution of Engineers (India), Journal, Mechanical Engineering Division (ISSN 0020-3408) vol. 72, pt. MC6 March 1992 p. 109-115. refs

A computer program aimed at determining the vital blade profile parameters has been developed. These parameters include chord, camber and setting angle at various radial locations of the impeller. The blade constructed on the basis of data obtained through the

software presented has a smooth surface and edge all over.

O.G.

N93-10012 General Electric Co., Cincinnati, OH. Aircraft Engines Div.

HYPERSONIC INLET EFFICIENCY REVISITED

PAUL H. KUTSCHENREUTER, J. A. DAVIS, and R. J. GAETA, JR. In JHU, The 1992 JANNAF Propulsion Meeting, Volume 1 p 203-214 Feb. 1992 Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD, 21044-3200 HC

The problem of inlet efficiency parameter definition for hypersonic scramjet propulsion at double-digit Mach numbers less than 20 is addressed. At such flight conditions, the inlet compression process is no longer adiabatic. Real gas chemistry takes on extra importance, and the combined effects of entropy layer and viscous effects lead to highly nonuniform flow profile characteristics at the combustor entrance. The concept of using inlet entropy increase is proposed, evaluated, and compared against traditional inlet parameters. Examples of its use in dealing with the problems of real gas chemistry, combustor entrance profile nonuniformity, and nonadiabatic compression are illustrated. Freestream Mach number 18 inlet CFD results are used as an example in computing the overall inlet entropy increase compared to results obtained from superposition of leading edge bluntness effects, friction, and inviscid shock losses - all calculated separately by simpler methods. Although CFD 'nose-to-tail' analysis capability has progressed significantly in the last few years, both numerical and physical accuracy requirements (as well as economics) are currently taxed significantly by double-digit Mach number applications. Thus, there remains a practical need to estimate high Mach number scramjet engine performance by less sophisticated techniques. Consequently, this paper concludes with an application of the inlet entropy increase approach based on an example nonuniform flow combustor entrance profile in order to permit a one-dimensional calculation of scramjet propulsion performance. Author

N93-10069*# Georgia Inst. of Tech., Atlanta. Signature Technology Lab.

LV SOFTWARE FOR SUPERSONIC FLOW ANALYSIS Final Technical Report, Oct. 1991 - Oct. 1992

WILLIAM A. BELL Oct. 1992 19 p (Contract NAG3-1215) (NASA-CR-190911; NAS 1.26:190911) Avail: CASI HC A03/MF A01

The NASA Lewis Research Center (LeRC) maintains a leadership position in research into advanced aerospace propulsion systems. For the next generation of aircraft, engine designs continue to involve complex, high-speed flows. Performing the detailed flow diagnostics to properly evaluate these designs requires advanced instrumentation to probe these highly turbulent flows. The hostile flow environment often requires nonintrusive measurement techniques such as the laser velocimeter (LV). Since the LV is a proven instrument for nonintrusive flow measurement, it can provide quantitative velocity data with minimal interference to the flow. Based on anticipated flow conditions, laser velocimeter systems were procured from TSI, Inc. The initial system utilized counter processor technology, but later procurements this past year include a more advanced, correlator-based processor, which significantly improves the overall LV performance. To meet the needs of advanced research into propulsion, this instrument must be integrated into an existing VAX/VMS computer system for data acquisition, processing, and presentation. The work done under this grant before this period concentrated on developing the software required to setup and acquire data from the TSI MI-990 multichannel interface, and the RMR 1989 rotating machinery resolver. With the basis established for controlling the operation of the LV system, software development this past year shifted in emphasis from instrumentation control and data acquisition to data analysis and presentation. The progress of the program is reported. Author

N93-10098*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.

NAVIER-STOKES DYNAMICS AND AEROELASTIC COMPUTATIONS FOR VORTICAL FLOWS, BUFFET AND AEROELASTIC APPLICATIONS Progress Report, 1 Oct. 1991 - 30 Sep. 1992

OSAMA A. KANDIL Sep. 1992 38 p
(Contract NAG1-648)
(NASA-CR-190692; NAS 1.26:190692) Avail: CASI HC A03/MF A01

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

N93-10320 Texas A&M Univ., College Station.
ANALYSIS OF WING-BODY JUNCTION FLOWFIELDS USING THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS, VOLUMES 1 AND 2 Ph.D. Thesis

BERNARD P. PAUL, JR. 1991 492 p
Avail: Univ. Microfilms Order No. DA9133985

An incompressible three dimensional Navier-Stokes flow solver has been developed for the analysis of wing-body junction flowfields on general aviation, light twin-engine aircraft. The numerical scheme used in the code is based on the cell-centered finite volume multistage Runge-Kutta time stepping scheme originally developed by Jameson et al. for the Euler equations and extended to viscous flows by Martinelli (two dimensions) and Vatsa (three dimensions). The code, INCRK3D, uses the techniques of local time stepping, implicit residual averaging, and multigridding to accelerate the solution to convergence. The development of the code was performed by taking the three dimensional compressible Navier-Stokes solver of Vatsa and extensively modifying the code and making it applicable to incompressible flow thru the use of the artificial compressibility concept. The code was then applied to a series of wing-body junction flow test cases for verification, the simplified wing-body junction that was experimentally analyzed by Dickinson, the Cougar wind tunnel model geometry, and the Cougar flight vehicle geometry. The numerical results obtained for the Dickinson test case agreed very well with the experimental data and demonstrated that the code had the ability to simulate the physics of junction flows. The comparison of the numerical and experimental pressure coefficients on the wing surface for the Cougar test cases yielded mixed results, with the wind tunnel results comparing poorly and the flight test results comparing very well. The new code has been found to be numerically efficient and accurate and applicable to simplified wing-body junction geometries. Its development constitutes the initial step in the process of developing an analytical tool capable of aiding in the design of junction drag reduction devices such as flow energizers. Dissert. Abstr.

N93-10340# University of Southern California, Los Angeles. Dept. of Aerospace Engineering.

CONTROL OF LIFT AND DRAG IN UNSTEADY FLOWS Final Technical Report, 15 May 1990 - 14 May 1992

CHIH-MING HO 1 Jul. 1992 75 p
(Contract F49620-90-C-0038)
(AD-A253146; AFOSR-92-0675TR) Avail: CASI HC A04/MF A01

The response of delta wings with different aspect ratios and a 2-D wing in unsteady free stream was investigated. It was found that the characteristics of the lift forces depend on the existence

of leading-edge vortex shedding. For delta wings with attached leading-edge vortex, the time-averaged lift force was found to be independent of reduced frequency since there is no intrinsic vortex convection time scale. With increasing angle of attack or aspect ratio, vortex shedding can occur, and the time required to convect along the chord becomes an intrinsic time scale. The appearance of the intrinsic convection time scale on the delta wing corresponds to increased lift with increasing reduced frequency, just like the 2-D wing. Flow visualizations of vortex breakdown position around the trailing edge does not affect the lift force. For the 2-D wing, the aerodynamic performance in the poststall region shows a maximum at an optimum frequency. Very high lift coefficients exceeding 10 can be observed at this reduced frequency. GRA

N93-10342# Aeronautical Research Labs., Melbourne (Australia).

DESIGN AND IMPLEMENTATION OF DIGITAL FILTERS FOR ANALYSIS OF F/A-18 FLIGHT TEST DATA

W. WALDMAN May 1992 35 p
(AD-A253447; ARL-STRUC-TM-555; DODA-AR-006-678) Avail: CASI HC A03/MF A01

This technical memorandum describes the methods and computer programs used to specify, design, and implement time-domain and frequency-domain FIR digital filters for use in the analysis of F/A-18 flight test data. Two bandpass filters covering the 10-20 Hz and 32-52 Hz frequency bands have been developed, and they can be used for analyzing the two dominant modes of structural vibration response occurring on the F/A-18 empennage. A highpass filter with a cutoff frequency of 8 Hz was also designed for filtering strain gauge data for use in producing fatigue load sequences for coupon testing. The effects of bandpass filtering on the transient response of short-term vibrations lasting about one second have also been investigated, leading to the conclusion that FIR digital filters have a negligible effect on the transient response characteristics of short bursts of vibration. GRA

N93-10349*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INTERACTIVE GRID GENERATION PROGRAM FOR CAP-TSD

SAMUEL R. BLAND Oct. 1990 29 p
(Contract RTOP 505-63-21-01)
(NASA-TM-102705; NAS 1.15:102705) Avail: CASI HC A03/MF A01

A grid generation program for use with the CAP-TSD transonic small disturbance code is described. The program runs interactively in FORTRAN on the Sun Workstation. A fifth-degree polynomial is used to map the grid index onto the computational coordinate. The grid is plotted to aid in the assessment of its quality and may be saved on file in NAMELIST format. Author

N93-10375# Naval Postgraduate School, Monterey, CA.

A METHOD OF TESTING TWO-DIMENSIONAL AIRFOILS M.S. Thesis

RICHARD K. JOYCE Mar. 1992 77 p
(AD-A253210) Avail: CASI HC A05/MF A01

The Naval Postgraduate School Aeronautics and Astronautics Department conducts research and development for the Navy's Unmanned Air Vehicle program. NPS currently lacks the capability of testing two-dimensional airfoils to obtain lift, drag and pitching moment coefficients. This thesis consists of the design and calibration of a method of measuring these coefficients using strain gages, and the method of obtaining purely two-dimensional flow over the airfoil. During the calibration process, two amplifiers were tested in an attempt to minimize system drift and to ensure repeatability during successive runs. These desired characteristics were not achieved, however. The final phase was to be validation of the design by testing an NACA 0012 airfoil and comparing measured airfoil data with established reference data. This final phase was not completed due to structural failure of the airfoil. GRA

N93-10544 Ecole Polytechnique, Montreal (Quebec). Dept. of Mechanical Engineering.

A COMPARATIVE STUDY OF SEMI-EMPIRICAL DYNAMIC STALL MODELS

R. BOTEZ, O. MARCHAND, and I. PARASCHIVOIU *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 586-587 May 1989

Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

Dynamic stall is more difficult to predict than static stall due to its dependence on a much larger number of parameters such as airfoil shape, reduced frequency, mean angle, Mach number, Reynolds number, type of motion, three dimensional and turbulence level effects. Several semi empirical methods have been developed based on experimental data for use in the helicopter industry. These methods are used for estimating the forces and moments on oscillating airfoils. These methods are summarized and compared. The UTRC method uses a direct and simple procedure for calculating unsteady aerodynamic loads, but it has the disadvantage of requiring extensive tests to provide the body of the tabulated data for each airfoil. Work is being done on developing analytical expressions to replace the tabulated data. The GORMONT, MIT, MODIFIED MIT and SIKORSKY methods have the great advantage of requiring only steady state airfoil data for their applications. ONERA method is based on a set of algebraic equations containing parameters that must be determined from the available synthesized experimental data. A comparison was made of the variation of the coefficient of lift with the angle of attack results estimated by the GORMONT, SIKORSKY, and UTRC models with those obtained experimentally in preliminary tests for an oscillating airfoil. The SIKORSKY method gave the best results. The GORMONT case gave larger hysteresis in the curve than the two other methods. In the high angle regions the moment computed for each of the three methods was poor in comparison with the experimental results. Author (CISTI)

N93-10547 Ecole Polytechnique, Montreal (Quebec). Dept. of Mechanical Engineering.

A FIELD PANEL METHOD FOR TRANSONIC FLOWS

C. MASSON, L. LAMARCHE, O. MARCHAND, and I. PARASCHIVOIU *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 598-599 May 1989

Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

This study concerns the development and implementation of a numerical method for the design and analysis of wings in transonic regime. A new approach, called the Field Panel Method, is used. It combines the advantages of panel methods (e.g., arbitrary configurations and boundary conditions) with solution techniques appropriate for the nonlinear transonic regime. It offers the possibility of treating very complex configurations and eases the handling of the boundary conditions such as design conditions, solid and porous wall conditions. A 2-D formulation is presented which is the first step in the development of a 3-D numerical method and computer code for the design and analysis of wings. The chosen integral formulation will permit evaluation of aerodynamic characteristics of the arbitrary configurations in flows up to the nonlinear transonic regime where discontinuous solutions (shock waves) can occur. Author (CISTI)

N93-10549 University of Western Ontario, London.
FLOW OVER A LEADING EDGE WITH DISTRIBUTED ROUGHNESS

J. M. FLORYAN and U. DALLMANN (Institut fuer Theoretische Stromungsmechanik, Goettingen, Germany) *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 660-661 May 1989

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Analysis of flow near a leading edge is of primary importance since this is where the boundary layer originates and where the disturbances could first penetrate into it. The purpose of this paper is to analyze modifications of the stagnation flow caused by presence of surface roughness. The resulting nonuniform flow might be subject to an instability mechanism which is different from the classical one. The results provide initial conditions necessary for tracking effects of surface roughness further downstream. Further applications include determination of increase of heat transfer due to the presence of roughness, and determination of shear and normal stress increases with applications to erosion and ablation. Numerical results show that the fluid is forced to flow away from the stagnation line and away from the peaks of roughness. The flow can be described as corresponding to the upper half of a layer of counter rotating vortex pairs, with vortex centers overlapping with the surface of the plate. An increase in shear acts on the peaks of roughness in the x-direction and a decrease in the shear acts on the valleys. An additional shear acts in the spanwise direction from the peak towards the valley position. The effects of roughness on heat transfer on an isothermal plate is such that there is an increase of heat transport through the peak area. Author (CISTI)

N93-10550 Moncton Univ., Edmundston (New Brunswick).
EXPERIMENTAL INVESTIGATION OF FLOWS BEHIND DIFFERENT LARGE-EDDY BREAKUP (LEBU) DEVICES IN THICK BOUNDARY LAYERS

D. VO-NGOC, J. R. LONGVAL, V. D. NGUYEN (Laval Univ., Quebec), and J. DICKINSON (Laval Univ., Quebec) *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 662-663 May 1989

Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

The current study was initiated to assess the influence of the state of the large-eddy breakup (LEBU) boundary layer on the local distribution of $C_{(sub f)}$ downstream of the device. Studies were carried out in a 1 m by 2 m wind tunnel equipped with vortex generators at the entrance, which results in a boundary layer thickness on the order of 50 cm, three meters downstream, at free stream velocities around 10 m/s. The vortex generators have a mean velocity profile following a 0.1 exponent law. The very extensive boundary layers permit the use of large LEBU devices, possessing both more easily controllable geometries and measurable secondary boundary layers and separating wakes. The different shapes of turbulence moderators on LEBUs were chosen comprising a cylinder, rectangular blades with and without chamferings of the leading and trailing edges, and a 15 m chord NACA-0015 profile. Measurements of mean velocity profiles and local $C_{(sub f)}$ distribution were conducted at a number of downstream stations. Turbulence skin friction was determined. Some of the preliminary results are presented. Author (CISTI)

N93-10551 Sherbrooke Univ. (Quebec). Dept. of Mechanical Engineering.

HARMONIC ANALYSIS OF THE AERODYNAMIC FORCES ON A DARRIEUS ROTOR [ANALYSE HARMONIQUE DES FORCES AERODYNAMIQUES SUR UN ROTOR DARRIEUS]

ABDELKRIM MAZOUZI, ANDRE LANEVILLE, and PIERRE VITTECOQ *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 680-681 May 1989 *In* FRENCH

Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

This article presents a harmonic analysis of aerodynamic forces measured on the vertical blades of a Darrieus type rotor in rotation. A new similarity parameter was developed and the relationship between this parameter and the aerodynamic coefficients of force makes it possible to distinguish the zone of dynamic stall. A new cyclical representation as a function of the variable Λ (theta), where theta is the azimuthal position, is proposed to facilitate the presentation of certain aerodynamic phenomena. A model of the

aerodynamic coefficients was formulated. A comparison with experimental results shows that only the first five harmonics are necessary to describe the aerodynamic forces. Author (CISTI)

N93-10648# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Applied Mechanics.

LDV MEASUREMENTS OF UNSTEADY FLOW FIELDS IN RADIAL TURBINE Final Report

W. TABAKOFF and M. PASIN Jul. 1992 165 p
(Contract DAAL03-90-G-0129)

(AD-A253592; ASE/EM-92-105) Avail: CASI HC A08/MF A02

Detailed measurements of an unsteady flow field within the inlet guide vanes (IGV) and the rotor of a radial inflow turbine were performed using a three component Laser Doppler Velocimeter (LDV) system together with a rotary encoder. The mean velocity, the flow angle and the turbulence contours for IGV passages are presented at four blade-to-blade planes for different rotor positions to give three dimensional, unsteady behavior of the IGV flow field. These results are compared with the measurements obtained in the same passage in the absence of the rotor. The flow field of the IGV passage was found to be affected by the presence of the rotor. The ratio of the tangential normal stresses to the radial normal stresses at the exit of the IGV was found to be more than doubled when compared to the case without the rotor. The rotor flow field measurements are presented as relative mean velocity and turbulence stress contours at various cross section planes throughout the rotor. The cross flow and turbulence stress levels were found to be influenced by the incidence angle. Transportation of the high turbulence fluid by the cross flow was observed downstream in the rotor blade passages. GRA

N93-10811# Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.

WIND TUNNEL SPIN DATA REDUCTION TO OBTAIN AERODYNAMIC SPIN DAMPING COEFFICIENTS BY USING NONLINEAR EQUATION OF MOTION

CHIU H. NG and SEUNGEUK HAN Aug. 1992 36 p
(AD-A253880; ARAED-TR-92011) Avail: CASI HC A03/MF A01

A compute program, SPINFIT, is designed for extracting the linear and nonlinear spin damping coefficients by fitting calculated values to the observed wind tunnel spin data. The approach used in this program was developed at NASA Ames. The example given in this report showed significant improvement in fitting with the nonlinear spin damping term in the equation of motion when compared to this exponential fit. GRA

N93-10824*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECT OF PLANFORM AND BODY ON SUPERSONIC AERODYNAMICS OF MULTIBODY CONFIGURATIONS

S. NAOMI MCMILLIN, STEVEN X. S. BAUER, and DOROTHY T. HOWELL Sep. 1992 281 p
(Contract RTOP 505-59-30-01)

(NASA-TP-3212; L-16976; NAS 1.60:3212) Avail: CASI HC A13/MF A03

An experimental and theoretical investigation of the effect of the wing planform and bodies on the supersonic aerodynamics of a low-fineness-ratio, multibody configuration has been conducted in the Langley Unitary Plan Wind Tunnel at Mach numbers of 1.60, 1.80, 2.00, and 2.16. Force and moment data, flow-visualization data, and surface-pressure data were obtained on eight low-fineness-ratio, twin-body configurations. These configurations varied in inboard wing planform shape, outboard wing planform shape, outboard wing planform size, and presence of the bodies. The force and moment data showed that increasing the ratio of outboard wing area to total wing area or increasing the leading-edge sweep of the inboard wing influenced the aerodynamic characteristics. The flow-visualization data showed a complex flow-field system of shocks, shock-induced separation, and body vortex systems occurring between the side bodies. This flow field was substantially affected by the inboard wing planform shape but minimally affected by the outboard wing planform shape.

The flow-visualization and surface-pressure data showed that flow over the outboard wing developed as expected with changes in angle of attack and Mach number and was affected by the leading-edge sweep of the inboard wing and the presence of the bodies. Evaluation of the linear-theory prediction methods revealed their general inability to consistently predict the characteristics of these multibody configurations. Author

N93-10845 Kansas Univ., Lawrence.

DEVELOPMENT OF NONLINEAR AERODYNAMIC MODELS FOR UNSTEADY RESPONSES Ph.D. Thesis

SUEI CHIN 1991 102 p

Avail: Univ. Microfilms Order No. DA9210033

In the current study, a method based on Fourier analysis is developed to analyze the force and moment data obtained in large amplitude forced oscillation tests at high angles of attack. The aerodynamic models for normal force, lift, drag and pitching moment coefficients are built up from a set of aerodynamic responses to harmonic motions at different frequencies. Based on the aerodynamic models of harmonic data, the indicial responses are formed. The final expressions for the models involve time integrals of the indicial type advocated by Tobak and Schiff. Results from linear two- and three-dimensional unsteady aerodynamic theories as well as test data for a 70-deg delta wing as used to verify the models. It is shown that the present modeling method is accurate in producing the aerodynamic responses to harmonic motions and the ramp type motions. The model also produces correct trend for a 70-deg delta wing in harmonic motion with different mean angles-of-attack. However, the current model cannot be used to extrapolate data to higher angles-of-attack than that of the harmonic motions which form the aerodynamic model. For linear ramp motions, a special method is used to calculate the corresponding frequency and phase angle at a given time. The calculated results from modeling show higher lift peak for linear ramp motion than for harmonic ramp motion. The current model also shows reasonably good results for the lift responses at different mean angles of attack. To the author's knowledge, the current methodology of aerodynamic modeling is the first to produce the harmonic oscillation responses at high angle-of-attack and the ramp type motions. Dissert. Abstr.

N93-10856# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

ONE TYPE OF AUTOMATICALLY ADJUSTED DIFFERENCE SCHEME WITH ARTIFICIAL VISCOSITY TO CALCULATE ABLATED EXTERIOR SHAPES

MAOZHAO YANG 17 Jan. 1992 14 p Transl. into ENGLISH from Yuhang Xuebao (China), no. 3, 1988 p 55-60
(AD-A254108; FASTC-ID(RS)T-0786-91) Avail: CASI HC A03/MF A01

In the calculation of the exterior form of ablated reentry nose tips, through automatic wave filter processing with reference to the shape of the object, a type of explicit difference scheme with added artificial viscosity quantities was created. This type of scheme reaches first order accuracy in areas where shape change is wavy and second order accuracy in areas where it is smooth. Tests with numerical values clearly show that this type of method is effective in guaranteeing the accuracy of exterior shape calculations, enlarging time increments and saving computer time. GRA

N93-10858# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

ARGUMENTS CONCERNING WIND TUNNEL TEST STUDIES OF THE TRIM CHARACTERISTICS OF OBJECTS WITH SMALL ASYMMETRIES'

MINGXI FENG 17 Jan. 1992 7 p Transl. into ENGLISH from Yuhang Xuebao (China), no. 4, 1988 p 87-88
(AD-A254111; FASTC-ID(RS)T-0788-91) Avail: CASI HC A02/MF A01

The experimental methods and results set out in the discussions of the referenced earlier work are all correct. However, the

02 AERODYNAMICS

mathematical methods and formulae set down in the referenced work are not appropriate. This article brings out some different ideas about this and supplies discussion. GRA

N93-10877 Maryland Univ., College Park.
CONTRIBUTIONS TO THE EXPERIMENTAL INVESTIGATION OF ROTOR/BODY AERODYNAMIC INTERACTIONS Ph.D.

Thesis

NAIPEI BI 1991 358 p

Avail: Univ. Microfilms Order No. DA9133035

A series of tests were successfully conducted in both hover and forward flight to investigate the mutual aerodynamic interactions between a four-bladed, fully articulated rotor and a helicopter like fuselage. Comprehensive measurements were made of the forces and moment on the body, the thrust and power on the rotor, the time-averaged body pressures and the unsteady pressures on the body. Measurements of the total pressures and corresponding induced velocities below and behind the rotor were made using 7-hole probes. The wide-field shadowgraph technique was also used to visualize the rotor wake vortices. Experiments were conducted at various combinations of rotor thrust, advance ratio and tip path plane angle. Measurements were made on the isolated body, the body with the hub rotating but without the blades, and on the rotor/body combination. It was found that the mutual aerodynamic interactions occurring between the rotor and body were very complicated and highly unsteady. The presence of the rotor significantly affected the time-averaged and unsteady loads on the body. The rotor performance was also affected by the presence of the body, although mainly at low advance ratios. Four basic types of unsteady pressure signatures on the body surface were identified due to: (1) blade passage effected, (2) close wake vortex/body interactions, (3) wake impingement interactions, and (4) post wake-impingement interactions. This classification was supported by unsteady potential flow theory and by flow visualization using the side-field shadowgraph method. The tip vortex behavior near the body surface was also investigated.

Dissert. Abstr.

N93-11020# Rolls-Royce Ltd., Derby (England).
APPLICATION OF LAMINAR FLOW TO AERO ENGINE NACELLES

A. J. MULLENDER, A. L. BERGIN (Manchester Univ., England), and D. I. A. POLL (Manchester Univ., England) 1 May 1991 9 p Presented at the Royal Aeronautical Society Boundary Layer Transition and Control, Cambridge, England, 8-12 Apr. 1991 Sponsored by Ministry of Defence and RAE (PNR-90916; ETN-92-92205) Avail: CASI HC A02/MF A01

In the search for methods of reducing aircraft drag, the engine nacelle is considered as a candidate for laminar flow control. Preliminary results from wind tunnel tests on a two dimensional model of Laminar Flow Control (LFC) by suction nacelles, are presented. An approach to transition prediction using stability theory is outlined. The experimental results demonstrated the achievement of laminar flow by suction to a length Reynolds number of 4,600,000, in a two dimensional model with a pressure distribution similar to that found on a conventional aero engine nacelle. The theoretical results obtained to date are not inconsistent with the experimental results. The theoretically predicted separation bubble is located above the first suction compartment of the laminar flow control model and would be removed with the application of suction. ESA

N93-11050 Department of the Navy, Washington, DC.

RIBLESS RAM AIR PARACHUTE Patent

JAMES A. BUCKLEY, inventor (to Navy) 7 Jan. 1992 9 p Filed 7 May 1990

(AD-D015351; US-PATENT-5,078,344;

US-PATENT-APPL-SN-519626; US-PATENT-CLASS-244-145)

Avail: US Patent and Trademark Office

The upper and lower panel of a ram air inflated parachute canopy are connected on the interior of the canopy by lines extending between the panels at points spaced chordwise and spanwise of the panels so that airflow is unrestricted within the

canopy and the weight and bulk of chordwise ribs is eliminated. The parachute suspension lines have connections to the lower panel at points where the interior lines connect to the lower panel and these connections may be made by loops incorporated in the lower panel. The interior line lengths and the proportions of spanwise end panels of the canopy may correspond to a triangular chordwise cross sectional shape of the canopy. The upper panel may have an extension in front of the lower panel with lines extending between the extension and the suspension lines to downwardly curve the extension and partially close the open forward end of the canopy. GRA

N93-11070# Rolls-Royce Ltd., Derby (England).
A COMBINED EXPERIMENTAL AND THEORETICAL STUDY OF LAMINAR FLOW CONTROL WITH PARTICULAR RELEVANCE TO AERO ENGINE NACELLES

A. J. MULLENDER and D. I. A. POLL (Manchester Univ., England) 30 Apr. 1992 5 p Presented at the 1st European Forum on Laminar Flow Technology, Hamburg, Fed. Republic of Germany, 16-18 Mar. 1992 Sponsored by Ministry of Defence and Ministry of Trade and Industry (PNR-90991; ETN-92-92247) Copyright Avail: CASI HC A01/MF A01

A two dimensional model having a datum pressure distribution representative of that found on a typical nacelle was tested in the 2.7 by 2.1 m low turbulence, low speed, closed circuit wind tunnel. The model features full chord suction through a continuous laser drilled surface mounted on 13 independently controlled plenum chambers. Boundary layer state is determined by the use of 48 microphones mounted beneath the surface and an array of hot films. Incidence is variable over the range -5 to +5 deg, which enables a wide range of surface pressure distributions representative of a spectrum of designs applicable to aeroengine nacelles, from natural laminar flow through hybrid laminar flow control to laminar flow control by boundary layer suction. Theoretical methods, being developed and validated in a parallel study for both the determination of the mean compressible boundary layer development with suction, using a finite difference scheme and stability analysis of the resultant boundary layer profiles are also considered. These codes are to be used to determine a method for boundary layer prediction which can be applied to the design of optimized nacelles. ESA

N93-11113# Rolls-Royce Ltd., Derby (England).
A EUROPEAN COLLABORATIVE NLF NACELLE FLIGHT DEMONSTRATOR

P. P. SHIPLEY, N. T. BIRCH, H. RIEDEL (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany), K. H. HORSTMANN (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany), and P. LUECKING (Motoren- und Turbinen-Union Muenchen G.m.b.H., Germany) 7 Apr. 1992 10 p (PNR-90992; ETN-92-92248) Copyright Avail: CASI HC A02/MF A01

Progress made to date on the collaborative Natural Laminar Flow (NLF) nacelle flight demonstrator program is described. The aerodynamic concept of the NLF nacelle is described in terms of the expected drag benefits, the required design methodology, and the requirements for flight testing. The nacelle aerodynamic design is considered, including the effects of installation, using a three dimensional Euler method. Forthcoming flight program and overall objectives of the flight testing are also described. ESA

N93-11221*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

OVERVIEW OF SUPERSONIC LAMINAR FLOW CONTROL RESEARCH ON THE F-16XL SHIPS 1 AND 2

BIANCA T. ANDERSON and MARTA BOHN-MEYER Oct. 1992 15 p Presented at the 1992 Aerotech Conference, Anaheim, CA, 5-8 Oct. 1992

(Contract RTOP 533-02-39)

(NASA-TM-104257; H-1858; NAS 1.15:104257; SAE PAPER 92-1994) Avail: CASI HC A03/MF A01

NASA is directing research to develop technology for a high-speed civil transport. Supersonic laminar flow control has been identified as a program element, since it offers significant drag-reduction benefits and is one of the more promising technologies for producing an economically viable aircraft design. NASA is using two prototype F-16XL aircraft to research supersonic laminar flow control. The F-16XL planform is similar to design planforms of high-speed civil transports. The planform makes the aircraft ideally suited for developing technology pertinent to high-speed transports. The supersonic laminar flow control research programs for both aircraft are described. Some general results of the ship-1 program demonstrate that significant laminar flow was obtained using laminar flow control on a highly swept wing at supersonic speeds. Author

N93-11223*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE ENGINE DESIGN ENGINE. A CLUSTERED COMPUTER PLATFORM FOR THE AERODYNAMIC INVERSE DESIGN AND ANALYSIS OF A FULL ENGINE

J. SANZ, K. PISCHEL, and D. HUBLER 1992 10 p Presented at the Grand Challenges, Washington, DC, 20-22 Sep. 1992, sponsored by NRL

(Contract RTOP 505-62-52)

(NASA-TM-105838; E-7278; NAS 1.15:105838) Avail: CASI HC A02/MF A01

An application for parallel computation on a combined cluster of powerful workstations and supercomputers was developed. A Parallel Virtual Machine (PVM) is used as message passage language on a macro-tasking parallelization of the Aerodynamic Inverse Design and Analysis for a Full Engine computer code. The heterogeneous nature of the cluster is perfectly handled by the controlling host machine. Communication is established via Ethernet with the TCP/IP protocol over an open network. A reasonable overhead is imposed for internode communication, rendering an efficient utilization of the engaged processors. Perhaps one of the most interesting features of the system is its versatile nature, that permits the usage of the computational resources available that are experiencing less use at a given point in time. Author

N93-11250 Virginia Polytechnic Inst. and State Univ., Blacksburg.

THE HEMISPHERE-CYLINDER AT AN ANGLE OF ATTACK

Ph.D. Thesis

NGOC THAI HOANG 1991 318 p

Avail: Univ. Microfilms Order No. DA9220636

An experimental investigation was carried out of the flow over a hemisphere-cylinder at angles of attack $\alpha = 0$ deg to 90 deg. Visualizations of skin-friction lines were conducted and were focused mainly on the development of the laminar separation bubble as a function of angle of attack, the conditions under which open and closed separation exist, and the interaction between the separation bubble and the leeward vortices. A digital processing method was developed to convert flow visualizations to numerical data. Static pressure measurements over a large range of Reynolds numbers were obtained for two models with different sizes and the same length-to-diameter ratios. Detailed velocity fields, mapped out by a seven hole probe and a laser-Doppler velocimeter (LDV) probe, were carefully examined to provide information on the development of vortical structures on the surfaces of the model. Comparisons were made of the results obtained using these two instruments. The flow field in the wake of the hemisphere-cylinder was also examined at an angle of attack $\alpha = 30$ deg. A small bead was strategically placed near the nose to force vortex asymmetry. Different sizes of beads were also tested to investigate the effectiveness on the asymmetric pattern. Hot-wire anemometers and a dynamic signal analyzer were employed to study the unsteady motion of leeward vortices. Dissert. Abstr.

Dissert. Abstr.

N93-11365# Admiralty Research Establishment, Gosport (England).

EXPERIMENTS ON LOW ASPECT RATIO HYDROPLANES TO MEASURE LIFT UNDER STATIC AND DYNAMIC CONDITIONS

A. R. J. M. LLOYD and B. WARD Mar. 1990 41 p Original contains color illustrations

(ARE-TM(UHR)-90306; BR114028; ETN-92-92296) Copyright Avail: CASI HC A03/MF A01

Experiments in the circulating water channel to measure lift forces on low aspect ratio hydroplanes under static and dynamic conditions are described. The dynamic conditions consisted of oscillating runs and ramping motions. Empirical equations to represent the results are given. The results showed the dynamic effects on oscillating hydroplanes were small but worth noting. The most interesting aspect of the experiment was the delayed stall noted during the ramping motion experiments. ESA

N93-11377# Admiralty Research Establishment, Gosport (England). Maritime Div.

LIFT COEFFICIENT OF A RANDOMLY OSCILLATING HYDROPLANE

M. J. SMITH Aug. 1991 46 p Original contains color illustrations

(DRA/MAR-TM(MTH)-91320; BR305563; ETN-92-92294)

Copyright Avail: CASI HC A03/MF A01

The measurement of lift on a randomly oscillating hydroplane is described. A comparison is made between oscillating the hydroplane randomly or with regular sinusoidal signals together with the different methods of analysis. In the 'regular' experiments three different aspect ratio hydroplanes were tested in several different flow speeds and a number of different oscillation frequencies. As the 'random' tests were performed when the regular experiments allowed, only one hydroplane aspect ratio (1.5), was tested in one flow speed (2.5 m/s nominal). For the random experiments two spectra were used, one narrow band and one broadband. Spectrum 1 was a 5 second period ITTC spectrum covering frequencies from 0.12 to 0.44 Hz. Spectrum 2 was a constant energy density spectrum covering frequencies from zero to 1.2 Hz. It was found that measurement of lift coefficient and other similar quantities on constrained models can be conducted more quickly and efficiently using random signals. Explanations are given. ESA

N93-11464# Glasgow Univ. (Scotland). Dept. of Aerospace Engineering.

THE CONVECTION SPEED OF THE DYNAMIC STALL VORTEX Final Report, 1 Nov. 1989 - 31 Oct. 1991

R. B. GREEN, R. A. GALBRAITH, and A. J. NIVEN 1 Jan. 1992 125 p

(Contract AF-AFOSR-0397-89)

(AD-A247258; GU-AERO-9202) Avail: CASI HC A06/MF A02

This report describes measurements of the convection speed of the dynamic stall vortex. A survey reveals a disharmony between the various researchers as to the dependency of the convection speed upon the aerofoil motion. A preliminary analysis of pressure data from aerofoil models tested at Reynolds and Mach numbers of 1.5 million and 0.11 respectively showed that the convection speed was independent of aerofoil motion and model type to a first order. Testing a high aspect ratio NACA 0015 showed that wind tunnel constraint was not a significant factor. An enhanced analysis technique produced results which, in spite of their poor accuracy, suggest that at low pitch rates the convection speed falls with increasing reduced pitch rate to a constant value for the NACA 0015 and 0018 models. The effect of a leading edge trip was to significantly alter the details of the dynamic stall and to change the vortex convection speed. Although the convection speed/aerofoil motion dependency anomaly has not been fully solved, it is suggested that leading edge effects influence the convection speed, and the aerofoil leading edge geometry, Reynolds and Mach numbers are highlighted. GRA

N93-11532*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
CORRELATION OF FOREBODY PRESSURES AND AIRCRAFT YAWING MOMENTS ON THE X-29A AIRCRAFT AT HIGH ANGLES OF ATTACK

DAVID F. FISHER, DAVID M. RICHWINE (PRC Kentron, Inc., Edwards, CA.), and STEPHEN LANDERS (PRC Kentron, Inc., Edwards, CA.) Nov. 1992 17 p Presented at the AIAA Flight Test Conference, Hilton Head, SC, 24-26 Aug. 1992 (Contract RTOP 533-02-38) (NASA-TM-4417; H-1851; NAS 1.15:4417; AIAA PAPER 92-4105) Copyright Avail: CASI HC A03/MF A01

In-flight pressure distributions at four fuselage stations on the forebody of the X-29A aircraft have been reported at angles of attack from 15 to 66 deg and at Mach numbers from 0.22 to 0.60. At angles of attack of 20 deg and higher, vortices shed from the nose strake caused suction peaks in the pressure distributions that generally increased in magnitude with angle of attack. Above 30 deg-angle of attack, the forebody pressure distributions became asymmetrical at the most forward station, while they remained nearly symmetrical until 50 to 55 deg-angle of attack for the aft stations. Between 59 to 66 deg-angle of attack, the asymmetry of the pressure distributions changed direction. Yawing moments for the forebody alone were obtained by integrating the forebody pressure distributions. At 45 deg-angle of attack, the aircraft yaws to the right and at 50 deg and higher, the aircraft yaws to the left. The forebody yawing moments correlated well with the aircraft left yawing moment at an angle of attack of 50 deg or higher. At a 45 deg-angle of attack, the forebody yawing moments did not correlate well with the aircraft yawing moment, but it is suggested that this was due to asymmetric pressures on the cockpit region of the fuselage which was not instrumented. The forebody was also shown to provide a positive component of directional stability of the aircraft at angles of attack of 25 deg or higher. A Mach number effect was noted at angles of attack of 30 deg or higher at the station where the nose strake was present. At this station, the suction peaks in the pressure distributions at the highest Mach number were reduced and much more symmetrical as compared to the lower Mach number pressure distributions. Author

N93-11605*# North Carolina State Univ., Raleigh.
EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF AFT BLOWING WITH VARIOUS NOZZLE EXIT GEOMETRIES ON A 3.0 CALIBER TANGENT OGIVE AT HIGH ANGLES OF ATTACK: FOREBODY PRESSURE DISTRIBUTIONS Final Technical Report

NDAONA CHOKANI and N. M. GITTNER 1 May 1992 93 p (Contract NCC1-46) (NASA-CR-190935; NAS 1.26:190935) Avail: CASI HC A05/MF A01

An experimental study of the effects of aft blowing on the asymmetric vortex flow of a slender, axisymmetric body at high angles of attack was conducted. A 3.0 caliber tangent ogive body fitted with a cylindrical afterbody was tested in a wind tunnel under subsonic, laminar flow test conditions. Asymmetric blowing from both a single nozzle and a double nozzle configuration, positioned near the body apex, was studied. Aft blowing was observed to alter the vortex asymmetry by moving the blowing-side vortex closer to the body surface while moving the non-blowing-side vortex further away from the body. The effect of increasing the blowing coefficient was to move the blowing-side vortex closer to the body surface at a more upstream location. The data also showed that blowing was more effective in altering the initial vortex asymmetry at the higher angles of attack than at the lower. The effects of changing the nozzle exit geometry were studied and it was observed that blowing from a nozzle with a low, broad exit geometry was more effective in reducing the vortex asymmetry than blowing from a high, narrow exit geometry. Author

N93-11610*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FURTHER BUFFETING TESTS IN A CRYOGENIC WIND TUNNEL

D. G. MABEY (Royal Aircraft Establishment, Bedford, England), R. P. BOYDEN, and W. G. JOHNSON, JR. Sep. 1992 55 p Previously announced as X92-71521 (Contract RTOP 505-59-30-01) (NASA-TM-107621; NAS 1.15:107621; RAE-TM-AERO-2231) Avail: CASI HC A04/MF A01

Further measurements of buffeting, using wing-root strain gauges, were made in the NASA Langley 0.3 m Cryogenic Wind Tunnel to refine techniques which will be used in larger cryogenic facilities such as the United States National Transonic Facility (NTF) and European Transonic Wind Tunnel (ETW). The questions addressed included the relative importance of variations in frequency parameter and Reynolds number, the choice of model material (considering both stiffness and damping) and the effects of static aeroelastic distortion. The main series of tests was made on half models of slender 65 deg delta wings with a sharp leading edge. The three delta wings had the same planform but widely different bending stiffness and frequencies (obtained by varying both the material and the thickness of the wings). It was known that the flow on this configuration would be insensitive to variations in Reynold number. Additional tests were made on one unswept half-wing of aspect ratio 1.5 with an NPL 9510 aerofoil section, known to be sensitive to variations in Reynolds number at transonic speeds. For brevity the test Mach numbers were restricted to $M = 0.21$ and 0.35 for the delta wings and to $M = 0.30$ for the unswept wing. Author

N93-11622*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-SPEED LONGITUDINAL AND LATERAL-DIRECTIONAL AERODYNAMIC CHARACTERISTICS OF THE X-31 CONFIGURATION

DANIEL W. BANKS, GREGORY M. GATLIN, and JOHN W. PAULSON, JR. Oct. 1992 340 p (Contract RTOP 505-68-30-04) (NASA-TM-4351; L-16921; NAS 1.15:4351) Avail: CASI HC A15/MF A03

An experimental investigation of a 19 pct. scale model of the X-31 configuration was completed in the Langley 14 x 22 Foot Subsonic Tunnel. This study was performed to determine the static low speed aerodynamic characteristics of the basic configuration over a large range of angle of attack and sideslip and to study the effects of strakes, leading-edge extensions (wing-body strakes), nose booms, speed-brake deployment, and inlet configurations. The ultimate purpose was to optimize the configuration for high angle of attack and maneuvering-flight conditions. The model was tested at angles of attack from -5 to 67 deg and at sideslip angles from -16 to 16 deg for speeds up to 190 knots (dynamic pressure of 120 psf). Author

N93-11742# Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.

EFFECTS OF SWEEP ON THE PHYSICS OF UNSTEADY SHOCK-INDUCED TURBULENT SEPARATED FLOWS Final Report, 1 Mar. 1989 - 30 Jun. 1991

DAVID S. DOLLING 10 Jan. 1992 43 p (Contract AF-AFOSR-0112-86) (AD-A247035; AFOSR-92-0154TR) Avail: CASI HC A03/MF A01

To examine the effects of sweepback on the unsteady separation in Mach 5 compression ramp interactions, fluctuating wall pressure measurements have been made upstream of the corner line in interactions generated by unswept, and 10, 20, 25, 30, 40, and 50 deg. swept models. The streamwise ramp angle was 28 deg. in all cases. The data were analyzed using standard time series analysis techniques and condition all sampling algorithms. The results show that in highly swept interactions (i.e., corner line sweeps greater than 25 deg.), the rms distributions of pressure fluctuations as well as the mean distributions are quasi-conically symmetric. Rms levels decrease globally with

increasing sweep as does the maximum rms generated by the translating separation shock. The length of the intermittent region, over which the separation shock foot translates, decreases with increasing sweep. In a given interaction, the length of the intermittent region grows spanwise. Dominant separation shock frequencies, observed in both surface pressure fluctuations and separation shock foot histories, increase from about 0.3 to 0.5 kHz for unswept flow to about 2-7 kHz in highly swept flows. In a given interaction, shock frequencies decrease spanwise. Separation shock dynamics defined in terms of the shock foot history and its statistics are essentially the same in all interactions. The separation shock foot position is normally distributed, and the mean shock velocities are essentially equal. The only difference is in the length of the region in which the separation shock moves. Higher frequencies are a direct result of the decrease in the length scale of the separation shock motion. GRA

N93-11876*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

BOUNDARY LAYER RELAMINARIZATION DEVICE Patent Application

THEODORE R. CREEL, inventor (to NASA) 7 Jan. 1992 13 p (NASA-CASE-LAR-14470-1; NAS 1.71:LAR-14470-1; US-PATENT-APPL-SN-823809) Avail: CASI HC A03/MF A01

Relamination of a boundary layer formed in supersonic flow over the leading edge of a swept airfoil is accomplished by means of at least one band, especially a quadrangular band, and most preferably a square band. Each band conforms to the leading edge and the upper and lower surfaces of the airfoil as an integral part thereof and extends perpendicularly from the leading edge. Each band has a height of about two times the thickness of the maximum expected boundary layer. NASA

N93-11882# Royal Aerospace Establishment, Bedford (England). Aerospace Div.

INTRODUCTION OF ELECTRONIC PRESSURE SCANNING AT THE ROYAL AEROSPACE ESTABLISHMENT

J. W. HOLMES Oct. 1991 28 p Presented at the 37th Instrument Society of America International Instrumentation Symposium, San Diego, CA, 5-9 May 1991 (RAE-TM-AERO-2222; BR305818; ETN-92-92304) Copyright Avail: CASI HC A03/MF A01

An electronic pressure scanning system was installed at the Royal Aerospace Establishment (England), and used to provide pressure data in wind tunnel tests in aircraft models. The results and conclusions from the laboratory experiments that were undertaken to assess the effectiveness of the system in the wind tunnel environment are presented. The system's performance during model tests in the first six months of tunnel running is discussed. It is shown that the system offers considerable savings in pressure data gathering times over mechanical pressure switches previously in use. Error analysis of the data from the system indicated that existing high measurement accuracy was retained. The advantages and disadvantages of using such a system are highlighted. ESA

N93-11883# Royal Aerospace Establishment, Bedford (England). Aerospace Div.

THE 13 FT BY 9 FT LOW SPEED WIND TUNNEL FACILITY AT DRA (AEROSPACE DIVISION) BEDFORD (ENGLAND)

M. N. CRIPPS 4 Dec. 1991 24 p Original contains color illustrations (RAE-TM-AERO-2228; BR308896; ETN-92-92305) Copyright Avail: CASI HC A03/MF A01

The Defence Research Agency (DRA) 13 ft by 9 ft low speed tunnel at the Royal Aerospace Establishment, Bedford (England), is described. The facility was commissioned in 1954 to provide low turbulence tests, concerning speeds up to 90 m/s at atmospheric pressure. The tunnel provides an ideal low speed research facility for both full and half models, with a range of support options for sting and strut mounted full models or floor mounted half models. Static and dynamic measurements can be made, along with a variety of flow visualization techniques, such

as liquid crystals, laser illuminated smoke screen, and microtufts. The tunnel has a fast start up and shut down time, requires minimal supervision by the user and has relatively low operating costs. ESA

N93-11886 Texas A&M Univ., College Station.
LEADING EDGE FILM COOKING HEAT TRANSFER INCLUDING THE EFFECT OF MAINSTREAM TURBULENCE
Ph.D. Thesis

SHICHUAN OU 1991 278 p

Avail: Univ. Microfilms Order No. DA9216993

The influence of high mainstream turbulence on the leading edge heat transfer coefficient and film effectiveness for film slots and film holes with three injection configurations (i.e., one row at plus or minus 15 deg, one row at plus or minus 40 deg, and two rows at plus or minus 15 deg and plus or minus 40 deg from the stagnation line) were studied experimentally for flow across a blunt body with a semi-cylinder leading edge and a flat afterbody. The cross sectional slot length-to-width ratio was equal to two. Adjacent slots in each row were spaced three cross-sectional slot lengths apart ($P = 3l$); however, adjacent holes in each row were spaced four hole-diameters apart ($P = 4d$). Each slot had the same cross-sectional area as each hole. All slots and holes were inclined at 30 deg and 90 deg to the surface in the spanwise and streamwise directions, respectively. The spanwise and streamwise distributions of heat transfer coefficient and film effectiveness were obtained under various conditions of the blowing ratio ($B = 0.4, 0.8, 1.2$), the mainstream turbulence levels ($Tu = 3.31-5.07$ percent generated by a bar grid and 7.59-9.67 percent generated by a passive grid), and the Reynolds numbers ($Re_{sub D} = 25,000, 40,000, 100,000$). The results show that, for one row injection, the heat transfer coefficient increases and the film effectiveness decreases with increasing blowing ratio. The film effectiveness reaches its maximum at blowing ratio of $B = 0.8$ for two row injection. The heat transfer coefficient increases and the film effectiveness decreases with increasing mainstream turbulence level at low blowing ratio. However, the mainstream turbulence effect decreases at high blowing ratio. Both the heat transfer coefficient and the film effectiveness increase with increasing mainstream Reynolds number. For one row injection, the film cooling performance decreases with increasing blowing ratio regardless of the mainstream turbulence level and the Reynolds number. For two row injection, the blowing ratio $B = 0.8$ provides the best film cooling performance, but the difference between $B = 0.8$ and $B = 0.4$ is small. Two row injection usually provides better performance than corresponding one row injection. The film cooling performance between two rows of slots ($P = 3l$) and two rows of holes ($P = 4d$) is comparable. The former performs slightly better than the latter at low mainstream turbulence, but the reverse is true at high mainstream turbulence. The blowing ratio $B = 0.8$ performs the best for both geometries at both low and high mainstream turbulence levels. The liquid crystal thermal visualization technique reveals that a blowing ratio of 0.8 or less is recommended for leading edge film cooling with two row injection. Dissert. Abstr.

N93-11899 Arizona State Univ., Tempe.

NUMERICAL STUDY OF ADVANCED ROTOR BLADES Ph.D. Thesis

GHASEM L. ABDY 1992 161 p

Avail: Univ. Microfilms Order No. DA9223078

In this study, the effect of rigid body motion on the aerodynamics of a blade in the context of computational fluid dynamics is investigated. Specifically, the feathering and flapping motion of a rigid blade is studied. The three dimensional Navier-Stokes equations are solved using an implicit, time-accurate, lower-upper decomposition method. The implicit method provides higher stability time limits with the additional advantage of time accurate analysis for unsteady flow problems. The inviscid part of the equations is cast into diagonal form using the characteristics of Euler equations. Only the convection terms are treated implicitly. The explicit treatment of viscous terms offers simpler finite difference equations suitable for analytic matrix inversion than time

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consuming numerical matrix inversion. The method benefits from a small computational work load and small computer memory requirements, and it is easily adapted for vectorization on vector machines. The computer code is used to investigate the flow over helicopter blades in hover and forward flight up to high angles of attack. The blade dynamics for a blade known as British Experimental Rotor Program (BERP) is computed in forward flight. Results show that the blade tip acts as an effective stall barrier and improves blade performance over the conventional blades.

Dissert. Abstr.

N93-12004*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

AN INVESTIGATION OF THE EFFECTS OF AFT BLOWING ON A 3.0 CALIBER TANGENT OGIVE BODY AT HIGH ANGLES OF ATTACK M.S. Thesis

NATHAN M. GITTNER 1992 100 p

(Contract NCC1-46)

(NASA-CR-190934; NAS 1.26:190934) Avail: CASI HC A05/MF A02

An experimental investigation of the effects of aft blowing on the asymmetric vortex flow of a slender, axisymmetric body at high angles of attack was conducted. A 3.0 caliber tangent ogive body fitted with a cylindrical afterbody was tested in a wind tunnel under subsonic, laminar flow test conditions. Asymmetric blowing from both a single nozzle and a double nozzle configuration, positioned near the body apex, was investigated. Aft blowing was observed to alter the vortex asymmetry by moving the blowing-side vortex closer to the body surface while moving the non-blowing-side vortex further away from the body. The effect of increasing the blowing coefficient was to move the blowing-side vortex closer to the body surface at a more upstream location. The data also showed that blowing was more effective in altering the initial vortex asymmetry at the higher angles of attack than at the lower. The effects of changing the nozzle exit geometry were investigated and it was observed that blowing from a nozzle with a low, broad exit geometry was more effective in reducing the vortex asymmetry than blowing from a high, narrow exit geometry. Author

N93-12063# Calspan-Buffalo Univ. Research Center, NY.

A PRELIMINARY STUDY ASSOCIATED WITH THE EXPERIMENTAL MEASUREMENT OF THE AERO-OPTIC CHARACTERISTICS OF HYPERSONIC CONFIGURATIONS Final Report, 10 Feb. 1991 - 9 Feb. 1992

MICHAEL S. HOLDEN Jun. 1992 158 p

(Contract F49620-91-C-0026)

(AD-A253792; AFOSR-92-0692TR) Avail: CASI HC A08/MF A02

A program of fundamental, experimental research and analysis has been conducted to design additional components necessary to modify, assemble and develop a ground-based facility (LENS) to duplicate flowfield environment around a hypersonic endo-atmospheric interceptor to evaluate optical seeker performance. Aero-optic instrumentation, used to measure the aero-optical characteristics of the viscous and shock layer over transpiration-and-filmed cooled nosetips at hypersonic speeds were also investigated. In the design of the facility, particular care was taken in designing the systems for a contamination-free hypersonic flow and in isolating the loads associated with the operation of the shock tunnel from the model support system and the aero-optic instrumentation. Five instrumentation systems, including holography, imagery, boresight/jitter, radiometry, and spectrometry were evaluated to provide consistent evaluation in ENDO-LEAP mission environments. State-of-the-art CFD codes with capabilities determining the inherent salient flowfield features such as turbulence and reacting chemistry were investigated and the GASP code was selected as the basic computational method. The stress levels and motion of shock tunnels were studied and analyzed using two approaches, a numeric marching code and a numeric solution to the wave equation. A flight test program based on existing sounding rocket technology was examined in order to design a high confidence flight test to validate the LENS ground test results. GRA

N93-12179# Army Natick Research and Development Command, MA.

THE DEGRADATION OF PARACHUTES: AGE AND MECHANICAL WEAR Final Report, Oct. 1988 - Sep. 1990

RONALD A. SEGARS May 1992 56 p

(Contract DA PROJ. 1L1-62786-D-283)

(AD-A252243; NATICK/TR-92/035) Avail: CASI HC A04/MF A01

New and previously published data involving the strength of parachute suspension cord are consolidated and critically analyzed for the purpose of extracting the effect of age (storage life) from the combined effect of age use (number of jumps). Test results from both new and used parachutes (some as old as 23 years) show that a 35 percent decrease in the tensile strength of parachute suspension cord (usually occurring within the first five year of service) can be attributed to use. Fluorescence measurements and mass spectral data obtained on samples selected from the previous in-house studies show no correlation between the strength of the parachute suspension cord and any of the fluorescence or mass spectral. This lack of correlation indicates that breakdown of nylon 66 is negligible in normally aged parachutes. This is consistent with the analysis of the strength data which shows a degradation rate of approximately 0.5 percent per year for unused parachutes under normal storage conditions. GRA

N93-12190 Purdue Univ., West Lafayette, IN.

UNSTEADY PROPELLER/WING AERODYNAMIC INTERACTIONS Ph.D. Thesis

ROBERT THOMAS JOHNSTON 1991 212 p

Avail: Univ. Microfilms Order No. DA9215573

The unsteady nature of the propeller slipstream interacting with a wing was studied by flow visualization and unsteady wing surface pressure measurements. This work has yielded information on the motion of the propeller wake as it passes over the wing. The flow field encountered in a propeller swirl recovery vane combination was investigated using a stator mounted downstream of a propeller. Flow visualization was done on the motion of the propeller helical vortex as it passes over the center of a 9.0 aspect ratio wing. Viscous dissipation at the leading edge causes the vortex to be severed, with the filaments ending on the upper and lower wing surface. The propeller tip vortex was found to experience significant spanwise displacements when passing across a lifting wing. An image vortex effect which deformed the propeller tip vortex was observed at the wing leading edge. Unsteady wing surface pressures in the propeller wake were measured by traversing a pressure instrumented wing section in a spanwise direction through the propeller wake. Inexpensive microphones proved to be suitable for pressure measurements of this type and were successfully utilized in this experiment. The propeller tip vortex was identifiable as a small region of low pressure relative to the rest of the wake. Vortex position on the wing was evident from contour plots of the pressures. Spanwise motions of the tip vortex were plotted and found to support an image vortex model proposed after the flow visualization tests. Chordwise motion of the tip vortex showed that for a lifting wing condition the upper surface vortex had a higher velocity than the lower surface. This observation of the chordwise speed agrees with what is expected for flow over lifting wing. Viscous action on the surface of the wing was attributed with decreasing the magnitude of the wing surface pressure fluctuations as the wake progressed along the wing surface. The vortex interaction encountered in the flow field of a propeller and a stator was investigated using smoke flow visualization. A stator at angle of attack was used to generate a line vortex which interacted with the helical vortex filaments generated by a propeller. Changes in the relative vortex strengths and vortex rotational directions yielded several distinct vortex structures. Axial flow in the vortex cores is determined to influence the development of the vortex interaction. Dissert. Abstr.

N93-12321*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

AN APPROACH TO CONSTRAINED AERODYNAMIC DESIGN WITH APPLICATION TO AIRFOILS

RICHARD L. CAMPBELL Nov. 1992 24 p
(Contract RTOP 505-59-10-03)
(NASA-TP-3260; L-17108; NAS 1.60:3260) Avail: CASI HC
A03/MF A01

An approach was developed for incorporating flow and geometric constraints into the Direct Iterative Surface Curvature (DISC) design method. In this approach, an initial target pressure distribution is developed using a set of control points. The chordwise locations and pressure levels of these points are initially estimated either from empirical relationships and observed characteristics of pressure distributions for a given class of airfoils or by fitting the points to an existing pressure distribution. These values are then automatically adjusted during the design process to satisfy the flow and geometric constraints. The flow constraints currently available are lift, wave drag, pitching moment, pressure gradient, and local pressure levels. The geometric constraint options include maximum thickness, local thickness, leading-edge radius, and a 'glove' constraint involving inner and outer bounding surfaces. This design method was also extended to include the successive constraint release (SCR) approach to constrained minimization. Author

N93-12343*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
STUDIES OF A FLAT WAKE ROTOR THEORY Final Report
H. C. CURTISS, JR. and R. M. MCKILLIP, JR. Oct. 1992 35 p
(Contract NAG1-1038)
(NASA-CR-190936; NAS 1.26:190936; MAE-T1960) Avail: CASI
HC A03/MF A01

A computer code was developed at Princeton University to calculate the velocity components in the flow field near a lifting rotor. The induced velocity components in the rotor flow field predicted by this theory are compared with experiment. It appears that on balance, this relatively simple theory gives a reasonable prediction of the average induced velocities in a rotor flow and is quite suitable for such applications as estimating the influence of the rotor wake on the tail surfaces of rotorcraft. The theory predicts that significant induced velocity components are present in all three flow directions in the wake at a lifting rotor. It should be noted, however, that there are a few experimental measurements of the longitudinal and lateral induced velocity components in the rotor wake. This theory, known as the flat wake theory, is essentially the rotary wing analog of Prandtl's lifting line theory. The theory is described in this report. Calculations based on the theory are presented and compared with a modern free wake theory. Author

N93-12344 Missouri Univ., Rolla.
NEW ACCELERATION POTENTIAL METHOD FOR SUPERSONIC UNSTEADY AERODYNAMICS OF LIFTING SURFACES, FURTHER EXTENSION OF THE NONPLANAR SUPERSONIC DOUBLET POINT METHOD, AND NONLINEAR, NONGRADIENT OPTIMIZED RATIONAL FUNCTION APPROXIMATIONS FOR SUPERSONIC, TRANSIENT RESPONSE UNSTEADY AERODYNAMICS Ph.D. Thesis
ASHISH TEWARI 1992 170 p
Avail: Univ. Microfilms Order No. DA9224685

A new method is devised for the calculation of pressure and aerodynamic influence coefficients on lifting-surface configurations oscillating in supersonic flow. The scheme is based upon the concept of the acceleration potential doublet and provides a simpler alternative to the Doublet Point method. The kernel function is expressed in a form analytic on the Mach boundary, and the nonplanar interference is treated by a finite-difference approximation. The normalwash is averaged over a trapezoidal averaging region instead of the rectangular region of the Doublet Point method. The concept of kernel separation into steady and unsteady parts is reserved for averaging regions lying directly downstream of the sending point. Good comparisons are observed with other methods. The nonplanar, supersonic Doublet-Point method is further extended to the treatment of surfaces with non-zero dihedral angle. Rational-function approximation in the Laplace domain with consistently optimized lag-states is presented

for supersonic unsteady aerodynamics. The new approximation provides the capability to predict the transient response of lifting-surfaces in supersonic flow by using an analytic continuation from pure oscillatory motion to a general motion. The lag-states in the resulting unsteady aerodynamic state-space form are determined through a nonlinear, nongradient optimization procedure. Repeated optimized lag-state values are replaced by a higher order pole in the rational unsteady aerodynamic transfer-function. Although the multiple-pole arises out of a repeated lag-state, its use in a non-repeated case drastically reduces the cost of optimization while retaining a fit accuracy as well as the total number of augmented states in the formulation. The rational function approximations are inadequate for transonic regime. Dissert. Abstr.

N93-12352# National Aerospace Lab., Tokyo (Japan).
Aeroengine Div.
AIR EJECTOR EXPERIMENTS USING THE TWO-DIMENSIONAL SUPERSONIC CASCADE TUNNEL: RELATIONSHIP BETWEEN EJECTOR PERFORMANCE AND THROAT AREA RATIO, PART 1 Report No. 2 [CHOUONSOKU NIJIGEN YORURETSU FUUDOU YOU KUUKI EZEKUTA NO JIKKEN. DAI 2 HOU: EZEKUTA SEINOU TO MENSEKIHI NO KANKEI, 1]
SUSUMU TAKAMORI and HAJIME SAKAGUCHI Dec. 1991
34 p In JAPANESE
(ISSN 0452-2982)
(NAL-TM-642-PT-1; JTN-92-80411) Avail: CASI HC A03/MF A01

To determine the feasibility of using an ejector as a suction pump for boundary layer air removal in the two dimensional supersonic cascade tunnel, especially when a portion of the tunnel's air supply is used for its primary flow, both subsonic and supersonic air ejector tests were conducted. The tested ejector was axially symmetrical and a center jet type, with its geometrical configuration being varied, i.e. the primary nozzle to mixing tube throat area ratio, and the straight mixing space (mixing tube) and diverging passage section (diffuser) lengths. These configuration changes enabled geometrical effects on ejector performance to be obtained. The experimental results on the air ejector's zero secondary flow performance were discussed in the first report, whereas this report presents the experimental results concerning the relationship between subsonic ejector performance and throat area ratio, i.e., the effects of the primary nozzle to mixing tube throat area ratio on the secondary flow rate of a subsonic ejector. Author (NASDA)

N93-12353*# National Aeronautics and Space Administration.
Hugh L. Dryden Flight Research Facility, Edwards, CA.
A SUMMARY OF THE FOREBODY HIGH-ANGLE-OF-ATTACK AERODYNAMICS RESEARCH ON THE F-18 AND THE X-29A AIRCRAFT
LISA J. BJARKE, JOHN H. DELFRATE, and DAVID F. FISHER
Nov. 1992 20 p Presented at the SAE Aerotech 1992 Conference, Anaheim, CA, 5-8 Oct. 1992
(Contract RTOP 505-68-71; RTOP 533-02-38)
(NASA-TM-104261; H-1862; NAS 1.15:104261; SAE-92-1996)
Avail: CASI HC A03/MF A01

High-angle-of-attack aerodynamic studies have been conducted on both the F18 High Alpha Research Vehicle (HARV) and the X-29A aircraft. Data obtained include on- and off-surface flow visualization and static pressure measurements on the forebody. Comparisons of similar results are made between the two aircraft where possible. The forebody shapes of the two aircraft are different and the X-29A forebody flow is affected by the addition of nose strakes and a flight test noseboom. The forebody flow field of the F-18 HARV is fairly symmetric at zero sideslip and has distinct, well-defined vortices. The X-29A forebody vortices are more diffuse and are sometimes asymmetric at zero sideslip. These asymmetries correlate with observed zero-sideslip aircraft yawing moments. Author

N93-12369# National Aerospace Lab., Kakuda (Japan).
MACH 4 TESTING OF SCRAMJET INLET MODELS Report No. 1 [MAHHA 4 NI OKERU SUKURAMUJETTO KUUKI TORIIREGUCHI NO JIKKEN, SONO 1]
 TAKESHI KANDA, TOMOYUKI KOMURO, GORO MASUYA, KENJI KUDO, ATSUO MURAKAMI, KOUICHIRO TANI, YOSHIO WAKAMATSU, and NOBUO CHINZEI Dec. 1991 57 p In JAPANESE
 (ISSN 0389-4010)

(NAL-TR-1137; JTN-92-80405) Avail: CASI HC A04/MF A01
 A parametric study of several scramjet inlet models was conducted in a Mach 4 wind tunnel. The investigated parameters were side plate sweep angle, contraction ratio, and cowl geometry. Wall and pitot pressures were measured and schlieren photographs were taken. A schlieren photograph of the shock pattern inside one of the models correlated well with calculation results. Both the mass capture ratio and total pressure recovery were found to be between 50 to 80 percent. Within the range of the present study, an optimum sweep angle and a cowl length which maximized total pressure recovery were obtained. Author (NASDA)

N93-12414# Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Aerodynamics.

NUMERICAL INVESTIGATIONS INTO THE BASE DRAG OF VARIOUS WEDGES USING THE BASE FLOW MODEL DEVELOPED BY MAURI TANNER

ESA SALMINEN and SEPPO LAINE 12 Jun. 1992 51 p (ISSN 0356-0864)

(REPT-B-36; ISBN-951-22-1042-8) Avail: CASI HC A04/MF A01
 The base flow model of Tanner for two-dimensional wedges is studied. The separation region is modeled to form a closed body behind the wedge. The flow past the wedge and the separation region, the form of which is systematically varied, is calculated using potential flow theory. Three wedges are studied: 5, 30, and 60 degrees. The potential flow is calculated using a low-order panel method. For the 60 degree-wedge, results are compared with experiments. Author

N93-12503# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.

WIND TUNNEL INVESTIGATION OF A TWIN-ENGINE JET TRANSPORT SEMI-SPAN MODEL WITH UPPER SURFACE BLOWN JET FLAP [SOUHATSU USB HANSAI MOKEI FUUDOU SHIKEN]

HITOSHI TAKAHASHI, HIROTOSHI FUJIEDA, AKIHITO IWASAKI, TOSHIMI FUJITA, and MASAKI SAITO (Kawasaki Heavy Industries Ltd., Kobe, Japan) Dec. 1991 46 p In JAPANESE
 (ISSN 0389-4010)

(NAL-TR-1134; JTN-92-80402) Avail: CASI HC A03/MF A01
 In parallel with the research and development conducted by the National Aerospace Laboratory (NAL) on the experimental aircraft 'ASKA', a Short TakeOff and Landing (STOL) Computer Aided Design (CAD) program for four engine Upper Surface Blowing (USB) aircraft was developed and refined. To apply this CAD program to twin and three engine USB aircraft, aerodynamic data must be acquired for twin engine USB aircraft. This led to the present study which modified the existing four engine USB semispan model into a twin engine model and subsequently conducted low speed wind tunnel tests. Resultant aerodynamic characteristics of the numerous aerodynamic elements included in this model are described. Author (NASDA)

AIR TRANSPORTATION AND SAFETY

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

**A93-10328
 COMPARISON OF TOXICITY RANKINGS OF SIX AIRCRAFT CABIN POLYMERS BY LETHALITY AND BY INCAPACITATION IN RATS**

DONALD C. SANDERS, BOYD R. ENDECOTT, and ARVIND K. CHATURVEDI (FAA, Civil Aeromedical Inst., Oklahoma City) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 63, no. 10 Oct. 1992 p. 870-874. refs
 Copyright

Polymeric aircraft cabin materials have the potential to produce toxic gases in fires. Lethality (LC50) in animal models is a standard index to rank polymers on the basis of their combustion toxicity. However, the use of times-to-incapacitation (ti) may be more realistic for predicting relative escape times from a fire. Therefore, LC50 and ti for polymers, polyamide (I), polystyrene (II), Nylon 6/6 (III), polysulfone (IV), polyethylene (V) and chlorinated polyethylene (VI), of different chemical classes were determined and compared. Male rats, 12/fuel loading, were exposed to the pyrolysis products from selected weights of each polymer for 30 min in a 265-L combustion/exposure system, and LC50 values were determined following a 14-d observation period. For each polymer, ti was measured at 16 g and at its respective LC50 using the inability of rats to walk in rotating cages as a criterion for incapacitation. LC50 (45.7-87.5 mg/L) of the polymers increased in the order of 1, (II about equal to 111), IV, V, VI, while their ti (6.6-21.1 min) at 16 g (60 mg/L) increased in the order of (III about equal to I), (V about equal to II), VI, IV. Based on ti at LC50, polymers were grouped into III and V; I, II and VI; and IV. LC50 and ti did not exhibit the same relative toxic hazard rankings for these polymers; ti were also not equal at the LC50 concentrations. These findings demonstrate the possible involvement of different mechanisms of action for the combustion products of these polymers at the selected end points. Author

**A93-11364
 THE IMPROVEMENT OF THE STATIC LAUNCH METHOD IN JAPAN**

J. NISHIMURA, H. HIROSAWA, N. YAJIMA, S. OHTA, H. AKIYAMA, M. FUJII, T. YAMAGAMI, M. NAMIKI, Y. OKABE, and Y. MATSUZAKA (Inst. of Space and Astronautical Science, Sagami-hara, Japan) Advances in Space Research (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 63-66. refs
 Copyright

We have improved the static launch method to reduce the shock for the scientific instruments during launching and to increase the ability of launching heavier payloads. In the launch method, the entire balloon train is extended vertically before launch. The launch condition in the system is satisfactory, for both lowering shock while launching and maintaining stability of the payload when the balloon lift is equally divided to the launch rope and the payload suspension rope. Under the new launch method, a payload of more than 1000 kgs has been successfully launched with the launching shock of about 0.3G. Author

**A93-11366
 TRANS-OCEANIC, POLAR PATROL BALLOONS AND FUTURE PROSPECTS**

J. NISHIMURA (Inst. of Space and Astronautical Science, Sagami-hara, Japan) Advances in Space Research (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 77-85. refs
 Copyright

Two long-duration scientific balloon concepts are described in the context of an investigation of a one-week balloon flight with payload recovery. Transoceanic flights between China and Japan

are assessed in terms of their meteorological feasibility based on high-altitude wind data. Telemetry, command, and tracking systems are described that are appropriate for these types of flights with attention given to results of balloon performance. Test flights are also reported of zero-pressure Polar Patrol Balloons to perform circumpolar flights, and ballast consumption and balloon trajectories are analyzed. Also reviewed is a concept for a satellite-linked balloons that follow a 'boomerang' trajectory that is shown to be practical. The use of superpressure balloons is shown to be important for these long-duration projects, and the Polar Patrol Balloon is reported to have completed three-week flight that demonstrates long-duration capabilities. C.C.S.

A93-11367**THE GRAD SUPERNOVA OBSERVER - FIRST FLIGHT OF A VERY LARGE BALLOON OVER ANTARCTICA**

A. C. RESTER (Florida Univ., Alachua) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 87-99. Research supported by DARPA refs (Contract N00014-87-G-1259; NSF DPP-87-15809) Copyright

The flight of a very large zero-pressure balloon over Antarctica is reported in which a gamma-ray detector was carried to study SN1987A, and the results are analyzed to make recommendations on long-duration flights. The detector payload weighed about 1000 kg and required a balloon with a volume of 330,000 cu m to maintain the required altitude of 36.6 km. The conditions of the mission are described in detail emphasizing the wind patterns at float altitude and launch and flight performance. The project accomplished successful launch, three-day flight, tracking with ARGOS, and datalink with an airborne telemetry station. It is recommended that Antarctic balloon flights utilize simple experimental payloads that are integrated before arrival in Antarctica. Both the pointing and the retrieval of the instruments and payload are shown to be difficult components of the mission. C.C.S.

A93-11372**TRANS-OCEANIC BALLOON FLIGHT OVER EAST CHINA SEA**

N. YAJIMA, H. HIROSAWA, H. AKIYAMA, S. OHTA, M. FUJI, T. YAMAGAMI, M. NAMIKI, Y. MATSUZAKA, Y. OKABE, J. NISHIMURA (Inst. of Space and Astronautical Science, Sagami-hara, Japan) et al. *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 123-126. refs Copyright

Trans-oceanic flights between Japan and China have been successfully carried out for three years (from 1986 to 1988), and nine balloons were launched from Kyushu Island toward China. Although two flights were terminated due to balloon problems during ascending phase, seven balloons reached China successfully and those payload were recovered in the inland of China. During the long duration flights lasting for more than ten hours, the scientific objectives were accomplished by the scientists of both countries in collaboration and many useful data could be obtained. Author

A93-11373**POLAR PATROL BALLOON EXPERIMENT IN ANTARCTICA**

M. EJIRI, A. KADOKURA, T. HIRASAWA, N. SATO, R. FUJII, H. MIYAOKA (National Inst. of Polar Research, Tokyo, Japan), J. NISHIMURA, N. YAJIMA, T. YAMAGAMI (Inst. of Space and Astronautical Science, Sagami-hara, Japan), S. KOKUBUN (Tokyo Univ., Japan) et al. *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 127-130. refs Copyright

A long-term circumpolar balloon experiment called Polar Patrol Balloon (PPB) project aims at establishing a station network in the stratosphere over the Antarctic region for geophysical and astrophysical observations. Three test flights in 1987 and 1990 show that the PPB would come back to the launching site. This paper reports unique advantages of this PPB experiment and briefly reviews the past PPB experiments. Author

A93-11383* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

SCIENTIFIC BALLOONING PAYLOAD TERMINATION LOADS

E. ROBBINS (New Mexico State Univ.; NASA, Wallops Flight Facility, Wallops Island, VA) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 181-184. refs Copyright

NASA's high altitude balloon borne scientific payloads are typically suspended from a deployed flat circular parachute. At flight termination, the recovery train is pyrotechnically separated at the parachute apex and balloon nadir interface. The release of elastic energy stored in the parachute at zero initial vertical velocity in the rarefied atmosphere produces high canopy opening forces that subject the gondola to potentially damaging shock loads. Data from terminations occurring at altitudes to 40 km with payloads up to 2500 kg on parachutes up to 40 m in diameter are presented. Measured loads are markedly larger than encountered via packed parachute deployment for similar canopy loadings. Canopy inflation is significantly suppressed in the early stages and then accelerated during final blossoming. Data interpretation and behavioral phenomena are discussed along with proposed shock attenuation techniques. Author

A93-11384**RESONANCE FREQUENCIES OF A GONDOLA SUBMITTED TO A FORCED ROTATION UNDER A STRATOSPHERIC BALLOON**

J. P. DUCARTERON and J. P. TREILHOU (Centre d'Etude Spatiale des Rayonnements, Toulouse, France) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 185-188. Copyright

This analysis studies the resonance frequencies of a gondola suspended from a stratospheric balloon to evaluate the effects on magnetic-field measurements by three-axis magnetometers. Attention is given to the torsional oscillations in a quiet atmosphere, assumed vertical oscillations, and the potential for double- and triple-pendulum motion in a disturbed atmosphere. It is found that the magnetometers are affected by the mechanical oscillations, although the effects can be filtered or measured independently for data treatment. C.C.S.

A93-11498**BREAKING THROUGH THE 10 EXP 6 BARRIER**

RONALD W. HOWARD (GEC Avionics, Ltd., Rochester, United Kingdom) *Aeronautical Journal* (ISSN 0001-9240) vol. 96, no. 957 Aug.-Sept. 1992 p. 260-270. refs Copyright

Possible means for overall increase in the safety of air transport are discussed using the fatal accident levels as presented by the statistics. It is suggested that planned improvements quantified by statistical safety assessment methods will be required in future. This assessment should encompass the totality of an integrated air transport system, air traffic management, flight operations management, and air navigation systems in isolation. An integrated systems approach should be used for setting new targets for overall safety. O.G.

A93-12367**REVIEW OF HUMAN ERROR ACCIDENTS IN CIVIL AVIATION**

H. S. KHOLA (Civil Aviation and Technical Centre, New Delhi, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267) vol. 44, no. 2 May 1992 p. 123-127.

A critical examination of civil aviation accidents during 1980-89 in India and worldwide is presented with attention given to the overall contribution of human error to the statistics. A total of 162 accidents are investigated showing that 76 percent of the accidents are due in some respect to human error. The errors are subdivided into deliberate errors (17 percent), skill errors (35 percent), and inadvertent errors (24 percent), and some strategies for reducing each category are advanced. C.C.S.

03 AIR TRANSPORTATION AND SAFETY

A93-12372

SLICING MODEL FOR FOREIGN SOFT-BODY OBJECTS IMPACTING ON BLADE ROWS

JING YIN and WEI CHEN (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 24, no. 4 Aug. 1992 p. 403-408. In Chinese. refs

The impacts caused by birds, hail, and ice slabs are all called the foreign soft-body object impacts. At first the foreign soft-body objects ingested into engines with air are cut into slices by the chopping action of the first-stage fan blades or compressor blades. It is the slice of foreign soft-body object that impacts on a blade. Thus, it is necessary to determine first the geometry and mass of the slices of bird or ice, formed by rotating fan or compressor blades. In this paper, the expressions which determine the geometry and mass of the greatest slice of birds, ice spheres, and ice slabs are derived in detail. As an example, the computations are conducted for some type of engine. The geometry and mass of the greatest slice are obtained for the birds of different sizes, and for the ice spheres of different diameters. Author

A93-13630

NEW LAMPS FOR OLD - SAFETY REGULATION THROUGH STRUCTURAL AIRWORTHINESS STANDARDS

A. J. EMMERSON (Civil Aviation Authority of Australia, Safety Regulation and Standards Div., Canberra, Australia) In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 67-94. refs

Copyright

The purpose and evolution of safety regulations based on airworthiness standards are discussed to propose guidelines for incorporating fracture mechanics into structural inspections. The numbers of air-safety occurrences in which fatigue is a causal factor is shown to be significant, and standards development is argued to be evolutionary and based on crises as catalysts of change. Key safety margins should be incorporated into the design standards for such effects as high-speed upsets, gust alleviation, and the use of automatic flight controls. The approach developed in a 1973 international symposium is examined and shown to predict problems in fuselage lap joints and multiple site damage at fasteners. However, the structural details were often not inspected or considered critical, and crack initiation and loading characteristics should be part of the structural standards. Specific standards are proposed for fiber-reinforced plastics based on damage tolerance as well as structural airworthiness. C.C.S.

N93-11319# Deutsche Lufthansa A.G., Cologne (Germany).

ACTIVITIES REPORT OF LUFTHANSA Annual Report, 1990 [LUFTHANSA DAS JAHR 1990]

ROLF-DIETER GRASS, ed. 1990 72 p In GERMAN (ISSN 0722-3838) (ETN-92-92100) Avail: CASI HC A04/MF A01

The following are reported: an 8.4 percent turnover increase in 1990; an important investment program in order to increase and renew the fleet; prospects in international competition for Europe, North America, South America, Asia, Africa, the Near East, and Germany following German reunification; a new freightage strategy; the personnel education program; Lufthansa commercial plane characteristics; the development of an environmental program, with a view to reducing pollution and fuel consumption; the construction of a new aircraft enameling hall for 'aquastripping', a newly patented process for taking enamel off the plane surfaces; and the use of solid enamel containing less solvent, to drastically reduce noxious solvent vapor emissions. ESA

N93-11357 Civil Aviation Authority, London (England).

UK AIRMISSES INVOLVING COMMERCIAL AIR TRANSPORT, MAY-AUGUST 1991

1992 34 p (ISSN 0951-6301)

(ETN-92-92260) Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratten Road, Cheltenham, England

In the introduction the following are briefly discussed: origination of an airmiss; purpose of airmiss reports; investigation of airmiss reports; categorization of airmisses; involvement of commercial air transport aircraft; airmisses related to flying hours. Tabulated statistics of the following are presented: the number of incidents of commercial air transport airmisses; commercial air transport aircraft involved in airmisses; commercial air transport airmisses related to flying hours. Reports in the commercial air transport airmisses from May - Aug. 1991 are presented. These contain summaries of: pilot reports, transcripts of relevant RT frequencies, radar video recordings, and reports from appropriate air traffic control and operating authorities. The working groups discussion is summarized, and the risk and cause assessed. ESA

N93-11375 Bundesanstalt fuer Flugsicherung, Frankfurt am Main (Germany).

ACTIVITIES REPORT OF THE GERMAN INSTITUTE FOR FLIGHT SAFETY Annual Report, 1990 [JAHRESBERICHT DER BUNDESANSTALT FUER FLUGSICHERUNG 1990]

1990 49 p In GERMAN

(ETN-92-92272) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldsdorfen 2, Germany

Subjects reported cover: execution of air traffic services, operative control home record tape printing system maintenance, flight data processing in aeronautical telecommunication service, measures taken for increasing safety and regularity during flight operations, air traffic accidents in German air space, faults against air traffic rules, description of the Cooperative Air Traffic Management Concept (CATMAC), air traffic development statistics, navigation and radiotelephony techniques, information communication techniques, radar techniques, the Coordination Center for Military Aerospace Utilization (COMIL), simulation techniques, testing, investments, personnel, regional stations. ESA

N93-11471# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: ATLANTIC SOUTHEAST AIRLINES, INC. FLIGHT 2311, UNCONTROLLED COLLISION WITH TERRAIN, AN EMBRAER EMB-120, N270AS, BRUNSWICK, GEORGIA, 5 APRIL 1991

28 Apr. 1992 51 p

(PB92-910403; NTSB/AAR-92/03) Avail: CASI HC A04/MF A01

This report explains the loss of control, in flight, and crash of Atlantic Southeast Airlines, Inc., Flight 2311, while the airplane was conducting a landing approach to runway 07 at the Glyco Jetport, Brunswick, Georgia. The safety issues discussed in the report include the certification and inspection requirements for the Hamilton Standard model 14RF and other model propeller systems, and the scheduling of reduced flightcrew rest periods that are beyond the intent of Federal regulations. Safety recommendations concerning these issues were made to the Federal Aviation Administration, Atlantic Southeast Airlines, Inc., and the Regional Airline Association. GRA

N93-12193# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: EXPLOSIVE DECOMPRESSION-LOSS OF CARGO DOOR IN FLIGHT, UNITED AIRLINES FLIGHT 811, BOEING 747-122, N4713U, HONOLULU, HI, 24 FEBRUARY 1989

18 Mar. 1992 116 p Supersedes PB90-910401

(PB92-910402; NTSB/AAR-92/02) Avail: CASI HC A06/MF A02

The report explains the explosive decompression resulting from the loss of a cargo door inflight on United Airlines flight 811, a Boeing 747-122, near Honolulu, Hawaii, on 24 Feb. 1989. The safety issues discussed in the report are the design and certification of the B-747 cargo doors, the operation and maintenance to assure the continuing airworthiness of the doors, and emergency response. Recommendations concerning these issues were made to the

Federal Aviation Administration, the State of Hawaii, and the U.S. Department of Defense. GRA

N93-12489# Air Force Systems Command, Wright-Patterson AFB, OH.

EVALUATION OF CKU-5/A EJECTION SEAT CATAPULTS UNDER VARIED ACCELERATION LEVELS Final Report, Aug. 1987 - Mar. 1991

JAMES W. BRINKLEY and CARL G. TOLER May 1991 134 p (Contract AF PROJ. 7231)

(AD-A248021; AL-TR-1991-0111) Avail: CASI HC A07/MF A02

Post accident investigations of high performance aircraft, such as the F-16, led to the concern about the performance of the ACES 2 ejection seat catapult (CKU-5/A) loaded by an impressed acceleration. In response to this concern, eight catapults were tested using a horizontal deceleration facility in cooperation with the F-16 System Program Office, the Life Support System Program Office, and the Naval Ordnance Station at Indian Head, Maryland. The objective of the tests was to evaluate the performance of the ACES 2 CKU-5/A catapult operating at impressed acceleration levels of 0, 3.5, and 7 G in the +Z axis. Analysis of the test results indicates that, although the velocity at separation was not significantly affected, significant delays in time to first motion and time to catapult strip-off occurred. Furthermore, critically high accelerations will be imparted to the ejection seat and crewmember. The Dynamic Response Index Modeling Technique was used to estimate the probability of injury from the catapult acceleration data. The probability of spinal injury increases from less than 1 percent at the 0-G level to greater than 99 percent at the 7-G level. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A93-10782

PRECISION NAVIGATION WITH AN INTEGRATED NAVIGATION SYSTEM [PRAEZISIONSNAVIGATION MIT EINEM INTEGRIERTEN NAVIGATIONSSYSTEM]

B. TIEMEYER (Technische Univ., Braunschweig, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 257-262. In German. Research supported by DGLR refs

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The system concept of the integrated navigation system of the Institute for Flight Guidance, Technical University of Braunschweig, is used to explain satellite components and inertial navigation and system integration using a Kalman filter technique. The Institute's research aircraft is used to show that an integrated system can fulfill the accuracy requirements of ICAO CAT III for precision landing even under satellite masking conditions. C.D.

A93-10976

IEEE PLANS '92 - POSITION LOCATION AND NAVIGATION SYMPOSIUM, MONTEREY, CA, MAR. 24-27, 1992, RECORD

New York Institute of Electrical and Electronics Engineers, Inc. 1992 577 p.

(ISBN 0-7803-0469-1) Copyright

Various papers on position location and navigation are presented. The general topics addressed include: space-based navigation systems; inertial technology; radio navigation systems; positioning, pointing, and stability of space systems; integrated comm/nav/surveillance systems and avionics; GPS equipment and applications; integrated navigation, targeting, and control; civil aviation and marine navigation/traffic control; GPS equipment and military applications; differential GPS, integrated GPS/inertial navigation; survey mapping applications; GPS system integrity;

geodesy, gravity measurement, and earth sciences; surface vehicle NAV positioning and information systems. (For individual items see A93-10977 to A93-11044) C.D.

A93-10977

PROGRESS TOWARDS JOINT CIVIL USE OF GPS AND GLONASS

P. DALY (Leeds Univ., United Kingdom) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 1-6. refs Copyright

Navstar GPS (Global Positioning System) and GLONASS are approaching the onset of their operational phases, probably reaching full global, continuous 3-D coverage during the period 1994-95. GPS and GLONASS are intended to operate as stand-alone systems, but much discussion has revolved around the question of the joint use of GPS and GLONASS for civil applications, perhaps augmented by a small number of geostationary satellites to be provided by Inmarsat. Of particular interest in this regard are the plans of the civil aviation community to use GNSS as a supplementary and later as a sole-means navigation system. I.E.

A93-10981

CIVIL STANDARDIZATION OF THE GLOBAL POSITIONING SYSTEM FOR THE AVIATION COMMUNITY

ANDREW NELSON (Booz, Allen & Hamilton, Inc., Bethesda, MD) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 27-31. Copyright

The author describes the international standardization process required for the eventual use of the GPS (Global Positioning System) in an aviation mission role. He provides a brief overview of the ICAO (International Civil Aviation Organization), addresses issues regarding the standardization process as it applies to GPS (or its successor), considers the ICAO standardization process, and gives an example of the standardization process based on the Microwave Landing System (MLS) development. I.E.

A93-10987

MERGER AND ACQUISITION - ENHANCING LORAN PROPAGATION TECHNOLOGY WITH ARTIFICIAL INTELLIGENCE

FRANKLIN D. MACKENZIE and FRANCIS J. COYNE (DOT, National Transportation Systems Center, Cambridge, MA) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 74-81. refs Copyright

In November 1993 NFOLDS's (National Field Office for Loran Data Support) work-but not its expert staff-will move to the FAA in Oklahoma City. To recreate NFOLDS's skills in detecting data anomalies, a merger of artificial intelligence and propagation technology has been designed into the system. The authors describe the use of a neural network acting on Loran data to classify anomalies. They also describe an expert system for Loran area monitors (EXSLAM) to aid operators in managing data collection. It is concluded that the use of artificial intelligence will preserve the quality of Loran data and enhance its value to the scientific community. I.E.

A93-10988

MEASUREMENT TECHNIQUE FOR LORAN-C PULSE WAVE DISTORTION MEASURES AND PERFORMANCE IN AN ENVIRONMENT OF NOISE

NOBUYOSHI KOUJUCHI (Kobe Univ. of Mercantile Marine, Japan), MASASHI SATO (Osaka Sangyo Univ., Japan), and NORIHIKO MORINAGA (Osaka Univ., Suita, Japan) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Electronics Engineers, Inc. 1992 p. 82-87. refs
Copyright

The Loran-C system suffers an individual additional secondary factor (ASF) error on each propagation path from a transmitter to a receiver. The authors propose a method to predict ASF error values using self-contained pulse distortion measures (charge of half cycle length and envelope-to-cycle difference) on the received waves and show that the ASF error over mixed propagation paths can be reduced by these distortion measures. They describe a measurement technique for Loran-C pulse wave distortion measures and present analysis and simulation results of the performances of those measures in an environment of AWGN (adaptive white Gaussian noise) models. I.E.

A93-10998 AUTOMATIC DEPENDANT SURVEILLANCE FOCUS OF CIVIL AVIONICS INTEGRATION

B. R. CLIMIE *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 162-166. refs
Copyright

The International Civil Aviation Organization (ICAO) has developed a concept for an integrated, global air navigation system focused on satellite technology for the 21st Century. Automatic dependant surveillance (ADS) is a key element of this system and the center of integration. ADS extracts aircraft position and intent information from the onboard navigation system and transmits these vital data by means of automatic data link systems to ground facilities. Further, the ADS functionality is being integrated into multifunction software. In future aircraft, such as the Boeing B-777, the software will use robust partitioning techniques supported by a multifunction host computer. In other applications, ADS is being incorporated as another function within existing flight management computers. Civil aviation administrations and aircraft operators see ADS as the vehicle for early and significant improvements in safety and efficiency in air traffic management. Thus, the civil aviation community is being driven by the promise of early benefits to take major steps in extending functional and software integration in avionic systems. I.E.

A93-10999 AUTOMATIC DEPENDENT SURVEILLANCE (ADS) PACIFIC ENGINEERING TRIALS (PET)

PETER L. MASSOGLIA and ROBERT D. TILL (FAA, Washington) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 167-172. refs

The Federal Aviation Administration (FAA) Technical Center is conducting automatic dependent surveillance (ADS) engineering trials over the Pacific Ocean region in cooperation with the governments of Japan and Australia and participating airlines. The objective of the program is to gain early experience with ADS and satellite data link. Test flights began with a United Airlines B-747-400 aircraft in a flight from San Francisco to Singapore in September 1990. The avionics used in the initial testing are designed to a subset of international standards and are expected to evolve as the program matures. One phase of the program will demonstrate whether satellite position reports can replace oceanic HF radio voice progress reports. The data link experience gained with controllers will be used for implementation and future enhancements to the Oceanic Program. Data collected during these tests may be used to certify the satellite link for transmission of Aeronautical Mobile Satellite Safety Services. I.E.

A93-11004 DEVELOPMENT OF A TRN/INS/GPS INTEGRATED NAVIGATION SYSTEM

MICHAEL A. G. PETERS (National Aerospace Lab., Amsterdam, Netherlands) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record

New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 202-208.

Copyright

The National Aerospace Laboratory (NLR) has been awarded a contract by the Netherlands Ministry of Defense for the investigation and development of a TRN/INS/GPS (terrain reference navigation system/inertial navigation system/Global Positioning System) integrated navigation system. The integrated system should be capable of providing degraded modes. The three navigation sensors and a dedicated processing unit (for data merging) were configured around a MIL-STD-1553B digital data bus. Due to the inherent complexity of the integrated navigation system, much emphasis was given to careful testing of this system. Initial flight test results indicate that the integrated navigation system showed good performance, even when the performance of the individual sensors was deteriorated. I.E.

A93-11005 INTEGRATING TCAS INTO THE AIRSPACE MANAGEMENT SYSTEM

JAMES A. DECKERT (Honeywell, Inc., Minneapolis, MN) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 218-222. Copyright

It is suggested that TCAS-II (Traffic Alert/Collision Avoidance System II) will evolve from its limited collision-avoidance-only role to become an integral part of the airspace management system. Benefits will be cooperative air traffic procedures, reduced separations, and independent routings. I.E.

A93-11006 A MINIMUM RATE OF POSITION REPORTING IN THE FUTURE OCEANIC AIR TRAFFIC CONTROL SYSTEM

BENNETT FLAX (FAA, Technical Center, Washington) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 223-230. refs

The automatic dependent surveillance (ADS) system, currently under development, will enable aircraft to automatically send reports of their positions through communication satellites to ground-based air traffic control (ATC) centers. The author illustrates, through a simple example, how operational requirements can be applied to determine parameters of the interface between the ADS system and the oceanic ATC system it will support. I.E.

A93-11007 CAPACITY AS A CONSIDERATION FOR PROVIDING AERONAUTICAL MOBILE SATELLITE AIR TRAFFIC SERVICES IN THE U.S. DOMESTIC AIRSPACE

CURTIS A. SHIVELY (Mitre Corp., McLean, VA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 231-239. refs
Copyright

International standards are being developed by the International Civil Aviation Organization for an Aeronautical Mobile-Satellite Service (AMSS). Moreover, the American Mobile Satellite Corporation (AMSC) is constructing a satellite communications that could provide this service in US domestic airspace. The author describes a preliminary analysis of the capacity (number of aircraft) that could be handled by the first-generation AMSC system in the early part of the 21st century. The analysis is based on assumptions for the service demand, the Aeronautical Telecommunications Network (ATN), the communications scheme, the satellite channel, and the aircraft earth station (AES). Capacity is examined in terms of spectral bandwidth required and satellite power limitations. Service demand is for data link messages for the air traffic services functions of the AMSS. Sensitivity of the results is examined with regard to (1) variations in service demand, (2) spectral efficiencies of different modulation techniques, (3) aircraft antenna equipage,

high-gain or low-gain, and (4) the amount of overhead associated with the ATN. I.E.

**A93-11008
FLIGHT MANAGEMENT SYSTEMS INFORMATION EXCHANGE
WITH AERA TO SUPPORT FUTURE AIR TRAFFIC CONTROL
CONCEPTS**

SATISH C. MOHLEJI (Mitre Corp., McLean, VA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 240-247. refs (Contract DTFA01-89-C-00001)
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A goal of the future Air Traffic Control (ATC) system is to permit aircraft to fly according to their preferences (e.g., direct routes and optimum altitudes). Towards this goal, advanced automated en route ATC (AERA) concepts are currently in the research and development phase to provide a gradual evolution of ATC automation capabilities. The airborne flight management systems (FMSs) can provide accurate information on aircraft states needed to meet the automation objectives of advanced AERA concepts. The impact of user-preferred flight paths and altitudes on future ATC operations is analyzed. The results highlight potential fuel savings for the airspace users. Air/ground functional integration and information flow are discussed to minimize data ambiguities, and to reduce duplication of data in the airborne and ground computers. For a future operating environment, with the role of pilot as the manager of the flight, while the ATC personnel manage the airspace, computer/human interface requirements are also addressed. Key technical issues which must be addressed in order for the ground system to support flexible use of airspace, and increase system capacity in a diverse mix of aircraft operations are identified. The results presented show that FMS-equipped aircraft could realize significant fuel savings if permitted to fly preferred altitudes using step climbs. In order to achieve these benefits under all operating conditions, advanced ATC concepts such as AERA will need to accurately estimate and predict aircraft states. I.E.

**A93-11009
REQUIREMENTS FOR INTEGRATED FLIGHT AND TRAFFIC
MANAGEMENT DURING FINAL APPROACH**

J. A. SORENSEN, C. G. HUNTER, and M. M. SHEN (Seagull Technology, Inc., Sunnyvale, CA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 248-255. Research supported by FAA refs
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It is pointed out that significant runway throughput is lost due to ineffective control of aircraft spacing during final approach. The solution is to integrate the terminal air traffic management (ATM) automation process with cockpit avionics via data link. Components of the ultimate integrated ATM-cockpit design might include (a) an ATM spacing algorithm that accounts for wake vortex and runway occupancy spacing constraints; (b) downlink of desired final approach speed profile; (c) uplink of desired spacing and threshold crossing times; (d) a heads-up traffic display to provide pilot spacing guidance; (e) a flight management system to drive the aircraft to meet timing requirements; and (f) an ATM display to allow close monitoring of the landing process. The research required to develop this integrated ATM-cockpit concept is presented. I.E.

**A93-11010
DME/P CRITICAL AREA DETERMINATION ON MESSAGE
PASSING PROCESSORS**

M. CELENK, M. DIBENEDDETTO, and J. RAJENDRAN (Ohio Univ., Athens) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 261-268. refs
Copyright

The authors discuss research whose objective is to optimize the simulation process required for development of the Precision Distance Measuring Equipment (DME/P) critical area guidance material. This material is developed from the analysis of error contour plots, which provide the guidance system errors along the desired approach path due to signal scattering from a surface vehicle. The contour data are generated by executing the Microwave Landing System (MLS) mathematical model considering a interfering surface vehicle positioned at selected locations on an M x N grid and analyzing the model data as described. Optimal grid spacing is necessary to accurately describe the errors as a function of surface vehicle location while minimizing the simulation time required. A method based on the two-dimensional fast Fourier transform is described to estimate the spatial frequency spectrum of the contour data. Once spectral estimates become available, the optimal grid spacing is obtained using the Nyquist sampling theorem. To further reduce the overall processing time of this task, parallel processing is desired. A technique for parallel implementation on a Symult S-2010 message passing system is presented. I.E.

**A93-11012
INTEGRATION OF FULL SCALE DEVELOPMENT AIRCRAFT
GPS USER EQUIPMENT (AN/ARN-151) WITH DOPPLER
RADAR SYSTEMS**

R. MULLEN, B. TANJU, M. MAY (U.S. Navy, Naval Air Development Center, Warminster, PA), C. MANNIS, C. SIVES, and M. ENGELHART (Galaxy Scientific Corp., Mays Landing, NJ) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 276-283. refs
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Tests of a full-scale development aircraft GPS (Global Positioning System) user equipment (AN/ARN-151) Receiver-3A integrated with a simulated DRS (Doppler radar system) via a mission computer MIL-STD-1553B bus were performed. Test conditions were particularized to an SH-60F platform as a baseline; specific test conclusions should not be generalized to embedded GPS/DRS suites or other GPS/DRS integrations. The simulation results indicate that overall benefits in the areas of satellite acquisition/reacquisition, antijamming performance, and performance during degraded satellite availability accrue when the Receiver-3A is integrated with the Doppler system. Without Doppler aiding, the Receiver-3A under conditions of jamming-to-signal ratios greater than 42 dB or under conditions of two or less satellite availability would potentially have an unbounded position error growth. With Doppler aiding, the acquisition/reacquisition process is improved, the antijamming margin is increased by at least 10 dB, and position error growth is always bounded by (at worst) Doppler position error growth. I.E.

**A93-11013
ARCHITECTURES AND GPS/INS INTEGRATION - IMPACT ON
MISSION ACCOMPLISHMENT**

ZDZISLAW H. LEWANTOWICZ (USAF, Wright Lab., Wright-Patterson AFB, OH) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 284-289. refs

It is pointed out that the GPS (Global Positioning System) signal contains information which, when properly combined with information from INS (inertial navigation system) and other sensors, provides exceptionally high-accuracy position, velocity, attitude, and time information. These ten elements of information (three each in position, velocity, and attitude, and one in time) are common, in various combinations, to most of the avionics functions. When viewed from a system perspective, this high-precision information can be thought of as the integration basis, or a reference set, which offers opportunities for reconfiguration of the offensive, defensive, communication, navigation, and other sensors. Various integration architectures for fusion of these sensors can inherently enhance, enable, or severely limit these potential mission

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capabilities. The choice of integration architecture can directly and profoundly affect performance, cost of integration, cost of ownership, and exploitation of much greater mission capability. This is illustrated with the GPS/INS integration example. I.E.

A93-11014

DESIGN, CAPABILITIES, AND PERFORMANCE OF THE MINIATURIZED AIRBORNE GPS RECEIVER

VERLYN MOEN, STEVE RANKIN, JEFF KACIREK, and REDGE BARTHOLOMEW (Rockwell International Corp., Collins Avionics & Communications Div., Cedar Rapids, IA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 290-297. refs
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The authors describe the design, functional capabilities, and performance characteristics of the DoD standard five-channel miniaturized (less than 3/8 ATR) airborne GPS (Global Positioning System) receiver. The details of the receiver's hardware and software architectures are presented, along with a description of its functional capabilities. In addition, performance data captured during both stationary and dynamic testing, with or without host vehicle aiding, and under jammed and unjammed conditions, are presented. I.E.

A93-11015

THE TEXAS INSTRUMENTS/HONEYWELL GPS GUIDANCE PACKAGE

PHILLIP W. WARD (Texas Instruments, Inc., Dallas) and MAHESH JEERAGE (Honeywell, Inc., Minneapolis, MN) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 298-305.
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The authors describe the Texas Instruments/Honeywell Phase 1 Global Positioning System (GPS) Guidance Package (GGP) architecture and performance characteristics. The GGP is a tightly coupled, integrated miniature GPS receiver (MGR) and miniature inertial measurement unit (MIMU) capable of performing precision navigation, time coordination, mission management, and flight control for a broad class of Department of Defense platforms. These include strike weapons, unmanned airborne vehicles, and avionics platforms. The MGR architecture contains a highly integrated six-channel (expandable to eight channels) L1/L2 P(Y) code precise positioning service receiver/processor packaged on a single wiring board. The MGR design features a low-power GaAs integrated front end. The MIMU contains three interferometric fiber-optic gyros and three solid-state accelerometers in an inertial sensor assembly plus associated electronics and a microprocessor. The IFOG design features a high-power, broadband light source and mostly digital implementation of the gyro electronics. The remaining GGP architecture consists of a data processor/data bus unit (DP/DBU) and an adaptable interface unit (AIU). The DP/DBU performs the tightly coupled, integrated navigation function. It has reserve memory and throughput cavity to perform mission management and flight control functions. The AIU supports numerous standard interfaces, including a 1553B avionics bus, and is expandable to accommodate a variety of host vehicle interfaces. I.E.

A93-11019* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

DIFFERENTIAL GPS/INERTIAL NAVIGATION APPROACH/LANDING FLIGHT TEST RESULTS

SCOTT SNYDER, BRIAN SCHIPPER, LARRY VALLOT (Honeywell Systems and Research Center, Minneapolis, MN), NIGEL PARKER (Honeywell, Inc., Clearwater, FL), and CARY SPITZER (NASA, Langley Research Center, Hampton, VA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 336-344. refs
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In November of 1990 a joint Honeywell/NASA-Langley

differential GPS/inertial flight test was conducted at Wallops Island, Virginia. The test objective was to acquire a system performance database and demonstrate automatic landing using an integrated differential GPS/INS (Global Positioning System/inertial navigation system) with barometric and radar altimeters. The flight test effort exceeded program objectives with over 120 landings, 36 of which were fully automatic differential GPS/inertial landings. Flight test results obtained from post-flight data analysis are discussed. These results include characteristics of differential GPS/inertial error, using the Wallops Island Laser Tracker as a reference. Data on the magnitude of the differential corrections and vertical channel performance with and without radar altimeter augmentation are provided. I.E.

A93-11021

MAGNETIC VARIATION - A PRIMITIVE CONCEPT AND ITS HOLD ON CONTEMPORARY NAVIGATION

MICHAEL J. MIRESSI (FAA, Aeronautical Center, Oklahoma City, OK) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 357-361.

The author addresses the application of magnetic variation to components of the National Airspace System (NAS). He examines the determination and application of magnetic variation, discusses rates of change and differences in variation, and recommends rules for making this ancient mariners' computation more relevant for modern navigators. I.E.

A93-11022

THE DERIVATION OF PATH FOLLOWING ERROR AND CONTROL MOTION NOISE FILTERS FOR THE REDUCTION OF GLOBAL POSITIONING SYSTEM FLIGHT TEST DATA

ANDREW NELSON (Booz, Allen & Hamilton, Inc., Bethesda, MD) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 362-366.
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In order to perform a complete comparison with existing systems and properly define and analyze the error properties of the GPS (Global Positioning System), PFE (path following error), and CMN (control motion noise) filters need to be defined for use during testing activities. The author discusses PFE and CMN characteristics and how these error components affect flight and aircraft systems, and then derives digital filters that can be used to reduce GPS data into components of PFE and CMN based on international specifications. I.E.

A93-11023

THE MICROWAVE LANDING SYSTEM - A PRECISION APPROACH FOR THE FUTURE

RICHARD P. ARNOLD (FAA, Washington) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 367-374.

In response to a report to the US Congress by the General Accounting Office in May 1988, the Federal Aviation Administration implemented a series of studies and demonstrations designed to determine the economic and operational benefits of the Microwave Landing System (MLS). Final results from this program have been reported to Congress in accordance in language contained in US Senate Report 101-398 on the Department of Transportation and Related Agencies Appropriations Act for fiscal year 1991. The author identifies and describes key findings of the MLS demonstration program. The results support a decision to commence with the deployment of the MLS in accordance with international implementation schedules. I.E.

A93-11024

IMPLEMENTATION OF BMLS COMPUTER MODEL ON HYPERCUBE SYSTEMS

MEHMET CELENK (Ohio Univ., Athens) and MOHANAHARAN MYLVAGANAM (Telos Systems Group, Rockville, MD) *In* IEEE

PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 375-382. refs

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The authors describe a time-efficient implementation of the Baseline Microwave Landing System (BMLS) computer model on 16- and 64-node hypercube processors. First the sequential execution of the model was improved by eliminating the receiver input data file which logically connects the transmitter (BMLST) and receiver (BMLSR) units of the BMLS. The combined code was then mapped onto the nodes of parallel processors (AMETEK S-14/16 and 64) by creating a child program to run the combined BMLST and BMLSR routines in S-14 and a parent program to handle all the I/O and disk operations in the host (VAX 11/750). Parallel decomposition of the 95 percent PFE (path following error) contour generation task was achieved by dividing the search grid points into 16 or 64 groups, each of which was assigned to a particular node of the system S-14. Each processing element executed the same combined code for a different set of gridpoints of an airport scenario. This resulted in 15- and 60-fold speedups for 16- and 64-node implementations. I.E.

A93-11032

ACHIEVING MODULARITY WITH TIGHTLY-COUPLED GPS/INS
DONALD T. KNIGHT (Knight Systems, San Pedro, CA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 426-432. refs

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The author addresses a problem of GPS/INS (Global Positioning System/inertial navigation system) integration wherein the conflicting goals of modularity and tight coupling are both sought. The advantages to be gained from modularity are described, including the ability to rapidly configure any INS with any GPS receiver within broad performance classes. The well-known performance advantages of tight coupling are reviewed, and it is explained why it is so difficult to achieve both modularity and tight coupling in the same architecture. A candidate is then presented and evaluated relative to the stated goals. Key aspects of its operation and timing structure are described, including difficulties the architecture overcomes such as discontinuous INS aiding of receiver tracking loops as the system transitions through various modes. System functional requirements are separated into distinct areas so that designers of GPS and INS components are free to solve problems in their respective areas without detailed knowledge of other components or of their integration. Computational requirements and throughput of the integration processor are discussed. The problem of testing individual components is considered where those components are normally expected to operate only when fully integrated. The author deals primarily with low-cost applications such as remotely piloted vehicles and tactical munitions where tight coupling and modularity are especially valuable. I.E.

A93-11035

RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM) CAPABILITY FOR SOLE-MEANS GPS NAVIGATION IN THE OCEANIC PHASE OF FLIGHT

YOUNG C. LEE (Mitre Corp., McLean, VA) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 464-472. refs

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The author analyzes GPS (Global Positioning System) RAIM capability for sole-means navigation in the oceanic phase of flight, where the position protection limit requirement for the integrity function is not as stringent as for nonprecision approaches, and yet both detection and identification functions may be required if GPS is to be used as a sole-means system. For this purpose, a novel detection and identification algorithm is developed which takes advantage of the fact that, for the oceanic phase of flight,

a much larger position error is acceptable than for the nonprecision approach phase of flight. The performance of this novel algorithm and an algorithm proposed previously by others is estimated via simulation and compared. On the basis of the results, recommendations are made on how RAIM may be used if GPS is to be coupled with an inertial system to provide a sole-means capability in the oceanic phase of flight. I.E.

A93-11044

GPS INTEGRITY MONITORING AND SYSTEM IMPROVEMENT WITH GROUND STATION AND MULTISTATIONARY SATELLITE SUPPORT

L. CAPORICCI and C. SODDU (Ital Spazio S.p.A., Rome, Italy) *In* IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 559-565. refs

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The authors propose a monitoring and warning system based on ground stations capable of supporting reliable operations. The same stations can also be used for the implementation of a differential mode of operation, through the transmission of measurement corrections relevant to the tracked GPS (Global Positioning System) satellites. A combined operation of the stations is implemented in this manner. For civil aviation applications, the system operation can be enhanced with the integration of four multistationary satellites within the GPS space segment. The addition of four multistationary satellites will extend the integrity monitoring and system availability worldwide up to very high latitudes. The adoption of multistationary satellites presents valuable advantages over geostationary satellites. The results of some preliminary simulations are presented for the integrity monitoring and the system availability improvement. I.E.

A93-11095

EFFECT OF SKYWAVE INTERFERENCE ON THE COVERAGE OF LORAN-C

J. D. LAST, R. G. FARNWORTH, and M. D. SEARLE (Wales Univ., Bangor, United Kingdom) *IEE Proceedings, Part F: Radar and Signal Processing (ISSN 0956-375X) vol. 139, no. 4 Aug. 1992 p. 306-314. refs*

(Contract SERC-GR/F/58288)

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Receivers for the Loran-C terrestrial radio-navigation system are designed to distinguish pulses received by groundwave propagation from skywave interference components which arrive later. The technique, however, has significant limitations when implemented in receivers of finite bandwidth. The International Electrotechnical Commission and other authorities specify minimum standards of receiver performance in this respect. Drawing data from a range of sources, including Decca Navigator records, the paper proposes methods of predicting skywave-to-groundwave ratio and skywave delay, the key elements of these specifications. This information is used to calculate the range limits due to skywave interference at various times and seasons, considering individual transmitters and both present and proposed Loran-C chains. The results demonstrate that the use of high transmitter powers is generally not justified. The paper points out ambiguities in the current minimum performance standards for receivers. It demonstrates that they are inadequate to protect users against the effects of skywave interference and identifies areas in which improved specifications are required. Author

A93-11294* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLIGHT TEST EVALUATION OF PRECISION-CODE DIFFERENTIAL GPS FOR TERMINAL APPROACH AND LANDING

B. D. MCNALLY, DAVID N. WARNER, JR., DANIEL M. HEGARTY, THOMAS A. SCHULTZ (NASA, Ames Research Center, Moffett Field, CA), and RICHARD BRONSON (TAU Corp., Los Gatos, CA) *Navigation (ISSN 0028-1522) vol. 39, no. 2 Summer*

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1992 p. 155-175. Research supported by DOD and DOT refs
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A flight test evaluation conducted at the NASA Ames Research Center of precision-code differential GPS for terminal approach and landing is described. Differential corrections to satellite range and range-rate measurements are computed in a stationary ground reference system, uplinked to the test aircraft, and employed to correct corresponding airborne satellite data. Differentially corrected range and range-rate data, combined with inertial data, are then utilized with satellite position and velocity to compute aircraft position and velocity employing an eight-state extended Kalman filter.
R.E.P.

A93-11295

MULTIPATH EFFECTS ON GPS CODE PHASE MEASUREMENTS

RICHARD D. J. VAN NEE (Delft Univ. of Technology, Netherlands) *Navigation* (ISSN 0028-1522) vol. 39, no. 2 Summer 1992 p. 177-190. refs
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An analysis of multipath errors in GPS code phase measurements is presented, assuming the code phase is measured with the widely used noncoherent delay lock loop. Both specular and diffuse reflections are considered. A rough estimate for the fading bandwidth is given for mobile and stationary users, showing that averaging is far more effective for mobile than for stationary users. In general, however, a certain mean range error is present for both stationary and mobile users, depending on the power-delay profile of the received signal. Measurements near buildings confirm the asymmetry of multipath errors, which causes the nonzero mean, and show that range errors can take values of more than 100 m.
Author

A93-11297

STATISTICAL VALIDATION FOR GPS INTEGRITY TEST

JAMES L. FARRELL (NAVAIDE, Severna Park, MD) and FRANK VAN GRAAS (Ohio Univ., Athens) *Navigation* (ISSN 0028-1522) vol. 39, no. 2 Summer 1992 p. 205-216. refs
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Continuing progress in integrity analysis is providing enhanced perspective for the characterization of integrity requirements and the means for supporting rigorously quantified goals. Adopting a statistical quality control approach allows capitalization on decades of firmly established methods. The realization of ultimate integrity objectives can be facilitated through coordination with enhancements in other areas, such as enlightened interface definition and improved displays.
R.E.P.

A93-11298

THE USE OF SATELLITE GEOMETRY FOR PREVENTION OF CYCLE SLIPS IN A GPS PROCESSOR

JAMES W. SENNOTT and DAVID SENFFNER (Bradley Univ., Peoria, IL) *Navigation* (ISSN 0028-1522) vol. 39, no. 2 Summer 1992 p. 217-235. refs
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For kinematic survey and precise control of aviation, marine, and land vehicles, reliable GPS carrier phase tracking is critically important. In commercial GPS receivers, carrier phase tracking functions for individual satellites are carried out in a decoupled fashion, ignoring intersatellite path correlations seen at the receiver antenna. In contrast with traditional GPS signal processors, the performance of the new coupled tracker is geometry-dependent. Simulations for the complete tracking loop system illustrate how the coupled structure takes advantage of path correlations to greatly reduce phase tracking errors during periods of signal attenuation and blockage. The coupled processor is compared with a traditional processor during simulated aircraft turning maneuvers. Cycle tracking continuity is explored for overdetermined and minimal geometry scenarios. Differential correction options and computational load are also addressed.
Author

A93-12123

THE 21ST CENTURY NAVIGATION STATION

D. F. H. GROCCOTT *Journal of Navigation* (ISSN 0373-4633) vol. 45, no. 3 Sept. 1992 p. 315-328.

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A historical overview of the development of aeronavigation is presented. Attention is given to the principles of navigation, the mechanization of navigation, and the technological developments bearing on the future. Consideration is given to the development of fully automated, integrated navigation and communication systems that will enable an aircraft to operate under automatic control from takeoff to landing.
R.E.P.

A93-12124

OPTIONS FOR CONTROL AND NAVIGATION OF UNMANNED AIRCRAFT

P. GARDNER and C. R. DAY (Defence Research Agency, Aerospace Div., Sevenoaks, United Kingdom) *Journal of Navigation* (ISSN 0373-4633) vol. 45, no. 3 Sept. 1992 p. 352-368.

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This paper concentrates on the airborne elements which form a system that is aimed at de-skilling the process of flight control and navigation and allowing the greatest degree of autonomy consistent with economy. Attention is given to the UAV system that includes a TV sensor for target acquisition, radar sensors for surveillance, and ground station and operator skills. Advances in processing power are allowing an unmanned aircraft to be operated with little training and no flying skills except in the protocols of the work station used and the mission objectives.
R.E.P.

A93-12125

OPTIMIZATION OF TIME SAVING IN NAVIGATION THROUGH AN AREA OF VARIABLE FLOW

R. W. LUNNON and A. D. MARKLOW (Meteorological Office, Bracknell, United Kingdom) *Journal of Navigation* (ISSN 0373-4633) vol. 45, no. 3 Sept. 1992 p. 384-399. refs

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In planning routes between well-defined points of departure and arrival, aircraft and ships can take into account forecast values of certain geophysical parameters so that the route chosen is generally optimized. The time saving by the use of an optimal route is shown to be relative to flying along a great circle ground track and an approximate formula is derived to be used for calculating the time-saving. The results of applying the formula to atmospheric data are discussed.
R.E.P.

A93-12559

THE TENTH CONFERENCE ON AIR NAVIGATION - A LANDMARK IN THE HISTORY OF CIVIL AVIATION [LA DECIMA CONFERENCIA DE NAVEGACION AEREA - UN HITO EN LA HISTORIA DE LA AVIACION CIVIL]

JOSE L. BALLESTEROS CASAL *Ingenieria Aeronautica y Astronautica* (ISSN 0020-1006) no. 329 Oct. 1992 p. 29-42. In Spanish.

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An overview of civil navigation systems (CNSs) for aeronautical use is given emphasizing the results of a recent conference on related technologies and methodologies. Specific attention is given to the technological inflexibility of existing CNS systems and the lack of real-time data and processing media. Emerging air navigation technologies are reviewed with attention given to the GPS, GLONASS, and integrated GPS/GLONASS systems, and area-navigation techniques. Techniques for satellite communications and vigilance are also shown to be available including a mobile aeronautical satellite service, automatic dependent sensing, and a Spanish system called Prosat. Also examined are microwave landing systems, on-board anticollision systems, radar monitoring, satellite radar data transmission, and aeronautical communication via satellite between fixed points.
C.C.S.

A93-13267#

ELECTRONIC COUNTER COUNTERMEASURES/ADVANCED RADAR TEST BED (ECCM/ARTB)

T. KING and C. CARTER (USAF, Wright-Patterson AFB, OH) Aug. 1992 7 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4098)

The 4950th Test Wing at Wright-Patterson AFB, Ohio has developed an airborne asset that provides the flexibility and functionality of the laboratory along with the fidelity of an aircraft installation containing a radar system. The Electromagnetic Counter Countermeasures/Advanced Radar Testbed (ECCM/ARTB) is an Air Force C-141A cargo aircraft that instruments and physically accommodates the radomes of the F-15, F-16 and B-1B aircraft. The current configuration of the ARTB has the F-15 radome with the AN/APG-63 radar installed. The ARTB allows testing of both air-to-air and air-to-ground radar modes in both autonomous and range supported operations. The ARTB will be discussed with special emphasis on the Test Article Subsystem and the Radar Test Instrumentation System. Also discussed are current RTIS modifications and upcoming test program plans. Author

N93-10065# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

ADVANCED TERRAIN DISPLAYS TO TRANSPORT

CATEGORY AIRCRAFT Final Report, Jan. - Sep. 1991

J. K. KUCHAR and R. J. HANSMAN Feb. 1992 88 p Prepared in cooperation with Massachusetts Inst. of Tech., Cambridge (Contract DTRS57-88-C-00078) (PB92-197136; DOT-VNTSC-FAA-92-4; DOT/FAA/RD-92/4; AD-A252495) Avail: CASI HC A05/MF A01

A preliminary evaluation of terrain information presentation methods was conducted in a part-task simulation study. Pilots qualified on autoflight aircraft used both paper and prototypical electronic instrument approach plate formats to obtain terrain information. Approaches were flown using the MIT Aeronautical Systems Laboratory Advanced Cockpit Simulator. During the simulation, terrain situational awareness was tested by issuing erroneous vectors into terrain. Pilots successfully detected and avoided terrain hazards only 3 out of 52 times (6 percent). This low-hazard recognition rate is thought to be due to high level of confidence in Air Traffic Control (ATC) clearances, and highlighted the fact that current terrain depiction methods appear to be inadequate. To evaluate the increased effectiveness of advanced terrain depiction methods on electronic displays, several terrain situation display formats were designed and evaluated in a second simulation study. Spot elevation and smoothed contour terrain presentation techniques were examined using a separate moving map display dedicated to terrain information. In addition, a prototypical Graphical Ground Proximity Warning System (GGPWS) was developed and used to solicit pilot opinions and comments. Experimental methodology followed that of the preliminary terrain depiction study closely - erroneous vectors were again given by ATC, and pilot performance and opinion data were recorded. When given vectors into terrain, there was an overall 50 percent hazard recognition rate when pilots used the spot elevation display, and a 78 percent recognition rate with the contour display. Author

N93-10323# Systems Control Technology, Inc., Arlington, VA. **ROTORCRAFT EN ROUTE ATC ROUTE STANDARDS Final Report**

RAYMOND H. MATTHEWS and BRIAN M. SAWYER Aug. 1991 50 p (Contract DTFA01-87-C-00014) (AD-A249129; SCT-90-RR67; DOT/FAA/RD-90/19) Avail: CASI HC A03/MF A01

Constraints on helicopter operations in the en route environment as they relate to visual flight rules (VFR), special visual flight rules (SVFR), and instrument flight rules (IFR) are identified. However, since there is relatively little VFR/SVFR interaction between helicopters in the en route environment, the report concentrates on IFR operations and recommends modifications to route development standards using existing and planned navigation capabilities that will ultimately maximize the use of NAS en route airspace, enhance capacity, and accommodate the unique operational capabilities and requirements of helicopters.

This is the second in a series of three reports that address rotorcraft/helicopter standards, route structures, and procedures applied by FAA air traffic facilities. The series consists of: (1) Rotorcraft Terminal ATC Route Standards, DOT/FAA/RD-90/18, (2) Rotorcraft En Route ATC Route Standards, DOT/FAA/RD-90/19, and (3) Rotorcraft ATC Route Standards - Implementation Guidelines, DOT/FAA/RD-90/20. GRA

N93-10459# Federal Aviation Administration, Atlantic City, NJ. **AIR TRAFFIC CONTROL VISUAL SCANNING Report, Jan. 1991 - Jan. 1992**

EARL S. STEIN Jul. 1992 108 p (Contract FAA-F2003-C) (DOT/FAA/CT-TN92/16) Avail: CASI HC A06/MF A02

Air traffic controllers scan multiple displays to gather information necessary to make critical decisions in order to separate aircraft flying in the National Airspace System (NAS). When controllers make an error, they often respond that they did not see a piece of information that was right in front of them. Little is known about how controllers systematically scan their displays. This study was undertaken to determine whether there were patterns of scanning that characterized personnel with different levels of skill. Ten FAA controllers from a very active Terminal Radar Approach Control Facility (TRACON) participated in this study in which they controlled simulated radar traffic while their eye movements were monitored with an oculometer. This device allowed the computation of fixation frequencies and saccade duration during dynamic operations. Results indicated that the more experienced personnel had higher fixation frequencies than those who were in training. There were also significant changes in scanning behavior over time that the controllers worked. This occurred irrespective of experience and indicated that it takes between 5 and 10 minutes for the controller to establish a pattern which continues for the remainder of the work period. This suggests the importance of systematic relief period as personnel come on to control position. Author

N93-10738# Federal Aviation Administration, Washington, DC. Office of System Engineering.

A DESCRIPTION OF THE MODE SELECT BEACON SYSTEM (MODE S) AND ITS ASSOCIATED BENEFITS TO THE NATIONAL AIRSPACE SYSTEM (NAS) Final Report

P. DOUGLAS HODGKINS Aug. 1992 43 p (DOT/FAA/SE-92/6) Avail: CASI HC A03/MF A01

This report describes the operation of the Mode S subsystem and identifies benefits that the Mode S system provides to the National Airspace System (NAS) for surveillance and data link operations. These benefits include a reduction in asynchronous interference, reduced sensitivity to synchronous garble, more accurate and reliable surveillance, and support of air-ground data link operations. The benefits of using the mode select (Mode S) beacon system as an alternative for replacement of existing air traffic control beacon interrogators are addressed. Author

N93-10745*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

APPRAISAL OF DIGITAL TERRAIN ELEVATION DATA FOR LOW-ALTITUDE FLIGHT

RICHARD E. ZELENKA and HARRY N. SWENSON Jan. 1992 12 p (Contract RTOP 505-64-36) (NASA-TM-103896; A-91241; NAS 1.15:103896) Avail: CASI HC A03/MF A01

The use of terrain elevation databases in advanced guidance and navigation systems has greatly expanded. However, the limitations and accuracies of these databases must be considered and established prior to safe system flight evaluation. A simple approach to quantify reasonable flight limits is presented and evaluated for a helicopter guidance system dependent on a terrain database. The flight test evaluated involved a helicopter equipped with a Global Positioning System (GPS) receiver and radar altimeter, and a ground station GPS receiver which provided improved helicopter positioning. The precision navigation and radar altimeter

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data was acquired while flying low-altitude missions in south-central Pennsylvania. The aircraft-determined terrain elevations were compared with the terrain predicted by the Defense Mapping Agency (DMA) Level 1 terrain elevation data for the same area. The results suggest a safe set clearance altitude of 220 ft for flight testing of a DMA-based guidance avionics in the same area.

Author

N93-10961*# State Univ. of New York, Buffalo. Dept. of Industrial Engineering.

METHODS AND PRINCIPLES FOR DETERMINING TASK DEPENDENT INTERFACE CONTENT Semiannual Progress Report

VALERIE L. SHALIN, NORMAN D. GEDDES (Applied Systems Intelligence, Inc., Gainesville, GA.), and BRIAN G. MIKESSELL Aug. 1992 46 p
(Contract NAG1-1342)
(NASA-CR-190837; NAS 1.26:190837) Avail: CASI HC A03/MF A01

Computer generated information displays provide a promising technology for offsetting the increasing complexity of the National Airspace System. To realize this promise, however, we must extend and adapt the domain-dependent knowledge that informally guides the design of traditional dedicated displays. In our view, the successful exploitation of computer generated displays revolves around the idea of information management, that is, the identification, organization, and presentation of relevant and timely information in a complex task environment. The program of research that is described leads to methods and principles for information management in the domain of commercial aviation. The multi-year objective of the proposed program of research is to develop methods and principles for determining task dependent interface content. Author

N93-11139*# University of Central Florida, Orlando. Dept. of Industrial Engineering and Management Systems.

DESIGN OF AN AIR TRAFFIC COMPUTER SIMULATION SYSTEM TO SUPPORT INVESTIGATION OF CIVIL TILTROTOR AIRCRAFT OPERATIONS Annual Report

RALPH V. ROGERS 15 Aug. 1992 17 p
(Contract NAG2-625)
(NASA-CR-190811; NAS 1.26:190811) Avail: CASI HC A03/MF A01

This research project addresses the need to provide an efficient and safe mechanism to investigate the effects and requirements of the tiltrotor aircraft's commercial operations on air transportation infrastructures, particularly air traffic control. The mechanism of choice is computer simulation. Unfortunately, the fundamental paradigms of the current air traffic control simulation models do not directly support the broad range of operational options and environments necessary to study tiltrotor operations. Modification of current air traffic simulation models to meet these requirements does not appear viable given the range and complexity of issues needing resolution. As a result, the investigation of systemic, infrastructure issues surrounding the effects of tiltrotor commercial operations requires new approaches to simulation modeling. These models should be based on perspectives and ideas closer to those associated with tiltrotor air traffic operations. Author

N93-11252# Federal Aviation Administration, Cambridge, MA. Operator Performance and Safety Analysis Div.

DESIGN OF INSTRUMENT APPROACH PROCEDURE CHARTS: COMPREHENSION SPEED OF MISSED APPROACH INSTRUCTIONS CODED IN TEXT OR ICONS Final Report, Jul. - Dec. 1991

DAVID W. OSBORNE (Dynatrend, Inc., Woburn, MA.) and M. STEPHEN HUNTLEY Feb. 1992 62 p
(PB92-205673; DOT-VNTSC-FAA-92-3; DOT/FAA/RD-92/3)
Avail: CASI HC A04/MF A01

Instrument approach procedure (IAP) charts are often cluttered and confusing. The quantified effects of chart design changes on information transfer are needed by chart manufacturers to make changes which will enhance information transfer and human

performance. The present study was conducted as part of a continuing effort at the Volpe National Transportation Systems Center Human Performance Laboratory to develop human performance-based design guidelines for IAP charts. The objectives of the experiment were to determine whether encoding missed approach instructions in text or icons would result in more efficient information transfer, and if the information transfer efficiency for either coding technique was dependent upon the level of information content. Twelve pilots currently licensed for instrument (IFR) flight participated as subjects. Text instructions were either taken directly or developed from instructions found on National Ocean Service (NOS) IAP charts. Because of formatting inconsistencies in current NOS missed approach instructions, a standard format was developed. In order to approximate the range of information content found in current NOS missed approach instructions, these instructions possessed one of three levels of information content: low, medium, and high. Comprehension speed was measured by counting the number of one second presentations (glances) subjects required to view the instructions in order to verbally report them. Report accuracy was also measured. Subjects completed questionnaires concerning their flight experience, preferences for IAP chart manufacturers, and preference for text or iconic coding of the instructions. GRA

N93-11704# Federal Aviation Administration, Atlantic City, NJ. **CONTROLLER EVALUATION OF INITIAL DATA LINK TERMINAL AIR TRAFFIC CONTROL SERVICES: MINI STUDY 2, VOLUME 1 Final Report**

NICHOLAS J. TALOTTA Apr. 1992 97 p
(Contract FAA-T2001-B)
(DOT/FAA/CT-92/2-VOL-1) Avail: CASI HC A05/MF A02

This document details the results of the second mini-study of the Federal Aviation Administration (FAA) Technical Center investigation and development of initial terminal air traffic control (ATC) services for transmission using data link technology. Initial data link services were evaluated under part task simulation conditions in order to identify service delivery methods which optimize controller acceptance, performance, and workload, and to study the effects of various potential data link message response delays. Author

N93-11705# Federal Aviation Administration, Atlantic City, NJ. **CONTROLLER EVALUATION OF INITIAL DATA LINK TERMINAL AIR TRAFFIC CONTROL SERVICES: MINI STUDY 2, VOLUME 2 Final Report**

NICHOLAS J. TALOTTA Apr. 1992 123 p
(Contract FAA-T2001-B)
(DOT/FAA/CT-92/2-VOL-2) Avail: CASI HC A06/MF A02

This document details the results of the second mini-study of the Federal Aviation Administration (FAA) Technical center investigation and development of initial terminal air traffic control (ATC) services for transmission using data link technology. Initial data link services were evaluated under part task simulation conditions in order to identify service delivery methods which optimize controller acceptance, performance, and workload, and to study the effects of various potential data link message response delays. Author

N93-12320*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INTEGRATION OF RADAR ALTIMETER, PRECISION NAVIGATION, AND DIGITAL TERRAIN DATA FOR LOW-ALTITUDE FLIGHT

RICHARD E. ZELENIKA Aug. 1992 11 p
(Contract RTOP 505-64-13)
(NASA-TM-103958; A-92158; NAS 1.15:103958) Avail: CASI HC A03/MF A01

Avionic systems that depend on digitized terrain elevation data for guidance generation or navigational reference require accurate absolute and relative distance measurements to the terrain, especially as they approach lower altitudes. This is particularly exacting in low-altitude helicopter missions, where aggressive terrain hugging maneuvers create minimal horizontal

and vertical clearances and demand precise terrain positioning. Sole reliance on airborne precision navigation and stored terrain elevation data for above-ground-level (AGL) positioning severely limits the operational altitude of such systems. A Kalman filter is presented which blends radar altimeter returns, precision navigation, and stored terrain elevation data for AGL positioning. The filter is evaluated using low-altitude helicopter flight test data acquired over moderately rugged terrain. The proposed Kalman filter is found to remove large disparities in predicted AGL altitude (i.e., from airborne navigation and terrain elevation data) in the presence of measurement anomalies and dropouts. Previous work suggested a minimum clearance altitude of 220 ft AGL for a near-terrain guidance system; integration of a radar altimeter allows for operation of that system below 50 ft, subject to obstacle-avoidance limitations. Author

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A93-10776

MPC75 AS THE FORERUNNER OF A NEW REGIONAL AIRCRAFT FAMILY [MPC75 ALS WEGBEREITER FUER EINE NEUE REGIONALE FLUGZEUGFAMILIE]

J. THOMAS (Deutsche Airbus GmbH, Hamburg, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 201-207. In German.

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The extent and duration of preparatory work for the new MPC75 aircraft program which are needed to fulfill the requirements for a go-ahead are considered. About \$100 million is needed in the preliminary phase, about 5 percent of which represents the total development costs of the program. To minimize the program initiation risk, extensive theoretical studies, wind tunnel measurements, structural tests, and system tests need to be conducted, and mockups of the cabin and cockpit have to be constructed in cooperation with potential customers. C.D.

A93-10917

TEST AND ANALYSIS OF AN ADVANCED TECHNOLOGY LANDING GEAR

JOYANTO K. SEN, AKIF O. BOLUKBASI (McDonnell Douglas Helicopter Co., Mesa, AZ), and NED A. CHASE (U.S. Army, Aviation Applied Technology Directorate, Fort Eustis, VA) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 3 July 1992 p. 42-52. refs (Contract DAAJ02-85-C-0049)

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A retractable, crashworthy main landing gear for a utility helicopter was designed, fabricated and tested to the crashworthiness requirements of a vertical velocity of 42 fps, at +/- 10 deg roll and -5/+15 deg pitch. The landing gear is very compact and highly maintainable, and automatically extends in less than two seconds in an emergency. Through energy absorbing trade-off studies and crashworthiness analyses, the gear was optimized to absorb 60 percent of the energy from a level impact at 42 fps; the remaining energy was absorbed by the fuselage and the stroking seat. The landing gear was evaluated through single-gear platform and iron-bird drop tests. Analytical models were also used to predict the performance of the landing gear design. The analysis results compared very well with the test results. Author

A93-11251

AIAA BIENNIAL FLIGHT TEST CONFERENCE, 6TH, HILTON HEAD ISLAND, SC, AUG. 24-26, 1992, SELECTED PAPERS

Washington American Institute of Aeronautics and Astronautics 1992 422 p.

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Topics presented include training for avionics evaluation, flight testing in the '90s, methodology for the critical evaluation of flight test data, flight testing of an electric powered vehicle, and the flying qualities of a remotely piloted vehicle. Also presented are airspeed calibration using GPS, the design and conduct of a windshear detection flight experiment, the 757 fly-by-wire demonstrator flight test, and an update of the B-52 flight test program. (For individual items see A93-11252 to A93-11285)

R.E.P.

A93-11257#

MEASURING FLIGHT TEST PROGRESS ON LARGE SCALE DEVELOPMENT PROGRAMS

CHARLES H. THORNTON and PERRY LAMY (USAF, Washington) /In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 37-43. refs

(AIAA PAPER 92-4070) Copyright

Traditional methods of measuring flight test progress using flight hours and counting test points may not be adequate for large developmental flight test programs because of their size, complexity and political constraints. A tailored Cost/Schedule Performance Measurement System to measure the work scheduled and performed has been developed to improve the process of flight test planning, measurement, and control. Flight hours are used as the cost factor. A detailed computer automated program management network is used to integrate the technical requirements of test points between the various disciplines, the resources required to accomplish the test objectives, and the programmatic milestones which establish test priorities. Progress toward intermediate milestones, program milestones or certification of weapon system capabilities is credibly measured to provide a more meaningful report of flight test status to program office, service department, or DOD acquisition manager. Author

A93-11260#

FLIGHT TEST AND WIND-TUNNEL STUDY OF A SCALED UNMANNED AIR VEHICLE

RICHARD M. HOWARD and ROBERT M. BRAY (U.S. Naval Postgraduate School, Monterey, CA) /In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 63-70. Research supported by U.S. Navy refs

(AIAA PAPER 92-4075)

Flight tests of a half-scale radio-controlled model of the Pioneer Unmanned Air Vehicle were conducted, and the results compared to those of a wind-tunnel test of a 0.4-scale Pioneer tested at full-scale Reynolds numbers. Desired was a comparison of aerodynamic performance and static longitudinal and lateral-directional stability-and-control characteristics. The air vehicle was instrumented to measure control-surface deflections, angle of attack, sideslip angle, and airspeed; telemetry was used to downlink the data to a ground recorder for later processing. The determination of the neutral point agreed well with other methods of prediction, and indicated that the static margin was sufficient to open the center-of-gravity envelope. Other control-related considerations may provide overriding concerns, however. Crosswind limits were determined from sideslip maneuvers. Low-cost scaled-vehicle flight testing appears to be a useful tool in providing aerodynamic data for UAV simulation and training purposes. Author

A93-11262#

FLIGHT TESTING OF AN ELECTRIC POWERED VEHICLE

ALVIN CROSS (U.S. Navy, Naval Research Lab., Washington) /In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American

Institute of Aeronautics and Astronautics 1992 p. 77-83.
 Research supported by U.S. Navy refs
 (AIAA PAPER 92-4077)

The progressive development of an electric powered unmanned flight vehicle, the semi-autonomous research aircraft (SARA), from design concept through flight testing is presented. Emphasis is focused on the flight testing phase of this UAV. Flight testing of the SARA has demonstrated key technologies believed to be applicable to systems intended for utilization in military flight hardware. R.E.P.

A93-11268*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN AND CONDUCT OF A WINDSHEAR DETECTION FLIGHT EXPERIMENT

MICHAEL S. LEWIS, KENNETH R. YENNI, HARRY A. VERSTYNEN, and LEE H. PERSON (NASA, Langley Research Center, Hampton, VA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 132-145. refs

(AIAA PAPER 92-4092) Copyright

A description is presented of the design and conduct of a series of flight experiments that tested the performance of candidate windshear detection devices. A NASA 737 test aircraft with prototype windshear sensors installed flew numerous low altitude penetrations of microburst windshear conditions. These tests were preceded by extensive preparations including piloted simulations, determination of safe operating conditions, and the development of displays, unique flight test hardware, and procedures. R.E.P.

A93-11271#

757 FLY-BY-WIRE DEMONSTRATOR FLIGHT TEST

LAUREN ARENT and JAY FALATKO (Boeing Co., Seattle, WA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 162-172.

(AIAA PAPER 92-4099) Copyright

A production 757-200 was modified to emulate the 777 FBW control laws to evaluate the performance and operation of the 777 FBW flight control laws in flight. The flight test FBW longitudinal system is a two channel flight control system. A summary of the aircraft FBW modifications and the flight test program to evaluate and validate the 777 FBW flight control laws is presented. R.E.P.

A93-11272*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

IN-FLIGHT FLOW VISUALIZATION RESULTS FROM THE X-29A AIRCRAFT AT HIGH ANGLES OF ATTACK

JOHN H. DEL FRATE (NASA, Flight Research Center, Edwards, CA) and JOHN A. SALTZMAN (PRC, Inc., Edwards, CA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 173-186. refs

(AIAA PAPER 92-4102) Copyright

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

A93-11273*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

CORRELATION OF FOREBODY PRESSURES AND AIRCRAFT YAWING MOMENTS ON THE X-29A AIRCRAFT AT HIGH ANGLES OF ATTACK

DAVID F. FISHER (NASA, Flight Research Center, Edwards, CA), DAVID M. RICHWINE, and STEPHEN LANDERS (PRC, Inc., Edwards, CA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 187-200. refs

(AIAA PAPER 92-4105) Copyright

In-flight pressure distributions are presented at angles of attack from 15 deg to 66 deg and at Mach numbers from 0.22 to 0.60 at four fuselage stations on the forebody of the X-29A aircraft. Forebody yawing moments are obtained from the integrated pressure distributions and the results are correlated with the overall aircraft yawing moments. Yawing moments created by the forebody were not significant until an angle of attack of 50 deg or above and correlated well with the aircraft left yawing moment. R.E.P.

A93-11274*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT TEST RESULTS FROM A SUPERCRITICAL MISSION ADAPTIVE WING WITH SMOOTH VARIABLE CAMBER

SHERYLL G. POWERS, LANNIE D. WEBB, EDWARD L. FRIEND, and WILLIAM A. LOKOS (NASA, Flight Research Center, Edwards, CA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 201-228. refs

(AIAA PAPER 92-4101) Copyright

Results from the wing surface and boundary layer pressures, buffet studies and flight deflection measurement system for the advanced fighter technology integration F-111 mission adaptive wing program are presented. The different aerodynamic technologies studied on the aircraft, and their relationship with each other are described. The wingtip twist measurements provide an insight as to how dynamic pressures for positive normal accelerations affect the wingtip pressure profiles. R.E.P.

A93-11275*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SUBSONIC HIGH-LIFT FLIGHT RESEARCH ON THE NASA TRANSPORT SYSTEM RESEARCH VEHICLE (TSRV)

LONG P. YIP (NASA, Langley Research Center, Hampton, VA), PAUL M. H. W. VIJGEN (High Technology Corp., Hampton, VA), JAY D. HARDIN (Lockheed Engineering and Sciences Co., Hampton, VA), and C. P. VAN DAM (California Univ., Davis) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 229-246. refs

(Contract NAS1-18240; NAS1-19299; NAS1-19000; NCC1-163)

(AIAA PAPER 92-4103) Copyright

Flight tests are being conducted as part of a multiphased subsonic transport high-lift research project for correlation with ground based wind tunnel and computational results. The NASA Langley TSRV 737-100 airplane is utilized to obtain flow characteristics at full-scale Reynolds numbers to contribute to the knowledge of several dominant high-lift flow issues such as boundary layer transition, confluent boundary layer development, and 3D flow separation. Recent test results obtained for a full-chord wing section including the slat, main-wing, and flap elements are presented. R.E.P.

A93-11276# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

INTEGRATED FLIGHT PROPULSION CONTROL RESEARCH RESULTS USING THE NASA F-15 HIDEFLIGHT RESEARCH FACILITY

JAMES F. STEWART (NASA, Flight Research Center, Edwards, CA) /in AIAA Biennial Flight Test Conference, 6th, Hilton Head

Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 247-265. Previously announced in STAR as N92-27379 refs (Contract RTOP 533-02-36)
(AIAA PAPER 92-4106) Copyright

Over the last two decades, NASA has conducted several flight research experiments in integrated flight propulsion control. Benefits have included increased thrust, range, and survivability; reduced fuel consumption; and reduced maintenance. These flight programs were flown at NASA Dryden Flight Research Facility. This paper presents the basic concepts for control integration, examples of implementation, and benefits of integrated flight propulsion control systems. The F-15 research involved integration of the engine, flight, and inlet control systems. Further extension of the integration included real time, onboard optimization of engine, inlet, and flight control variables; a self repairing flight control system; and an engine only control concept for emergency control. The flight research programs and the resulting benefits are described for the F-15 research. Author

A93-11277*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PITCH CONTROL MARGIN AT HIGH ANGLE OF ATTACK - QUANTITATIVE REQUIREMENTS (FLIGHT TEST CORRELATION WITH SIMULATION PREDICTIONS)

J. LACKEY and C. HADFIELD (U.S. Navy, Naval Warfare Center, Patuxent River, MD) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 266-281. Research supported by U.S. Navy and NASA refs
(AIAA PAPER 92-4107)

Recent mishaps and incidents on Class IV aircraft have shown a need for establishing quantitative longitudinal high angle of attack (AOA) pitch control margin design guidelines for future aircraft. NASA Langley Research Center has conducted a series of simulation tests to define these design guidelines. Flight test results have confirmed the simulation studies in that pilot rating of high AOA nose-down recoveries were based on the short-term response interval in the forms of pitch acceleration and rate. R.E.P.

A93-11278# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT TESTING AND SIMULATION OF AN F-15 AIRPLANE USING THROTTLES FOR FLIGHT CONTROL

FRANK W. BURCHAM, JR., TRINDEL MAINE, and THOMAS WOLF (NASA, Flight Research Center, Edwards, CA) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 282-299. Previously announced in STAR as N92-32864 refs (Contract RTOP 533-02-36)
(AIAA PAPER 92-4109) Copyright

Flight tests and simulation studies using the throttles of an F-15 airplane for emergency flight control have been conducted at the NASA Dryden Flight Research Facility. The airplane and the simulation are capable of extended up-and-away flight, using only throttles for flight path control. Initial simulation results showed that runway landings using manual throttles-only control were difficult, but possible with practice. Manual approaches flown in the airplane were much more difficult, indicating a significant discrepancy between flight and simulation. Analysis of flight data and development of improved simulation models that resolve the discrepancy are discussed. An augmented throttle-only control system that controls bank angle and flight path with appropriate feedback parameters has also been developed, evaluated in simulations, and is planned for flight in the F-15. Author

A93-11280*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT EXPERIENCE WITH LIGHTWEIGHT, LOW-POWER MINIATURIZED INSTRUMENTATION SYSTEMS

PHILIP J. HAMORY and JAMES E. MURRAY (NASA, Flight

Research Center, Edwards, CA) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 309-322. refs
(AIAA PAPER 92-4111) Copyright

Engineers at the NASA Dryden Flight Research Facility (NASA-Dryden) have conducted two flight research programs with lightweight, low-power miniaturized instrumentation systems built around commercial data loggers. One program quantified the performance of a radio-controlled model airplane. The other program was a laminar boundary-layer transition experiment on a manned sailplane. The purpose of this paper is to report NASA-Dryden personnel's flight experience with the miniaturized instrumentation systems used on these two programs. The paper will describe the data loggers, the sensors, and the hardware and software developed to complete the systems. The paper also describes how the systems were used and covers the challenges encountered to make them work. Examples of raw data and derived results will be shown as well. Finally, future plans for these systems will be discussed. Author

A93-11285# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MEASUREMENT OF ATTACHMENT-LINE LOCATION IN A WIND-TUNNEL AND IN SUPERSONIC FLIGHT

NAVAL K. AGARWAL, STAN J. MILEY, MICHAEL C. FISHER (NASA, Langley Research Center, Hampton, VA), BIANCA T. ANDERSON, and ROBERT J. GEENEN (NASA, Flight Research Center, Edwards, CA) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 404-414. refs
(AIAA PAPER 92-4089) Copyright

For the supersonic laminar flow control research program, tests are being conducted to measure the attachment-line flow characteristics and its location on a highly swept aircraft wing. Subsonic wind tunnel experiments were conducted on 2D models to develop sensors and techniques for the flight application. Representative attachment-line data are discussed and results from the wind tunnel investigation are presented. R.E.P.

A93-11357

THE SUPERPRESSURE STRATOSPHERIC VEHICLE

J. L. RAND (Winzen International, Inc., San Antonio, TX), L. G. SEELY (Winzen International, Inc., Inflatable Products Div., Sulphur Springs, TX), and T. M. LEW (Winzen International, Inc., San Antonio, TX) Advances in Space Research (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 33-36. refs
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The development of the Superpressure Stratospheric Vehicle (SSV) is described in terms of the materials, construction techniques, and flight testing. The use of a biaxially oriented nylon film is discussed in the context of the development of a balloon system with reduced failure modes and the potential for sizes comparable to zero-pressure balloons. A scale-model balloon was designed to support a sample payload at the design altitude, and the scaled SSV was built using adhesives for sealing. The pressure and stresses in the balloon are shown to be directly related to the amount of injected gas, and flight tests show that the balloon was intact to an altitude of 36 km. The SSV balloon system as designed is reported to be capable of ascent through the tropopause indicating the suitability of the technology for these stratospheric balloons. C.C.S.

A93-11359

THE UNREALIZED POTENTIAL FOR HEAVY BALLOON PAYLOADS

J. A. WINKER (Raven Industries, Inc., Sioux Falls, SD) Advances in Space Research (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 41-44. refs
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An overview of the capabilities of emerging and developed polyethylene films is presented with attention given to the

corresponding maximum achievable payloads for scientific balloons. The stress index developed for balloon bubbles is examined in the light of emerging material properties, and changes in balloon structure indicate that higher stresses can occur at high altitudes. The stress-index equation by NASA is shown to be accurate, although it is not based on emerging material and structural technology. A stress index is proposed that accounts for heat-sealing techniques and high-strength films, and the revised stress index shows that 84 percent higher inflation values are possible. The main conclusions are that: (1) balloons should be capable of substantially heavier payloads; (2) significant increases in altitude can be achieved for typical scientific payloads; and (3) efficient production is leading to less expensive balloon technologies. C.C.S.

A93-11361* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

RECENT REFINEMENTS AND INCREASED CAPABILITIES IN BALLOON VERTICAL PERFORMANCE ANALYSIS

G. R. CONRAD (New Mexico State Univ.; NASA, Wallops Flight Facility, Wallops Island, VA) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 49-53. refs
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The NASA Thermal Trajectory analysis model for predicting the vertical performance of balloons is described in terms of two critical refinements and recent results. The model employs heat-balance equations and a vertical equation of motion, and revised methods are employed to predict maximum balloon volume, balloon shape, and the continuous computation of gas loss. Also incorporated are modeling techniques for assessing the solar radiation input that can affect the load tapes, and autoballast control algorithms are employed. The model permits the evaluation of the presence of cap layers as well as the effects of small leaks and programmed venting. The revised model is shown to give good predictions of balloon performance during flight in terms of altitude changes, descent rates, gas-mass flow, and leak potential. The model is found to be more versatile due to *autoballasting and leak analysis, and good prediction are possible for the float phase and descent of current balloon shapes.* C.C.S.

A93-11363* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

NASA BALLOON DESIGN AND FLIGHT - PHILOSOPHY AND CRITERIA

I. S. SMITH, JR. (NASA, Wallops Flight Facility, Wallops Island, VA) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 59-62. refs
Copyright

The NASA philosophy and criteria for the design and flight of scientific balloons are set forth and discussed. The thickness of balloon films is standardized at 20.3 microns to isolate potential film problems, and design equations are given for specific balloon parameters. Expressions are given for: flight-stress index, total required thickness, cap length, load-tape rating, and venting-duct area. The balloon design criteria were used in the design of scientific balloons under NASA auspices since 1986, and the resulting designs are shown to be 95 percent effective. These results represent a significant increase in the effectiveness of the balloons and therefore indicate that the design criteria are valuable. The criteria are applicable to four balloon volume classes in combination with seven payload ranges. C.C.S.

**A93-11369
LONG-DURATION BALLOON FLIGHTS IN THE MIDDLE STRATOSPHERE**

P. MALATERRE (CNES, Toulouse, France) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 107-114. refs
Copyright

The development and design are described for the Infrared Montgolfiere (IRM) balloon can carry small payloads for several weeks at stratospheric altitudes. The IRM balloon is a hot-air

balloon warmed at night by IR flux from the earth, and the thermal absorption and losses are described theoretically. The primary design driver is low emissivity for the skyward portion of the balloon and high emissivity for the portion that faces the earth. The design uses aluminized and transparent mylar for the balloon, and prototype designs demonstrated the effectiveness of these and polyethylene model balloons. Numerical modeling demonstrates the importance of atmospheric parameters such as IR flux levels, atmospheric pressure, and balloon vs ambient temperatures. Flight tests of the IRM concept are shown to be successful with flight of 3-45 days and one balloon that circled the globe twice in 53 days. The IRM can carry up to 50 kg of payload in the middle or lower stratosphere for long-duration flights. C.C.S.

**A93-11371
CONCEPT FOR AN OPEN-NECK STRATOSPHERIC BALLOON WITH LONG-DURATION FLIGHT CAPABILITY**

C. TOCKERT (CNES, Toulouse, France) *Advances in Space Research* (ISSN 0273-1177) vol. 13, no. 2 Feb. 1993 p. 119-122. refs
Copyright

The CNES Balloon Division recently designed an open-neck stratospheric balloon with a long-duration flight capability. The main feature of this concept is that it ensures stable flight level under all conditions without the need to release ballast. The approach adopted is to cover the top of the balloon envelope with an insulating 'cape' corresponding to 3 percent of the total envelope area under daytime conditions. As the balloon descends after sunset, its volume decreases while the proportion of the gas bubble covered by the cape increases to 50 percent. This configuration produces a sufficient improvement in the balloon's heat budget to ensure a stable float altitude in the lower stratosphere. In one assumes that flight duration is limited only by gas diffusion through the envelope, this type of balloon should be able to remain aloft for up to three weeks. Author

**A93-11418
A330 - COMPLETING THE FAMILY**

DAVID LEARMOUNT Flight International (ISSN 0015-3710) vol. 142, no. 4334 Sept. 2, 1992 p. 61, 62, 64 (6 ff.).
Copyright

A review is presented of the new A330, focusing on the aircraft, its systems, engines and the market at which it is aimed. Attention is given to the aircraft's basic data, the selection of powerplants, payload range, flight control architecture, and envelope protection. An exploded-view drawing of the aircraft that details all subsystems is included. R.E.P.

**A93-11420
THE SMART TRUCK**

GUY NORRIS Flight International (ISSN 0015-3710) vol. 142, no. 4335 Sept. 9, 1992 p. 39, 40, 42 (9 ff.).
Copyright

A report is presented of the USAF C-17 heavy-lift, extended-range, four-jet FBW airlifter currently in flight test. Attention is given to the cargo carrying capability, the high-bypass turbofans, the computer-controlled environmental system, the two-man flight deck, and basic specifications. An exploded-view drawing of the aircraft that details all subsystems is included. R.E.P.

A93-11654* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NONLINEAR FEEDBACK CONTROL OF HIGHLY MANOEUVRABLE AIRCRAFT

WILLIAM L. GARRARD (Minnesota Univ., Minneapolis), DALE F. ENNS (Honeywell Systems and Research Center, Minnesota Univ., Minneapolis), and S. A. SNELL (California Univ., Davis) *International Journal of Control* (ISSN 0020-7179) vol. 56, no. 4 Oct. 1992 p. 799-812. refs
(Contract NAG1-821)
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This paper describes the application of nonlinear quadratic

regulator (NLQR) theory to the design of control laws for a typical high-performance aircraft. The NLQR controller design is performed using truncated solutions of the Hamilton-Jacobi-Bellman equation of optimal control theory. The performance of the NLQR controller is compared with the performance of a conventional $P + I$ gain scheduled controller designed by applying standard frequency response techniques to the equations of motion of the aircraft linearized at various angles of attack. Both techniques result in control laws which are very similar in structure to one another and which yield similar performance. The results of applying both control laws to a high-g vertical turn are illustrated by nonlinear simulation. Author

A93-11809
WHEEL SHIMMY ANALYSIS FOR MAIN LANDING GEAR OF AIRCRAFT

DE-PEI ZHU (Northwestern Polytechnical Univ., Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A507-A509. In Chinese. refs

Applying the general linear theory of shimmy, this paper analyzes the main wheel shimmy problem of a special type of the main landing gear equipped with an additional shimmy damper between the upper part and the lower part of torque arms. The influence of various structural and operational parameters on shimmy is discussed, and the results show that the additional damper is necessary and effective for preventing shimmy. Meanwhile, a new version of this type of aircraft with four-wheel main landing gear is also investigated. It is concluded that in this case the additional damper can be omitted, since this landing gear itself is inherently stable with respect to shimmy. Author

A93-11815
BIRD IMPACT DYNAMIC RESPONSE ANALYSIS FOR AIRCRAFT ARC WINDSHIELD

ZHI-LIN ZHANG, QI-QIAO ZHANG, and MING-XING LI Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A538-A542. In Chinese. refs

The method of equivalent dynamic load is adopted to analyze the bird impact dynamic response for a trainer aircraft arc windshield. The effects of the strain rate on material characterization and the geometrical nonlinearity on the stiffness matrix are considered in the process of dynamic response analysis. The flexible target load, suitable to arc windshield, is given by studying the bird impact load. The result, of comparing the calculation results with the full scale bird impact tests show that the structure deflection and strain responses are sensitive to the variation of the strain rate and geometrical nonlinearity of structure. The calculation results obtained by considering the effects of the strain and the geometrical nonlinearity of structure are in accordance with the test results. Author

A93-11816
INVESTIGATION OF CABIN NOISE REDUCTION IN THE Y12
 QI-HANG YAO, WEN-CHAO HUANG, and XIAO-JUN MA Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A543-A547. In Chinese. refs

This paper deals with the noise control measures applied to the Y12 aircraft. It mainly includes the application of honeycomb sandwich stiffened panels, dynamic absorbers, damping treatments, window acoustic design, and replacement of the windows and doors closure devices. The results of cabin noise levels in flight measurements are given for acoustic treated Y12 aircraft. The analysis of the flight results shows that the noise control measures are effective. The added weight of the noise control package is about 0.8 percent of the total gross takeoff weight of the aircraft. Author

A93-11818
TRANSITION OF FLUTTER MODE OF TWO-DIMENSIONAL WING WITH EXTERNAL STORE
 ZHI-CHUN YANG and LING-CHENG ZHAO (Northwestern Polytechnical Univ., Xian, China) Acta Aeronautica et Astronautica

Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A552-A554. In Chinese. refs

By using the theory of frequency coalescence and steady aerodynamics, the wing store flutter problem is studied in the space of normal mode coordinates. It is found that, for most cases, only two normal modes have predominant effects on the constitution of flutter mode. The flutter boundary which depicts the changes of flutter speed vs store pitching stiffness is calculated with each two-normal-mode binary system to identify the evolution and transition of wing-store flutter mode. The prerequisite information is only the normal mode data, which are the direct results of the ground vibration test or the routine vibration analysis. The results show that the estimating calculation can give the flutter boundary with reasonable accuracy, and the constitution and evolution of wing-store flutter mode can be determined from the node position of its normal modes. Author

A93-11820
EFFECTS OF THE PYLON PITCHING STIFFNESS ON WING-STORE FLUTTER

LI-JUN WANG and LING-CHENG ZHAO (Northwestern Polytechnical Univ., Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A560-A563. In Chinese. refs

Three methods, the v-g method, Niblett's method, and a model wind-tunnel test, are used to analyze the effects of the pylon pitching stiffness on wing-store flutter. Niblett's method of the binary airfoil is extended to a three-dimensional wing. The concept of the center line of aerodynamic pressure is suggested. The alteration of the relative position between the mode node-line and the centerline of aerodynamic pressure makes clear why the type of wing-store flutter changes and the flutter speed drops sharply. Author

A93-11821
THE INVESTIGATION ON VIBRATION CHARACTERISTICS OF ALL-MOVABLE STABILIZER OF AN AIRCRAFT

YING-BEN XIAO and DA-QUAN ZHOU Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A564-A566. In Chinese. refs

A new aircraft has adopted the all-movable stabilizer whose shaft is fixed on the fuselage. The results of the calculations and model tests indicate that the rotation frequency of the all-movable stabilizer is an important parameter for the flutter characteristics of an aircraft. The rotation frequency of the all-movable stabilizer depends on many factors. The nonlinear effects on rotation frequency are briefly described in this paper. The measures adopted to raise the rotation frequency are also presented. A higher rotation frequency is obtained and the design requirements met without any weight penalty. Author

A93-12434
TRANSPORT RESURRECTION
 JOHN WILEY Flight International (ISSN 0015-3710) vol. 142, no. 4339 Oct. 7, 1992 p. 31-33. Copyright

A review is presented of the Italian G.222 twin-turboprop military transport redesignated and ordered by the USAF as the C-27A Spartan for operations from remote airstrips in South America. The C-27A's navigation and radio equipment makes it a tactical aircraft with strategic communications capability. The T64 turboprops are rated at 2,500 kW and flat-rated to 45 C at sea level. R.E.P.

A93-12727
NONLINEAR MULTI-POINT MODELLING AND PARAMETER ESTIMATION OF THE DO 28 RESEARCH AIRCRAFT
 WEI WANG, XINHAI CHEN, SHUNDA XIAO (Northwestern Polytechnical Univ., Xian, China), and R. BROCKHAUS (Braunschweig, Technische Univ., Germany) In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 p. Abridged.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Translation. Previously cited in issue 07, p. 983, Accession no. A91-22357 refs

A93-12978

EFFECT OF FLIGHT CONDITIONS ON THE SOUND INSULATION OF THE AIRCRAFT PASSENGER COMPARTMENT [O VLIANII POLETNYKH USLOVII NA ZVUKOIZOLIATSIIU SALONA SAMOLETA]

V. F. ILLARIONOV and A. V. KEDROV TsAGI, Trudy no. 2502 1991 p. 3-11. In Russian. refs
Copyright

The effect of a boundary layer formed on the fuselage of an aircraft on the sound insulation of the passenger compartment is estimated. It is shown, in particular, that at frequencies above 25 Hz the sound-insulating properties of the boundary layer are practically nonexistent at all incidence angles. The effect of full internal reflection may be observed in the case of negative incidence angles with an absolute value greater than 35 deg, which may contribute to a reduction of noise level inside the passenger compartment. V.L.

A93-13261*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT TEST OPERATIONS USING AN F-106B RESEARCH AIRPLANE MODIFIED WITH A WING LEADING-EDGE VORTEX FLAP

DANIEL J. DICARLO, PHILIP W. BROWN, and JAMES B. HALLISSY (NASA, Langley Research Center, Hampton, VA) Aug. 1992 13 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4094) Copyright

Flight tests of an F-106B aircraft equipped with a leading-edge vortex flap, which represented the culmination of a research effort to examine the effectiveness of the flap, were conducted at the NASA Langley Research Center. The purpose of the flight tests was to establish a data base on the use of a wing leading-edge vortex flap as a means to validate the design and analysis methods associated with the development of such a vortical flow-control concept. The overall experiment included: refinements of the design codes for vortex flaps; numerous wind tunnel entries to aid in verifying design codes and determining basic aerodynamic characteristics; design and fabrication of the flaps, structural modifications to the wing tip and leading edges of the test aircraft; development and installation of an aircraft research instrumentation system, including wing and flap surface pressure measurements and selected structural loads measurements; ground-based simulation to assess flying qualities; and finally, flight testing. This paper reviews the operational aspects associated with the flight experiment, which includes a description of modifications to the research airplane, the overall flight test procedures, and problems encountered. Selected research results are also presented to illustrate the accomplishments of the research effort. Author

A93-13266#

B-2 FLIGHT TEST PROGRAM - AN UPDATE

RONALD E. HART (USAF, Edwards AFB, CA) Aug. 1992 58 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4118)

An overview of the B-2 flight-test program is presented giving characteristics of the B-2 cockpit, flight-test metrics, and preliminary results. System tests were conducted to support the flight test which consisted of measurements of system performance against operational criteria to verify operational concepts. Flight tests for observability, weapons systems, radar and navigation, and envelope expansion led to good results for the operational envelope, structural characteristics, and avionics of the B-2. C.C.S.

A93-13269#

TEST PILOT'S NOTES ON FLYING THE LOW ALTITUDE/AIRSPPEED UNMANNED RESEARCH AIRCRAFT (LAURA)

RICHARD J. FOCH (U.S. Navy, Naval Research Laboratory,

Washington) Aug. 1992 11 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4078) Copyright

The Low Altitude/Airspeed Unmanned Research Aircraft was developed at the Naval Research Laboratory to collect flight data and demonstrate the feasibility of very low airspeed long endurance unmanned aircraft, based on recent advances in low Reynolds number aerodynamics and composite structures. Four unique airplane configurations: a joined wing, variable span wing, a tandem wing, and a three-lifting-surface design, were developed during this research program. All initial tests of each of the four LAURA designs were flown via radio control by a ground-based pilot. This paper presents the observations made by the primary test pilot. General handling, stability and control, and performance characteristics for the initial flights of the four configurations are discussed. Additionally, an overall assessment of each LAURA design is presented. Author

A93-13273# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

THE F-18 HIGH ALPHA RESEARCH VEHICLE - A HIGH-ANGLE-OF-ATTACK TESTBED AIRCRAFT

VICTORIA REGENIE, DONALD GATLIN (NASA, Flight Research Center, Edwards, CA), ROBERT KEMPEL (PRC, Inc., Edwards, CA), and NEIL MATHENY (NASA, Flight Research Center, Edwards, CA) Aug. 1992 15 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 Previously announced in STAR as N92-33404 refs (AIAA PAPER 92-4121) Copyright

The F-18 High Alpha Research Vehicle is the first thrust-vectoring testbed aircraft used to study the aerodynamics and maneuvering available in the poststall flight regime and to provide the data for validating ground prediction techniques. The aircraft includes a flexible research flight control system and full research instrumentation. The capability to control the vehicle at angles of attack up to 70 degrees is also included. This aircraft was modified by adding a pitch and yaw thrust-vectoring system. No significant problems occurred during the envelope expansion phase of the program. Author

A93-13284#

INTEGRATED AERODYNAMICS AND CONTROL SYSTEM DESIGN FOR TAILLESS AIRCRAFT

STEPHEN J. MORRIS (Stanford Univ., CA) Aug. 1992 25 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (AIAA PAPER 92-4604) Copyright

This paper presents a numerical method for simultaneously designing an aircraft and its feedback control system to minimize drag with a fixed level of handling qualities. The method uses a nonlinear optimization to reconfigure the aircraft and choose control gains that minimize a composite performance index consisting of trimmed drag and a handling qualities measure, both evaluated at several flight conditions. Using this technique, tailless aircraft are synthesized for minimum drag with acceptable handling qualities. Some cases include a feedback control system so that the impact of active control on reduced trimmed drag can be assessed. The method shows how low drag can be achieved in unaugmented designs by careful choice of wing sweep, taper, and twist. Designs with stability augmentation show a 13-percent reduction in drag over the best designs without augmentation. Author

A93-13311*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PRELIMINARY DESIGN FEATURES OF THE RASCAL - A NASA/ARMY ROTORCRAFT IN-FLIGHT SIMULATOR

EDWIN W. AIKEN, ROBERT A. JACOBSEN (NASA, Ames Research Center, Moffett Field, CA), MICHELLE M. ESHOW (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), WILLIAM S. HINDSON, and DOUGLAS H. DOANE (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 17 p. AIAA and AHS, Flight Simulation Technologies Conference, Hilton Head Island,

SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4175) Copyright

Salient design features of a new NASA/Army research rotorcraft - the Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) - are described. Using a UH-60A Black Hawk helicopter as a baseline vehicle, the RASCAL will be a flying laboratory capable of supporting the research requirements of major NASA and Army guidance, control, and display research programs. The paper describes the research facility requirements of these programs together with other critical constraints on the design of the research system, including safety-of-flight. Research program schedules demand a phased development approach, wherein specific research capability milestones are met and flight research projects are flown throughout the complete development cycle of the RASCAL. This development approach is summarized, and selected features of the research system are described. The research system includes a full-authority, programmable, fault-tolerant/fail-safe, fly-by-wire flight control system and a real-time obstacle detection and avoidance system which will generate low-latitude guidance commands to the pilot on a wide field-of-view, color helmet-mounted display. Author

A93-13314#

AN ANALYSIS OF HELICOPTER DYNAMIC RESPONSE TO TURBULENCE USING FUSELAGE AND BLADE ELEMENT ATMOSPHERIC SAMPLING TECHNIQUES

JOHN D. FUNK, JR. and CORIN P. BECK (U.S. Navy, Naval Air Warfare Center, Warminster, PA) Aug. 1992 17 p. AIAA and AHS, Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4148)

An analysis is presented of three techniques for incorporating turbulent airflow similar to that close to a ship into a blade element rotorcraft dynamic simulation model. The goal of this study is to increase the understanding of the characteristics of rotorcraft dynamic response to turbulence utilizing different sampling resolutions. For this analysis a blade element rotorcraft model has been modified so that the velocities of a simulated flowfield in an inertially based coordinate system may be sampled by single blade elements, the tail rotor and the fuselage. R.E.P.

A93-13315#

HELICOPTER IN-FLIGHT SIMULATOR ATTHES - A MULTIPURPOSE TESTBED AND ITS UTILIZATION

HEINZ-JUERGEN PAUSDER, GERD BOUWER, WOLFGANG VON GRUENHAGEN, and RAINER HOLLAND (DLR, Inst. fuer Flugmechanik, Braunschweig, Germany) Aug. 1992 11 p. AIAA and AHS, Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4173) Copyright

An Advanced Technology Testing Helicopter System (ATTHes) has been developed based on a BO 105 helicopter. This testbed is equipped with a full authority nonredundant FBW control system for the main rotor and a fly-by-light system for the tail rotor. With the implemented software structure the flexibility is realized to alter the control laws without any changes in the real-time process. R.E.P.

A93-13326*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PRACTICAL CONSIDERATIONS IN WAVERIDER APPLICATIONS

DANIEL R. STEVENS (Lockheed Engineering & Sciences Co.; NASA, Langley Research Center, Hampton, VA) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4247) Copyright

This paper proposes a practical perspective for waverider shapes with respect to their use in the commercial and military aerospace industry. Also, integration problems that must be considered when deriving these shapes for operational aircraft are discussed and general approaches to solving them are suggested. The inverse design methodology that is used to

generate waverider geometries is discussed as a potentially powerful tool for the aerospace industry in the design of practical operational high-speed (Mach 4 to 25) aircraft. Further, it is suggested that unless this methodology proves to be a valuable tool in the near future, it will not likely find a customer in the aerospace industry and may become no more than an interesting academic study in aerodynamic optimization. Author

A93-13336*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

STRUCTURAL AND AERODYNAMIC CONSIDERATIONS FOR AN OBLIQUE ALL-WING AIRCRAFT

M. H. WATERS (Eloret Inst., Palo Alto, CA), M. D. ARDEMA (NASA, Ames Research Center, Moffett Field, CA), C. ROBERTS (Sterling Software, Inc., Palo Alto, CA), and I. KROO (Stanford Univ., CA) Aug. 1992 40 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4220) Copyright

A key design issue for the Oblique All-Wing aircraft is the packaging of the payload compartment, the fuel tanks, and the other internal components within the airfoil. The internal arrangement of such vehicles is strongly coupled to the exterior vehicle geometry. For example, the height requirements of a passenger cabin directly influence the aircraft thickness and span. As a result, the internal arrangement strongly affects aerodynamic performance and structural weight. Configuration criteria are defined and/or discussed, and a baseline aircraft is developed. Also, some of the major tradeoffs that affect structural weight and aerodynamic performance are presented. Author

A93-13337*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

OBLIQUE WING SUPERSONIC TRANSPORT CONCEPTS

THOMAS GALLOWAY, PAUL GELHAUSEN, MARK MOORE (NASA, Ames Research Center, Moffett Field, CA), and MARK WATERS (Eloret Inst., Moffett Field, CA) Aug. 1992 11 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4230) Copyright

The economic and technical features of two SST concepts that offer the potential of reducing the impact of the environmental constraints on the aircraft design and performance are presented. The potential economic performance of these aircraft is referenced to equivalent passenger size subsonic designs employing consistent design guidelines and assumptions. Total operating cost and airline return on investment are utilized for the economic comparisons. R.E.P.

A93-13340*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXTRACTING DIMENSIONAL GEOMETRIC PARAMETERS FROM B-SPLINE SURFACE MODELS OF AIRCRAFT

U. JAYARAM, ARVID MYKLEBUST (Virginia Polytechnic Inst. and State Univ., Blacksburg), and P. GELHAUSEN (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 14 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4283) Copyright

Research that creates techniques to automatically obtain dimensional geometric parameters from the nonuniform B-spline surface description of an object is presented. These techniques have been implemented successfully in the aircraft design software, ACSYNT, a computer-aided design system for conceptual aircraft design created at Virginia Tech and NASA Ames. The techniques created and implemented in this research are also of significance to general-purpose design. R.E.P.

A93-13348#

THE CONCEPTUAL STUDY OF SUPERSONIC TRANSPORT STRUCTURE

K. USUKI, T. HIRAMOTO (Fuji Heavy Industries, Ltd., Tokyo, Japan), T. UCHIDA (Japan Aircraft Development Corp., Tokyo), Y. SHIMOMURA (Kawasaki Heavy Industries, Ltd., Japan), and K.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

INABA (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan) Aug. 1992 6 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4219) Copyright

The structural concepts of an SST in the Mach 2.2 to 2.5 regime are presented. In this investigation, main structures utilizing materials that have sufficient heat resisting properties are analyzed concerning flight load, thermal stress and heat transfer. R.E.P.

A93-13353# USING AERODYNAMIC ANALYSIS CODES TO ASSIST IN STRUCTURAL DESIGN AND OPTIMIZATION OF DUCTED ROTOR/WING BLADES

WILLIAM A. CROSSLEY (Arizona State Univ., Tempe) and STEVEN M. BASS (McDonnell Douglas Helicopter Co., Mesa, AZ) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4280) Copyright

The rotor/wing aircraft, a high-speed rotorcraft concept, presents many design challenges, including structural design of the blade. This paper discusses the use of aerodynamic analysis codes with a structural design code to improve the accuracy of the generation blade structural designs. New blade designs were generated using the improved structural design tool and show an improvement over previous designs. These improvements demonstrated an innovative combination of different analysis codes to create a useful design tool. The methods employed to use the aerodynamic analysis codes to assist in the structural design and optimization of the rotor/wing blades also provide a basis from which a multidisciplinary design tool can be developed. Author

A93-13355# HSCT HIGH-LIFT AERODYNAMIC TECHNOLOGY REQUIREMENTS

D. L. ANTANI and J. M. MORGENSTERN (Douglas Aircraft Co., Long Beach, CA) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4228) Copyright

The paper addresses high-speed civil transport (HSCT) high-lift aerodynamic technology requirements. To meet economic viability and environmental compatibility goals of the HSCT, an advanced-technology, high-performance, high-lift system will be required. Fundamental high-lift issues and past experience are discussed to provide background on the subject. System requirements for meeting mission, takeoff/landing, and noise constraints are discussed briefly to highlight their relation to high-lift performance. Aerodynamic technology issues that require resolution and areas where improvements are required are presented to help guide the efforts of technologists and designers. Author

A93-13359# ADVANCED TECHNOLOGY TILT WING STUDY

JOHN W. RUTHERFORD and STEVEN M. BASS (McDonnell Douglas Helicopter Co., Mesa, AZ) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4237) Copyright

The design concept and the salient features of the Tilt Wing aircraft are discussed, showing that the concept has many features which make it attractive as a transport vehicle when compared to a Tilt Rotor. It is shown that the application of advanced technologies to the Tilt Wing (such as improved engines, composite structures, advanced propellers, and a circulation control wing) significantly reduces the gross weight and power required, while maintaining conversion descent capabilities acceptable for both the commercial and military transport type aircraft. I.S.

A93-13370# AIRCRAFT MODEL FOR MULTICRITERIAL ANALYSIS IN DECISION MAKING

A. LLINCA (Ecole Polytechnique, Montreal, Canada) Aug. 1992

7 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4192) Copyright

The paper deals with the relative influence of different technical and economical features of an aircraft model using an utility function. A set of independent technical parameters, which completely determines the aircraft performance and the utility function has been identified. Partial utility functions corresponding to different flight regime-take-off, climb, cruise, combat (for military aircrafts), glide and landing are assembled in a global utility function, together with the cost as an economic factor. Such a model can be used in the design process to identify the most important characteristics, which can be adjusted to achieve best possible performance. A comparison between different aircraft can be done. Author

A93-13371# AN ULTRALIGHT FREEWING AIRCRAFT DESIGN STUDY

WEIPING CHEN and JEWEL B. BARLOW (Maryland Univ., College Park) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4194) Copyright

This paper presents the selection of freewing design parameters according to the gust alleviation ability and a description of a wind tunnel test for a freewing aircraft. The wing oscillation test is specifically described because of its importance for freewing design. The wind tunnel test results and analyses shows that the freewing design can be less sensitive to atmospheric turbulence, is very unlikely to stall and performs well as compared to the typical ultralight aircraft. This is expected to lead to significant improvement in safety and in utility. A prototype airplane that is currently being flight tested is described. Author

A93-13372# ADAPTIVE OPTIMIZATION OF GENERAL AVIATION AIRCRAFT

YECHIEL CRISPIN (Embry-Riddle Aeronautical Univ., Daytona Beach, FL) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4195) Copyright

This work explores the application of an evolutionary based adaptive search algorithm to the optimal sizing of an executive jet aircraft at the conceptual design stage. This directed random search global optimization method, which mimics biological evolution processes has the advantage that it can be applied to nonlinear problems whose design space can be characterized by either a continuous or discontinuous and multimodal hypersurface. As a consequence, the algorithm is less susceptible to 'fall' in a local minimum of the design space which might be far from the real global optimum. The method is applied to the weight minimization of an executive jet aircraft and it is found that the algorithm converges to an optimum aircraft configuration even when the initial design population consists of unrealistic baseline configurations which are used to start the design procedure. Author

A93-13378# OUT WITH THE MECHANICAL FASTENERS

JAN ROSKAM and ED WENNINGER (Kansas Univ., Lawrence) Aug. 1992 11 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4210) Copyright

Through the use of novel composite-construction techniques, it is shown that the bolting and screwing of composite structures along lines familiar from metallic structural practices can be obviated. These novel, composites-oriented design practices are presently illustrated in the cases of a low-wing general aviation aircraft and a composite version of the currently metallic Cessna 152 aircraft. Attention is given to the installation of aileron actuators, the mountings for an advanced flight management system, wing and fuselage structures, and the attachment of the empennage and landing gear. O.C.

A93-13381*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRCRAFT CONCEPT OPTIMIZATION USING THE GLOBAL SENSITIVITY APPROACH AND PARAMETRIC MULTIOBJECTIVE FIGURES OF MERIT

BRETT MALONE and W. H. MASON (Virginia Polytechnic Inst. and State Univ., Blacksburg) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(Contract NAG1-224; NSF DDM-90-08451)

(AIAA PAPER 92-4221) Copyright

An extension of our parametric multidisciplinary optimization method to include design results connecting multiple objective functions is presented. New insight into the effect of the figure of merit (objective function) on aircraft configuration size and shape is demonstrated using this technique. An aircraft concept, subject to performance and aerodynamic constraints, is optimized using the global sensitivity equation method for a wide range of objective functions. These figures of merit are described parametrically such that a series of multiobjective optimal solutions can be obtained. Computational speed is facilitated by use of algebraic representations of the system technologies. Using this method, the evolution of an optimum design from one objective function to another is demonstrated. Specifically, combinations of minimum takeoff gross weight, fuel weight, and maximum cruise performance and productivity parameters are used as objective functions.

Author

A93-13401

ROTORCRAFT RELIABILITY AND MAINTAINABILITY: FUTURE DESIGN REQUIREMENTS; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, MAR. 20, 1991

London Royal Aeronautical Society 1991 54 p.

(ISBN 0-903409-88-7) Copyright

The present conference discusses the accurate assessment of reliability and maintainability characteristics, a military operator's experience of reliability and maintainability characteristics, and the viewpoint on future rotorcraft reliability of a civil operator. Also discussed are the viewpoint on these issues of an aircraft designer, the design of rotorcraft propulsion systems with a view to operating cost minimization, reliability testing procedures and results for the EH101 helicopter, and a British Civil Aviation Authority view of future reliability and maintainability trends. (For individual items see A93-13402 to A93-13407)

O.C.

A93-13404

AIRCRAFT DESIGNER'S VIEWPOINT OF RELIABILITY AND MAINTAINABILITY

A. J. HILL (Westland Helicopters, Ltd., Yeovil, United Kingdom) *In* Rotorcraft reliability and maintainability: Future design requirements; Proceedings of the Conference, London, United Kingdom, Mar. 20, 1991 London Royal Aeronautical Society 1991 p. 4.1-4.7.

Copyright

It is argued that reliability and maintainability (R&M) should be given a degree of attention comparable to that of aircraft performance during the design stage. Loosely defined or ambiguous requirements often result in expensive redesign chores during the aircraft development phase. Attention is given to examples of R&M features that are intrinsically associated with weight and cost penalties, the designing-in of ground personnel access to R&M-critical areas, and the essential feedback that must be obtained from R&M specialists during weight-reduction phases of aircraft development.

O.C.

A93-13406

RELIABILITY TESTING OF THE EH101

D. GREENHORNE (Westland Helicopters, Ltd., Yeovil, United Kingdom) *In* Rotorcraft reliability and maintainability: Future design requirements; Proceedings of the Conference, London, United Kingdom, Mar. 20, 1991 London Royal Aeronautical Society 1991 p. 6.1-6.6.

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An account is given of the reliability testing program to which the EH101 helicopter was subjected during its design, development, and vendor and preproduction flight testing. It has been found essential to allocate adequate funding for a testing program at the very outset of development, and to institute a failure reporting and corrective action system (FRACAS). The FRACAS is a team effort which must be organized across numerous areas of competence within a company, while employing data trackers, investigation progress chasers, and configuration-monitoring efforts.

O.C.

A93-13407

ROTORCRAFT RELIABILITY AND MAINTAINABILITY - A CA VIEW OF FUTURE TRENDS

JOHN E. WITHAM (Civil Aviation Authority, Gatwick, United Kingdom) *In* Rotorcraft reliability and maintainability: Future design requirements; Proceedings of the Conference, London, United Kingdom, Mar. 20, 1991 London Royal Aeronautical Society 1991 p. 7.1-7.5.

Copyright

The objectives of rotorcraft maintainability have been characterized by Britain's Civil Aviation Authority in terms of increases in (1) fatigue life, (2) intervals between inspections, and (3) intervals between overhaul. Attention is given to the possibility of enhancing reliability and maintainability by employing ever-higher emergency engine ratings which will yield adequate performance after engine failure. Condition-monitored maintenance is presently noted to be a well-established concept on fixed-wing aircraft; it is anticipated that future helicopter designs will be tailored to this concept.

O.C.

A93-13412

ADVANCED TECHNOLOGY AND THE PILOT

W. A. WAINWRIGHT (Airbus Industrie, Toulouse, France) *In* Human factors on advanced flight decks; Proceedings of the Conference, London, United Kingdom, Mar. 14, 1991 London Royal Aeronautical Society 1991 p. 6.1-6.4.

Copyright

The A 320 airliner's cockpit is an organic, evolutionary development from the A 300 and A 310 designs which renders the aircraft easy to use in both manual and automatic flight modes. The automation system's philosophy if focused on the pilot's retention of his tasks of flight-path control; automatic systems are used to match the flow of information to the requirements of the pilot in a given flight context, and to accomplish tasks for which human operators are poorly equipped. Systems and navigation aids are designed to engage the pilot only to the extent that is familiar from more conventional aircraft in which the pilot was accompanied by a navigator and flight engineer.

O.C.

A93-13415

CIVIL SPIN-OFF FROM MILITARY AIRCRAFT COCKPIT RESEARCH

D. N. JARRETT (Royal Aerospace Establishment, Flight Systems Dept., Farnborough, United Kingdom) *In* Human factors on advanced flight decks; Proceedings of the Conference, London, United Kingdom, Mar. 14, 1991 London Royal Aeronautical Society 1991 p. 10.1-10.9. refs

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Current configurations of military high speed aircraft cockpits and the flight decks of civil transport aircraft are compared, with a view to plausible further development of military systems and such developments' applicability to civil cockpits. Although the HUD may find use in civil transport aircraft, especially high benefits are anticipated from the application of helmet-mounted displays to civil rotorcraft. 'Virtual' cockpits are longer-term developments more relevant to future aerospacecraft.

O.C.

A93-13629

LOADS AT THE NOSE LANDING GEARS OF CIVIL TRANSPORT AIRCRAFT DURING TOWBARLESS TOWING OPERATIONS

O. BUXBAUM (Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt,

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Germany), J. J. CUNY (Airbus Industrie, Toulouse, France), H. KLAETSCHKE, and H. STEINHILBER (Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt, Germany) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 43-65. refs*
Copyright

Tow tractors operating without towbar facilitate the ground handling of civil transport aircraft. In this paper, the loads at the nose landing gears during towbarless towing operations are described based on extensive measurements and on analytical investigations. The necessary load limitation during extreme situations, e.g., emergency brakings, is discussed. Fatigue load spectra for towbarless towing and push-back operations were derived from operational measurements and are compared with load spectra for towbar operations. Recommendations are presented how the operational loads can be reduced by an appropriate design of towbarless tractors. Some remarks are made about towing of fully loaded aircraft to the runway. Author

A93-13631

REASSESSMENT OF THE C-141 STRUCTURAL LIFE

JOHN W. LINCOLN (USAF, Wright-Patterson AFB, OH) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 95-112. refs*
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This paper is a summary of actions that were taken to reassess the 45,000-flight-hour life of this aircraft. It examines the cracking of the durability test article for the purpose of establishing the flight hours when service aircraft may be expected to reach functional impairment. Both safety and economic considerations were included in the assessment. The safety evaluation of the wing considered the potential for multiple site damage degrading the fail-safe capability of the wing box. Author

A93-13635

AGING REVIEW OF THE YS-11 AIRCRAFT

T. SHIOHARA (Mitsubishi Heavy Industries, Ltd., Service Dept., Nagoya, Japan), M. NAKATA, and H. KUMADA (Mitsubishi Heavy Industries, Ltd., Aircraft Engineering Dept., Nagoya, Japan) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 175-193. refs*
Copyright

The current status of aging deficiencies in the YS-11 fleet - corrosion and cracks - is described, and the aging reevaluation currently being made is discussed. Also described is the structural design concept of YS-11 as well as two of previous aging reviews. Also addressed are establishment of service life limit and development of supplemental inspection document. Author

A93-13636

SUPER PUMA MK II - ROTOR AND GEARBOX FATIGUE

G. MESNARD (Aerospatiale, Div. Helicopteres, Marignane, France) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 195-215.*
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A review of technological concepts and failure-analysis techniques developed for the Super Puma MK II helicopter is given. Specific results are presented for the main rotor, tail rotor hub and blades, and the main gearbox. The designs of these elements are described including materials evaluations, and tests are conducted including failsafe plate behavior, FEM computations, and conventional fatigue testing. Specific attention is given to the

use of airborne recording and monitoring systems (ARMS) and to material-specific fatigue issues. Failure modes, effects, and criticality are analyzed to support the experimental results from bending/torsion tests, impact testing, and propagation tests. Scratches of 0.15 mm or more depth in structural elements of 30NCD16 steel are found to considerably lower the fatigue limits. The other areas of critical damage are the loss of tightening torque and corrosion and fretting-corrosion damage. C.C.S.

A93-13637

THE ROLE OF FATIGUE TESTING IN THE DESIGN, DEVELOPMENT AND CERTIFICATION OF THE ATR 42/72

A. MINUTO, S. SCAFARO (Alenia GAT, Naples, Italy), A. LANCIOTTI, and L. LAZZERI (Pisa Univ., Italy) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 217-236. refs*
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The paper describes the main lines of the test programs followed for the certification, for what concerns the fatigue design, of a commuter aircraft. A large number of experiments have been performed and the results are discussed here. The paper includes the description of the approach followed by ALENIA in defining the load spectra, the criteria for loading sequence construction and the necessary approximation (truncation and omission) required to carry out the tests in the most convenient way. The paper also discusses some of the main problems encountered in the full-scale test. Author

A93-13642

DAMAGE TOLERANCE ASSESSMENT ON THE MULTISITE CRACKS FOR THE YS-11 AIRCRAFT

MASAHIKO NAKATA (Mitsubishi Heavy Industries, Ltd., Aircraft Engineering Dept., Nagoya, Japan), TOSHIHIKO NISHIMURA (Mitsubishi Heavy Industries, Ltd., Engineering Research Dept., Nagoya, Japan), and KENJI INABA (Mitsubishi Heavy Industries, Ltd., Aircraft Engineering Dept., Nagoya, Japan) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 355-374. refs*
Copyright

Damage tolerance analysis is carried out based upon the multisite crack concept to evaluate the inspection interval required for inspection of the corner-angle fitting in the aft pressure bulkhead of the YS-11 aircraft. The crack-growth life is predicted using the stress intensity factor defined at each crack tip based upon linear elastic fracture mechanics. The analysis is verified by a fatigue-crack propagation test. When the analysis is conducted for the full-scale corner-angle fitting, the repeat inspection interval is reduced by about 31 percent compared to the current interval calculated under the single-site crack assumption. Author

A93-13700

HOVERING DECISIONS

DOUGLAS BARRIE *Flight International (ISSN 0015-3710) vol. 142, no. 4341 Oct. 21, 1992 p. 26-30.*
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A review is presented of the EH-101 multirole-helicopter program. Attention is given to the variants under consideration that include a maritime ASW version, several military/utility models, SAR options and tactical troop/transport-logistics support helicopters. An exploded view drawing of the vehicle that details all subsystems is included. R.E.P.

N93-10011 National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH.

A CONFIGURATION DEVELOPMENT STRATEGY FOR THE NASP

CURTIS D. SNYDER and S. ZANE PINCKNEY (Lockheed Engineering and Sciences Co., Hampton, VA.) *In JHU, The 1992 JANNAF Propulsion Meeting, Volume 1 p 195-202 Feb. 1992*

Previously announced in IAA as A91-56156 and A92-17830
 Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia,
 MD, 21044-3200 HC

Characteristics of airframe-integrated scramjet (AIS) aerospacecraft are studied using elementary and a recently developed AIS analysis code. Of principal interest is the definition of the AIS and what concepts offer the most potential. One of the concepts is selected for a limited optimization study aimed at defining the relationship of exhaust area to performance potential. The study shows that, if the AIS vehicle is to be fully constrained within the 'optimum' flowpath envelope, large values of exhaust-area-to-capture-area ratio are desired. A benefit of this choice is that performance at the very highest airbreather speeds is improved and, thus, may delay the need to switch to rocket power. Author

N93-10322 Southampton Univ. (England).

AN EXPERIMENTAL AND A THEORETICAL INVESTIGATION OF ROTOR PITCH DAMPING USING A MODEL ROTOR Ph.D.

Thesis

CONSTANTINOS PANTELIS SOTIRIOU 1990 456 p
 Avail: Univ. Microfilms Order No. BRDX93277

An experimental investigation was conducted to study rotor pitch damping in hover, axial flight (climb speed to tip speed ratios: 0-0.0549), and low speed forward flight (advance ratios: 0.05-0.088), for a variation in rotor thrust coefficient 0.001-0.0.13, and for the range of flapping frequency ratios squared 1.0-1.11. The tests were conducted at the following oscillation ratio frequencies, (frequency of oscillation divided by rotor angular speed), 0.186 for hover and axial flight and 0.1068 for low speed forward flight and in hover for the case of flapping frequency equal to unity. The nature of the damping of the rig was investigated since it was found that frictional effects contaminated the estimates of the rotor aerodynamic damping. To do this, a parameter estimation method, based on a nonlinear minimization procedure, was developed that does not require a large amount of data to identify the viscous and frictional damping coefficients from the free response of the rotor. A theoretical model for low frequency coupled rotor body dynamics was developed, and the effects of rotor and inflow degrees of freedom on rotor damping were investigated. Results indicate that both rotor and inflow degrees of freedom are required in the mathematical description of low frequency coupled rotor-body dynamics for the adequate estimation of rotor damping. The dynamic inflow degrees of freedom were described by using momentum theory and by assuming a nonuniform distribution for the steady induced velocity given by a Glauert wake. A blade flexibility study was conducted to define the flapping frequency for blade-linear spring configurations producing both time invariant and time dependent boundary conditions at the spring location. Comparison of theoretical damping estimates with the experimental data in hover and axial flight shows that at oscillation ratio frequency 0.186, the no-inflow model is in reasonable agreement with the experimental data and that the inclusion of dynamic inflow theory produces no improvement in the experimental data correlation. In hover and in low speed forward flight at oscillation frequency ratio 0.1068, the inclusion of dynamic inflow theory provides an improvement in the experimental data correlation indicating that for these conditions inflow degrees of freedom are also required for the adequate prediction of rotor pitch damping. Dissert. Abstr.

N93-10803# Royal Aircraft Establishment, Farnborough (England).

FLIGHT TEST AND ANALYSIS PROCEDURES FOR NEW HANDLING CRITERIA

M. T. CHARLTON and S. S. HOUSTON 5 May 1989 54 p
 Presented at the Royal Aeronautical Society Conference on Helicopter Handling Qualities and Control, London, England, Nov. 1988
 (RAE-TM-FM-26; BR111319) Copyright Avail: CASI HC A04/MF A01

There is work underway to revise the US MIL-H-8501 and the UK Def-Stan 00970 design requirements for the specification of

handling qualities for military rotorcraft. Current RAE research activities in support of the two programs are reported. The focus of this work has been an extensive series of flight trials to investigate handling and performance requirements for low level-nap-of-earth operations. Results of trials on two different aircraft in a small amplitude, high gain pitch tracking task, and for two discrete moderate amplitude maneuvers are introduced and discussed. Author

N93-10842# Massachusetts Inst. of Tech., Cambridge. Technology Lab. for Advanced Composites.

NONLINEAR AEROELASTICITY OF COMPOSITE STRUCTURES Final Report, 1 Jul. 1986 - 31 Jan. 1991

PETER E. DUNN and JOHN DUGUNDJI Oct. 1991 24 p
 (Contract F49620-86-C-0066)

(AD-A254285; AFOSR-92-0807TR) Avail: CASI HC A03/MF A01

The nonlinear, stalled, aeroelastic behavior of rectangular, graphite/epoxy, cantilevered plates with varying amounts of bending-torsion stiffness coupling and with NACA 0012 Styrofoam airfoil shapes is investigated for low Reynolds number flow (less than 200,000). A general Rayleigh-Ritz formulation is used to calculate point load static deflections, and nonlinear static vibration frequencies and mode shapes for varying tip deflections. Nonlinear lift and moment aerodynamics are used in the context of the Rayleigh-Ritz formulation to calculate static airload deflections. The nonlinear, stalled ONERA model using non-constant coefficients - initially developed by Tran and Petot - is reformulated into a harmonic balance form and compared against a time-marching Runge-Kutta scheme. Low angle-of-attack, linear flutter calculations are done by applying Fourier analysis to extract the harmonic balance method and a Newton-Raphson solver to the resulting nonlinear. GRA

N93-10900 Illinois Inst. of Tech., Chicago.

CONTROL OF PANEL FLUTTER AT HIGH SUPERSONIC SPEED Ph.D. Thesis

SEoud AHMED ABOU-AMER 1991 117 p
 Avail: Univ. Microfilms Order No. DA9222167

The exterior panels of flight vehicles travelling through the atmosphere at supersonic speed are often susceptible to the occurrences of limit-cycle type self-excited vibrations called flutter. The development of methods for the prevention and control of flutter, without adversely affecting the weight and cost, is desirable, and is the objective of this thesis. The two methods for suppressing flutter investigated in this study involve the use of damping treatment and piezoelectric actuators. The effect of both aerodynamic loading and damping, the structural damping, in-plane applied loads, the thermal stresses, and the cavity pressure are investigated through parametric study. Viscoelastic damping layers have been used in existing studies for noise and vibration control, and they are employed here to control panel flutter. Two different methods of damping are used. Modified formulations of the plate equations of motion with viscoelastic and constraining layers are represented, and the flutter behavior of the plate with and without damping are compared for both methods. A new advanced technique to control the plate flutter using a distributed piezoelectric material is developed and the modified formulation is derived. The values of the control voltage and the effect of piezoelectric material properties are investigated. Both methods give good results and succeed in suppressing the plate flutter at its operating condition. Dissert. Abstr.

N93-10968# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT ADVANCES IN MULTIDISCIPLINARY OPTIMIZATION OF ROTORCRAFT

HOWARD M. ADELMAN, JOANNE L. WALSH, and JOCELYN I. PRITCHARD Sep. 1992 14 p Presented at the Fourth AIAA/USAF/NASA/OAI Symposium on Multidisciplinary Analysis and Optimization, Independence, OH, 21-23 Sep. 1992
 (Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36-06)
 (NASA-TM-107665; NAS 1.15:107665; AVSCOM-TR-92-B-012; AIAA PAPER 92-4777) Avail: CASI HC A03/MF A01

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A joint activity involving NASA and Army researchers at NASA LaRC to develop optimization procedures to improve the rotor blade design process by integrating appropriate disciplines and accounting for all of the important interactions among the disciplines is described. The disciplines involved include rotor aerodynamics, rotor dynamics, rotor structures, airframe dynamics, and acoustics. The work is focused on combining these five key disciplines in an optimization procedure capable of designing a rotor system to satisfy multidisciplinary design requirements. Fundamental to the plan is a three-phased approach. In phase 1, the disciplines of blade dynamics, blade aerodynamics, and blade structure are closely coupled while acoustics and airframe dynamics are decoupled and are accounted for as effective constraints on the design for the first three disciplines. In phase 2, acoustics is integrated with the first three disciplines. Finally, in phase 3, airframe dynamics is integrated with the other four disciplines. Representative results from work performed to date are described. These include optimal placement of tuning masses for reduction of blade vibratory shear forces, integrated aerodynamic/dynamic optimization, and integrated aerodynamic/dynamic/structural optimization. Examples of validating procedures are described.

Author

N93-11161# Centro Italiano Ricerche Aerospaziali, Naples.
ARTIFICIAL INTELLIGENCE AND CFD: EXPERT SYSTEMS FOR THE DESIGN OF AIRFOILS AND FOR GRID GENERATION

DOMENICO QUAGLIARELLA 29 Jan. 1992 14 p
(DIGE-EST-TN-016; ETN-92-92413) Avail: CASI HC A03/MF A01

The potential application of Artificial Intelligence (AI) and of Expert Systems (ES) to Computational Fluid Dynamics (CFD) is shown. The application of such techniques to the design of aerodynamic shapes is discussed. The expert system IDEA (Intelligence Design of Airfoils) is presented. The problems connected to the acquisition and codification of aerodynamic design expertise are shown. Application of AI techniques to the problem of the positioning/decomposition of a computational domain is outlined. The solution of such problems is important to facilitate the generation of three dimensional grids and to create better data structures for massively parallel computing. ESA

N93-11334# Rolls-Royce Ltd., Derby (England).

THE CHANGING NATURE OF DESIGN

D. A. FORD 7 Mar. 1992 3 p Presented at the Rapid Prototyping Conference, Cheltenham, England, 6-7 Feb. 1992 (PNR-91011; ETN-92-92253) Avail: CASI HC A01/MF A01

The changing nature of design in the aerospace industry away from traditional drafting and design methods towards electronic design data and concurrent engineering is discussed. The new methods show an improved time base from component design to test. Some of the technologies which have contributed to the development of rapid development manufacture are the following: computer aided design fully integrated with analysis; computer aided drafting; simultaneous engineering between design and manufacture; multi-axis machine capability; process modeling of manufacturing processes; automated coordinate measurement machines; and rapid prototyping. The importance of rapid prototyping for commercial benefit is discussed, noting the Japanese experience and philosophy towards marketing: it is concluded that there is some way to go to satisfy the many demands on rapid prototyping, particularly speed of processing, cost of equipment, finished part definition, and materials. ESA

N93-11461# Systems Control Technology, Inc., Arlington, VA.
ROTORCRAFT HEALTH AND USAGE MONITORING SYSTEMS: A LITERATURE SURVEY Final Report

LARRY MILLER, BARBARA MCQUISTON, JEFF FRENSTER, and DIANE WOHLER May 1991 71 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/RD-91/6; SCR-91RR-5) Avail: CASI HC A04/MF A01

The rotorcraft industry is developing a number of techniques,

methodologies, and associated equipment for monitoring health and usage of critical rotorcraft flight components. Industry is planning to incorporate this technology on a number of new aircraft. The Federal Aviation Administration (FAA) has the responsibility for certification of these aircraft and the equipment they contain. This effort is concerned with the health and usage equipment. To best accomplish the certification of these equipment, the FAA expects to develop detailed certification criteria addressing specific issues of concern. In the near-term, the FAA objective is to develop a better understanding of what is being developed by industry (with emphasis on United States industry), what firms are involved, who are the key people involved, what parts of this technology are mature to the point that some airworthiness credit may be appropriate, and what parts of this technology are not yet mature. With information such as this, the issues that need to be addressed via certification criteria can be determined quickly. This effort is principally intended to provide support in reaching the FAA's near-term objectives. This report describes the results of an extensive literature search of health and usage monitoring technology. Over 1,000 abstracts were reviewed and analyzed. The report contains a description of 20 systems and abstracts of 90 papers pertinent to health and usage monitoring. Author

N93-11485# Royal Aerospace Establishment, Farnborough (England). Propulsion Dept.

DEVELOPMENTS IN ICING TEST TECHNIQUES FOR AEROSPACE APPLICATIONS IN THE RAE PYESTOCK (ENGLAND) ALTITUDE TEST FACILITY

A. R. OSBORN, V. E. W. GARRATT, and R. G. T. DRAGE 25 Sep. 1990 15 p Presented at the Tenth International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991 Previously announced in IAA as A91-56223 (RAE-TM-P-1214; P305695-04; ETN-92-92300) Copyright Avail: CASI HC A03/MF A01

The development of cloud simulation and the icing certification regulations are reviewed. Royal Aerospace Establishment (RAE) test facilities and their capability for monitoring voice formation and shedding are described. The development of water spray rakes is discussed. The use of the calibration facility in exploring these variables and the development of special measurement equipment is explained. The altitude test facilities at Pyestock are used in support of clearance of aeroengines, intakes, and helicopter rotors to operate under severe icing conditions. An important aspect of the work is the simulation of the wet icing cloud in terms of water concentration, mean droplet size, and spectrum. Water spray rakes or booms were developed and individual nozzles were calibrated in a wind tunnel using a laser particle sizer. In future work, the main objectives are to satisfy the customer requirements and the evolving demands of international regulatory authorities. ESA

N93-11719 Wichita State Univ., KS.

A SIMPLIFIED NUMERICAL PROCEDURE TO COMPUTE THE OPTIMAL TRAJECTORY OF AN AIRCRAFT Ph.D. Thesis

BIJAN RASHIDIAN 1991 122 p
Avail: Univ. Microfilms Order No. DA9221971

A simplified numerical method to obtain the optimal flight path trajectory for an aircraft flying in the presence of proximate aircrafts (commonly called intruders) or the presence of the restricted airspace zones is presented. Singular perturbation method along with Energy state approximation is used to formulate the mathematical model. The Pontryagin's Minimum Principle along with an efficient and realistic method of modeling the control time history is then used to calculate the optimal trajectory flight path. Several flight path and cost scenarios involving multiple intruders and risk airspaces, and some correlation with published data are presented. With the proper scaling of the weighting parameters the method generates trajectories with different end conditions and trajectory objectives. Dissert. Abstr.

N93-11725 Georgia Inst. of Tech., Atlanta.

A THEORY FOR THE ANALYSIS OF ROTORCRAFT OPERATING IN ATMOSPHERIC TURBULENCE Ph.D. Thesis

MARK FRANCIS COSTELLO 1992 170 p
 Avail: Univ. Microfilms Order No. DA9223775

A frequency domain model describing the atmospheric turbulence velocity field which is experienced by rotorcraft components is developed. Atmospheric turbulence over any particular rotor blade is approximated radially and azimuthally. With this expansion, a stochastic model is formed. The model is cast in the frequency domain. Example results are given for the CH-47D Tandem Rotor Helicopter. The model developed is drastically different from standard conventional rotorcraft atmospheric turbulence models owing to the fact that the statistics of atmospheric turbulence, which determine the stochastic model, are sampled at points on the rotating blade elements as opposed to the conventional rotorcraft atmospheric turbulence models which compute the statistics of atmospheric turbulence at the center of gravity of the aircraft. Dissert. Abstr.

N93-11838# Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.

EMBEDDED TRAINING CAPABILITIES FOR THE LAMPS MK 3 SYSTEM Final Report
 ROBERT S. ROMALEWSKI and JAMES H. HAMMOND Jan. 1992 11 p
 (AD-A250697; NOARL-PR-92-020-252) Avail: CASI HC A03/MF A01

An SH-60 helicopter incorporation the Light Airborne MultiPurpose System (LAMPS) MK 3 was tested using the AN/SRO-4 UHF secure data link to AN/SQQ-28 Sonobuoy Processor at the Naval Air Test Center (NATC) Patuxent River, MD. During the time the helicopter was on the simulated mission, it 'dropped' sonobuoys and received normal mission feedback. This was done during testing of a potential wide-area network, with the acoustic stimulation for the LAMPS MK 3 accomplished by passing control and acoustic information from an ANN/SQQ-89 On-Board Trained (OBT) at Patuxent River via an on-site data link network. A master control unit was used to drive NATC's OBT from Fleet ASW Training Center, Norfolk, over normal telephone lines. Multiple OBT connections from the master control unit are possible and will further team training by combining expertise located at another training center with all other connected assets. Other additions to the OBT interface will provide additional aircrew radar training via the AN/ APS-124 Remote Radar Operator (REMRO) system and EW software upgrades. The OBT is used at NATC in evaluation of helicopter ASW subsystems as well as for training. GRA

N93-11863*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT TEST RESULTS FROM A SUPERCRITICAL MISSION ADAPTIVE WING WITH SMOOTH VARIABLE CAMBER
 SHERYLL GOECKE POWERS, LANNIE D. WEBB, EDWARD L. FRIEND, and WILLIAM A. LOKOS Nov. 1992 31 p Presented at the AIAA 6th Biennial Flight Test Conference, Hilton Head, SC, 24-26 Aug. 1992
 (Contract RTOP 533-02-11)
 (NASA-TM-4415; H-1855; NAS 1.15:4415; AIAA PAPER 92-4101)
 Copyright Avail: CASI HC A03/MF A01

The mission adaptive wing (MAW) consisted of leading- and trailing-edge variable-camber surfaces that could be deflected in flight to provide a near-ideal wing camber shape for any flight condition. These surfaces featured smooth, flexible upper surfaces and fully enclosed lower surfaces, distinguishing them from conventional flaps that have discontinuous surfaces and exposed or semiexposed mechanisms. Camber shape was controlled by either a manual or automatic flight control system. The wing and aircraft were extensively instrumented to evaluate the local flow characteristics and the total aircraft performance. This paper discusses the interrelationships between the wing pressure, buffet, boundary-layer and flight deflection measurement system analyses and describes the flight maneuvers used to obtain the data. The results are for a wing sweep of 26 deg, a Mach number of 0.85, leading and trailing-edge cambers (delta(sub LE/TE)) of 0/2 and 5/10, and angles of attack from 3.0 deg to 14.0 deg. For the

well-behaved flow of the delta(sub LE/TE) = 0/2 camber, a typical cruise camber shape, the local and global data are in good agreement with respect to the flow properties of the wing. For the delta(sub LE/TE) = 5/10 camber, a maneuvering camber shape, the local and global data have similar trends and conclusions, but not the clear-cut agreement observed for cruise camber. Author

N93-12206 Illinois Univ. at Urbana-Champaign, Savoy.
AN EXPERIMENTAL STUDY OF THE RELATIONSHIP BETWEEN FORCES AND MOMENTS AND VORTEX BREAKDOWN ON A PITCHING DELTA WING Ph.D. Thesis
 MOHAMMAD REZA SOLTANI 1992 265 p
 Avail: Univ. Microfilms Order No. DA9215885

Wind-tunnel experiments were performed to study the complex flow mechanisms on a 70 deg sharp leading-edge delta wing model at both static and dynamic conditions at a Reynolds number of 1.43×10^6 (exp 6). Large amplitude oscillatory motions were produced by sinusoidally pitching the model over a range of reduced frequencies. Ramp motions were obtained using an initial sinusoidal increase in angle of attack and hold. Aerodynamic forces and moments were obtained from a six component internal strain-gauge balance. In addition, smoke flow visualization was conducted to study the development and breakdown of the leading-edge vortices under static, dynamic, and ramp conditions. The visualization experiment was performed at a Reynolds number of 0.16×10^6 (exp 6). Static forces compared well with previously published data. The non-linear vortex lift and the movement of the burst point over the wing surface were related to changes in the measured lift-curve slope. Asymmetrical bursting produced by testing the model at nonzero sideslip angle had a significant influence on the magnitude of the measured forces and moments. Dynamic data varied substantially with reduced frequency. Large forces and moments overshoots, a delay in dynamic stall, and a hysteresis loop between the values of aerodynamic loads in upstroke and downstroke motion were observed. The dynamic vortex breakdown point was seen to reach the trailing-edge at a smaller angle of attack than it did when in the static case. However, at large angles of attack, its position lagged that of the static model. The magnitude of the rolling moment coefficient was strongly influenced by the reduced frequency. For the ramp motion case, aerodynamic forces and moments closely followed those of the oscillatory case during the pitch-up motion. However, upon cessation of the motion, the persistence of the dynamic effects was a strong function of the pitch rate. Terminating the motion at 24 deg angle of attack produced lower lift and normal force values when the data were compared to their static values. This was caused by the early bursting phenomenon observed during the dynamic motion, thus reducing dynamic lift and normal force coefficients. Dissert. Abstr.

N93-12354# National Aerospace Lab., Tokyo (Japan). Management Team Flight Test Section.

FLIGHT TEST PROGRESS OF THE STOL RESEARCH AIRCRAFT ASKA [STOL JIKKENKI ASUKA NO HIKOU SHIKEN KIROKU SHASHIN TO SHIKEN KEIKA]
 EIICHI ABO Dec. 1991 28 p In JAPANESE Original contains color illustrations
 (ISSN 0452-2982)
 (NAL-TM-643; JTN-92-80412) Avail: CASI HC A03/MF A01

Flight tests of the STOL research aircraft 'ASKA' were conducted during the period of about three and a half years from Oct. 1985 to Mar. 1989 and provided many productive results. The resultant progress of these flight tests are subsequently described using applicable photographs. Author (NASDA)

N93-12458*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ACTIVE COOLING FROM THE SIXTIES TO NASP
 H. NEALE KELLY and MAX L. BLOSSER *In its Current Technology* for Thermal Protection Systems p 189-249 Oct. 1992
 Avail: CASI HC A04/MF A03

Vehicles, such as the X-15 or National Aero-Space Plane,

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

traveling at hypersonic speeds through the earth's atmosphere experience aerodynamic heating. The heating can be severe enough that a thermal protection system is required to limit the temperature of the vehicle structure. Although several categories of thermal protection systems are mentioned briefly, the majority of this paper describes convectively cooled structures for large areas. Convective cooling is a method of limiting structural temperatures by circulating a coolant through the vehicle structure. Efforts to develop convectively cooled structures during the past 30 years--from early engine structures, which were intended to be tested on the X-15, to structural--are described. Many of the lessons learned from these research efforts are presented. Author

N93-12485# Maryland Univ., College Park. Dept. of Aerospace Engineering.

THE FOURTH WORKSHOP ON DYNAMICS AND AEROELASTIC STABILITY MODELING OF ROTORCRAFT SYSTEMS Final Report, 1 May 1991 - 30 Apr. 1992

INDERJIT CHOPRA Nov. 1991 821 p Workshop held in College Park, MD, 19-21 Nov. 1991 (Contract DAAL03-91-G-0159) (AD-A255065; ARO-28860.1-EG-CF) Avail: CASI HC A99/MF A10

The workshop was held as scheduled. An assessment of the state-of-the-art of predictive capability for rotorcraft dynamics problems was made. GRA

N93-12488# Dayton Univ., OH.

EVALUATION OF ALTERNATIVES FOR INCREASING A-7D REARWARD VISIBILITY Interim Report, Aug. 1988 - May 1990

G. J. FRANK and G. J. STENGER Apr. 1992 154 p (Contract F33615-84-C-3404) (AD-A255071; UDR-TR-90-121; WL-TR-92-3009) Avail: CASI HC A08/MF A02

Experience has shown that the present A-7D canopy provides poor rearward visibility for defensive maneuvering against an adversary behind the A-7. Alternatives were identified and evaluated for increasing rearward visibility, including: increasing the length of the canopy transparency; adding external mirrors; modifying the existing internal mirrors; using a refractive lens; and altering the canopy profile. This evaluation showed that increasing the transparency length would provide the greatest increase in rearward visibility with the least distortion. The feasibility of extending the transparency was analyzed using a finite element model which showed that the transparency could be extended without increasing the maximum stress levels. Advanced composites were used to design an alternate canopy frame to allow the transparency to be extended by five inches. This frame was designed to be as stiff and strong as the current aft frame. The design required no modification to the surrounding fuselage and did not change the overall canopy weight. GRA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A93-10982

A FAULT-TOLERANT AIR DATA/INERTIAL REFERENCE SYSTEM

CHARLES R. MCCLARY (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 40-45. refs

Copyright

A fault-tolerant air data inertial reference system (ADIRS) is described. The system consists of a fault-tolerant air data inertial reference unit (ADIRU), a secondary air data attitude reference

unit (SAARU), and six air data modules (ADMs). The ADIRS replaces the conventional inertial reference and air data systems on aircraft and uses ARINC 629 bidirectional serial digital data bus interfaces. The ADIRS is designed to be the inertial and air data reference for the ARINC 651 Integrated Modular Avionics (IMA) distributed architecture and provides low life cycle cost and high availability through high reliability, simple high-integrity monitoring, and deferred maintenance. I.E.

A93-11000

ADVANCED REAL TIME INTEGRATED PROCESSORS

THOMAS H. ROBINSON and EDWARD TRUJILLO (Hughes Aircraft Co., Los Angeles, CA) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 173-178.

Copyright

A powerful integrated processor architecture has been developed by Hughes Aircraft Company to meet sensor, sensor fusion, and mission processing requirements. The Hughes Modular Processor (HMP) is based on development for the Lockheed F-22 Advanced Tactical Fighter Common Integrated Processor (CIP), and rests on an extensive prior history of high-performance imbedded signal and data processors. The authors discuss the HMP integrated, open architecture. This architecture has been demonstrated in an integrated electronic warfare, communications, radar, electrooptical, and mission processing application, as well as in stand-alone sensor/mission processing configurations. By virtue of its modularity, single application HMP configurations such as mission computing and dedicated sensor processors can be derived. Key technology issues are addressed, and innovative solutions to the difficulties of modular systems are presented. Specific module designs incorporating advanced packaging technology are discussed with emphasis on functionality and performance. The overall support software environment is characterized, with particular emphasis on the Ada compilation system, the operating system, and application user software development system. I.E.

A93-11018

SENSOR ALIGNMENT KALMAN FILTERS FOR INERTIAL STABILIZATION SYSTEMS

L. W. STIMAC (Aerospace and Defense Systems, Inc., Grand Rapids, MI) and THOMAS A. KENNEDY (Hughes Aircraft Co., Los Angeles, CA) /n IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 321-334. refs

Copyright

To achieve a particular set of motion compensation requirements and transfer alignment requirements a device called a motion sensor subsystem (MSS) was developed. The MSS is a strapdown inertial navigation system coupled with two decentralized Kalman filters that perform transfer alignment and estimation of various SINS instrument errors and system angular misalignments. One Kalman filter transfer aligns the MSS to the master navigator and the other filter estimates and corrects the misalignments between the MSS instrument axes and the sensor axes. The design, simulation, implementation, and flight testing of the MSS are described. These filters are coupled together through a process called regeneration that transfers one filter's shared state estimate to the other. In addition, because the filters operate in a closed-loop system, the computational time delay incurred by the filters significantly affects loop stability. A method of providing loop stability is discussed. The results of the MSS flight test have shown that using a methodology for developing a large Kalman filter based on intensive system covariance analysis and Monte Carlo simulation yields a system design that meets requirements. I.E.

A93-11203

TRENDS OF THE AIRBORNE COCKPIT DISPLAY FORMAT

MINORU SHIBATA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 464 1992 p. 480-486. In Japanese. refs

The design and structures of cockpit display and man-machine interface are presented. Various flight panel displays are compared and the technical characteristics of the liquid crystal display that need to be improved are listed. Research on head-up display and head-down display is discussed, and helmet-mounted display is also addressed. Y.P.Q.

A93-11281# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

THE DEVELOPMENT OF AN AIRBORNE INFORMATION MANAGEMENT SYSTEM FOR FLIGHT TEST

GLENN BEVER (NASA, Flight Research Center, Edwards, CA) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 323-332. Previously announced in STAR as N92-32866 refs (Contract RTOP 505-68-50)

(AIAA PAPER 92-4113) Copyright

An airborne information management system is being developed at the NASA Dryden Flight Research Facility. This system will improve the state of the art in management data acquisition on-board research aircraft. The design centers around highly distributable, high-speed microprocessors that allow data compression, digital filtering, and real-time analysis. This paper describes the areas of applicability, approach to developing the system, potential for trouble areas, and reasons for this development activity. System architecture (including the salient points of what makes it unique), design philosophy, and tradeoff issues are also discussed. Author

A93-13263*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT EVALUATION OF A STAGNATION DETECTION HOT-FILM SENSOR

MICHAEL A. SCOTT, NATALE A. STRAIN, and CYNTHIA C. LEE (NASA, Langley Research Center, Hampton, VA) Aug. 1992 14 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4085) Copyright

Results are presented of flight evaluation tests of a stagnation detection hot-film sensor. Experiments were conducted at steady level-flight conditions over a range of altitudes, angles of attack, and air speeds, as well as quasi-steady conditions during level-flight velocity acceleration and deceleration maneuvers. The results demonstrate the ability of a hot-film sensor to provide an accurate, reliable, and relatively nonintrusive measurement of the stagnation region in a flight environment. Stagnation could be identified within 0.1 inches. I.S.

A93-13265*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

RECENT FLIGHT-TEST RESULTS OF OPTICAL AIRDATA TECHNIQUES

RODNEY K. BOGUE (NASA, Flight Research Center, Edwards, CA) Aug. 1992 22 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4086) Copyright

Optical techniques for measuring airdata parameters have been demonstrated with promising results on high-performance fighter aircraft. These systems can measure the airspeed vector, and some are not as dependent on special in-flight calibration processes as current systems. Optical concepts for measuring free stream static temperature and density are feasible for in-flight as applications. The best feature of these concepts is that the airdata measurements are obtained nonintrusively, and for the most part well into the freestream region of the flowfield about the aircraft. Current requirements for measuring airdata at high angle of attack, and future need to measure the same information at hypersonic flight conditions place strains on existing techniques. Optical technology advances show outstanding potential for application in

future programs and promise to make common use of optical concepts a reality. This paper summarizes results from several flight-test programs and identifies the technology advances required to make optical airdata techniques practical. Author

A93-13272#

AIRSPED CALIBRATION USING GPS

RALPH D. KIMBERLIN and JOSEPH P. SIMS (Tennessee Univ., Tullahoma) Aug. 1992 7 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4090) Copyright

This paper discusses the results of flight test using the Global Positioning System as a method of obtaining pitot-static systems calibrations. Data from this method are compared with data from the two conventional methods for pitot-static system calibrations. Initial results from these tests are encouraging and testing is continuing. Author

A93-13310*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PILOT/VEHICLE DISPLAY DEVELOPMENT FROM SIMULATION TO FLIGHT

ALAN R. DARE (Lockheed Engineering & Sciences Co., Hampton, VA) and JAMES R. BURLEY, II (NASA, Langley Research Center, Hampton, VA) Aug. 1992 10 p. AIAA and AHS, Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4174) Copyright

The Pilot Vehicle Interface Group, Cockpit Technology Branch, Flight Management Division, at the NASA Langley Research Center is developing display concepts for air combat in the next generation of highly maneuverable aircraft. The High-Alpha Technology Program, under which the research is being done, is involved in flight tests of many new control and display concepts on the High-Alpha Research Vehicle, a highly modified F-18 aircraft. In order to support display concept development through flight testing, a software/hardware system is being developed which will support each phase of the project with little or no software modifications, thus saving thousands of manhours in software development time. Simulation experiments are in progress now and flight tests are slated to begin in FY1994. Author

A93-13351#

TCAS DISPLAY ISSUES

WILLIAM B. COTTON (United Airlines, Chicago, IL) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4242) Copyright

Various display issues relative to TCAS design are reviewed. Attention is given to existing implementations, resolution advisories, and traffic advisories. It is pointed out that enhancements to TCAS logic is continuing and refinements to symbology to improve the information transfer to pilots has also been identified. R.E.P.

A93-13373#

A GUIDANCE DISPLAY SYSTEM FOR SINGLE PILOT OPERATION

M. G. NAGATI, C. L. FULTON, and S. MIRSAFIAN (Wichita State Univ., KS) Aug. 1992 11 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4196) Copyright

A guidance system advising the single pilot of an aircraft in a heavy workload environment was developed and evaluated from the standpoints of effectiveness and pilot acceptance. The displays present the navigation data in a condensed easily interpreted manner. The effectiveness of the scheme was assessed with a model of a divided attention pilot and compared to actual tests. R.E.P.

N93-12367# National Aerospace Lab., Tokyo (Japan). Control Systems Div.

FLIGHT SIMULATOR EVALUATION OF D-SIZE LIQUID CRYSTAL FLAT PANEL DISPLAYS Report No. 2 [EKISHOUGATA FURATTO PANERU DESIPUREI NO SHIMYURETA HYOKA SHIKEN. SONO 2: D SAIZU GATA PFD, DMD]

HIROYASU KAWAHARA, KAORU WAKAIRO, and AKIRA WATANABE Dec. 1991 27 p In JAPANESE Original contains color illustrations (ISSN 0389-4010) (NAL-TR-1136; JTN-92-80404) Avail: CASI HC A03/MF A01

The so-called 'glass cockpit' has been introduced in recent years into commercial aircraft, where large color Cathode Ray Tubes (CRT's) are used as the primary flight instruments. In the near future, cockpit instruments using various types of flat panel displays such as a Liquid Crystal Flat Display (LCD), Light Emission Diode (LED), or plasma displays will be put into practical use, thereby superseding CRT's. Among these displays, the LCD seems to have the most superior advantages. The National Aerospace Laboratory (NAL) and Japan Aviation Electronics Industry, Ltd. (JAE) jointly conducted flight simulations to evaluate basic functions, performance, and display formats of D-size LCD displays using an NAL flight simulator. Two types of displays, a Primary Flight Display (PFD) and a Digital Map Display (DMD), were evaluated. Simulation results indicate that both LCD's have sufficient functions and performance necessary for actual use in commercial aircraft. The general outline and results from these simulator evaluation tests are described. Author (NASDA)

N93-12370# National Aerospace Lab., Tokyo (Japan). Control Systems Div.

AN OPTICAL FIBER MULTI-TERMINAL DATA BUS SYSTEM FOR AIRCRAFT [KOUKUUKI YOU MARUCHITAMINARU HIKARI DETABASU NO KENKYUU]

MITSUYOSHI MAYANAGI, MINORU TAKIZAWA, AKIRA WATANABE, and KAORU WAKAIRO Oct. 1991 103 p In JAPANESE (ISSN 0389-4010) (NAL-TR-1125; JTN-92-80393) Avail: CASI HC A06/MF A02

An optical fiber multiterminal data bus system was constructed and tested so as to provide the necessary technology bases for use on a Fly-By-Light (FBL) control system which will be required on future aircraft. The data bus system, designed and built in accordance with the protocol and system organization requirements set forth in MIL-STD-1553B (United States Air Force (USAF)), is a breadboard model comprised of a bus control unit, five remote terminal units, an 8:8 star coupler, and 12 fiber optic cables. This system improved the data transmission rate to 2 M bit/sec. Single fiber optic cable was utilized as the data transmission medium, with an electrically passive and transmitting 8:8 star coupler being newly developed for optical coupling. Serial bus control and message handling techniques were also developed for the data bus. The adaptability of this newly developed data bus to the FBL control system was verified by flight simulator tests.

Author (NASDA)

N93-12383# National Aerospace Lab., Tokyo (Japan). Control Systems Div.

LIQUID CRYSTAL FLAT PANEL DISPLAY EVALUATION TESTS USING A FLIGHT SIMULATOR Report No. 1 [EKISHOU GATA FURATTO PANERU DESUPUREI NO SHIMYURETA HYOKA SHIKEN. SONO 1: 5 INCHI GATA EADI]

HIROYASU KAWAHARA, KAORU WAKAIRO, and AKIRA WATANABE Sep. 1991 32 p In JAPANESE Original contains color illustrations (ISSN 0389-4010) (NAL-TR-1122; JTN-92-80409) Avail: CASI HC A03/MF A01

Color Liquid Crystal Display (LCD) are currently being developed as next generation flight instrument indicators. The National Aerospace Laboratory (NAL) and Yokogawa Electric Corporation performed evaluation tests on function, performance and display formats of a 5 x 5 inch flat panel LCD display. In these tests,

twenty-three pilots evaluated the LCD using a flight simulator. It was confirmed that this display is an effective indicator for flight instruments. The results of these evaluation tests are discussed.

Author (NASDA)

07

AIRCRAFT PROPULSION AND POWER

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

A93-10179

A STUDY OF A PULSED ELECTRICAL FIELD NEAR THE JET OF A TURBOJET ENGINE [ISSLEDOVANIE PUL'SIRUIUSHCHEGO ELEKTRICHESKOGO POLIA VBLIZI STRUI TURBOREAKTIVNOGO DVIGATELIA]

A. B. VATAZHIN, V. A. LIKHTER, V. V. FARAMAZIAN, D. V. KHEIFETS, and V. I. SHUL'GIN /n Turbulent jet flows with condensation and electrophysical effects Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 48-62. In Russian. refs

Copyright

Results of measurements of the pulsations of an electrical field formed by the electrically charged exhaust jet of an aviation turbojet engine are reported. A physical model is proposed which demonstrates that the principal parameters of the jet radio emission can be related to the exhaust current intensity, some design features of the turbine, and engine operating conditions. V.L.

A93-10732

TURBINE ENGINE DEVELOPERS EXPLORE WAYS TO LOWER NO(X) EMISSION LEVELS

D. W. BAHR (GE Aircraft Engines, Cincinnati, OH) ICAO Journal (ISSN 0018-8778) vol. 47, no. 8 Aug. 1992 p. 14-17.

Copyright

The development of low-NO(x) combustors is reviewed for applications to both subsonic and supersonic aircraft engines. The typical configuration for annular combustors is presented, and NO(x) reduction is shown to be feasible by reducing peak flame temperatures with lean fuel/air mixtures. Low- and ultralow-NO(x) combustors are described that are based on lean premixed/prevaporized combustion and rich/lean series-staged combustion. C.C.S.

A93-11209

EVALUATION OF 2D SCRAMJET NOZZLE PERFORMANCE

TETSUO HIRAIWA, SHIGERU SATO, SYUICHI UEDA, KOUICHIRO TANI, TOHRU MITANI, HIROSHI MIYAJIMA, MASAHIKO YAMAMOTO, MASASHI MATSUMOTO, and SHOHACHI YASU Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 464 1992 p. 515-522. In Japanese. refs

Scramjet nozzles were experimentally studied under Mach 8 flight conditions using a high temperature gas flow produced by combustion of monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO). The stagnation temperature was designed to be 3170 K and the stagnation pressure to be 1 MPa. Scramjet nozzles with expansion ratios of three (EN3) and five (EN5) were examined. Delivered specific impulse was found to be 17.3 s (EN3) and 26.1 s (EN5). Nozzle performance was predicted using numerical codes, and energy release loss, kinetic loss, and 2D loss were identified. The 2D loss was predicted to be 16.5 percent in the EN3 nozzle and to decrease to 7.0 percent in the EN5 nozzle. The kinetic loss due to chemical freezing was found to be about 4 percent. A friction loss evaluated from thrusts suggested laminar flow in the scramjet nozzle in the MMH/NTO experiments. Measured heat flux in nozzles also supported the laminar boundary layer. C.D.

A93-11419

POTENT TRENT

JULIAN MOXON Flight International (ISSN 0015-3710) vol. 142, no. 4334 Sept. 2, 1992 p. 136-140, 142.
Copyright

A review is presented of the RR Trent 700 turbofan engine developed and competing to power the A330 and 777 twin-engine commercial transports. An exploded-view drawing of the engine that details the entire powerplant package is included. R.E.P.

A93-11870

RESEARCH OF STARTING TEST OF THE SMALL TURBOJET IN SIMULATED ALTITUDE CONDITION

QING ZHU (Ministry of Aerospace Industry, 31st Inst., China) Chinese Society of Astronautics, Journal (ISSN 1000-1328) no. 1 1992 p. 75-80. In Chinese. refs

The test facility, measurement system, and test technology used for a starting test of a small turbojet are described. Conditions in some high-altitude cabins are simulated. The results have significant applications. C.D.

A93-12236

ADVANCED THREE-SHAFT ENGINES - CONFIGURED FOR RELIABILITY, EFFICIENCY AND GROWTH

H. M. BASELEY (Rolls-Royce, PLC, London, United Kingdom) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 41-48.

The characteristics of the family of RB211 three-shaft high-bypass-ratio engines are examined, and the unique benefits offered by the three-shaft concept are described. It is shown that the three-shaft engines display high strength and efficiency, excellent performance, and high reliability, as well as record-breaking on-wing lives. In addition, these engines have a fundamental growth capacity, which is one of the most significant benefits of the unique three-shaft design concept. I.S.

A93-12237

NUMERICAL SOLUTION OF DYNAMIC EQUATIONS ARISING IN A JET ENGINE SIMULATION

R. RAJASEKARAN, B. K. LAKSHMANAN, SANJAY PALSANE, and V. SUNDARARAJAN (Gas Turbine Research Establishment, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 49-54. refs

A numerical solution of a system of differential equations arising in the analysis of the transient performance of engine configurations was obtained using the Euler implicit integration scheme with multidimensional Newton Raphson iterative procedure and choosing the minimum computational time as the criterion of the Jacobian control. It was found that, for the given criterion, the rate of the CPU-time reduction decreases as the integration times increase. It is shown that it is possible to choose larger time steps in the numerical integration, without compromising the response of the system. I.S.

A93-12238

A MATHEMATICAL MODEL TO DETERMINE THE HEALTH OF COMPONENTS BASED ON SOAP DATA

C. JAGANATHAN (RTO /Engines/, Sunabeda, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 1 Feb. 1992 p. 55-58.

A mathematical model was developed for quick analysis of SOAP (spectrometric oil analysis program) data obtained with the purpose of detecting the wear status of oil-washed components of aircraft engines. The method also helps to decide whether to continue the operation or to withdraw the engine from service, by classifying the component in question as critical or noncritical, respectively. I.S.

A93-12452

NUMERICAL SIMULATION FOR AEROELASTICITY IN TURBOMACHINES WITH VORTEX METHOD. I - THEORY AND METHOD

WENQUAN WU (Shanghai Inst. of Mechanical Engineering, China)

and F. SISTO (Stevens Inst. of Technology, Hoboken, NJ) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 13, no. 2 May 1992 p. 142-149. In Chinese. refs

A new method to predict quantitatively the interaction between the unsteady aerodynamics and structural dynamics was developed. The unsteady flowfield with large scale separation is simulated numerically with the developed discrete vortex method. In this calculation process, the instantaneous unsteady force and moment acting on the blades can be obtained at each time step. On the other hand, the cascade is considered as an elasticity system with damping effects including the effects of the interblade phase angle. The blades are excited to vibrate by the unsteady force and moment. The resulting code contains these two large subprograms. The information obtained from these two algorithms is exchanged at each time step. The calculation is started from the initial time at which the blades are stationary, and the long-range behavior of the interaction is obtained with this extensive time-marching program. This method was demonstrated qualitatively. Author

A93-12733

AN EXPERIMENTAL INVESTIGATION OF HYDROGEN-FUELED SUPERSONIC COMBUSTOR

LING LIU, ZHANG ZHEN, TANG MING (Northwestern Polytechnical Univ., Xian, China), JINGHUA LIU, LIXIN YANG, and XINGFU WANG (31st Inst., Beijing, China) In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 7 p. Translation. Previously cited in issue 19, p. 3245, Accession no. A91-46168 Research supported by NNSFC refs

A93-12736

EFFECT OF HUB TREATMENT ON PERFORMANCE OF AN AXIAL FLOW COMPRESSOR

ZHAOHUI DU and ZHIWEI LIU (Northwestern Polytechnical Univ., Xian, China) In Aerospace - Collected translations of selected papers, 1992 Xian, China Northwestern Polytechnical University 1992 5 p. Translation. Previously cited in issue 07, p. 1327, Accession no. A91-25880 refs

A93-12810

AN EXPERIMENTAL STUDY OF A METHOD FOR REDUCING THE JET NOISE OF BYPASS ENGINES USING MECHANICAL FLOW MIXERS [EKSPERIMENTAL'NOE ISSLEDOVANIE METODA SNIZHENIIA SHUMA STRUI TRDD S POMOSHCH'IU MEKHANICHESKIKH SMESITELEI POTOKOV]

I. S. ZAGUZOV and K. V. KAKHOVSKII Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 46-49. In Russian. refs
Copyright

Results of an experimental study of the effect of lobe mixers on the noise level of bypass turbofan engines are examined. It is shown that the principal parameter responsible for the effective reduction of the jet noise is the radial clearance between the mixer lobes and the discharge nozzle. A diagram of an experimental 18-lobe mixer is presented. V.L.

A93-12811

ALLOWING FOR THE EFFECT OF FLOW NONISOTHERMALITY ON TOTAL PRESSURE LOSSES IN THE AFTERBURNER DIFFUSERS OF AUGMENTED TURBOFAN ENGINES [UCHET VLIANIYA NEIZOTERMICHNOSTI POTOKOV NA POTERI POLNOGO DAVLENIIA V DIFFUZORAKH FORSAZHNYKH KAMER TRDDF]

V. V. MEDVEDEV and N. N. PONOMAREV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 49-52. In Russian. refs
Copyright

Based on an analysis of analytical and experimental studies, a method is proposed for taking account of the effect of flow nonisothermality in the bypass exhausts on total pressure loss in the diffusers of the afterburners of augmented turbofan engines with flow mixing. It is shown that, in the case of isothermal scavenging, the ratio of total exhaust pressures should be used as the parameter characterizing the inlet flow nonuniformity. V.L.

A93-12812

A STUDY OF HEAT TRANSFER FROM A DISK IN A ROTATING CAVITY WITH AXIAL AND RADIAL-AXIAL FLOW OF A LIQUID [ISSLEDOVANIE TEPLOTDACHI DISKA VO VRASHCHAIUSHCHEISIA POLOSTI S OSEVYM I RADIAL'NO-OSEVYM TECHENIEM ZHIDKOSTI]

N. N. SALOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 53-57. In Russian. refs
Copyright

Heat transfer from a disk in a rotating cavity with axial or radial-axial flow of a medium is investigated experimentally. The experimental results are presented in the form of generalized relations for the mean Nusselt number along the disk radius. A hot medium layer flowing toward the axis of rotation is found to exist along a heated disk. V.L.

A93-12815

PARAMETRIC DIAGNOSTICS OF THE STEADY STATES OF GAS TURBINE ENGINES [PARAMETRICHESKAIA DIAGNOSTIKA USTANOVIVSHIKHSIA SOSTOIANII GTD]

IU. V. KOZHEVNIKOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 66-71. In Russian. refs
Copyright

A rigorous mathematical formulation is presented for the problem of the diagnostics of gas turbine engines from the results of observations of their thermodynamic and gasdynamic parameters with random errors. In contrast to the known studies, conditions for the existence of a solution are obtained, and multiple-step diagnostic algorithms are proposed. V.L.

A93-12818

EVALUATION OF THE EFFICIENCY OF THE DIRECT SEARCH METHOD IN SOLVING THE PROBLEM OF NUMERICAL CALCULATION OF THE COMPLEX HYDRAULIC COOLING SYSTEMS OF AVIATION GAS TURBINE ENGINES [ANALIZ EFEKTIVNOSTI METODA PRIAMOGO POISKA V RESHENII ZADACHI O CHISLENNOM RASCHETE SLOZHNYKH GIDRAVLICHESKIKH SISTEM OKHLAZHDENIIA AVIATSIONNYKH GTD]

B. V. BARANOVSKII and I. V. VORONIN Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 82-84. In Russian.
Copyright

A numerical experiment was carried out to evaluate the efficiency of the direct search method in the numerical analysis of the cooling systems of aviation gas turbine engines. It is found that the convergence of the computational algorithm is obtained for up to one hundred nodes. This confirms that the method is applicable to the analysis of state-of-the-art gas turbine engines. V.L.

A93-12820

EFFECT OF THE POWERPLANT CONFIGURATION ON THE AIR FLOW RATE OF THE JET SHIELD [VLIANIE KOMPOZOVKI SILOVOI USTANOVKI NA RASKHOD VOZDUKHA STRUINOI ZASHCHITY]

M. M. VYSOKOGORETS and M. G. KHABIBULLIN Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 87, 88. In Russian. refs
Copyright

The use of a jet screen is examined as a promising method of preventing the entry of the high-temperature gases of the reverse jet into the air intake during the landing run. A generalized relation is obtained which makes it possible to determine the required air flow rate of the jet shield for the known powerplant configuration and speed of the landing run. V.L.

A93-12822

A METHOD FOR ESTIMATING THE TECHNICO-ECONOMIC EFFICIENCY OF MEASURES INCREASING THE RELIABILITY OF GAS TURBINE ENGINES IN SERVICE [METODIKA OTSENKI TEKHNIKO-EKONOMICHESKOI EFEKTIVNOSTI MEROPRIATII, POVYSHAIUSHCHIKH NADEZHNOST' AVIATSIONNYKH GTD V EKSPLUATATSII]

A. I. EVDOKIMOV and A. I. RYDAEV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 91-94. In Russian. refs
Copyright

An algorithm is developed for evaluating the technico-economic efficiency of measures aimed at increasing the reliability of gas turbine engines. The algorithm can be used in developing the operation strategies and in predicting the consequences of specific decisions. Implemented on a computer, the algorithm provides a convenient way to narrow choices during the selection of alternative reliability-improving measures. V.L.

A93-13330*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DETERMINATION OF YAV-8B REACTION CONTROL SYSTEM BLEED FLOW USAGE

PAUL F. BORCHERS, ERNESTO MORALES, III, VERNON K. MERRICK, MICHAEL W. STORTZ (NASA, Ames Research Center, Moffett Field, CA), and DAVID J. H. EAMES (Rolls-Royce, Inc., Atlanta, GA) Aug. 1992 25 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4232) Copyright

Using a calibrated Rolls-Royce Pegasus engine, total Reaction Control System (RCS) bleed flow rates have been measured on a YAV-8B Harrier during typical short takeoff, transition, hover and vertical landing maneuvers. Using existing aircraft instrumentation and pressure taps located in the RCS ducts, bleed flow rates at each RCS valve were also measured directly during flight and ground tests. These data were compared with the calibrated engine data and with the RCS part of a YAV-8B mathematical model used in piloted simulation at NASA Ames Research Center. Areas of disagreement were small, being confined to the estimation of closed RCS valve leakages and the modeling of the RCS butterfly valve pressure losses. Author

A93-13333*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DYNAMIC ANALYSIS OF A PRE-AND-POST ICE IMPACTED BLADE

G. H. ABUMERI, E. S. REDDY (Sverdrup Technology, Inc., Brook Park; NASA, Lewis Research Center, Cleveland, OH), P. L. N. MURTHY, and C. C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4273) Copyright

The dynamic characteristics of an engine blade are evaluated under pre-and-post ice impact conditions using the NASA in-house computer code BLASIM. The ice impacts the leading edge of the blade causing severe local damage. The local structural response of the blade due to the ice impact is predicted via a transient response analysis by modeling only a local patch around the impact region. After ice impact, the global geometry of the blade is updated using deformations of the local patch and a free vibration analysis is performed. The effects of ice impact location, ice size and ice velocity on the blade mode shapes and natural frequencies are investigated. The results indicate that basic nature of the mode shapes remains unchanged after impact and that the maximum variation in natural frequencies occurs for the twisting mode of the blade. Author

A93-13334*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE MULTI-HEAT ADDITION TURBINE ENGINE

LEO C. FRANCISCUS (NASA, Lewis Research Center, Cleveland, OH) Aug. 1992 15 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4272) Copyright

A study was made of multiheat addition turbine engines (MHATE) which incorporate multiple burners and turbines. The types of engines studied were a MHATE two-spool duct burning turbo fan and a single-spool turbojet. A conventional duct burning turbofan and a TBE turbojet were studied for comparison. Comparisons of the thrust and specific fuel consumption of the engines were made for maximum burner temperatures of 2400 F

and 2900 F. The results of the study show that the MHATE engines with maximum burner temperatures of 2400 F obtain the same thrust and specific fuel consumption as the conventional engines having maximum burner temperatures of 2900 F. This would have the potential for significant reductions in harmful emissions of NO(x). When the MHATE and conventional engines have the same maximum burner temperatures, the MHATE engines achieve 15 to 50 percent more thrust. Author

A93-13352#
REACTION DRIVE ROTORS - LESSONS LEARNED (HERO HAD A GOOD IDEA - BUT)

ROBERT E. HEAD (McDonnell Douglas Helicopter Co., Mesa, AZ) Aug. 1992 8 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4279) Copyright

The reaction turbine concept invented by Hero of Alexandria forms the basis for tipjet powered helicopter rotors. Jet helicopter concepts are technically feasible but high fuel consumption and loud noise have limited their acceptance. Several methods for generating the propulsion gas for jet rotors are described. The disadvantages and applications of jet helicopters are discussed. The technology required and progress in this area are reviewed. The reaction drive while technically feasible for small helicopters has not yet found a place in the real-world economic marketplace. A.O.

A93-13360#
A DESIGN APPROACH TO HIGH MACH NUMBER SCRAMJET PERFORMANCE

P. H. KUTSCHENREUTER, S. V. SUBRAMANIAN, R. J. GAETA, JR., P. K. HICKEY, and J. A. DAVIS (GE Aircraft Engines, Cincinnati, OH) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4248) Copyright

This paper focuses on the implications of supersonic combustion ramjet (scramjet) operation at flight Mach numbers of 10 and above. In this regime, performance is driven by kinetics; flowpath cooling requirements dictate fuel equivalence ratios in excess of stoichiometric; and fuel axial momentum provides a significant percent of propulsion system net thrust. Consequently, design approaches producing acceptable scramjet performance at lower flight Mach numbers are inadequate; and different design approaches for high flight Mach number operation are required. A high Mach number design philosophy is delineated; some specific approaches are suggested, and the resulting performance potential is examined. Author

A93-13366#
FEASIBILITY STUDY ON SINGLE BYPASS VARIABLE CYCLE ENGINE WITH EJECTOR

TOSHINORI SEKIDO, JUNICHI HIROKAWA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), and NAOKI FUTATSUDERA (Japan Aircraft Development Corp., Tokyo) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4268) Copyright

Results are presented of the assessment of several candidate propulsion systems under noise constraint. The engine configurations assessed include single bypass variable cycle engines with ejector nozzle and tandem fan engines. Design cruise speed and design range are Mach 2.2 and 6000 NM, respectively. Results of a parametric evaluation indicate that, for single bypass engines, there exists an optimal combination of bare engine and ejector nozzle. Under the conditions of this study, this optimum engine was found to be superior to tandem fan engines. I.S.

A93-13383# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.

EFFECTS OF TURBINE COOLING ASSUMPTIONS ON PERFORMANCE AND SIZING OF HIGH-SPEED CIVIL TRANSPORT

PAUL F. SENICK (NASA, Lewis Research Center, Cleveland, OH)

Aug. 1992 8 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 Previously announced in STAR as N92-23537 refs (Contract RTOP 537-01-22) (AIAA PAPER 92-4217) Copyright

The analytical study presented examines the effects of varying turbine cooling assumptions on the performance of a high speed civil transport propulsion system as well as the sizing sensitivity of this aircraft to these performance variations. The propulsion concept employed in this study was a two spool, variable cycle engine with a sea level thrust of 55,000 lbf. The aircraft used for this study was a 250 passenger vehicle with a cruise Mach number of 2.4 and 500 nautical mile range. The differences in turbine cooling assumptions were represented by varying amount of high pressure compressor bleed air used to cool the turbines. It was found that as this cooling amount increased, engine size and weight increased, but specific fuel consumption (SFC) decreased at takeoff and climb only. Because most time is spent at cruise, the SFC advantage of the higher bleed engines seen during subsonic flight was minimized and the lower bleed, lighter engines led to the lowest takeoff gross weight vehicles. Finally, the change in aircraft takeoff gross weight versus turbine cooling level is presented. Author

A93-13405
DESIGN OF PROPULSION SYSTEMS FOR LOW OPERATING COSTS

J. C. MELIET (Turbomeca, Bordes, France) *In* Rotorcraft reliability and maintainability: Future design requirements; Proceedings of the Conference, London, United Kingdom, Mar. 20, 1991 London Royal Aeronautical Society 1991 p. 5.1-5.11. Copyright

A French helicopter engine configuration development history is presented which gives attention to operating cost-minimizing features incorporated with progressively greater effectiveness. The engines in question, in order of chronological development, are the Arius, TM 333, MTR 390, and RTM 322. The beneficial effects accruing to the incorporation of digital engine control system are noted. O.C.

N93-10348*# Garrett Turbine Engine Co., Phoenix, AZ.
COMPOUND CYCLE ENGINE FOR HELICOPTER APPLICATION Final Report

JERE CASTOR, JOHN MARTIN, and CURTISS BRADLEY 30 Sep. 1987 188 p

(Contract NAS3-24346; DA PROJ. 1L1-61102-AH-45) (NASA-CR-180824; NAS 1.26:180824; GTEC-21-5854-1; AVSCOM-TR-87-C-30) Avail: CASI HC A09/MF A02

The compound cycle engine (CCE) is a highly turbocharged, power-compounded, ultra-high-power-density, lightweight diesel engine. The turbomachinery is similar to a moderate-pressure-ratio, free-power-turbine gas turbine engine and the diesel core is high speed and a low compression ratio. This engine is considered a potential candidate for future military helicopter applications. Cycle thermodynamic specific fuel consumption (SFC) and engine weight analyses performed to establish general engine operating parameters and configurations are presented. An extensive performance and weight analysis based on a typical 2-hour helicopter (+30 minute reserve) mission determined final conceptual engine design. With this mission, CCE performance was compared to that of a contemporary gas turbine engine. The CCE had a 31 percent lower-fuel consumption and resulted in a 16 percent reduction in engine plus fuel and fuel tank weight. Design SFC of the CCE is 0.33 lb/hp-hr and installed wet weight is 0.43 lb/hp. The major technology development areas required for the CCE are identified and briefly discussed. Author

N93-10456*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.

COMPARISON OF ALL-ELECTRIC SECONDARY POWER SYSTEMS FOR CIVIL SUBSONIC TRANSPORTS

DAVID D. RENZ 1992 6 p Presented at the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, 3-7

07 AIRCRAFT PROPULSION AND POWER

Aug. 1992; sponsored by SAE, ACS, AIAA, ASME, IEEE, AICHe, and ANS
(Contract RTOP 538-01-10)
(NASA-TM-105852; E-7300; NAS 1.15:105852) Avail: CASI HC A02/MF A01

Three separate studies have shown operational, weight, and cost advantages for commercial subsonic transport aircraft using an all-electric secondary power system. The first study in 1982 showed that all-electric secondary power systems produced the second largest benefit compared to four other technology upgrades. The second study in 1985 showed a 10 percent weight and fuel savings using an all-electric high frequency (20 kHz) secondary power system. The last study in 1991 showed a 2 percent weight savings using today's technology (400 Hz) in an all-electric secondary power system. This paper will compare the 20 kHz and 400 Hz studies, analyze the 2 to 10 percent difference in weight savings and comment on the common benefits of the all-electric secondary power system. Author

N93-10539 Toronto Univ. (Ontario). Dept. of Mechanical Engineering.

THEORETICAL AND EXPERIMENTAL INVESTIGATIONS CONCERNING THE STRUCTURAL INTEGRITY OF AEROENGINE COMPRESSOR DISCS

S. A. MEGUID, B. THEOBALD (Rolls-Royce Ltd., Derby, England), and J. WISEMAN (Rolls-Royce Ltd., Bristol, England) *In* Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 484-485 May 1989
Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

The dovetail regions of aeroengine compressor discs are critical regions for which lifetime certification is necessary. Attention is devoted here to features and interface conditions in the dovetail region upon the least damage fail-safe design criterion. These features include inner and outer fillet radii $R(\text{sub } 1)$ and $R(\text{sub } 2)$, flank length and angle, and the coefficient of friction at the blade-disc interface. Three aspects of the work were examined. The first was concerned with the stressing of a given disc, the second with the initiation and subsequent propagation of cracks in regions exhibiting maximum stress concentration, and the third with the minimum principal stress criterion. Finally, the results were compared with photoelastic spin tests using the stress freezing technique. Author (CIST)

N93-10983* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN INTERACTIVE PREPROCESSOR FOR THE NASA ENGINE PERFORMANCE PROGRAM

JEFFREY J. BERTON and ROBERT M. PLENCNER Aug. 1992 28 p
(Contract RTOP 505-69-50)
(NASA-TM-105786; E-7216; NAS 1.15:105786) Avail: CASI HC A03/MF A01

The Simplified NEPP Automated Preprocessor (SNAP), which is written to aid in the preparation of input data files for the NASA Engine Performance Program (NEPP), is described. Specifically, SNAP is a software package on the Virtual Machine operating system that prompts the NEPP user for input information via a series of menus. The data collected from these menus are assimilated into an input file suitable for the running of NEPP. SNAP acts as a user-friendly preprocessing interface for NEPP. This serves as an introduction to the SNAP software, a user's manual, a description of the program logic, and a maintenance manual for future modifications to the software. Author

N93-11019# Rolls-Royce Ltd., Derby (England).

MATERIALS: TOWARD THE NON-METALLIC ENGINE

P. J. POSTANS 1 Jan. 1992 5 p
(PNR-90915; ETN-92-92204) Copyright Avail: CASI HC A01/MF A01

The constraints that are put on the aeroengine by the limited strength and temperature capability of available materials are

considered. The trends in engine materials from steel and aluminum to titanium and nickel are discussed. The present requirement for new materials to be lighter, stiffer, have predictable behavior at high stress levels, and operate well above today's temperatures, is stressed. The role of fiber reinforced metals and ceramics, the most promising successors to today's metals, is discussed. The eventual aim, to use ceramic composites for turbine aerofoils and discs, is also discussed. ESA

N93-11023# Rolls-Royce Ltd., Derby (England).

AN EXPERIMENTAL EVALUATION OF PREDICTION METHODS FOR CONTRAFANS

DAVID GEOFFREY HENSHAW 15 Nov. 1991 10 p Presented at the European Propulsion Forum 1991, Paris, France, 13-15 Nov. 1991

(PNR-90924; ETN-92-92209) Copyright Avail: CASI HC A02/MF A01

The testing of a contrafan rig in an anechoic wind tunnel at tunnel speeds up to Mach 0.22 is described. The rig is a one-sixth scale model of the fans and bypass duct of the RB529 contrafan engine, and was tested to assess the noise and performance of this configuration at off design conditions. In duct and far field noise levels were measured for a number of different model geometries, demonstrating the effects of changing the rotor-rotor spacing, of changing the rear rotor-rear strut separation, and of removing the front inlet struts. The effects of incidence and forward speed on noise levels were also measured. ESA

N93-11024# Rolls-Royce Ltd., Derby (England). Mechanical Test Engineering Dept.

TESTING FOR INTEGRITY

J. HORSLEY 18 Oct. 1991 14 p Presented at RAeS/IMEchE Aeroengine Reliability, Integrity and Safety, Bristol, England, 17-18 Oct. 1991

(PNR-90927; ETN-92-92210) Copyright Avail: CASI HC A03/MF A01

Principal tests involved and techniques and facilities used to carry out tests of stresses and strains induced in gas turbine engine components during service are described. Focus is on civil engines. Three categories of tests are outlined: engine tests, component tests, and specimen tests. Lubrication and transmission testing is also considered. ESA

N93-11036# Rolls-Royce Ltd., Derby (England).

ROLLS-ROYCE CIVIL ENGINE TECHNOLOGY

C. HORNBLLOWER 5 Dec. 1991 10 p Presented at the Avia India 1991 Conference, New Delhi, India, 5 Dec. 1991

(PNR-90936; ETN-92-92216) Copyright Avail: CASI HC A02/MF A01

The Trent engine and the technology that produces it are described. Details of the following are given: design philosophy, Trent family, engine configuration, nacelle, wide chord fan, structure, high pressure system, low pressure turbine, FADEC control system, operational considerations, and development program. ESA

N93-11037# Rolls-Royce Ltd., Derby (England).

THE TRENT: TOWARDS GREATER THRUST

C. HORNBLLOWER 11 Oct. 1991 8 p Presented at the International Pacific Air and Space Technology Conference, Gifu, Tokyo, 7-11 Oct. 1991

(PNR-90937; ETN-92-92217) Copyright Avail: CASI HC A02/MF A01

The Trent engine and the technology that produces it are described. Details of the following are given: design philosophy, Trent family, engine configuration, nacelle, wide chord fan, structure, high pressure system, low pressure turbine, FADEC control system, operational considerations, and development program. ESA

N93-11038# Rolls-Royce Ltd., Derby (England).

FROM RB211 TO TRENT: AN ONGOING DEVELOPMENT STRATEGY

C. HORNBLOWER 6 Sep. 1991 9 p Presented at the 10th International Society of AirBreathing Engines, Nottingham, England, 1-6 Sep. 1991 Previously announced in IAA as A91-56246 (PNR-90938; ETN-92-92218) Copyright Avail: CASI HC A02/MF A01

An overview of the development and present state of the art of the RB211 (RB211-22, RB211-524, and RB211-535) and the Trent engines is given. The three shaft configuration of the RB211, designed in 1967, has stood the test of time well in operational service. The concept produced a truly modular engine which was exploited by progressive development and technology read across as the family of engines increased. The engine has accumulated over 40 million service hours, and it powers variants of the Lockheed Tristar and Boeing 747, 757, and 767 in 66 customer airlines. The market demands for further improvements in wide body aircraft capacity and operating costs now call for engines in the 70,000 to 80,000 lb thrust class with growth requirements to 95,000 lb and possibly more. The Rolls-Royce contender in this arena is the Trent engine, the latest development of the RB211 and one which takes the first fundamental steps to modify the architecture of the engine in terms of both the mounting arrangement and the number of aerodynamic stages employed, to deliver thrust levels twice those of the original RB211 first tested twenty two years ago. ESA

N93-11039# Rolls-Royce Ltd., Derby (England).

INTRODUCTION TO THE ROLLS-ROYCE DESIGN PROCESS

A. J. B. JACKSON 15 Apr. 1991 102 p Presented at the Integrated Manager Development Scheme Product Evaluation (IMDS) Course, Coventry, England, Apr. 1991 (PNR-90939; ETN-92-92219) Copyright Avail: CASI HC A06/MF A02

A set of graphics for a lecture on an integrated manager development scheme, given as part of a product evaluation course, is presented. The important selling points of Rolls-Royce, safety, thrust, and competitiveness are discussed. These take into account such factors as fuel and thermal efficiency. The Trent engine is considered with respect to the following: powerplant, sales, performance, materials, weight, and cost. Under design engineering the following are presented: design, performance, compressor technology, turbine technology, powerplant and noise technologies, mechanical and material technologies, and the detail drawing offices. The experimental manufacture and development process, the production, and 'after sales' are also discussed. ESA

N93-11040# Rolls-Royce Ltd., Derby (England).

THE ROLE OF TURBOMACHINERY TESTING FOR STABILITY IN DISTORTED FLOW

T. P. HYNES (Cambridge Univ., England) and D. D. WILLIAMS (Rolls-Royce Ltd., Bristol, England) 15 Nov. 1991 17 p Presented at the RAeS Conference, Paris, France, Nov. 1991 (PNR-90943; ETN-92-92220) Copyright Avail: CASI HC A03/MF A01

Reasons for turbomachinery testing are discussed: performance verification, problem diagnosis, part of technology development. The task of stability assessment for realistic problems is of such difficulty that no theory or calculation method that exists presently is able to make reliable predictions without some empirical input. The combination of theory and empiricism represents a great challenge to those who work in the particular field. Some of the ways in which work has contributed to understanding in this area are reviewed. Progress to date is summarized and the role that testing plays in future areas of development is discussed. The importance of taking account of the environment in which a compressor is operating when making a stability assessment for a distorted inlet flow is stressed. Measures of the strength of flow field coupling, compressor testing for inlet distortion, total temperature, distortion, and coupling in turbofan geometries are discussed. ESA

N93-11055# Rolls-Royce Ltd., Derby (England).

EXPERIMENTAL HEAT TRANSFER RESULTS IN TURBINE STATORS AND ROTORS AND A COMPARISON WITH THEORY

R. W. AINSWORTH (Oxford Univ., England), W. D. E. ALLAN (Oxford Univ., England), T. V. JONES (Oxford Univ., England), T. GARSIDE (Oxford Univ., England), N. W. HARVEY, and R. C. KINGCOMBE (Defence Research Agency, Farnborough, England) 15 Nov. 1991 35 p Presented at the 3rd European Propulsion Forum, Paris, France, 13-15 Nov. 1991 Sponsored by Ministry of Defence and Science Research Council (PNR-90945; ETN-92-92222) Copyright Avail: CASI HC A03/MF A01

Detailed heat transfer distributions of heat transfer to both turbine stators and rotors was measured under simulated full scale turbine conditions of Reynolds number and Mach number. Transient techniques were used to perform both these measurements and in particular the isentropic light piston tunnel and thin film heat transfer gauge instrumentation were employed. The results presented are mean heat transfer values and these compared satisfactorily with values found from available methods of boundary layer analysis. Stator endwall measurements were similarly satisfactorily predicted. Therefore, it is clear that both stator and rotor mean heat transfer may be estimated in the regions considered using available methods when boundary layer transition can be defined. ESA

N93-11061# Rolls-Royce Ltd., Derby (England).

CONCORDE PROPULSION: DID WE GET IT RIGHT? THE ROLLS-ROYCE/SNECMA OLYMPUS 593 ENGINE REVIEWED

G. A. GANLEY (Rolls-Royce Ltd., Bristol, England) 1 Oct. 1991 11 p Presented at the SAE Aerotech 1991, CA, 23-26 Sep. 1991 (PNR-90970; ETN-92-92237) Copyright Avail: CASI HC A03/MF A01

The adopted control philosophy is considered. The engine and its reheat and secondary nozzle systems are considered from a mechanical point of view, and the mechanical performance is evaluated as a function of the special aspects of supersonic flight. How the long hot soak at cruise, which sets the Olympus apart from all other engines, was obtained is considered by giving an overview of the engine on a modular and system basis that includes the following: compressor intake module, low pressure compressor module, intermediate casing and gear box modules, high pressure (HP) compressor module Olympus 593 stage 6 HP compressor peak temperature and stress range, combustion module, turbine modules, reheat system, secondary nozzle assembly, engine electrical system. It is concluded that the 600,000 hours of operational experience, over half at Mach 2.0, have shown that the adopted control philosophies were correct and are showing that the most significant difference between civil subsonic and supersonic engines is the cruise at high inlet air temperatures which has produced some unexpected mechanical affects. ESA

N93-11062# Rolls-Royce Ltd., Derby (England).

SIMULTANEOUS ENGINEERING IN THE DESIGN OF AERO ENGINES

R. J. HILL 1 Nov. 1991 16 p Presented at the BUAA Inst./Northwest Polytechnical/Nanjing Aeronautic Inst./Zhuzhou Inst. Lectures, China, 6-20 Oct. 1991 (PNR-90973; ETN-92-92238) Copyright Avail: CASI HC A03/MF A01

Simultaneous engineering, a way of managing the design of aero-engines to reduce the risk, cost, and time required to launch an aero-engine and to ensure that it can be made at the most economical cost possible is defined and discussed. It is receiving increasing attention as the costs of launching a major engine increase and the market becomes more competitive. A typical product launch cycle and cost base are illustrated and the organizational structure of simultaneous engineering is considered. The help brought to this process by computer aided engineering is shown. Applications to the production of compressor blades, combustors, and the Trent wide chord fan blades are illustrated.

07 AIRCRAFT PROPULSION AND POWER

The balancing of technology acquisition to manufacturing and engineering is considered. The application of simultaneous engineering in aero-gas turbine design and manufacture summarizes the whole process. ESA

93-11063# Rolls-Royce Ltd., Derby (England).

THE TRENT FAMILY OF ENGINES

R. J. HILL 13 Nov. 1991 16 p Presented at the BUAA Inst./Northwest Polytechnical/Nanjing Aeronautic Inst./Zhuzhou Inst. Lectures, China, 6-20 Oct. 1991 (PNR-90974; ETN-92-92239) Copyright Avail: CASI HC A03/MF A01

The concept of a 'family' of engines is introduced. The evolution of the Trent family from the RB211 is outlined giving attention to the development of the different engine components: the fan, compressors, combustor, and turbines. The engine's full authority digital electronic system is discussed. ESA

93-11068# Rolls-Royce Ltd., Derby (England). Aerospace Group.

ADVANCED THREE-SHAFT ENGINES: CONFIGURED FOR RELIABILITY, EFFICIENCY, AND GROWTH

H. M. BASELEY 5 Mar. 1991 12 p Presented at the 43rd AGM of the Aeronautical Society of India, 7-8 Feb. 1992 (PNR-90986; ETN-92-92245) Copyright Avail: CASI HC A03/MF A01

The family of Rolls-Royce RB211 3 shaft engines is examined and the series of unique benefits which are enjoyed by operators because of the 3 shaft concept are outlined. The benefits are addressed under three main headings: fundamental design features; in service reliability and efficiency; and future growth capability. The Trent engine, which represents the advanced three shaft growth engine family, is considered. ESA

93-11069# Rolls-Royce Ltd., Derby (England). Aerospace Group.

MAINTAINABILITY OF LARGE GAS TURBINE AERO ENGINES

JOHN G. CHAMBERS 30 Apr. 1992 7 p Presented at the I Mech E Conference on Maintenance, Birmingham, England, Jun. 1992 (PNR-90987; ETN-92-92246) Copyright Avail: CASI HC A02/MF A01

The approach to maintainability on the RB211 engine series is outlined with the aim of transferring ideas elsewhere. History has shown its original revolutionary concepts to be excellent, and experience has dictated needs, and found ways and means of further enhancement. The influences of engine size increases and the advent of the electronic revolution are touched upon. It is considered that maintainability needs to be thought about very carefully, both at the conceptual and the detailed design stage. Whether the machine can be easily and conveniently broken down into subassemblies must be considered. It must be ensured that those items which need to be maintained on a relatively regular basis are positioned for easy access, with due regard for adverse environment conditions, such as temperature, and intrusion of the elements. If the opportunity arises whereby a significant design change occurs, the maximum advantage should be taken of this opportunity by the process of consultation with people who have had to use the machine for real in its true environment. It should be noted however that this consultation process should in any case be going on continuously as a catalyst to any product improvement process. ESA

93-11085# Rolls-Royce Ltd., Derby (England).

CIVIL AIRCRAFT ENGINES: THE NEXT GENERATION

R. P. ARTHEY 14 Oct. 1991 5 p Presented at the 9th World Airports Conference, London, England, 10-13 Sep. 1991 (PNR-90962; ETN-92-92235) Copyright Avail: CASI HC A01/MF A01

Some commercial pressures and trends that define the direction in which the aircraft engine industry is going are discussed: more power, more fuel efficient, more reliable, quieter, and cleaner engines are required. The way in which engine manufacturers are

responding is discussed. The critical importance of close cooperation between airframe constructors and engine manufacturers is stressed. It is concluded that in order to achieve the required goals in supersonic transport without putting engine manufacturers at unacceptable business risk, international collaboration will be necessary. ESA

93-11105# Rolls-Royce, Inc., Atlanta, GA.

ADVANCED MATERIALS IN GAS TURBINE ENGINES: AN ASSESSMENT

S. GUPTA and M. GOULETTE (Rolls-Royce Ltd., Derby, England) Nov. 1991 7 p Presented at the 1991 Yokohama International Gas Turbine Congress, Yokohama, Japan, 27 Oct. - 1 Nov. 1991 (PNR-90946; ETN-92-92223) Copyright Avail: CASI HC A02/MF A01

The following requirements for advanced materials are considered: low density, high temperature capability, high specific strength and stiffness, low expansion coefficients, reliable and predictable behavior, and low cost. The large number of potential material options are discussed: high temperature polymers, titanium aluminides, metal matrix composites, glass composites, ceramic composites, carbon/carbon composites, and carbon ceramic composites. The application development of these advanced materials is considered. ESA

93-11106# Rolls-Royce, Inc., Atlanta, GA.

DEVELOPMENT OF ADVANCED CARBON-CARBON ANNULAR FLAMEHOLDERS FOR GAS TURBINES

S. GUPTA, W. WESTPHAL, A. F. JARVIS (Rolls-Royce Ltd., Bristol, England), and R. DIRLING (Science Applications International Corp., Santa Ana, CA.) Nov. 1991 5 p Presented at the 1991 Yokohama International Gas Turbine Congress, Yokohama, Japan, 27 Oct. - 1 Nov. 1991 (PNR-90947; ETN-92-92224) Copyright Avail: CASI HC A01/MF A01

A program to assess the potential of using carbon-carbon composites in aero gas turbine engines is discussed: a set of annular flameholders was the chosen component system. These were designed, fabricated, coated, and successfully engine tested. The viability of using an integrated approach to the material system, design, and fabrication was clearly demonstrated. The critical areas identified were the low interlaminar strength of the material, difficulties of obtaining an acceptable coating on complex parts, lack of reliability and repeatability in the coating and fabrication processes, and susceptibility of the coatings to such environmental factors as humidity. The program, as a whole, was a success. ESA

93-11108# Rolls-Royce Ltd., Derby (England).

THE DEVELOPMENT OF THE ROLLS-ROYCE TRENT AERO GAS TURBINE

M. A. SPENCER 8 Apr. 1991 28 p Presented at the Inst. of Mechanical Engineers' North Eastern Branch, 8 Apr. 1991 (PNR-90949; ETN-92-92226) Copyright Avail: CASI HC A03/MF A01

A lecture given to mechanical engineers, which was backed up by a set of figures that are listed but not given, is presented. Reasons why the Trent was launched are given together with a brief description of the configuration of the engine. Explanations for some of the major decisions taken to date are given, and the aircraft market is discussed. The status of the test program is covered and some of the significant test results obtained to date are discussed. The Trent, the largest member of the RB211 family, recently commenced its development test program which will lead to engine certification in the middle of 1992 and entry into service in 1993. ESA

93-11112# Rolls-Royce Ltd., Derby (England).

DEVELOPMENT OF THE NEUTRON DIFFRACTION TECHNIQUE FOR THE DETERMINATION OF NEAR SURFACE RESIDUAL STRESSES IN CRITICAL GAS TURBINE COMPONENTS

A. N. EZEILO (Imperial Coll. of Science and Technology, London,

England), P. S. WEBSTER, G. A. WEBSTER (Imperial Coll. of Science and Technology, London, England), and P. J. WEBSTER (Salford Univ., England) 1 Apr. 1991 7 p Presented at the NATO Advanced Research Workshop on Measurement of Residual and Applied Stress Using Neutron Diffraction, Oxford, England, Mar. 1991 Submitted for publication (PNR-90984; ETN-92-92243) Copyright Avail: CASI HC A02/MF A01

The role of residual stress in improving the fatigue performance of a compressor assembly is outlined. One method of producing compressive residual stresses in the surface region of components to give improved resistance to fatigue fracture is shot peening. Neutron diffraction methods are successfully being used to determine through thickness engineering strains in polycrystalline materials. Results of measurements that were made on shot peened samples of a nickel superalloy are given. Good instrumental characteristics, sample positioning in the beam and the correction of near surface data resulted in the accurate determinations of the residual stress fields. It is observed that the stress profile has a characteristic shape irrespective of material or of the peening intensity employed, and also that the distribution of stresses balancing the surface compressive field results in a peak tension of approximately one third of the maximum surface compression. ESA

N93-11114# Rolls-Royce Ltd., Derby (England).
A KNOWLEDGE-BASED BLACKBOARD SYSTEM TO INTERPRET GRAPHICAL DATA FROM VIBRATION TESTS OF GAS TURBINES

R. J. ALLWOOD (Loughborough Univ. of Technology, England), S. P. KING (Loughborough Univ. of Technology, England), and N. J. PITTS (Rolls-Royce Ltd., Bristol, England) 13 Apr. 1992 19 p Presented at AI Eng 1992, Waterloo, Ontario, 1992 (PNR-90993; ETN-92-92249) Copyright Avail: CASI HC A03/MF A01

The second phase of a research project to develop an automatic vibration data analysis system is described. The normal graphical presentation of the data is retained and image processing methods are applied to it, coupled with knowledge about the response of an engineering system to excitation to locate the features an experienced engineer would find. Further knowledge coded for an expert system is used to identify and interpret the features found. In particular a 'blackboard' approach is used to enable a comparison to be made between the results from several blades in one stage of the engine and therefore expected to respond in a similar way. Several factors, particularly the effect of gauge position, make this comparison a difficult and challenging task, but it is essential if the system's report to an engineer is to be made in engineering units. ESA

N93-11206# Rolls-Royce Ltd., Derby (England).
THE USE OF SIMULTANEOUS ENGINEERING FOR THE DESIGN AND MANUFACTURE OF THE LOW PRESSURE TURBINE FOR THE ROLLS-ROYCE TRENT ENGINE

A. G. DODD and M. C. BUTCHER 1 Oct. 1991 24 p (PNR-90887; ETN-92-92191) Copyright Avail: CASI HC A03/MF A01

The activities needed to devise and then produce a new low pressure turbine for an engine, are outlined. If done in sequence these would take an unacceptable seven years. Hence, to create the design, the activities of the technical specialists and data transfer between the analysis tools, were integrated. The means by which early activities were arranged in parallel, using a 'hierarchy of iteration,' are outlined. Problems of working in parallel are also addressed, together with changes to traditional work methods and the lessons that were learned. The reduction in elapsed manufacturing timescales are stressed. It is shown how during this simultaneous engineering, the integration of all the design and technology specialities, together with the manufacturing suppliers, occurred at a very early stage in the design. Work proceeded in parallel, and the parts were delivered ahead of the competition. The low pressure turbine achieved its efficiency

targets, hence the quality of the product was not compromised.

ESA

N93-11207# Rolls-Royce Ltd., Derby (England). Aerospace Group.

INNOVATION IN ENGINEERING

T. BROUGHTON 8 Apr. 1992 14 p (PNR-90889; ETN-92-92192) Copyright Avail: CASI HC A03/MF A01

Graphics on the subject of how to achieve the world beating competitive design and manufacture of very complex products, such as the Trent engine, through integrated engineering are presented. It is concluded that since there are large gains in the aerospace industry for those who provide the right product at right cost, the following must be performed: improvement of the product in terms of performance, lower costs, and shorter lead times. This requires the following: product innovation for the metal engine and process innovation for the business engine; continued investment in people to operate these processes and provide an environment in which they can realize their full potential; and continued investment in advanced computing systems for predictive modeling, computer aided engineering, and advanced technology acquisition programs. ESA

N93-11208# Rolls-Royce Ltd., Derby (England). Aerospace Group.

SIMULTANEOUS ENGINEERING IN AERO GAS TURBINE DESIGN AND MANUFACTURE

T. BROUGHTON 8 Apr. 1992 10 p (PNR-90890; ETN-92-92193) Copyright Avail: CASI HC A02/MF A01

An analysis of the engineering process of aero gas turbine design and manufacture is carried out. In an attempt to optimize this process to the needs of business, the philosophies of simultaneous engineering are explored and are applied to it. The management of people is discussed in this highly integrated environment, and the impact of computer aided engineering is examined as an enabling device for simultaneous engineering. Examples of the successful implementation of simultaneous engineering are given, including the process of acquiring new design and manufacturing technologies. ESA

N93-11530*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

OVERVIEW OF HIGH PERFORMANCE AIRCRAFT PROPULSION RESEARCH

THOMAS J. BIESIADNY Oct. 1992 17 p Presented at the Aerotech 1992 Conference, Anaheim, CA, 5-8 Oct. 1992 (Contract RTOP 505-68-32) (NASA-TM-105839; E-7280; NAS 1.15:105839) Avail: CASI HC A03/MF A01

The overall scope of the NASA Lewis High Performance Aircraft Propulsion Research Program is presented. High performance fighter aircraft of interest include supersonic flights with such capabilities as short take off and vertical landing (STOVL) and/or high maneuverability. The NASA Lewis effort involving STOVL propulsion systems is focused primarily on component-level experimental and analytical research. The high-maneuverability portion of this effort, called the High Alpha Technology Program (HATP), is part of a cooperative program among NASA's Lewis, Langley, Ames, and Dryden facilities. The overall objective of the NASA Inlet Experiments portion of the HATP, which NASA Lewis leads, is to develop and enhance inlet technology that will ensure high performance and stability of the propulsion system during aircraft maneuvers at high angles of attack. To accomplish this objective, both wind-tunnel and flight experiments are used to obtain steady-state and dynamic data, and computational fluid dynamics (CFD) codes are used for analyses. This overview of the High Performance Aircraft Propulsion Research Program includes a sampling of the results obtained thus far and plans for the future. Author

07 AIRCRAFT PROPULSION AND POWER

N93-12077*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN EXPERIMENTAL INVESTIGATION OF THE FLOW IN A DIFFUSING S-DUCT

STEVEN R. WELLBORN (Iowa State Univ. of Science and Technology, Ames.), BRUCE A. REICHERT, and THEODORE H. OKIISHI (Iowa State Univ. of Science and Technology, Ames.) Aug. 1992 13 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE Previously announced in IAA as A92-54090

(Contract RTOP 505-62-52)

(NASA-TM-105809; E-7240; NAS 1.15:105809; AIAA PAPER 92-3622) Copyright Avail: CASI HC A03/MF A01

Compressible, subsonic flow through a diffusing S-duct has been experimentally investigated. Benchmark aerodynamic data are presented for flow through a representative S-duct configuration. The collected data would be beneficial to aircraft inlet designers and is suitable for the validation of computational codes. Measurements of the 3D velocity field and total and static pressures were obtained at five cross-sectional planes. Surface static pressures and flow visualization also helped to reveal flow field characteristics. All reported tests were conducted with an inlet centerline Mach number of 0.6 and a Reynolds number, based on the inlet centerline velocity and duct inlet diameter, of $2.6 \times 10^{(exp 6)}$. The results show that a larger region of streamwise flow separation occurred within the duct. Details about the separated flow region, including mechanisms which drive this complicated flow phenomenon, are discussed. Transverse velocity components indicate that the duct curvature induces strong pressure driven secondary flows, which evolve into a large pair of counter-rotating vortices. These vortices convect the low momentum fluid of the boundary layer towards the center of the duct, degrading both the uniformity and magnitude of the total pressure profile. Author

N93-12214*# Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.

HYPERVELOCITY SCRAMJET COMBUSTOR-NOZZLE ANALYSIS AND DESIGN Final Technical Report, 15 Feb. 1988 - 31 Dec. 1991

H. DOYLE THOMPSON and JOE D. HOFFMAN Nov. 1992 6 p

(Contract NAG1-854)

(NASA-CR-190965; NAS 1.26:190965) Avail: CASI HC A02/MF A01

The progress report for the grant entitled 'Hypervelocity of Scramjet Combustor-Nozzle Analysis and Design' is presented. The three main tasks in the program are combustor modeling study, development of analysis capabilities for hypersonic scramjet nozzles, and development of optimum design methods for hypersonic scramjet nozzles. The research performed was documented in a series of technical publications and presentations at various conferences. A brief description of the research in each of the above three areas and a list of the resulting technical publications are included. L.R.R.

N93-12402*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CONCURRENT OPTIMIZATION OF AIRFRAME AND ENGINE DESIGN PARAMETERS

THOMAS M. LAVELLE, ROBERT M. PLENCNER, and JONATHAN A. SEIDEL Oct. 1991 17 p Presented at the Fourth Symposium on Multidisciplinary Analysis and Optimization, Cleveland, OH, 21-23 Sep. 1992; sponsored by AIAA, USAF, and OAI

(Contract RTOP 505-69-50)

(NASA-TM-105908; E-7382; NAS 1.15:105908; AIAA PAPER 92-4713) Avail: CASI HC A03/MF A01

An integrated system for the multidisciplinary analysis and optimization of airframe and propulsion design parameters is being developed. This system is known as IPAS, the Integrated Propulsion/Airframe Analysis System. The traditional method of analysis is one in which the propulsion system analysis is loosely

coupled to the overall mission performance analysis. This results in a time consuming iterative process. First, the engine is designed and analyzed. Then, the results from this analysis are used in a mission analysis to determine the overall aircraft performance. The results from the mission analysis are used as a guide as the engine is redesigned and the entire process repeated. In IPAS, the propulsion system, airframe, and mission are closely coupled. The propulsion system analysis code is directly integrated into the mission analysis code. This allows the propulsion design parameters to be optimized along with the airframe and mission design parameters, significantly reducing the time required to obtain an optimized solution. Author

N93-12418*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN IMPROVED NUMERICAL MODEL FOR WAVE ROTOR DESIGN AND ANALYSIS

DANIEL E. PAXSON and JACK WILSON (Sverdrup Technology, Inc., Brook Park, OH.) Oct. 1992 12 p Proposed for presentation at the 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA

(Contract RTOP 505-62-10)

(NASA-TM-105915; E-7398; NAS 1.15:105915; AIAA PAPER 93-0482) Avail: CASI HC A03/MF A01

A numerical model has been developed which can predict both the unsteady flows within a wave rotor and the steady averaged flows in the ports. The model is based on the assumptions of one-dimensional, unsteady, and perfect gas flow. Besides the dominant wave behavior, it is also capable of predicting the effects of finite tube opening time, leakage from the tube ends, and viscosity. The relative simplicity of the model makes it useful for design, optimization, and analysis of wave rotor cycles for any application. This paper discusses some details of the model and presents comparisons between the model and two laboratory wave rotor experiments. Author

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A93-10777

MULTIPLE INPUT/MULTIPLE OUTPUT (MIMO) ANALYSIS PROCEDURES WITH APPLICATIONS TO FLIGHT DATA

J. K. SRIDHAR (National Aeronautical Lab., Bangalore, India) and G. WULFF (DLR, Inst. fuer Flugmechanik, Braunschweig, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 208-216. refs

Copyright

Iterative algorithms for the solution of multiple input/multiple output (MIMO) problems, formulated from stationary flight test data, are developed here. These are direct extensions of Bendat's MIMO algorithms. Computed are spectral, coherence, frequency response functions, both for the original and conditioned MIMO systems. A joint multiple coherence function is derived to describe the combined effects of both controls and states on any selected response. Additionally, output spectral decomposition is done to illustrate explicitly the effect of each of the controls and states. Specific MIMO applications studied from measured flight data of BO-105 helicopter are prediction of the effects of coupled controls and states on pitch rate response, and some lateral handling quality prediction of dutch roll and roll rotor flap modes. Author

A93-10916

ASPECTS OF MULTIVARIABLE FLIGHT CONTROL LAW DESIGN FOR HELICOPTERS USING EIGENSTRUCTURE ASSIGNMENT

M. A. MANNES and D. J. MURRAY-SMITH (Glasgow Univ., United Kingdom) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 3 July 1992 p. 18-32. Research supported by Royal Aerospace Establishment refs Copyright

The aim of this paper is to survey the wide range of control law design objectives which need to be addressed and to show that they can be satisfied using multivariable techniques. In order to put the discussion of design objectives in context, an eigenstructure assignment algorithm for decoupled tracking systems is presented, along with a brief description of the system dynamics and their influence on the flight control law design.

Author

A93-10919* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A ROBUST DIRECT-INTEGRATION METHOD FOR ROTORCRAFT MANEUVER AND PERIODIC RESPONSE

BRAHMANANDA PANDA (McDonnell Douglas Helicopter Co., Mesa, AZ) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 3 July 1992 p. 83-85. refs (Contract NAS2-12340)

Copyright

The Newmark-Beta method and the Newton-Raphson iteration scheme are combined to develop a direct-integration method for evaluating the maneuver and periodic-response expressions for rotorcraft. The method requires the generation of Jacobians and includes higher derivatives in the formulation of the geometric stiffness matrix to enhance the convergence of the system. The method leads to effective convergence with nonlinear structural dynamics and aerodynamic terms. Singularities in the matrices can be addressed with the method as they arise from a Lagrange multiplier approach for coupling equations with nonlinear constraints. The method is also shown to be general enough to handle singularities from quasisteady control-system models. The method is shown to be more general and robust than the similar 2GCHAS method for analyzing rotorcraft dynamics.

C.C.S.

A93-11207

LIMIT OF SAMPLING PERIODS FOR NONLINEAR FLIGHT TRAJECTORY CONTROLLER OF AIRCRAFT

YORIAKI BABA and KAZUYA SATONAKA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 464, 1992 p. 500-508. In Japanese. refs

In this paper, first, the nonlinear flight trajectory controller for an aircraft is designed using singular perturbation theory. The control system consists of a slow-time scale subsystem and a fast-time scale subsystem. Since a digital computer is used to realize these subsystems, they are reduced to digital control systems. Then, the sampling periods for which the subsystems become stable are computed using linear discrete-time control theory. They are the good criteria for selection of the sampling periods for the flight controller.

Author

A93-11264#

HANDLING QUALITIES FLIGHT TEST TECHNIQUES AND ANALYSES USED WITH THE PROPOSED MIL-H-8501B

LYNN HANKS and JOHNNIE A. HAM (U.S. Army, Aviation Technical Test Center, Fort Rucker, AL) /n AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 92-98. refs (AIAA PAPER 92-4081)

The U.S. Army Aviation Technical Test Center has been conducting numerous simulator and flight evaluations of rotorcraft handling qualities utilizing the requirements in ADS-33C, a proposed updated MIL-H-8501. This design standard has been adopted as the primary handling qualities specification for the RAH-66 Comanche helicopter program. Some of the major concerns resulting from these test programs are discussed.

R.E.P.

A93-11265#

EFFECTS OF THRUST LINE OFFSET ON NEUTRAL POINT DETERMINATION IN STABILITY FLIGHT TESTING

U. P. SOLIES (Tennessee Univ., Tullahoma) /n AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 99-110. refs (AIAA PAPER 92-4082) Copyright

On aircraft with high or low thrust lines, conventional stability flight test methods result in shifted neutral points, which do not correspond to the actual pitch stability neutral points of the aircraft. Specifically, e.g. an 'Elevator-Position Neutral point' extrapolated from flight test data of an aircraft with a high thrust line, may be significantly behind the actual 'Stick-Fixed Neutral Point', causing a potential hazard.

Author

A93-11266#

FLYING QUALITIES OF A REMOTELY PILOTTED VEHICLE

KEVIN BRENEMAN and MARK LOWER (U.S. Navy, Naval Air Warfare Center, Patuxent River, MD) /n AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 111-117. (AIAA PAPER 92-4083)

This paper presents an initial attempt at developing some techniques to facilitate the quantification of UAV flying qualities data. The first part of the paper presents the approach taken to apply manned aircraft flying qualities test techniques to UAVs, and some of the problems that were encountered in this attempt. The techniques applied include the use of the Cooper-Harper Handling Qualities Rating Scale, and mission relatable tasks, along with the quantification of the vehicles physical behavior. This is followed by a presentation of an example of the use of these techniques on the BQM-147A communications jammer vehicle. The data for this test was all obtained from very crude hand-held instrumentation such as stop watches and video screen overlays. Even so, voluminous useful information was generated. Finally, a recommendation for future research and development is made. This recommendation involves the development of more mission relatable tasks, and new, cost effective instrumentation systems.

Author

A93-11284#

RESEARCH ON THE STABILITY AND CONTROL OF SOARING BIRDS

ROBERT G. HOEY /n AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 393-402. (AIAA PAPER 92-4122) Copyright

A full-scale radio-controlled glider model of a soaring raven has been developed and flown in a manner that emulates the soaring flight of a bird. Though the model has no vertical stabilizing or controlling surfaces, it is statically stable and controllable in all axes. Flight results of the model correlated reasonably well with a simple analysis that predicted static lateral-directional stability based on the spanwise distribution of dihedral and wing sweep.

R.E.P.

A93-12012

STEADY AND QUASISTEADY RESONANT LOCK-IN OF FINNED PROJECTILES

N. ANANTHKRISHNAN and S. C. RAISINGHANI (Indian Inst. of Technology, Kanpur, India) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 692-696. refs

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Equations of motion for a rolling finned projectile presented by an earlier investigator are corrected. Steady resonant lock-in solutions, both normal and reverse, are presented and their stability investigated. Two-dimensional topological models are constructed to explain how the occurrence of resonant lock-in depends on initial conditions. Results from numerical simulations are used to

validate the suggested models. Quasisteady-state (QSS) resonant lock-in is shown to be possible for an unstable equilibrium solution at resonance. QSS solutions are found to lead to divergent yaw behavior typical of catastrophic yaw. It is suggested that catastrophic yaw can be demonstrated by modeling the effect of the nonlinear induced side forces and moments at resonance as a reduction in yaw damping. Author

A93-12653
ACCURACY ANALYSIS ON IMAGE MATCHING GUIDANCE SYSTEMS

KANG SU, SHIYI GUAN, and WEILI CHENG (Ministry of Aerospace, Inst. No. 3, China) Chinese Society of Astronautics, Journal (ISSN 1000-1328) no. 3 1992 p. 19-23. In Chinese. refs

A mathematical expression for analyzing the accuracy of image matching guidance systems has been derived from the associated model of the system, and all the factors which affect the accuracy have been analyzed. The correctness and feasibility of the method have been verified by the results of the system's simulation digital computer. The theoretical basis and effective method have been given for the accuracy analysis of image matching guidance systems. Author

A93-12802
STABILIZATION OF THE DYNAMIC CHARACTERISTICS OF THE AUTOMATIC CONTROL SYSTEMS OF A FLIGHT VEHICLE [STABILIZATSIIA DINAMICHESKIKH KHARAKTERISTIK SISTEM AVTOMATICHESKOGO UPRAVLENIIA LETATEL'NOGO APPARATA]

A. I. BOGOMOLOV and P. K. SEMENOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 10-16. In Russian. refs Copyright

A method is proposed for ensuring the stability of transient process characteristics in the system autopilot-flight vehicle in different flight regimes. The problem of transient process stabilization is solved for an autopilot with fixed gear ratios by substituting a signal formed by means of a special algorithm for the command transmitted to the input of the autopilot-flight vehicle system. The algorithm can be realized in real time using a microprocessor. A block diagram of a simple implementation of the method proposed here is presented. V.L.

A93-13126
ADAPTIVE CONTROL OF AIRCRAFT IN WINDSHEAR

GEORGE LEITMANN, SANDEEP PANDEY (California Univ., Berkeley), and EUGENE RYAN (Bath Univ., United Kingdom) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2157-2161. refs Copyright

The control of an aircraft encountering windshear after takeoff is treated as a problem of stabilizing the climb rate about a desired value. An adaptive strategy is developed which uses only climb rate information. Robustness vis-a-vis windshear structure and intensity is illustrated via simulations employing four different windshear models. Simulations were carried out for a Boeing-727 aircraft with three JT8D-17 turbofan engines. I.E.

A93-13247
H(INFINITY) OPTIMAL CONTROLLERS FOR A DISTRIBUTED MODEL OF AN UNSTABLE AIRCRAFT

DALE ENNS (Honeywell, Inc.; Minnesota Univ., Minneapolis), HITAY OZBAY (Ohio State Univ., Columbus), and ALLEN TANNENBAUM (Minnesota Univ., Minneapolis; Technion - Israel Institute of Technology, Haifa) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 3020-3024. refs (Contract NSF DMS-88-11084; AF-AFOSR-90-0024; DAAL03-91-G-0019) Copyright

The authors discuss the numerical computation of H(infinity)

optimal controllers for an unstable aircraft model with a time delay. It is shown that the optimal H(infinity) controller for this infinite dimensional model can be computed from a finite determinantal formula. The properties of the optimal controller are examined. For a particular choice of weights, the authors illustrate with an example that the optimal controller is stable and continuous. They examine approximations of this controller, and illustrate suboptimality of the controllers obtained from these approximations. I.E.

A93-13280#
SYNTHESIS OF A HELICOPTER NONLINEAR FLIGHT CONTROLLER USING APPROXIMATE MODEL INVERSION

J. V. R. PRASAD and A. M. LIPP (Georgia Inst. of Technology, Atlanta) Aug. 1992 9 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs

(AIAA PAPER 92-4468) Copyright

This paper considers synthesis of a helicopter full authority flight controller using approximate inversion of the nonlinear model of the vehicle. Based on the natural time scale separation between position and attitude dynamics of the vehicle, the vehicle attitudes are treated as pseudo-command variables. In order to simplify the controller, approximations to the body axes forces are used in the controller calculations. The first approximation involves neglecting the cyclic and pedal control force terms and the second approximation involves neglecting the body x- and y-axis force components in the controller calculations. The impact of these approximations on the performance of the closed-loop system is evaluated through nonlinear simulation of the Apache helicopter using typical command maneuvers. Author

A93-13285#
OPTIMIZATION-BASED LINEAR AND NONLINEAR DESIGN METHODOLOGIES FOR AIRCRAFT CONTROL. II - FINAL SIMULATIONS

CHIEN HUANG and JAMES TYLOCK (Grumman Corp., Bethpage, NY) Aug. 1992 12 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs

(AIAA PAPER 92-4627) Copyright

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. General optimization procedures were applied to the designs to produce gain sets. The designs were easily implemented, allowing fast turn-around. The designs were evaluated using an altitude-command, velocity-command, and sideslip-command across the operational flight envelope. The results show well-behaved responses for both controllers. Comments about the design process and control requirements are also included. Author

A93-13286#
LINEAR AND NONLINEAR AIRCRAFT FLIGHT CONTROL FOR THE AIAA CONTROLS DESIGN CHALLENGE

KEVIN A. WISE (McDonnell Douglas Missile Systems Co., Saint Louis, MO), MICHAEL W. DIERKS, BRUCE KERKEMEYER, and JICHENG TANG (Southern Illinois Univ., Edwardsville, IL) Aug. 1992 12 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs

(AIAA PAPER 92-4628) Copyright

This paper presents a linear and nonlinear flight control system design 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. Both the pitch and roll-yaw autopilots use proportional-plus-integral control elements, and are designed using linear quadratic theory and parameter optimization techniques, respectively. Both the pitch and roll-yaw autopilot gain selection has been completely automated. The nonlinear autopilot combines the linear autopilot control law with a nonlinear control designed using dynamic inversion. Simulation results show that the design challenge requirements were satisfied at the low altitude flight condition by both our linear

and nonlinear flight control designs. Actuator rate limits appeared to be the limiting factor in designing high performance into our flight control systems. Our nonlinear autopilot was found to improve performance during dynamic maneuvers. Author

A93-13328*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PILOTED SIMULATION EVALUATION OF PITCH CONTROL DESIGNS FOR HIGHLY AUGMENTED STOVL AIRCRAFT

S. A. ENGELLAND, J. A. FRANKLIN, M. W. STORTZ, and G. H. HARDY (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 23 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4234) Copyright

Analyses of design variations on a pitch axis stabilization and command augmentation system (SCAS) for a STOVL fighter aircraft are performed in a moving base simulation experiment. The primary goal of this study is to determine if turbulence-induced control activity could be reduced by modifying SCAS parameters while keeping the response-to-command characteristics of the baseline system that provide Level 1 flying qualities. Pilot ratings and control utilization statistics for the baseline system are in agreement with similar data gathered in a prior simulation test involving the same aircraft and control system. R.E.P.

A93-13338*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PILOTED SIMULATION STUDY OF TWO TILT-WING CONTROL CONCEPTS

LOURDES G. BIRCKELBAW and LLOYD D. CORLISS (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 15 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4236) Copyright

A two phase piloted simulation study was conducted to investigate alternative wing and flap controls for tilt-wing aircraft. The initial phase of the study compared the flying qualities of both a conventional (programmed) flap and an innovative geared flap. The second phase of the study introduced an alternate method of pilot control for the geared flap and further studied the flying qualities of the programmed flap, and two geared flap configurations. In general, the pilot ratings showed little difference between the programmed flap and the geared flap control concepts, although differences between the two control concepts were noticed and are discussed in this paper. The addition of pitch attitude stabilization in the second phase of the study greatly enhanced the aircraft flying qualities. This paper describes the simulated tilt-wing aircraft and the flap control concepts, and presents the results of both the first and second phases of the piloted simulation study. Author

A93-13345#
DESIGN OF A FULL TIME WING LEVELER SYSTEM USING TAB DRIVEN AILERON CONTROLS

DAVID W. LEVY (Michigan Univ., Ann Arbor) Aug. 1992 16 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4193) Copyright

The use of a control tab in a simple autopilot is discussed. The system is different from conventional installations in that the autopilot does not move the main control surface directly with a servo actuator. A servo tab is used to provide the necessary hinge moment. A further benefit of this approach is that the system may be operated full-time with only minor control force feedback to the pilot. For the case of the wing leveler system, the result is a full time stability augmentation system in the lateral axis. With improved stability, a large number of accidents due to loss of control could be prevented. Pilot workload is also reduced. The failure modes of such a system are benign, eliminating the need for redundancy and the associated costs. The system is shown to be stable and effective using either angular rate or attitude feedback. For the case of the light, four seat airplane studied, the basic wing leveler would weigh less than nine pounds and would

cost no more than a comparable conventional autopilot. Potential applications to other autopilot modes and to decoupled flight control systems are also discussed. Author

A93-13365#

A STABILITY AUGMENTATION SYSTEM FOR STUDENT DESIGNED REMOTELY-PILOTED VEHICLES

CHARLES E. HALL, JR. (North Carolina State Univ., Raleigh) Aug. 1992 7 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 Research supported by North Carolina State Univ refs (AIAA PAPER 92-4261) Copyright

During the 1991-1992 academic year, the students of the Advanced Stability and Control course at the North Carolina State University were given the problem of designing a digital longitudinal stability augmentation system (SAS) for the senior students' designed and built remotely piloted vehicles at a given static margin (5, 0, or -3 percent). The flight data that were collected allowed the students to perform postflight analysis of the performance of their SAS. The paper describes the SAS hardware and software and the student SAS design. Block diagrams of the SAS hardware and the SAS controller are presented along with some flight data. I.S.

N93-10070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN, TEST, AND EVALUATION OF THREE ACTIVE FLUTTER SUPPRESSION CONTROLLERS

WILLIAM M. ADAMS, JR., DAVID M. CHRISTHILF (Lockheed Engineering and Sciences Co., Hampton, VA.), MARTIN R. WASZAK, VIVEK MUKHOPADHYAY, and S. SRINATHKUMAR (National Aeronautics Lab., Bangalore, India) Oct. 1992 41 p (Contract RTOP 505-64-20-01) (NASA-TM-4338; L-17041; NAS 1.15:4338) Avail: CASI HC A03/MF A01

Three control law design techniques for flutter suppression are presented. Each technique uses multiple control surfaces and/or sensors. The first method uses traditional tools (such as pole/zero loci and Nyquist diagrams) for producing a controller that has minimal complexity and which is sufficiently robust to handle plant uncertainty. The second procedure uses linear combinations of several accelerometer signals and dynamic compensation to synthesize the model rate of the critical mode for feedback to the distributed control surfaces. The third technique starts with a minimum-energy linear quadratic Gaussian controller, iteratively modifies intensity matrices corresponding to input and output noise, and applies controller order reduction to achieve a low-order, robust controller. The resulting designs were implemented digitally and tested subsonically on the active flexible wing wind-tunnel model in the Langley Transonic Dynamics Tunnel. Only the traditional pole/zero loci design was sufficiently robust to errors in the nominal plant to successfully suppress flutter during the test. The traditional pole/zero loci design provided simultaneous suppression of symmetric and antisymmetric flutter with a 24-percent increase in attainable dynamic pressure. Posttest analyses are shown which illustrate the problems encountered with the other laws. Author

N93-10374 Composite Aircraft Products Ltd. (Canada).
PITCH CONTROL TRIMMING SYSTEM FOR CANARD DESIGN AIRCRAFT Patent Application

HUGH O. THOMAS, inventor (to Composite Aircraft Products Ltd.) 28 Nov. 1991 28 p (CA-PATENT-APPL-SN-2013236; INT-PATENT-CLASS-B64C-17/00; INT-PATENT-CLASS-B64D-27/08; INT-PATENT-CLASS-B64C-13/00; CTN-92-60362) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC/MF

A pitch control trimming system for a canard design aircraft has the ability to reposition the center of gravity of the aircraft along the longitudinal axis. The design permits trimming of the

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aircraft without external trim tabs and permits flaps to be used on a canard design aircraft without forward pitching moment occurring. The aircraft has a substantial mass associated with the aircraft, preferably the engine, which is movable substantially along the longitudinal axis of the aircraft, and includes an actuator to move the mass forward and aft on the longitudinal axis to reposition the center of gravity of the aircraft. In one embodiment of the invention, the canard design aircraft is of the pusher type wherein the aircraft engine represents the mass which is moved forward or aft along the aircraft's longitudinal axis. In another embodiment, a pressure sensor is positioned to measure the thrust of the engine and provide the pilot with an indication of engine thrust during flight or static conditions. Author (CISTI)

N93-10741*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INITIAL PILOTED SIMULATION STUDY OF GEARED FLAP CONTROL FOR TILT-WING V/STOL AIRCRAFT

LOURDES M. GUERRERO and LLOYD D. CORLISS Oct. 1991 39 p

(Contract RTOP 505-61-51)

(NASA-TM-103872; A-91175; NAS 1.15:103872) Avail: CASI HC A03/MF A01

A simulation study of a representative tilt wing transport aircraft was conducted in 1990 on the Ames Vertical Motion Simulator. This simulation is in response to renewed interest in the tilt wing concept for use in future military and civil applications. For past tilt wing concepts, pitch control in hover and low-speed flight has required a tail rotor or reaction jets at the tail. Use of mono cyclic propellers or a geared flap have also been proposed as alternate methods for providing pitch control at low speed. The geared flap is a subject of this current study. This report describes the geared flap concept, the tilt wing aircraft, the simulation model, the simulation facility and experiment setup, the pilots' evaluation tasks and procedures, and the results obtained from the simulation experiment. The pilot evaluations and comments are also documented in the report appendix. Author

N93-11176*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A PROBLEM FORMULATION FOR GLIDESLOPE TRACKING IN WIND SHEAR USING ADVANCED ROBUST CONTROL TECHNIQUES

CHRISTINE M. BELCASTRO, B.-C. CHANG (Drexel Univ., Philadelphia, PA.), and ROBERT FISCHL (Drexel Univ., Philadelphia, PA.) Aug. 1992 21 p

(Contract RTOP 505-64-52-01)

(NASA-TM-104164; NAS 1.15:104164) Avail: CASI HC A03/MF A01

A formulation of the longitudinal glideslope tracking of a transport-class aircraft in severe wind shear and turbulence for application to robust control system design is presented. Mathematical wind shear models are incorporated into the vehicle mathematical model, and wind turbulence is modeled as an input disturbance signal. For this problem formulation, the horizontal and vertical wind shear gradients are treated as real uncertain parameters that vary over an entire wind shear profile. The primary objective is to examine the formulation of this problem into an appropriate design format for use in m-synthesis control system design. Author

N93-11576# Ecole Centrale de Lyon (France). Lab. de Mecanique des Fluides.

ACTIVE CONTROL OF AEROACOUSTIC COUPLINGS BY MEANS OF ADAPTIVE SYSTEMS Ph.D. Thesis [CONTROLE ACTIF DES COUPLAGES AEROACOUSTIQUES A L'AIDE DE SYSTEMES AUROADAPTATIFS]

MOHAMMED SEBBANI 1991 183 p In FRENCH

(ECL-91-18; ETN-92-92337) Avail: CASI HC A09/MF A02

The active control of aerodynamic instabilities is investigated. Instead of using a standard feedback loop the experiments are carried out with a new real time adaptive control system. Two experiments are performed: one to control flow excited instabilities

occurring in a cavity, the other to suppress surge in a compressor reservoir system. In both cases, the sensor signal is simultaneously used as the reference signal and as the signal to be minimized. The controller suppresses both the closed loop and the natural instability. The controller modifies the system response. Theoretical and experimental results are in agreement. The results lead to the conclusion that the adaptive method is well suited for active control of instabilities: the controller automatically finds its optical parameters, avoids closed loop instabilities, and adapts to evolution of the system operating conditions. ESA

N93-11871 Southampton Univ. (England).

APPLICATION OF EIGENSTRUCTURE ASSIGNMENT TO THE CONTROL OF POWERED LIFT COMBAT AIRCRAFT Ph.D.

Thesis

PHILLIP RAYMOND SMITH 1990 311 p

Avail: Univ. Microfilms Order No. BRDX93358

An examination of the Eigenstructure Assignment control law design technique and its application to both a vectored thrust aircraft and a helicopter example are presented. In reviewing the design method new insight is shed upon the role of the left eigenvectors, which are shown to determine the nature of the input coupling into a dynamic system. It is concluded that selection of the right eigenvectors alone, as is often shown in the literature is insufficient to ensure decoupling in the system response. In each of the application studies, a non-linear aircraft mathematical model is examined in a number of different parts of the flight envelope. They are linearized to provide a state space representation of the aircraft and fixed gain controllers are designed using the method of Eigenstructure Assignment. These controllers are then implemented in the non-linear models and their behavior examined. It is seen that some classes of nonlinearity cause degradation of the closed-loop performance, whereas others result in instability or limit cycles. Examination of the frequency domain characteristics of a helicopter example are considered. This allows the controlled aircraft handling qualities to be determined. It is shown that simple dynamic elements in the command path can be used to tune the response when problems in obtaining a sufficiently high bandwidth are encountered. It is finally concluded that the method provides a viable approach to aircraft control law design, a chief attraction being the very simple structure of the resulting control laws. Dissert. Abstr.

N93-12216*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MODELING AND MODEL SIMPLIFICATION OF AEROELASTIC VEHICLES: AN OVERVIEW

MARTIN R. WASZAK, CAREY S. BUTTRILL, and DAVID K. SCHMIDT (Arizona State Univ., Tempe.) Sep. 1992 20 p

(Contract RTOP 505-64-52-03)

(NASA-TM-107691; NAS 1.15:107691) Avail: CASI HC A03/MF A01

The rigid-body degrees of freedom and elastic degrees of freedom of aeroelastic vehicles are typically treated separately in dynamic analysis. Such a decoupling, however, is not always justified and modeling assumptions that imply decoupling must be used with caution. The frequency separation between the rigid-body and elastic degrees of freedom for advanced aircraft may no longer be sufficient to permit the typical treatment of the vehicle dynamics. Integrated, elastic vehicle models must be developed initially and simplified in a manner appropriate to and consistent with the intended application. This paper summarizes key results from past research aimed at developing and implementing integrated aeroelastic vehicle models for flight controls analysis and design. Three major areas will be addressed: (1) the accurate representation of the dynamics of aeroelastic vehicles, (2) properties of several model simplification methods, and (3) the importance of understanding the physics of the system being modeled and of having a model which exposes the underlying physical causes for critical dynamic characteristics. Author

N93-12304*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A MONITOR FOR THE LABORATORY EVALUATION OF CONTROL INTEGRITY IN DIGITAL CONTROL SYSTEMS OPERATING IN HARSH ELECTROMAGNETIC ENVIRONMENTS

CELESTE M. BELCASTRO, ROBERT FISCHL (Drexel Univ., Philadelphia, PA.), and MOSHE KAM (Drexel Univ., Philadelphia, PA.) Oct. 1992 23 p

(Contract RTOP 505-64-10-10)

(NASA-TM-4402; L-17057; NAS 1.15:4402) Avail: CASI HC A03/MF A01

This paper presents a strategy for dynamically monitoring digital controllers in the laboratory for susceptibility to electromagnetic disturbances that compromise control integrity. The integrity of digital control systems operating in harsh electromagnetic environments can be compromised by upsets caused by induced transient electrical signals. Digital system upset is a functional error mode that involves no component damage, can occur simultaneously in all channels of a redundant control computer, and is software dependent. The motivation for this work is the need to develop tools and techniques that can be used in the laboratory to validate and/or certify critical aircraft controllers operating in electromagnetically adverse environments that result from lightning, high-intensity radiated fields (HIRF), and nuclear electromagnetic pulses (NEMP). The detection strategy presented in this paper provides dynamic monitoring of a given control computer for degraded functional integrity resulting from redundancy management errors, control calculation errors, and control correctness/effectiveness errors. In particular, this paper discusses the use of Kalman filtering, data fusion, and statistical decision theory in monitoring a given digital controller for control calculation errors. Author

N93-12305*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ANALYSIS OF FAULT-TOLERANT NEUROCONTROL ARCHITECTURES

T. TROUDET (Sverdrup Technology, Inc., Brook Park, OH.) and W. MERRILL 1992 12 p Proposed for presentation at the 31st Conference on Decision and Control, Tucson, AZ, 16-18 Dec. 1992; sponsored by IEEE

(Contract RTOP 505-62-50)

(NASA-TM-105898; E-7210; NAS 1.15:105898) Avail: CASI HC A03/MF A01

The fault-tolerance of analog parallel distributed implementations of a multivariable aircraft neurocontroller is analyzed by simulating weight and neuron failures in a simplified scheme of analog processing based on the functional architecture of the ETANN chip (Electrically Trainable Artificial Neural Network). The neural information processing is found to be only partially distributed throughout the set of weights of the neurocontroller synthesized with the backpropagation algorithm. Although the degree of distribution of the neural processing, and consequently the fault-tolerance of the neurocontroller, could be enhanced using Locally Distributed Weight and Neuron Approaches, a satisfactory level of fault-tolerance could only be obtained by retraining the degraded VLSI neurocontroller. The possibility of maintaining neurocontrol performance and stability in the presence of single weight or neuron failures was demonstrated through an automated retraining procedure of the neurocontroller based on a pre-programmed choice and sequence of the training parameters. Author

N93-12361# National Aerospace Lab., Tokyo (Japan).

ON STABILITY AND CONTROL OF SSTO SPACEPLANE IN SUPER- AND HYPERSONIC ASCENDING PHASE

ANDREAS DIEKMANN and KOICHI MATSUSHIMA Nov. 1991 38 p Sponsored by Commission of the European Communities (ISSN 0389-4010)

(NAL-TR-11287; JTN-92-80396) Avail: CASI HC A03/MF A01

The natural dynamic stability of a Single Stage To Orbit (SSTO) National Aerospace Laboratory spaceplane configuration is evaluated at seven reference points on a super to hypersonic

and constant dynamic pressure ascent trajectory. It is shown that dynamic instability occurs in the longitudinal and lateral motion during wide parts of the regarded trajectory. To counteract these instabilities a simple output feedback control is introduced to achieve a pole assignment of the dominant modes according to handling quality criteria commonly used for conventional aircraft. The sensitivity of augmented stability parameters to deviations in the feedback gain constants is evaluated. The dynamic behavior of stability augmented spaceplane is investigated by numerical simulation of its longitudinal motion during an ascent in standard clear air turbulence. Results indicate the sufficient performance of the control design. The controlled elevator deflection angles remain small despite the severe natural instability which occurred during wide parts of the ascent trajectory. Author (NASDA)

N93-12362# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.

A WIND TUNNEL INVESTIGATION TO DETERMINE BUFFET COUNTERMEASURES FOR STOL AIRCRAFT ALPHA-SWEEP FLIGHT TESTING [STOL ZENKI MOKEI BAFETTO TAISAKU FUUDOU SHIKEN]

HITOSHI TAKAHASHI, TERUOMI NAKAYA, YOSHIO HAYASHI, SHIGEO KAYABA, MASAYOSHI NOGUCHI, ISAMU NONAKA, MASATAKA HASHIDATE, HIDEO HOSHINO, SHIGERU BABA, and TAKASHI INOUE (Kawasaki Heavy Industries Ltd., Kobe, Japan) Nov. 1991 48 p In JAPANESE

(ISSN 0389-4010)

(NAL-TR-1129; JTN-92-80397) Avail: CASI HC A03/MF A01

During alpha sweep flight testing of the Short TakeOff and Landing (STOL) experimental aircraft 'ASKA', a buffet occurred earlier than expected, as well as large airframe vibrations, both of which contributed to preventing the high angle of attack portion of alpha sweep testing from being conducted. Wind tunnel tests were subsequently performed in order to delay the onset of the wind buffet that prevented the performance of this flight test and also to determine effective aerodynamic means to alleviate the buffet's strength. Results confirmed that both triangular fences fitted to the side of the nacelle and a drooped nose on the leading edge between the nacelles were most effective. These buffet countermeasures were then applied on 'ASKA' and flight tests were conducted. It was found that the onset of a buffet was delayed and the vibration frequency of the airframe was reduced. This allowed the alpha sweep testing to be safely carried out at higher angles of attack; hence enabling the initial objective to be achieved. Author (NASDA)

N93-12413*# Draper (Charles Stark) Lab., Inc., Cambridge, MA. **AIR-BREATHING HYPERSONIC VEHICLE GUIDANCE AND CONTROL STUDIES: AN INTEGRATED TRAJECTORY/CONTROL ANALYSIS METHODOLOGY, PHASE 2 Final Report**

PHILIP D. HATTIS and HARVEY L. MALCHOW Oct. 1992 86 p

(Contract NAS1-18565; RTOP 505-70-64-01)

(NASA-CR-189703; NAS 1.26:189703) Avail: CASI HC A05/MF A01

An integrated trajectory/control analysis algorithm has been used to generate trajectories and desired control strategies for two different hypersonic air-breathing vehicle models and orbit targets. Both models used cubic spline curve fit tabulated winged-cone accelerator vehicle representations. Near-fuel-optimal, horizontal takeoff trajectories, imposing a dynamic pressure limit of 1000 psf, were developed. The first model analysis case involved a polar orbit and included the dynamic effects of using elevons to maintain longitudinal trim. Analysis results indicated problems with the adequacy of the propulsion model and highlighted dynamic pressure/altitude instabilities when using vehicle angle of attack as a control variable. Also, the magnitude of computed elevon deflections to maintain trim suggested a need for alternative pitch moment management strategies. The second analysis case was reformulated to use vehicle pitch attitude relative to the local vertical as the control variable. A new, more realistic, air-breathing propulsion model was incorporated. Pitch trim calculations were

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dropped and an equatorial orbit was specified. Changes in flight characteristics due to the new propulsion model have been identified. Flight regimes demanding rapid attitude changes have been noted. Also, some issues that would affect design of closed-loop controllers were ascertained. Author

N93-12415# Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Aerodynamics.

DYNAC: A COMPUTER PROGRAM FOR ANALYZING THE DYNAMICAL STABILITY OF AIRCRAFT

KARI RENKO 1 Feb. 1991 56 p
(ISSN 0356-0864)
(REPT-B-31; ISBN-951-22-0519-X) Avail: CASI HC A04/MF A01

A macro-package for the Mathematica computer program is developed for analyzing aircraft as a part of a linear time-continuous control system. The package includes the classical small disturbance stability theory, linearized aircraft transfer functions, root locus method, and several frequency domain methods like Nyquist plots and Bode plots. Test cases are presented to demonstrate the use of the package. Author

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RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A93-10049

A TRANSFER STANDARD OF AN AIR FLOW RATE UNIT VET 150-2-87 [ETALON-KOPIIA EDINITSY SKOROSTI VOZDUSHNOGO POTOKA VET 150-2-87]

B. S. DUBOV, A. N. PETUNIN, and G. K. SHAPOVALOV *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 160-168. In Russian. Copyright

The composition and metrological characteristics of a transfer standard of an air flow rate unit, VET 150-2-87, a constituent part of the USSR State Standard GE 150 of air flow rate in the range 0.1 - 100 m/s, are described. The air flow rate transfer standard includes a closed-loop low-turbulence wind tunnel with a flow rate of 5 - 100 m/s, an integral and static pressure detector, and instruments for measuring temperature, static pressure, and air humidity. V.L.

A93-12097

A METHOD OF CALCULATING ELASTIC CURVE OF SEMIFLEXIBLE PLATE NOZZLE

MINGJIA LIU (Shanghai Fire Research Inst., China) National University of Defense Technology, Journal (ISSN 1001-2486) vol. 14, no. 2 June 1992 p. 109-114. In Chinese.

A method of calculating elastic curve for semiflexible plate wind tunnel nozzle has been presented, based on the linear theory of small deflection of beam deformation. In light of the matched results of curvature between flexible plate calculated and aerodynamic contour, the reasonable arrangement of jacks on the plate (which has an obvious effect on the curvature match) is of vital importance. The structure designer of a flexible nozzle should therefore be cautious of it. Author

A93-12216

DESIGN AND IMPLEMENTATION OF A FLIGHT SIMULATION SYSTEM

HASSAN DIAB (Beirut American Univ., Lebanon) Beirut/Syracuse, NY American University of Beirut/Syracuse University Press 1992 152 p. refs
Copyright

This book presents the design of a multicomputer system dedicated to providing real-time simulation of the visual systems of a flight simulator. Computer hardware design aspects and software issues are addressed along with the algorithms needed for the Computer Generated Imager (CGI) subsystem. C.D.

A93-12224

COMPARISON OF NONLINEAR TRACKING CONTROLLERS FOR A COMPRESSIBLE FLOW PROCESS

M. J. CHANEY (Sverdrup Technology, Inc., Tullahoma, TN) and J. J. BEAMAN (Texas Univ., Austin) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434) vol. 114, no. 3 Sept. 1992 p. 493-499. refs
Copyright

Comparisons are made of two pressure-temperature controllers for a wind-tunnel type compressible flow process that includes control of pressures across a converging nozzle. Nonlinear flow characteristics of the nozzle present the key challenge for tracking rapid command trajectories. One controller is a linear integral-plus-state feedback configuration with gain scheduling. The other is a model-following controller that includes a feedforward inverse-process model to decouple and linearize the system. Simulation testing is used to compare the controllers, and sensitivity to feedforward modeling errors and feedback bandwidth is evaluated. Operational and implementation features are also compared. Author

A93-12316

FREE PISTON SHOCK TUNNELS - DEVELOPMENTS AND CAPABILITIES

S. L. GAI (Univ. College, Campbell, Australia) Progress in Aerospace Sciences (ISSN 0376-0421) vol. 29, no. 1 March 1992 p. 1-41. refs
Copyright

The free piston shock tunnel has shown itself to be uniquely capable of adequately simulating real gas effects and has been successfully operating in Australia for more than two decades. As a consequence of the recent interest in hypersonic aerospace planes and general resurgence in hypersonic research, attention has been focused on this type of facility and free piston shock tunnels have recently been built or being considered in Europe, U.S.A. and elsewhere. It is in the light of these events that the paper discusses the development, performance and capabilities of free piston shock tunnels. Author

A93-12656

RECENT ADVANCES IN JET SIMULATION TECHNIQUES FOR FLIGHT VEHICLES

LIXIN YOU and KEMING CHEN (Nanjing Aeronautical Inst., China) Chinese Society of Astronautics, Journal (ISSN 1000-1328) no. 3 1992 p. 38-42. In Chinese. refs

Jet gases exhausted by flight vehicles are known to have significant effects on their total performance. This paper analyzes the parameters for jet simulation tests, and the characteristics of available cold jet and hot jet simulation techniques are described. The possibilities of utilizing cryogenic wind tunnels for jet simulation testing are discussed. R.E.P.

A93-13312#

WHY SIMULATORS DON'T FLY LIKE THE AIRPLANE: DATA - AN UPDATE WITH EXAMPLES FROM THE C-141B PROGRAM

DARYL J. SCHUELER, WILLIAM G. SCHWEIKHARD (Kohlman Systems Research, Inc., Lawrence, KS), and ROBERT G. HOEY Aug. 1992 12 p. AIAA and AHS, Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4161) Copyright

This paper focuses on the standard approach for generating simulator design and verification data, and then discusses a flight test approach for improving the quality of the data. Data developed by the standard approach are compared with data developed by this flight test approach. Comparisons are made of flight test vs. simulated results for operational maneuvers, one utilizing traditional data and the other using flight test generated data. R.E.P.

A93-13339*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SMALL SCALE JET EFFECTS AND HOT GAS INGESTION INVESTIGATIONS AT NASA AMES

C. E. HANGE and D. A. WARDWELL (NASA, Ames Research Center, Moffett Field, CA) Aug. 1992 21 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4252) Copyright

The Jet Calibration and Hover Test Facility at NASA Ames has been constructed to perform small scale experiments in hot gas ingestion and jet effects for STOVL aircraft. This new facility and how it is employed to examine the problems associated with STOVL configurations hovering in- and out-of-ground effect are presented. Some of the test procedures and results are described. R.E.P.

N93-11057* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

METHOD OF REMOTELY CHARACTERIZING THERMAL PROPERTIES OF A SAMPLE Patent

JOSEPH S. HEYMAN, inventor (to NASA), D. MICHELE HEATH, inventor (to NASA), CHRISTOPHER WELCH, inventor (to NASA), WILLIAM P. WINFREE, inventor (to NASA), and WILLIAM E. MILLER, inventor (to NASA) 21 Jul. 1992 5 p Filed 30 Sep. 1991 Continuation of US-Patent-Appl-SN-524108, filed 16 May 1990 which is a continuation of US-Patent-Appl-SN-146939, filed 22 Jan. 1988

(NASA-CASE-LAR-13508-3-CU; US-PATENT-5,131,758; US-PATENT-APPL-SN-768094; US-PATENT-APPL-SN-524108; US-PATENT-APPL-SN-146939; US-PATENT-CLASS-374-5; US-PATENT-CLASS-374-4; US-PATENT-CLASS-374-57; US-PATENT-CLASS-73-147; INT-PATENT-CLASS-G01N-25/72)
Avail: US Patent and Trademark Office

A sample in a wind tunnel is radiated from a thermal energy source outside of the wind tunnel. A thermal imager system, also located outside of the wind tunnel, reads surface radiations from the sample as a function of time. The produced thermal images are characteristic of the heat transferred from the sample to the flow across the sample. In turn, the measured rates of heat loss of the sample are characteristic of the flow and the sample.

Official Gazette of the U.S. Patent and Trademark Office

N93-11224# Loughborough Univ. of Technology (England). Dept. of Transport Technology.

AN INVESTIGATION OF GROUND ACCESS MODE CHOICE FOR DEPARTING PASSENGERS

SARA LOUISE BOLLAND, PATRICK N. NDOH, and NORMAN ASHFORD Apr. 1992 110 p
(TT-9201; ISBN-0-904747-36-X; ETN-92-92379) Copyright
Avail: CASI HC A06/MF A02

Some aspects of ground access airports were investigated. The term ground access covers the total spectrum of transportation which services an airport, both on and off the airfield. London's major airport, Heathrow (England), was chosen as a base for the investigation. From the data collected the following were analyzed: the different modes and combinations of modes used to access the airport; any patterns that may be found among different groupings of passengers and the choice of modes they used; the passengers' evaluation of the level of service experiences in relation to their chosen mode(s); other modes considered or which they would have liked to see available. The development of mode choice models was investigated using the findings of the study. Background information on the topic is reviewed and methodology and analytical procedures used are discussed. The data and results are reviewed. Findings are summarized and some useful conclusions, both for London Heathrow and airports in general, are drawn. ESA

N93-11225# Centro Italiano Ricerche Aerospaziali, Naples.

WIND TUNNEL OPERATOR AIMED COMPARISON BETWEEN TWO ELECTRONIC PRESSURE SCANNER SYSTEMS

F. NITTI (Italian Aerospace Research Center, Capua.) and F.

FUSCO (Italian Aerospace Research Center, Capua.) 28 Feb. 1992 8 p Repr. from ISA, 1992, Paper 92-0197
(DLAS-EST-TR-040; ETN-92-92414) Avail: CASI HC A02/MF A01

A comparison made between two different electronic pressure scanner systems is outlined. This comparison was done from the wind tunnel user point of view and covered the following topics: software and hardware setting up for a test configuration; calibration procedure; versatile and user friendly features of the software packages managing the systems; and response stability measurement. Differences and similarities of the systems are outlined. ESA

N93-11435# Royal Aerospace Establishment, Farnborough (England).

THE MEASUREMENT OF THE VELOCITY FIELD INDUCED BY A GUST GENERATOR IN A CLOSED-CIRCUIT SUBSONIC WIND-TUNNEL

R. T. JONES 23 Feb. 1988 28 p
(RAE-TM-MAT-STR-1102; BR106727; ETN-92-92299) Copyright
Avail: CASI HC A03/MF A01

The design, installation and testing of a moving vane gust generating system and the equipment used to measure its effect in a 4 by 3 ft closed circuit subsonic wind tunnel are described. The downstream effect of oscillating the vanes of this gust generator at an amplitude of 3 deg, using sinusoidal frequency sweeps, was measured at 90 different positions in the tunnel working section for each of four airstream velocities, 30, 35, 40 and 45 m/s. The results are presented in the form of 'carpet' plots showing the magnitude of the transfer functions of gust velocity at the measurement points to the generator motion. These plots of the gust as it travels down the tunnel clearly show the decay and the effects of the tunnel wall boundary layer. Further selected tests were made at gust vane amplitudes of 1 and 5 deg to investigate the linearity of the system. The results show no significant difference from the transfer functions obtained for a gust vane amplitude of 3 deg. ESA

N93-11616# Federal Aviation Administration, Atlantic City, NJ.

UPGRADE PRECISION RUNWAY MONITOR (PRM) OPERATIONAL TEST AND EVALUATION (OT/E) TEST PLAN

RICARDO ASTILLERO, THOMAS BRATTON, CHARLES DUDAS, and JEFFREY LIVINGS Oct. 1992 42 p
(DOT/FAA/CT-TN92/13) Avail: CASI HC A03/MF A01

The Upgrade Precision Runway Monitor (Upgrade PRM) Operational and Integration tests are defined that will be conducted at the Federal Aviation Administration (FAA) Operational facilities. These tests will be executed at Raleigh-Durham Airport (RDU) following the Contractor Site Acceptance Test. The Upgrade PRM test configuration is addressed in conjunction with the associated interfaces which will be required to perform the testing in as near an operational environment as possible. The Air Traffic (AT) Operational requirements and test objectives are contained in this test plan. In addition to providing requirements traceability, this plan contains a description of the tests which will be executed, associated success criteria, roles and responsibilities of test personnel, and the overall flow of activities required for a successful test program. Author

N93-11728# Loughborough Univ. of Technology (England). Dept. of Transport Technology.

AIRPORT STAND ASSIGNMENT MODEL Final Report

A. MARAWA and N. J. ASHFORD Jul. 1991 185 p
(TT-9104; ISBN-0-904947-31-9; ETN-92-92378) Copyright
Avail: CASI HC A09/MF A02

Work carried out in a contract, to develop an airport stand assignment simulation model, is summarized. The objectives are: to provide an interactive airport stand assignment model suitable for microcomputers for use at medium sized regional airports in both operations and planning; to provide an assignment model which will enable regional airport planners to determine current and future capacity according to the parameters by which regional airport operators decide to define capacity. Sufficient information

09 RESEARCH AND SUPPORT FACILITIES (AIR)

is provided to understand and trace the logic and methodology that went into the development of the model. Guidance is also given on how to use the simulation model. ESA

N93-11751# Army Engineer Topographic Labs., Fort Belvoir, VA.

AUTOMATED EXTRACTION OF AIRCRAFT RUNWAY PATTERNS FROM RADAR IMAGERY

RICHARD A. HEVENOR and PI-FUAY CHEN 5 May 1992 6 p
(AD-A254258; TEC-R-168) Avail: CASI HC A02/MF A01

A method is presented to extract linear terrain features from synthetic radar imagery. An input radar image is smoothed with an edge preserving smoothing operation. Edge detection is performed using a Sobel operator, and both the magnitude and the directional images are computed. The edges are strengthened using several iterations of a relaxation operation in which both the magnitude image and the directional image are updated with each iteration. The output of the relaxation operation is a binary edge image, which is thinned. A connected components routine is run in which two passes through the image are used to provide a unique label for each connected component. The connected components related only to the runway pattern are extracted by computing certain properties of each component. A border-following algorithm is used to follow only the outermost borders and give each of the pixels on an outermost border a maximum brightness value. GRA

N93-11906# Royal Aerospace Establishment, Bedford (England). Aerospace Div.

STRAIN-GAUGE BALANCE PERFORMANCE AND INTERNAL TEMPERATURE GRADIENTS MEASURED IN A CRYOGENIC ENVIRONMENT

R. D. LAW 29 Jan. 1992 36 p Presented at the Second European Wind Tunnel Cryogenic Technology Review Meeting, Cologne, Germany, Jun. 1988

(RAE-TM-AERO-2232; BR309937; ETN-92-92306) Copyright Avail: CASI HC A03/MF A01

Tests in which strain gauged balances and a simple axisymmetric dummy balance were subjected to temperature gradients are described. An external body of revolution was fitted over each balance to provide shielding from gas flows of 16 m/s at temperatures between ambient and 90 K. Convection around the balances could be controlled, and by extending the body of revolution the direction of temperature gradients was changed. A beam analysis is used to demonstrate that thermally induced axial force readings from the balance can be predicted from temperatures measured at the flexure roots. An axial force calibration was carried out in the balance at ambient and cryogenic temperatures to quantify sensitivity changes. To measure changes in interactions at low temperatures, pitching moment or normal force were also applied simultaneously with axial force. The results highlight the mechanism by which temperature gradients affect the outputs of strain gauged balances during temperature transients. During coding axial force, errors of up to 50 percent of full scale occur in individual flexures due to differential contraction within the balance. ESA

N93-11910*# Tennessee Univ. Space Inst., Tullahoma.

A WALL INTERFERENCE ASSESSMENT/CORRECTION SYSTEM Semiannual Report No. 2, Jan. - Jun. 1992

CHING F. LO, N. ULBRICH, W. L. SICKLES (Calspan Corp., Arnold AFS, TN.), and CATHY X. QIAN 1992 40 p

(Contract NAG2-733)

(NASA-CR-190617; NAS 1.26:190617) Avail: CASI HC A03/MF A01

A Wall Signature method, the Hackett method, has been selected to be adapted for the 12-ft Wind Tunnel wall interference assessment/correction (WIAC) system in the present phase. This method uses limited measurements of the static pressure at the wall, in conjunction with the solid wall boundary condition, to determine the strength and distribution of singularities representing the test article. The singularities are used in turn for estimating wall interferences at the model location. The Wall Signature method

will be formulated for application to the unique geometry of the 12-ft Tunnel. The development and implementation of a working prototype will be completed, delivered and documented with a software manual. The WIAC code will be validated by conducting numerically simulated experiments rather than actual wind tunnel experiments. The simulations will be used to generate both free-air and confined wind-tunnel flow fields for each of the test articles over a range of test configurations. Specifically, the pressure signature at the test section wall will be computed for the tunnel case to provide the simulated 'measured' data. These data will serve as the input for the WIAC method-Wall Signature method. The performance of the WIAC method then may be evaluated by comparing the corrected parameters with those for the free-air simulation. Each set of wind tunnel/test article numerical simulations provides data to validate the WIAC method. A numerical wind tunnel test simulation is initiated to validate the WIAC methods developed in the project. In the present reported period, the blockage correction has been developed and implemented for a rectangular tunnel as well as the 12-ft Pressure Tunnel. An improved wall interference assessment and correction method for three-dimensional wind tunnel testing is presented in the appendix. L.R.R.

N93-12349*# MCAT Inst., San Jose, CA.

STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNELS. PART 4: MODEL DEFORMATION Progress Report

GEORGE LEE Aug. 1992 41 p

(Contract NCC2-716)

(NASA-CR-190980; NAS 1.26:190980; MCAT-92-016) Avail: CASI HC A03/MF A01

A survey of systems capable of model deformation measurements was conducted. The survey included stereo-cameras, scanners, and digitizers. Moire, holographic, and heterodyne interferometry techniques were also looked at. Stereo-cameras with passive or active targets are currently being deployed for model deformation measurements at NASA Ames and LaRC, Boeing, and ONERA. Scanners and digitizers are widely used in robotics, motion analysis, medicine, etc., and some of the scanner and digitizers can meet the model deformation requirements. Commercial stereo-cameras, scanners, and digitizers are being improved in accuracy, reliability, and ease of operation. A number of new systems are coming onto the market. Author

N93-12359# National Aerospace Lab., Tokyo (Japan). Control Systems Div.

SIMULATION ANALYSIS OF A CABLE-MOUNT SYSTEM USED FOR DYNAMIC WIND TUNNEL TESTS (KEBURU SHIJI DOUTEKI FUJUDOU SHIKEN MOKEI NO SUUGAKU MODERU NI YORU UNDOU TOKUSEI KAISEKI)

MASAAKI YANAGIHARA, MASAHIKO NAGAYASU, SHUICHI SASA, and TAKASHI SHIMOMURA Oct. 1991 53 p In JAPANESE

(ISSN 0389-4010)

(NAL-TR-1127; JTN-92-80395) Avail: CASI HC A04/MF A01

Dynamic wind tunnel tests using a cable mounted aircraft model were conducted in the National Aerospace Laboratory (NAL) large-scale, low speed wind tunnel to identify the aerodynamic characteristics of the NAL spaceplane. The model was suspended by two cables and had freedom of motion. Motion characteristics of the model were investigated using a mathematical simulation model. Results showed both the longitudinal and lateral motions consist of three oscillational modes, where one of the longitudinal modes displayed several characteristics very similar to the short period mode of a free flight model. The other two modes were strongly affected by cable forces and moments, with one of these being significantly low damped and having high frequency translational oscillation caused by cable force. This mode approached the phugoid mode when a spring was added to the front cable and its spring constant was decreased. One lateral motion mode was found to have similar characteristics to the dutch roll mode, whereas one of the other two modes was unstable

when the model was located near the center height of the wind tunnel and the cable tension was low. Author (NASDA)

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ASTRONAUTICS

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

A93-12004

PAYLOAD VEHICLE AERODYNAMIC RE-ENTRY ANALYSIS

DONALD TONG (Boeing Defense & Space Group, Seattle, WA) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 641-645. Previously cited in issue 12, p. 1924, Accession no. A91-32178 refs Copyright

A93-13276*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NEAR-OPTIMAL ENERGY TRANSITIONS FOR ENERGY-STATE TRAJECTORIES OF HYPERSONIC AIRCRAFT

M. D. ARDEMA, J. V. BOWLES, E. J. TERJESEN (NASA, Ames Research Center, Moffett Field, CA), and T. WHITTAKER (Sterling Software, Inc., Palo Alto, CA) Aug. 1992 10 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (AIAA PAPER 92-4300)

A problem of the instantaneous energy transition that occurs in energy-state approximation is considered. The transitions are modeled as a sequence of two load-factor bounded paths (either climb-dive or dive-climb). The boundary-layer equations associated with the energy-state dynamic model are analyzed to determine the precise location of the transition. O.G.

N93-10960*# Lockheed Engineering and Sciences Co., Houston, TX.

REQUIREMENTS ANALYSIS NOTEBOOK FOR THE FLIGHT DATA SYSTEMS DEFINITION IN THE REAL-TIME SYSTEMS ENGINEERING LABORATORY (RSEL)

RICHARD B. WRAY Dec. 1991 117 p (Contract NAS9-17900)

(NASA-CR-185698; NAS 1.26:185698; LESC-29702) Avail: CASI HC A06/MF A02

A hybrid requirements analysis methodology was developed, based on the practices actually used in developing a Space Generic Open Avionics Architecture. During the development of this avionics architecture, a method of analysis able to effectively define the requirements for this space avionics architecture was developed. In this methodology, external interfaces and relationships are defined, a static analysis resulting in a static avionics model was developed, operating concepts for simulating the requirements were put together, and a dynamic analysis of the execution needs for the dynamic model operation was planned. The systems engineering approach was used to perform a top down modified structured analysis of a generic space avionics system and to convert actual program results into generic requirements. CASE tools were used to model the analyzed system and automatically generate specifications describing the model's requirements. Lessons learned in the use of CASE tools, the architecture, and the design of the Space Generic Avionics model were established, and a methodology notebook was prepared for NASA. The weaknesses of standard real-time methodologies for practicing systems engineering, such as Structured Analysis and Object Oriented Analysis, were identified. Author

N93-11133 Alabama Univ., Huntsville. Dept. of Mechanical Engineering.

EFFECTS OF REACTING FLOWS WITH TURBULENCE AND SHOCK WAVES ON EFFICIENCY OF SCRAMJET COMBUSTORS

T. J. CHUNG and W. S. YOON in JHU, The 28th JANNAF Combustion Subcommittee Meeting, Volume 1 p 1-14 Oct. 1991

Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

The mutual effects of chemical reactions, shock waves, and turbulence on the flowfield and the resulting efficiency of scramjet combustors are examined. Calculations are carried out using the Taylor-Galerkin finite elements. Example problems include scramjet flame holders and supersonic diffusers in which finite rate chemistry (hydrogen-oxygen reactions) is incorporated in turbulence interacting with shock waves. In general, chemical reactions are triggered by shock waves and they in turn disperse the shock discontinuities. For the scramjet flame holder with larger ramp angles, combustion appears to have been completed upstream of the flame holder. For the supersonic diffuser, turbulence causes the shock discontinuities to be further dispersed. Contour lines for all chemical species change in directions parallel to the wall and toward the center line (circulations and mixing), but other flow variables do not show such trends as distinctively as chemical species. Author

N93-11798# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

HYBRID GUIDANCE FOR MANEUVERING FLIGHT VEHICLES

DEHAI LING 4 Feb. 1992 22 p Transl. into ENGLISH from Yuhang Xuebao (China), no. 2, 1987 p 44-52

(AD-A254110; FASTC-ID(RS)T-0787-91) Avail: CASI HC A03/MF A01

This article puts forward one type of guidance option related to the maneuver programming of reentering flight vehicles. The option in question makes use of a radiation sensing system, precisely determining the location of the starting point of the reentering flight vehicle. Use is also made of strap-on type inertial guidance systems to control the impact points of flight vehicles. Maneuvering flight is an important direction in the development of the technology of strategic flight vehicles. It is possible to use it in sudden defense, adding programming, raising precision, and recovery. Maneuvering flight tests are capable of giving complete checks in all such areas as flight vehicle propulsion systems, materials structure, heat resistance systems, stability, guidance circuits, and attitude control systems. It is capable of carrying out experiments on different technological levels. Options which are relatively simple and easy to carry out are to make the reentering flight vehicle, within the longitudinal plane, fly maneuvers according to preset programs. Going through precise inertial guidance or celestial-inertial guidance systems, guidance is carried out on the flight vehicle in the main power stage, with controls and corrections to the free section flight orbital plane, such that the trajectory is capable of entering into the predicted reentry corridor. As far as initial flight tests are concerned, it is possible to make use of inertial guidance systems which already exist, relaxing the requirements for launch plane controls and lateral impact point deviations. GRA

N93-12447*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CURRENT TECHNOLOGY FOR THERMAL PROTECTION SYSTEMS

STEPHEN J. SCOTTI, comp. Washington Oct. 1992 321 p Workshop held in Hampton, VA, 11-12 Feb. 1992

(Contract RTOP 506-43-31-04)

(NASA-CP-3157; L-17118; NAS 1.55:3157) Avail: CASI HC A14/MF A03

Interest in thermal protection systems for high-speed vehicles is increasing because of the stringent requirements of such new projects as the Space Exploration Initiative, the National Aero-Space Plane, and the High-Speed Civil Transport, as well as

the needs for improved capabilities in existing thermal protection systems in the Space Shuttle and in turbojet engines. This selection of 13 papers from NASA and industry summarizes the history and operational experience of thermal protection systems utilized in the national space program to date, and also covers recent development efforts in thermal insulation, refractory materials and coatings, actively cooled structures, and two-phase thermal control systems.

N93-12537 Maryland Univ., College Park.
EXPERIMENTS AND ANALYSIS CONCERNING THE USE OF EXTERNAL BURNING TO REDUCE AEROSPACE VEHICLE TRANSONIC DRAG Ph.D. Thesis

CHARLES JOSEPH TREFNY 1991 297 p
 Avail: Univ. Microfilms Order No. DA9222775

The external combustion of hydrogen to reduce transonic drag was studied. A control volume analysis is developed and indicates that the specific impulse performance of external burning is competitive with other forms of airbreathing propulsion and depends on the fuel-air ratio, freestream Mach number, and the severity of the base drag. A method is presented for sizing fuel injectors for a desired fuel-air ratio in the unconfined stream. A two-dimensional Euler analysis is also presented which indicates that the total axial force generated by external burning depends on the total amount of energy input and is independent of the transverse and streamwise distribution of heat addition. Good agreement between the Euler and control volume analysis is demonstrated. Features of the inviscid external burning flowfield are discussed. Most notably, a strong compression forms at the sonic line within the burning stream which may induce separation of the plume and prevent realization of the full performance potential. An experimental program was conducted in a Mach 1.26 free-jet to demonstrate drag reduction on a simple expansion ramp geometry, and verify hydrogen-air stability limits at external burning conditions. Stable combustion appears feasible to Mach numbers of between 1.4 and 2 depending on the vehicle flight trajectory. Drag reduction is demonstrated on the expansion ramp at Mach 1.26, however force levels showed little dependence on fuel pressure or altitude in contrast to control volume analysis predictions. Various facility interference mechanisms and scaling issues were studied and are discussed. Dissert. Abstr.

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A93-11454
THERMAL SHOCK CAPABILITIES OF INFRARED DOME MATERIALS

JEFFREY S. LIN and LOUIS B. WECKESSER (Johns Hopkins Univ., Laurel, MD) Johns Hopkins APL Technical Digest (ISSN 0270-5214) vol. 13, no. 3 July-Sept. 1992 p. 379-385. refs
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An analytical/experimental investigation is described to study the thermal-shock capabilities of IR-transmitting materials for use as windows in air-defense missile systems. A series of IR dome thermal-shock tests are conducted with a device based on a laser IR source, an air heater, a Mach 5 nozzle, and an IR dome and sensor unit. Shock tests are performed on hot-pressed spinel, hot-isostatic-pressed spinel, yttria, zinc sulphide, and sapphire. Computer models are developed in parallel with the thermal shock testing which model heat transfer by determining temperature distributions and passing them to a finite-element structural analysis code. The aerothermal testing and model results are consistent and show that sapphire is the most thermal-shock-resistant material which provides the minimum required flight capability. C.C.S.

A93-12114
RAISING THE HIGH TEMPERATURE LIMIT OF THE NICKEL-IRON-BASE SUPERALLOY

J. K. TIEN, B. C. HENDRIX, J. H. HOWARD, P. L. BRETZ (Texas Univ., Austin), and J. P. COLLIER (British Oxygen Co., Morristown, NJ) In Morris E. Fine Symposium, TMS Fall Meeting, Detroit, MI, Oct. 8-11, 1990, Proceedings Warrendale, PA Minerals, Metals & Materials Society 1991 p. 251-254. Research supported by Texas Advanced Technology Program, Nippon Mining Co., Pratt & Whitney Group, et al refs
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The object of this alloy development project is to enhance the temperature capabilities of the IN718 superalloy system by increasing the stability of the gamma, gamma-prime, and gamma-double-prime phases, and as a result, reduce the kinetics of Widmanstatten delta-phase formation. It is found that the stability is increased by increasing the (Al+Ti)/Nb and Al/Ti ratios while maintaining the Fe and Nb concentrations at their present levels. Not only is the microstructure more stable, but also the heat resistance of the alloy is increased. The most stable superalloy in this class to date, known as Ticolloy is showing enhanced tensile strength, tensile ductility, creep, and stress-rupture resistances. High-temperature crack growth and hydrogen embrittlement test results are also presented. Author

A93-12202
SOME PHYSIO-CHEMICAL CHARACTERISTICS OF LUBRICATING OIL USED IN GAS TURBINES

SOLIMAN H. AL-KHOVAITER (King Saud Univ., Riyadh, Saudi Arabia) and ABDUL S. A. DAFALLA (Saudi Consolidated Electric Co., Riyadh, Saudi Arabia) Lubrication Engineering (ISSN 0024-7154) vol. 48, no. 10 Oct. 1992 p. 793-798. Research supported by Saudi Consolidated Electric Co refs
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This paper reports the changes in lubricating oil properties during service operation. New oil samples and in-service oil samples were subjected to physical and chemical analysis. Infra-red spectra were used to detect oxidation and gas chromatography (GC) for the evaluation of antioxidant. It was found that kinematic viscosity, acidity and color increase with time, while flash point decreases. Author

A93-12368
MIDHANI ALLOYS IN AERONAUTICAL SERVICE

K. SRINIVASA (Defence Research and Development Organisation, New Delhi, India) and B. GUPTA (Defence Research and Development Organisation, Hyderabad, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 2 May 1992 p. 129-143. refs

The processing facilities, practices, and applications of one manufacturer are reviewed for producing high-performance aerospace alloys. Specific attention is given to the production facilities and procedures for primary melting, refining, and remelting. The fabrication facilities are described with details of the ingots developed for feed stock and the corresponding levels of purity and defect occurrences. The critical aspects of materials approval/certification are discussed including the inspection of facilities and of the alloys' metallurgies and performances. Certified alloys by the manufacturer include Ni-base superalloys, Ti alloys, and stainless and HR steels. Innovations in the production of the aeronautical-grade alloys are described in the realms of processing, production, and indigenization with a good accompanying service record. C.C.S.

A93-12771
MICROSTRUCTURAL STUDY OF ALUMINIDE SURFACE COATINGS ON SINGLE CRYSTAL NICKEL BASE SUPERALLOY SUBSTRATES

W. F. GALE and J. E. KING (Cambridge Univ., United Kingdom) Materials Science and Technology (ISSN 0267-0836) vol. 8, no. 8 Aug. 1992 p. 673-678. Research supported by Rolls-Royce, PLC, SERC, British Gas, PLC, and Fellowship of Engineering

refs

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This paper is concerned with microstructural changes in aluminide diffusion coatings on single-crystal gamma-prime strengthened superalloy substrates during the course of high-temperature fatigue testing. The 'edge-on' transmission electron microscopy technique is employed to study cross-sections of two-stage (aluminization plus diffusion treatment) coated superalloy samples. The paper examines the degradation of the coating produced by phase transformations induced by loss of aluminium from the coating and/or aging of the coating. Aluminum removal both by interdiffusion with the substrate and by oxidation of the coating surface is considered. Microstructural development in the portion of the substrate influenced by interdiffusion with the coating is also discussed.

Author

A93-12781**DESIGN SENSITIVITY AND OPTIMIZATION OF COMPOSITE CYLINDERS**

ADITI CHATTOPADHYAY and JAY FERREIRA (Arizona State Univ., Tempe) Composites Engineering (ISSN 0961-9526) vol. 3, no. 2 1993 p. 169-179. refs

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Composite cylinders are often used in both rotary- and fixed-wing applications where low weight and high strength are important design issues. This paper, the first of a two-phase study, addresses the failure of such cylinders, under axial compressive loading using design optimization and sensitivity analysis procedures. Thin-walled cylinders made of different types of symmetric orthotropic laminates and several wall thicknesses are examined. Formal optimization techniques are used and the diameter and individual ply orientations are varied to maximize the critical buckling load of the cylinder. Constraints are imposed on the longitudinal, normal and in-plane shear stress of each ply. The optimization is performed using the nonlinear programming method of feasible directions. A two-point exponential approximation method is also used to reduce computational effort. Results are presented for Graphite/Epoxy, Glass/Epoxy and Kevlar/Epoxy composite cylinders with symmetric ply arrangements.

Author

A93-12823**EVAPORATION AND SPECIFIC HEATS OF MOTOR FUELS [TEPLOTA ISPARENIIA I TEPLOEMKOSTI MOTORNYKH TOPLIV]**

A. G. KOPEIKIN and S. V. BASHARIN *Aviatsionnaia Tekhnika* (ISSN 0579-2975) no. 1 1992 p. 94, 95. In Russian. refs

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Based on the concept of the intrinsic acoustic field of liquids, an analytical relationship is established between the evaporation heat and the specific heat difference, $C_p - CV$, of various liquids, both simple and complex and consisting of polar or nonpolar molecules, including motor fuels and oils. Calculation results are presented for several fuels, oils, and their mixtures.

V.L.

A93-12824**VISCOSITY OF AVIATION FUEL COMPONENTS (N-ALKANES) [VIAZKOST' KOMPONENTOV AVIATIONNYKH TOPLIV /N-ALKANY/]**

V. I. SKOMOROKHOV and A. F. DREGALIN *Aviatsionnaia Tekhnika* (ISSN 0579-2975) no. 1 1992 p. 96-98. In Russian. refs

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It has been shown in a previous study (Skomorokhov and Dregalin, 1991) that the two-parameter Frenkel equation with parameters A and B is the most accurate of the numerous correlations that have been proposed for calculating the dynamic viscosity of nonassociated liquids. Here values of the A and B parameters are presented which make it possible to calculate, with high accuracy, the dynamic viscosity coefficients of pure liquid n-alkanes from C1 to C20 in the temperature range from the melting point to boiling.

V.L.

A93-13640**EFFECTS OF PRIOR FATIGUE DAMAGE ON CRACK PROPAGATION RATES IN 2024-T351 ALUMINUM ALLOY**

W. J. D. SHAW (Calgary Univ., Canada) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991* Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 317-334. Research supported by NSERC refs

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A program to investigate the effect of prior fatigue damage on the subsequent fatigue crack propagation behavior is developed. Preliminary results for low prior damage conditions are obtained. The prior damage condition is seen to have a large effect on the crack propagation rate. This effect needs to be taken into account in damage tolerance evaluation when applied to aging aircraft.

Author

A93-13644**FLIGHT SIMULATION AND CONSTANT AMPLITUDE FATIGUE CRACK GROWTH IN ALUMINUM-LITHIUM SHEET AND PLATE**

R. J. H. WANHILL, W. G. J. T. HART, and L. SCHRA (National Aerospace Lab., Amsterdam, Netherlands) *In Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991* Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 393-431. Research sponsored by Netherlands Agency for Space Programs refs

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Since 1984 the NLR has done many fatigue crack growth tests to compare the modern Al-Li alloys 2090, 2091 and 8090 with the conventional damage tolerant alloys 2024 and 2324. Under constant amplitude loading the Al-Li alloy crack growth behavior is often equivalent or superior to that of the conventional alloys. However, under gust spectrum loading the conventional alloys are generally better. The changes in rankings are explained from fracture surface analysis. The practical significance of the results is discussed, and guidelines for further investigation are given.

Author

A93-13648**CERAMIC COATINGS ENHANCE MATERIAL PERFORMANCE**

GREG GEIGER *American Ceramic Society Bulletin* (ISSN 0002-7812) vol. 71, no. 10 Oct. 1992 p. 1470-1476, 1478-1481.

Copyright

An overview is presented of ceramic coating technology for applications where high temperatures, corrosion, oxidation, and wear are critical. Attention is given to numerous applications including thermal, electrical, optical, clearance control, debonding (for fiber-reinforced composites) and bi-compatible coatings for prostheses and dental implants. For jet engine applications, ceramic coatings are being applied for wear control of blades, seals, mounts and bearings.

R.E.P.

N93-10717# Rhode Island Univ., Kingston. Dept. of Mechanical Engineering and Applied Mechanics.

MECHANISMS AND MODELLING OF ENVIRONMENT-DEPENDENT FATIGUE CRACK GROWTH IN A NICKEL BASED SUPERALLOY Final Report, 1989 - 1991

H. GHONEM and D. ZHENG 12 Dec. 1991 252 p

(Contract AF-AFOSR-0285-89)

(AD-A253967; URI-MSL-921; AFOSR-92-0787TR) Avail: CASI HC A12/MF A03

At loading frequencies below that of the transitional frequency level, which is typical of mission cycles of jet engines, the elevated temperature fatigue crack growth process in Alloy 718 is viewed to be fully environment-dependent. Of all the crack growth stages, this process, while is the most critical in high temperature application due to its highly accelerated crack growth rate, is the least studied or understood. The objective of this research program is to focus on the understanding or the mechanism controlling this oxidation-dependent stage in order to develop the ability to

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predict its associated crack growth performance under different environment conditions. For this purpose, three major studies have been carried out; the first was to provide evidence of the existence of the fully environment-dependent stage in which the crack growth rate would be equal to the oxygen penetration rate at the crack tip. The second study was to establish a crack tip oxidation mechanism on the basis of material, environmental and loading parameters interactions in the crack tip region. The last objective of this program is to establish a micromechanical based quantitative model to predict the environmentally-dominated crack growth stage. GRA

N93-10770# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

MEASUREMENT OF AERODYNAMIC SHEAR STRESS USING SIDE CHAIN LIQUID CRYSTAL POLYMERS M.S. Thesis

CARLO G. DEMANDANTE 1992 75 p
(AD-A254312; AFIT/CI/CIA-92-067) Avail: CASI HC A04/MF A01

A novel concept was proposed exploiting the optical property response of liquid crystalline materials to various external effects. This study determined the feasibility of using side chain liquid crystal polymers as aerodynamic shear sensors. A method was developed to observe and measure the optical birefringent response of film coatings made from these polymer materials due to applied shear. Different polymers were synthesized, spray-coated, and tested for their shear-sensing potential. Empirical results confirmed the promise of this method on future aerodynamic testing. GRA

N93-10843# California Inst. of Tech., Pasadena.

SHOCK ENHANCEMENT AND CONTROL OF HYPERSONIC COMBUSTION Annual Technical Report, 1 Apr. 1991 - 31 Mar. 1992

FRANK E. MARBLE and EDWARD E. ZUKOSKI 18 Jun. 1992 21 p
(Contract AF-AFOSR-0804-92)

(AD-A254295; AFOSR-92-0804TR) Avail: CASI HC A03/MF A01
Experiments concerning the details of combustion in large vortices in the Caltech Unsteady Combustion Facility, using simultaneous measurements of pressure, shadowgraphy, and chemiluminescence are now about 50 percent complete. The detail of these results document a very different ignition mechanism and combustion pattern than previous experiments have suggested. Shock tube studies of shock enhanced mixing of helium into air, utilizing the Rayleigh scattering technique have been completed. Because of their greater sensitivity in the low concentration range, these measurements are significantly more accurate than those obtained with laser induced fluorescence and demonstrate that mixing is considerably more rapid and more complete than reported previously. Preliminary results have been obtained from experiments on the interaction of shock induced mixing with shear layers in the GALCIT M = 2.5 supersonic wind tunnel. GRA

N93-11027# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Zentrallabor.

SURFACE PROTECTION IN THE AIRCRAFT INDUSTRY [OBERFLAECHENSCHUTZ IN DER LUFTFAHRTINDUSTRIE]

FRANZ JOSEF GAMMEL 1992 12 p In GERMAN Presented at the Jahrestagung Verschleiss- und Korrosionsfeste Oberflaechen fuer Hochfeste Bauteile, Bad Nauheim, 9-10 Mar. 1992, Fed. Republic of Germany
(MBB-Z-0432-92-PUB; ETN-92-92126) Avail: CASI HC A03/MF A01

Among a number of surface protection techniques used in the aircraft industry, three methods pertaining to the electroplating field are presented: aluminum adhesive bonding preparatory treatment, steel chemical nickel plating, and titanium metallization. These processes are discussed using utilization examples such as the realization of clean surfaces for aircraft fuselage. It is shown that galvanic processes are in the foreground. ESA

N93-11031# Rolls-Royce Ltd., Derby (England).

SHORT FATIGUE CRACK GROWTH IN A NICKEL-BASE SUPERALLOY AT ROOM AND ELEVATED TEMPERATURE Final Report

J. C. HEALY (Birmingham Univ., England), L. GRABOWSKI, and C. J. BEEVERS (Birmingham Univ., England) 10 Aug. 1990 12 p
(PNR-90892; ETN-92-92194) Copyright Avail: CASI HC A03/MF A01

The fatigue behavior of Waspaloy was studied using an optical system developed to monitor short crack growth at elevated temperatures. Tests conducted at 19 and 500 C revealed the dominant mechanism of crack formation was slip band cracking. Crack formation was also associated with coarse carbide particles within the matrix. The dominant failure mechanism at 19 and 500 C was one of mixed mode 1 and 2 fractures, with mode 2 shear displacements giving rise to surface roughness induced non-closure. Oxide and plasticity induced non-closure processes made only a minor contribution to the overall growth process. Short fatigue crack growth measured at R 0.1 was faster at 500 C than at 19 C at an equivalent value of Delta-K(sub 1). This was attributed to a change in slip character from highly planar to one involving increasing amounts of cross slip at 19 and 500 C respectively. ESA

N93-11032# Rolls-Royce Ltd., Derby (England).

A TEST FACILITY FOR THE THERMOFLUID-DYNAMICS OF GAS BEARING LUBRICATION FILMS

S. I. HOGG (Oxford Univ., England), S. J. HUGHES (Oxford Univ., England), and T. V. JONES (Oxford Univ., England) 8 Apr. 1992 10 p Sponsored by Science Research Council
(PNR-90897; ETN-92-92196) Copyright Avail: CASI HC A02/MF A01

A novel test facility for making fundamental investigations of hydrodynamic gas bearing lubrication films is described. The work forms part of a wider research effort aimed towards the introduction of gas lubricated bearings in future gas turbine designs. The need for this experiment is discussed in the context of previous studies, and the design and manufacture of the facility is described. Some interesting test results for a hydrostatic thrust bearing are described. The results were obtained whilst commissioning the facility. These results are compared with numerical simulations obtained by solving Reynolds equation. ESA

N93-11035# Rolls-Royce Ltd., Derby (England). Company Applied Science Lab.

ROTATIONAL CARS MEASUREMENTS IN A ROTATING CAVITY WITH AXIAL THROUGHFLOW OF COOLING AIR: OXYGEN CONCENTRATION MEASUREMENTS

JOHN D. BLACK and CHRISTOPHER A. LONG (Sussex Univ., Brighton, England) 15 Dec. 1991 28 p Submitted for publication Sponsored in part by Defence Research Agency
(PNR-90935; ETN-92-92215) Copyright Avail: CASI HC A03/MF A01

In a rotating cavity rig, which models cooling air flow in the spaces between discs of a gas turbine compressor, the build up of oxygen concentration after the cooling gas was changed from nitrogen to air was monitored using rotational Coherent AntiStokes Raman Spectroscopy (CARS). From this information an estimate of the fraction of the throughflow entering the rotating cavity was obtained. This demonstrated that rotational CARS can be applied as a nonintrusive concentration measurement technique in a rotating engineering test rig. ESA

N93-11066# Rolls-Royce Ltd., Derby (England). Advanced Ceramics Centre.

AERO ENGINE CERAMICS: THE VISION, THE REALITY, AND THE PROGRESS

JAMES P. ANGUS 18 Feb. 1992 22 p Presented at Aerotech 1992, Birmingham, England, 16 Jan. 1992
(PNR-90983; ETN-92-92242) Copyright Avail: CASI HC A03/MF A01

In order to provide an understanding of what Rolls-Royce are

trying to achieve with ceramics, three areas are covered: the vision, the reality, and the progress. The 'vision' is described in terms of the benefit to engines and the potential cost savings to customers; the advantages of the high thrust to weight ratio offered by ceramics are discussed. For the 'reality' of trying to achieve this vision, some of the key technical issues to be addressed are described. These are discussed with reference to a component well suited to composite ceramics, the exhaust diffuser. Responses to the challenge these issues create are explained. Under 'progress' some of the real achievements made are discussed. The full range of ceramics being considered for aeroengines are discussed with a focus on one of the most promising groups of ceramics, the fiber reinforced ceramic composites. ESA

N93-11107# Rolls-Royce, Inc., Atlanta, GA.

SMALL PARTICLE IMPACT DAMAGE IN CARBON-CARBON COMPOSITES

S. GUPTA and W. WESTPHAL 1 Nov. 1991 6 p Presented at the 1991 Yokohama International Gas Turbine Congress, Yokohama, Japan, 27 Oct. - 1 Nov. 1991 (PNR-90948; ETN-92-92225) Copyright Avail: CASI HC A02/MF A01

Carbon-carbon composites, an important member of the fast emerging families of advanced material systems, which are making it feasible to achieve large advances in aero gas turbines of the future, are considered. In spite of a combination of outstanding properties, carbon-carbon composites do have serious oxidation problems. Oxidation protection technologies, essentially a barrier coating, become essential. Such coating systems, in addition to providing oxidation protection, must also accommodate environmental conditions in the engine. Small particle impact damage was one of the concerns. An experiment to investigate this, in which alumina grit was impacted on the surface of test specimens in a vertical erosion wind tunnel, is outlined. It was found that small particle impacts could indeed cause physical damage to the coating and consequently reduce its effectiveness, and as such must be considered in developing component applications for carbon-carbon composites. ESA

N93-11135*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EMPLOYMENT OF RADICALS AND EXCITED STATE SPECIES FOR SUPERSONIC COMBUSTION PHOTOCHEMICAL IGNITION OF PREMIXED HYDROGEN/OXYGEN MIXTURES WITH ARF LASER

YEHUDA NACHSHON (Energia, Inc., Princeton, NJ.), SURESH K. GULATI (Energia, Inc., Princeton, NJ.), JOHN G. STEVENS (Energia, Inc., Princeton, NJ.), MOSHE LAVID (Energia, Inc., Princeton, NJ.), and RICHARD JAFFE *In* JHU, The 28th JANNAF Combustion Subcommittee Meeting, Volume 1 p 25-35 Oct. 1991

(Contract NAS2-13187)

Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

The success of the new generation of hypersonic flight vehicles depends on the attainment of a true breakthrough in combustion technology. Conventional combustion processes are currently hindered by constraints imposed by severe conditions associated with the harsh hypersonic flow field. This is a research effort to determine the feasibility of using radicals and excited state species to improve the combustion of reactive systems fueled by hydrogen. These species have lower energy barriers than their ground state counterparts. Hence, they are capable of very high reaction rates, which can result in quantum enhancement in various combustion characteristics relevant to supersonic flows, such as ignition delay time, autoignition temperature, minimum ignition energy, combustion residence time, and overall combustion efficiency. The effect of in-situ production of atomic oxygen O(P-3) on hydrogen combustion is examined. The experimental test conditions are similar to those anticipated for supersonic combustion, i.e., $M = 6-10$, $P = 0.5$ atm, ER (equivalence ratio) = 1, and the temperature range is 500-750 K. Atomic oxygen at the ground level O(P-3) is produced by photodissociating molecular oxygen with ArF excimer laser line

(193 nm). Experimental results are very promising. Successful ignitions were obtained outside the explosion peninsula (above the second limit). Minimum laser ignition energies are given for various equivalence ratios at different temperatures. A detailed computer program is presented for calculating the rate of molecular oxygen photo-dissociation at the ignition site. It includes laser propagation through a non-uniform temperature absorbing medium, non-linear absorption 'hole drilling' in the output laser, and bleaching of the absorbers at the excited levels of the ground electronic state. Combination of measured laser energies and calculated dissociation rates of molecular oxygen yields the minimum required concentration of atomic oxygen for photo-chemical ignition. Results are presented for fuel-lean (0.2 - 1.0) and fuel-rich (1.0 - 2.0) hydrogen/oxygen mixtures at different temperatures (up to 800 K). Author

N93-11137 California State Univ., Sacramento.

THE COMBUSTION TIME LAG AND ITS ROLE IN RAMJET COMBUSTION INSTABILITY

FREDERICK H. REARDON *In* JHU, The 28th JANNAF Combustion Subcommittee Meeting, Volume 1 p 45-63 Oct. 1991 Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

The concept of a combustion time lag has proven useful in the study of combustion instability in both liquid propellant rockets and liquid-fueled ramjets. Direct measurement of the time lag is not feasible; for liquid propellant rockets, the time lag has been calculated from knowledge of the axial distribution of energy release in the combustion chamber. The same approach was applied in this study to ramjet combustors. A computational fluid dynamics code was used to calculate the axial distribution of the mean gas temperature and axial velocity in a coaxial-dump ramjet combustor. The dependence of the combustion time lag on several combustor design parameters was investigated for two modes of fuel injection. For fuel injection from the wall of the air inlet duct just upstream of the dump plane, the time lag increased with increasing fuel drop diameter and with increasing jet penetration distance (for most cases), and decreased with increasing air velocity and increasing fuel/air ratio. When the fuel was injected uniformly across the air inlet duct well upstream of the dump plane, the time lag was larger for longer combustors, was relatively insensitive to drop size and inlet/combustor diameter ratio, and decreased with increasing air velocity and fuel/air ratio. These results were used in a previously developed combustion instability model. Unfortunately, the combustion time lag values calculated appear to be too small by about a factor of two. The major reason for the disagreement appears to be the method of determining the time lag from the CFD results. Author

N93-11442# Oak Ridge National Lab., TN.

CERAMIC TECHNOLOGY PROJECT

Mar. 1992 504 p

(Contract DE-AC05-84OR-21400)

(DE92-018748; ORNL/TM-11984) Avail: CASI HC A22/MF A04

The Ceramic Technology Project was developed by the USDOE Office of Transportation Systems (OTS) in Conservation and Renewable Energy. This project, part of the OTS's Materials Development Program, was developed to meet the ceramic technology requirements of the OTS's automotive technology programs. Significant accomplishments in fabricating ceramic components for the USDOE and NASA advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible. These programs have also demonstrated that additional research is needed in materials and processing development, design methodology, and data base and life prediction before industry will have a sufficient technology base from which to produce reliable cost-effective ceramic engine components commercially. A five-year project plan was developed with extensive input from private industry. In July 1990 the original plan was updated through the estimated completion of development in 1993. The objective is to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines.

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The project approach includes determining the mechanisms controlling reliability, improving processes for fabricating existing ceramics, developing new materials with increased reliability, and testing these materials in simulated engine environments to confirm reliability. Although this is a generic materials project, the focus is on the structural ceramics for advanced gas turbine and diesel engines, ceramic bearings and attachments, and ceramic coatings for thermal barrier and wear applications in these engines. To facilitate the rapid transfer of this technology to US industry, the major portion of the work is being done in the ceramic industry, with technological support from government laboratories, other industrial laboratories, and universities. DOE

N93-12189 Cincinnati Univ., OH.
EROSION PREDICTIONS AND MEASUREMENTS OF HIGH-TEMPERATURE COATINGS AND SUPERALLOYS USED IN TURBOMACHINES Ph.D. Thesis

METWALLY ANWAR METWALLY 1992 221 p
Avail: Univ. Microfilms Order No. DA9223986

Nickel and cobalt superalloys are widely used in the hot section of gas turbines. Protective coatings are used to enhance superalloy erosion-corrosion at elevated temperatures. This investigation is devoted to wind tunnel measurements and analytical prediction of erosion rates and particle rebound characteristics of some newly developed coatings and superalloys. Both erosion rates and particle rebound characteristics are necessary for accurate prediction of erosion in turbomachines. The abrasive particles used in the measurements were coal ash with a weight average diameter of 15 microns. A three components laser Doppler velocimetry system was used to measure both particle impact and rebound velocities over a wide range of impingement angle. Empirical correlations have been developed for the restitution coefficients of both coated and uncoated surfaces. A high temperature erosion test facility was used to measure the erosion rates for the coatings and superalloys. The data was accumulated for wide ranges of the erosion parameters, namely, impingement angle, impact velocity, material temperature, and mass of particles which have the main effects on the material erosion behaviors. Erosion models have been developed to predict the erosion rates of materials whose behavior are ductile. The developed rebound and erosion models were used to predict the particle dynamics and resulting blade surfaces erosion of coal ash particles in a power turbine of an automotive gas turbine engine for both coated and uncoated blade surfaces. The results show the three dimensional particle trajectories through the turbine flow passages and the particle impact locations over the blade surfaces. The predicted counters of erosion rate and its related parameters over the blade surfaces are presented for coated and uncoated blades. In addition an experimental study was conducted which confirmed the locations of the blade surface impacts predicted by the theoretical analysis. Also, an attempt was made to estimate coating lives based on the erosion models. Dissert. Abstr.

N93-12237# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.

FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS
Technical Progress Report, 16 Sep. 1991 - 15 Aug. 1992

DANIEL P. DELUCA and CHARLES ANNIS 15 Aug. 1992 9 p
(Contract N00014-91-C-0124)

(AD-A254603; PW-FR-21998-10) Avail: CASI HC A02/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic materials. To understand these differences is the major goal of this project. GRA

N93-12248# Naval Air Development Center, Warminster, PA. Aircraft and Crew Systems Technology Directorate.

FATIGUE CRACK GROWTH IN AERMET 100 STEEL

EUN U. LEE 18 Oct. 1991 25 p

(AD-A249068; NADC-91111-60) Avail: CASI HC A03/MF A01

The fatigue behavior of a newly developed landing gear steel, AerMet 100, was studied. In this study, the fatigue tests were performed under constant amplitude loading for stress ratios $R = 0.1, 0.5, \text{ and } 0.8$ in dry nitrogen gas and a 3.5 percent NaCl solution at room temperature. The fatigue crack growth resistance of the AerMet 100 steel is superior to that of the 300M steel, which has been widely used for aircraft landing gears. Within the employed range of stress ratios, the greater the stress ratio, the smaller is the threshold stress intensity range for fatigue crack growth $\Delta(K_{th})$ and the greater is the fatigue crack growth rate da/dN for lower $\Delta(K)$. For higher $\Delta(K)$, however, the da/dN values of different stress ratios are similar in both environments. The $\Delta(K_{th})$ is greater and da/dN is smaller for lower $\Delta(K)$ in a 3.5 percent NaCl solution than in dry nitrogen gas, whereas the da/dN values are quite close for higher $\Delta(K)$ in both environments. This feature is attributable to corrosion-product-induced crack closure. GRA

N93-12456*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CURRENT RESEARCH IN OXIDATION-RESISTANT CARBON-CARBON COMPOSITES AT NASA. LANGLEY RESEARCH CENTER

CRAIG W. OHLHORST, WALLACE L. VAUGHN, and DAVID M. BARRETT *In its* Current Technology for Thermal Protection Systems p 149-168 Oct. 1992
Avail: CASI HC A03/MF A03

The significant potential of carbon-carbon composites for high-temperature structural applications is well established. For hypersonic vehicle applications, desirable properties include low density, high specific strength and stiffness, low coefficients of thermal expansion, and retention of mechanical properties above 3000 F. A significant problem associated with carbon materials, however, is that they oxidize rapidly in air at temperatures above about 800 F, and therefore must be protected from oxidation. Successful development of effective methods of oxidation protection is key to the eventual utilization of carbon-carbon composites on hypersonic vehicles such as NASP. In this presentation, the basic elements of an oxidation-protection system are described. Results from oxidation-performance evaluations of state-of-the-art ACC-4 type material in simulated airframe vehicle environments (temperature, pressure, and time) conducted at NASA Langley are also presented. NASA Langley has an active research effort to improve the oxidation resistance of carbon-carbon materials for airframe structural and vehicle thermal protection applications. Conversion coating and sealant development research is highlighted. Author

N93-12457*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THERMAL CONTROL/OXIDATION RESISTANT COATINGS FOR TITANIUM-BASED ALLOYS

RONALD K. CLARK, TERRY L. WALLACE, GEORGE R. CUNNINGTON (Lockheed Missiles and Space Co., Palo Alto, CA.), and KARL E. WIEDEMANN (Analytical Services and Materials, Inc., Hampton, VA.) *In its* Current Technology for Thermal Protection Systems p 169-188 Oct. 1992

Avail: CASI HC A03/MF A03

Extensive research and development efforts have been expended toward development of thermal control and environmental protection coatings for NASP and generic hypersonic vehicle applications. The objective of the coatings development activities summarized here was to develop light-weight coatings for protecting advanced titanium alloys from oxidation in hypersonic vehicle applications. A number of new coating concepts have been evaluated. Coated samples were exposed to static oxidation tests at temperatures up to 1000 C using a thermogravimetric apparatus. Samples were also exposed to simulated hypersonic flight conditions for up to 10 hr to determine their thermal and chemical stability and catalytic efficiency. The emittance of samples was determined before and after exposure to simulated hypersonic flight conditions. Author

ENGINEERING

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

A93-10009**DYNAMICS OF A HIGH-RPM COMPRESSOR [DINAMIKA VYSOKOOROTNOGO KOMPRESSORA]**

A. R. ISAIUK-SAEVSKAIA and A. S. KEL'ZON *Prikladnaia Matematika i Mekhanika* (ISSN 0032-8235) vol. 56, no. 2 Mar.-Apr. 1992 p. 331-335. In Russian. refs
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A study is made of the dynamics of a high-rpm compressor whose supports consist of two single-row rolling bearings pressed into a single bushing. Expressions are obtained which relate the mass characteristics of the bushings, stiffness coefficients of the elastic supports, and compressor rpm for which the dynamic pressures on the supports become zero. Formulas are obtained which determine the first two critical speeds of the compressor in elastic supports. V.L.

A93-10026**COLLECTION OF WORKS ON MEASURING AND COMPUTING SYSTEMS FOR RESEARCH ON THE AERODYNAMICS, DYNAMICS, AND STRENGTH OF FLIGHT VEHICLES [SBORNIK RABOT PO IZMERITEL'NYM I VYCHISLITEL'NYM SISTEMAM DLIA ISSLEDOVANIIA AERODINAMIKI, DINAMIKI I PROCHNOSTI LETATEL'NYKH APPARATOV]**

L. I. SHAKHOVA, ED. Moscow Tsentral'nyi Aerogidrodinamicheskii Institut (TsAGI, Trudy. No. 2464) 1990 169 p. In Russian.
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The papers contained in this volume provide an overview of recent advances in measuring and computing systems for the study of flight vehicle aerodynamics, dynamics, and strength. Topics discussed include aerodynamic measurement at high temperatures, an optomechanical strain gage, a sensor for the direct measurement of local surface friction, and a study of the metrological characteristics of LDV using stands simulating the LDV signal. Papers are also presented on a mathematical model and experimental study of the three-component strain-gage balances of a shock tunnel, hemispherical and spherical flow parameter detectors, and determination of the membrane and flexural shell deformations from the readings of a two-sided rosette-type strain gage. (For individual items see A93-10027 to A93-10049) V.L.

A93-10029**A PRESSURE DISTRIBUTION MEASURING SYSTEM WITH PNEUMATIC SWITCHES AND AUTOMATIC BAND SELECTION [IIS DLIA IZMERENIIA RASPREDELENIIA DAVLENIIA S PNEVMOKOMMUTATORAMI I AVTOMATICHESKIM VYBOROM DIAPAZONA]**

A. N. KOLBAEV, N. A. KOLGANOV, A. M. MIRONOV, V. E. NIKITIN, and V. E. RIADCHIKOV *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 16-23. In Russian. refs

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A pressure distribution measuring system is described which has been implemented on the basis of a commercial data processing and measuring system using pneumatic switches of the valve type. The system features automatic band selection, which is achieved by using a special sensor. The system has 44 channels with excess pressure bands of (2.5, 1.0, 0.16, and 0.016)

$\times 10 \exp 5$ Pa and rarefaction bands up to $0.6 \times 10 \exp 5$ Pa; the system processes at a rate of 1-5 channels per second with an accuracy to within 0.5 percent. V.L.

A93-10030**MEASUREMENT OF AERODYNAMIC FORCES AT HIGH TEMPERATURES [IZMERENIE AERODINAMICHESKIKH SIL V USLOVIIAKH VYSOKIKH TEMPERATUR]**

N. P. LEVITSKII, A. I. POSTNOV, G. N. SHUSTOVA, and M. A. KHRAMOVA *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 24-29. In Russian. refs

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Methods for protecting strain-gage balances against the effect of high temperatures are examined. The design of pipelines for the supply of a coolant in balance-protection systems is described. Two alternative balance-cooling system designs are shown. V.L.

A93-10032**A DATA PROCESSING AND MEASURING SYSTEM WITH A TRAVERSING PROBE FOR STUDYING FLOW IN THE ROTATING IMPELLER OF AN AXIAL-FLOW FAN [INFORMATSIONNO-IZMERITEL'NAIA SISTEMA S KOORDINATNIKOM DLIA ISSLEDOVANIIA TECHENIIA VO VRASHCHAIUSHCHEMSIA RABOCHEM KOLESE OSEVOGO VENTILIATORA]**

I. V. BRUSILOVSKII, N. M. IVANOVA, E. I. KARULIN, V. V. MITROFOVICH, I. G. MOSKOVKO, and V. D. RYL'KOV *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 33-42. In Russian. refs

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The general design and operation of a data processing and measuring system for studying flow in the rotating impeller of an axial-flow fan are described. The methodology and software support of the experiment are examined. Examples of flow parameter fields behind the impeller of a highly loaded axial-flow fan are presented, and the accuracy and reproducibility of the results are evaluated. V.L.

A93-10044**HEMISPHERICAL AND SPHERICAL FLOW PARAMETER DETECTORS [POLUSFERICHESKII I SFERICHESKII PRIEMNIKI PARAMETROV POTOKA]**

A. N. PETUNIN *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 116-131. In Russian. refs

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The design of hemispherical and spherical detectors of flow parameters is examined, and algorithms for processing measurement results are described. The characteristics of spherical and hemispherical detectors of large angles of attack are reported on the basis of tests at Mach 0.5-0.7, angles of attack of 0-40 deg, and slip angles of 0-12 deg. V.L.

A93-10047**DETERMINATION OF THE MEMBRANE AND FLEXURAL SHELL DEFORMATIONS FROM THE READINGS OF A TWO-SIDED ROSETTE-TYPE STRAIN GAGE [OPREDELENIE MEMBRANNYKH I IZGIBNYKH DEFORMATSII OBOLOCHKI PO POKAZANIIAM DVUSTORONNEI ROZETKI]**

V. P. KOLOMIETS *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 150-153. In Russian. refs

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A simple and sufficiently general method is presented whereby the stress-strain moment state of a shell can be determined from

the readings of a two-sided rosette-type strain gage. This method makes it possible to evaluate the nature and the possible direction of shell deformation at the site of the strain gage. The method is particularly suitable for thin-walled shells, which are commonly used in aircraft structures. V.L.

A93-10148
CALCULATION OF A GAS-DISPERSION LAMINAR BOUNDARY LAYER ON A PLATE WITH ALLOWANCE FOR LIQUID FILM FORMATION [RASCHET GAZODISPERSNOGO LAMINARNOGO POGRANICHNOGO SLOIA NA PLASTINE S UCHETOM OBRAZUIUSHCHEISIA ZHIDKOI PLENKI]

V. A. NAUMOV Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281) no. 2 Mar.-Apr. 1992 p. 179-181. In Russian. refs
 Copyright

A93-10176
TURBULENT JET FLOWS WITH CONDENSATION AND ELECTROPHYSICAL EFFECTS [TURBULENTNYE STRUINYE TECHENIIA S KONDENSATSIONNYMI I ELEKTROFIZICHESKIMI EFFEKTAMI]

A. B. VATAZHIN, ED. Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia (TsIAM, Trudy, No. 1288 (1)) 1991 176 p. In Russian.
 Copyright

The papers presented in this volume provide an overview of experimental, theoretical, and numerical research concerned with turbulent jet flows in the presence of condensation and electrophysical effects. In particular, attention is given to the frequency and volt-ampere characteristics of a corona discharge in gas flow, an electrostatic probe for determining particle characteristics in disperse flow, and an experimental study of the condensation of vapor-air jets. Papers are also presented on the numerical modeling of two-phase isobaric jets with homogeneous and heterogeneous condensation, effect of surfactants on condensation in vapor-air jets, and a study of the pulsed electrical field near the jet of a turbojet engine. (For individual items see A93-10177 to A93-10184) V.L.

A93-10178
AN ELECTROSTATIC PROBE FOR DETERMINING PARTICLE CHARACTERISTICS IN DISPERSE FLOW [ELEKTROSTATICHESKII ZOND DLIA OPREDELENIIA KHARAKTERISTIK CHASTITS V DISPERSNOM POTOKE]

A. B. VATAZHIN and A. M. RUSHAILO /in Turbulent jet flows with condensation and electrophysical effects Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 22-47. In Russian. refs
 Copyright

The theory of a shielded electrostatic probe with a dielectric coating on the sensitive element is examined, and computational formulas are presented for processing the measurement results. Requirements for a cylindrical electrostatic probe are formulated. It is demonstrated that probe measurements can be used to monitor the internal condition of gas turbine engines during bench testing. The design of a through-flow probe is described, and results of an experimental study of particle distribution in a swirling gasdynamic flow are reported. V.L.

A93-10180
EXPERIMENTAL STUDY OF CONDENSATION VAPOR-AIR JETS [EKSPERIMENTAL'NYE ISSLEDOVANIIA KONDENSATSIONNYKH PAROVOZDUSHNYKH STRUI]

A. B. VATAZHIN, V. A. LIKHTER, and V. I. SHUL'GIN /in Turbulent jet flows with condensation and electrophysical effects Moscow Tsentral'nyi Institut Aviatsionnogo Motorostroeniia 1991 p. 63-82. In Russian. refs
 Copyright

The characteristics of vapor condensation in jet flows are examined. An experimental setup for studying vapor jets and methods for measuring their disperse characteristics is described.

Experimental results are presented concerning the position of the condensation region within a vapor jet as well as changes of the jet temperature and Sauter mean diameter along its axis. V.L.

A93-10273
MULTIDISCIPLINARY DESIGN OF COMPOSITE AIRCRAFT STRUCTURES BY LAGRANGE

H. A. ESCHENAUER, G. SCHUHMACHER (Siegen Univ.-Gesamthochschule, Germany), and W. HARTZHEIM (MBB GmbH, Munich, Germany) Computers & Structures (ISSN 0045-7949) vol. 44, no. 4 Aug. 3, 1992 p. 877-893. refs
 Copyright

This paper deals with the application of a structural optimization method in order to find optimal layouts of fiber composite structures in aircraft construction. The goal of the optimization process is to minimize the structural weight and, simultaneously, to fulfill multidisciplinary constraints concerning failure criteria, stability requirements, dynamic responses, aeroelastic efficiencies and flutter speeds. Considering these requirements, the optimal values for the layer thicknesses and the fiber orientations of composite structures must be determined. This problem can be efficiently solved by structural optimization methods. The model formulation structural optimization will be described in general as well as the special optimization model and the structural and sensitivity analysis for fiber composite structures. An application example demonstrates the performance of the whole procedure. This example shows that the structural optimization method is very useful in increasing the efficiency of the design process as well as the quality and performance of aircraft structures. Author

A93-10275* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

OPTIMAL CONTROL OF LIFT/DRAG RATIOS ON A ROTATING CYLINDER

YUH-ROUNG OU (ICASE; NASA, Langley Research Center, Hampton, VA) and JOHN A. BURNS (Virginia Polytechnic Inst. and State Univ., Blacksburg) Applied Mathematics Letters (ISSN 0893-9659) vol. 5, no. 3 May 1992 p. 57-62. refs
 (Contract NAS1-18605; AF-AFOSR-89-0079; AF-AFOSR-89-0001)
 Copyright

We present the numerical solution to a problem of maximizing the lift to drag ratio by rotating a circular cylinder in a two-dimensional viscous incompressible flow. This problem is viewed as a test case for the newly developing theoretical and computational methods for control of fluid dynamic systems. We show that the time averaged lift to drag ratio for a fixed finite-time interval achieves its maximum value at an optimal rotation rate that depends on the time interval. Author

A93-10667
ITERATIVE TEMPERATURE CALCULATION METHOD FOR RECTANGULAR SANDWICH PANEL FINNS

KATSUHIKO NAKAJIMA (NTT, Radio Communication Systems Labs., Yokosuka, Japan) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 6, no. 4 Oct.-Dec. 1992 p. 693-699. refs
 Copyright

An iterative calculation method is developed for the steady-state temperature distribution in a two-dimensional rectangular sandwich panel fin heated within a rectangular footprint region, and dissipating energy to its environments as linearized radiation. This method enables the temperature of each panel skin to be individually calculated by controlling mean skin temperatures under an energy balance constraint. The formulations derived approximate the typical satellite application in which a heat-generating electronic component is mounted on an equipment panel, such as an aluminum honeycomb sandwich panel. Comparison of numerical results obtained from the proposed method, and lumped nodal network analysis, shows that the proposed method will be useful for the evaluation of sandwich panel radiation fins in trade studies where geometrical configuration, heat loads, thermal properties, and environmental parameters change frequently. Author

A93-10780

**CURRENT DEVELOPMENTS IN STRUCTURAL TECHNOLOGY
[AKTUELLE ENTWICKLUNGEN IN DER STRUKTURTECHNIK]**

F. J. ARENDTS (Stuttgart Univ., Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 16, no. 4 Aug. 1992 p. 231-246. In German. refs
Copyright

Current developments in materials, structural techniques, manufacturing methods, and construction procedures are described. Developments in both metallic and fiber composite materials and structures are addressed along with high-temperature materials. An introduction is given to the new thematic in multifunctional materials and modes of construction. Finally, multidisciplinary optimization and requirements for its application are addressed. C.D.

A93-10918* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE EFFECTS OF CRUSHING SURFACE ROUGHNESS ON THE CRUSHING CHARACTERISTICS OF COMPOSITE TUBES

GARY L. FARLEY (U.S. Army, Aerostructures Directorate; NASA, Langley Research Center, Hampton, VA), RICHARD L. WOLTERMAN, and JOHN M. KENNEDY (Clemson Univ., SC) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 3 July 1992 p. 53-60. refs
Copyright

The effects of crushing-surface roughness on the energy-absorption capability of graphite and glass-epoxy composite tubes were investigated. Fifty different combinations of fiber, matrix, and specimen ply orientation were evaluated. Two different crushing surface roughnesses were used in this investigation. Crushing surface significantly influences the energy-absorption capability only of tubes that crush in the lamina bending crushing mode; tubes that crush in other modes are not influenced because their lamina bundles do not slide against the crushing surface. Those tubes that crush in the lamina bending mode can achieve higher, lower, or no change in energy-absorption capability as crushing surface roughness increases. If the fiber failure strain of tubes that crush in the lamina bending crushing mode exceeds the matrix failure strain then the energy-absorption capability increases as crushing surface roughness increases. However, if the matrix failure strain exceeds the fiber failure strain then the energy-absorption capability increases as crushing surface roughness decreases. Energy-absorption capability is uninfluenced by crushing surface roughness for tubes that have equal fiber and matrix failure strains. Author

A93-10960

OPTICAL INTERCONNECTION AND PACKAGING TECHNOLOGIES FOR ADVANCED AVIONICS SYSTEMS

J. E. SCHROEDER, N. L. CHRISTIAN, and B. COTTI (Harris Corp., Government Aerospace Systems Div., Melbourne, FL) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985) vol. 7, no. 9 Sept. 1992 p. 5-9. Research supported by USAF
Copyright

An optical backplane developed to demonstrate the advantages of high-performance optical interconnections and supporting technologies and designed to be compatible with standard avionics racks is described. The hardware demonstrates the three basic components of optical interconnects: optical sources, an optical signal distribution network, and optical receivers. Results from characterization and environmental tests, including a demonstration of the reliable transmission of serial data at a 1 Gb/s, are reported. I.E.

A93-10963

A LARGE FLAT PANEL MULTIFUNCTION DISPLAY FOR MILITARY AND SPACE APPLICATIONS

JAMES S. PRUITT (Rockwell International Corp., Cedar Rapids, IA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985) vol. 7, no. 9 Sept. 1992 p. 30-35.
Copyright

A flat panel multifunction display (MFD) that offers the size and reliability benefits of liquid crystal display technology while achieving near-CRT display quality is presented. Display generation algorithms that provide exceptional display quality are being implemented in custom VLSI components to minimize MFD size. A high-performance processor converts user-specified display lists to graphics commands used by these components, resulting in high-speed updates of two-dimensional and three-dimensional images. The MFD uses the MIL-STD-1553B data bus for compatibility with virtually all avionics systems. The MFD can generate displays directly from display lists received from the MIL-STD-1553B bus. Complex formats can be stored in the MFD and displayed using parameters from the data bus. The MFD also accepts direct video input and performs special processing on this input to enhance image quality. I.E.

A93-10971

OPTIMIZED/ADAPTED FINITE ELEMENTS FOR STRUCTURAL SHAPE OPTIMIZATION

SRINIVAS KODIYALAM (GE Solid Mechanics Lab., Schenectady, NY) and V. N. PARTHASARATHY (General Electric Consulting Services, Albany, NY) Finite Elements in Analysis and Design (ISSN 0168-874X) vol. 12, no. 1 Sept. 1992 p. 1-11. refs
Copyright

A methodology for geometry-based structural shape optimization with adaptive meshing is developed. This method uses a two-level optimization problem where the first level is focussed on generation of good-quality finite elements/meshes and the second level deals with optimization of the overall structural shape based on responses computed on the adapted mesh. The first-level optimization problem uses the finite element nodal coordinates as design variables whereas the second-level problem uses design-oriented, geometry-based parameters for modifying the structural shape. An error indicator, based on effective stress variations in an element, is used to refine the finite element mesh. It is seen from initial investigation that, with mesh adaptation, the accuracy of the structural responses (displacements and stresses) are increased, resulting in a more accurate evaluation of the design objective and constraints, and therefore resulting in more conservative designs. Author

A93-10996

LESSONS LEARNED DURING TESTING OF THE ENHANCED POSITION LOCATION REPORTING SYSTEM (EPLRS)

MARK E. BROWN (Hughes Aircraft Co., Los Angeles, CA) and RAYMOND S. RESKA (Mitre Corp., Bedford, MA) In IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 147-151.
Copyright

EPLRS is a network of ultrahigh frequency radios managed by a control station. The small, lightweight radio sets can be carried on a soldier's back, mounted on a combat vehicle, or installed in aircraft. The control station providing network management functions is housed in a standard military S-280 shelter. The authors present some of the many lessons learned during the EPLRS testing. I.E.

A93-11206

DIGITAL MAP DISPLAY TECHNOLOGY

ICHIZO KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 464 1992 p. 496-499. In Japanese. refs

The advantages of using the digital map system (DMS) for aircraft are presented. The structure of the DMS consists of the mass storage unit (MSU), the control display unit (CDU), and the digital map generator (DMG). The man-machine interface system is discussed. Y.P.Q.

A93-11341

COKING CHARACTERISTICS OF POLYPHENYL ETHER LUBRICANTS USING A STATIC COKER AND A MICRO CARBON RESIDUE TESTER

RITA J. BYRD, COSTANDY S. SABA, and HOOVER A. SMITH (Dayton Univ., OH) *STLE Tribology Transactions* (ISSN 0569-8197) vol. 35, no. 4 Oct. 1992 p. 667-672. refs (Contract F33615-88-C-2517) Copyright

The coking characteristics of polyphenyl ether fluids were studied using the AFAPL Static Coker and the Micro Carbon Residue Tester. Test parameters were varied, and the effects of sample size, temperature, time, and test surface material on the amount and type of deposit formed were determined. The effects of oxidative degradation of the fluids and the presence of wear debris and antioxidants were also determined. Several used lubricants were obtained to identify differences in coking tendencies between the new and used polyphenyl ether lubricants. Deposit morphology, melting point, and solubility were determined to provide information about the types of deposit formed. Author

A93-11346**ON THE FATIGUE LIFE OF M50 NiL ROLLING BEARINGS**

T. A. HARRIS (Pennsylvania State Univ., University Park), JOHN SKILLER (SKF Engineering and Research Centre, Nieuwegein, Netherlands), and RONALD F. SPITZER (MRC Bearings, Jamestown, NY) *STLE Tribology Transactions* (ISSN 0569-8197) vol. 35, no. 4 Oct. 1992 p. 731-737. refs Copyright

The fatigue life of rolling bearings made of M50 NiL (a nickel-low carbon variant of M50 tool steel) was investigated using data from a battery of 15 R2 endurance test rigs specially modified to accommodate the aircraft application test conditions. Results indicate that bearings manufactured from case-hardened M50 NiL steel can provide significantly greater rolling contact fatigue life than bearings made from through-hardened M50 steel. In addition, it was found that M50 NiL bearings endurance-tested under conditions of heavy tensile hoop stresses showed no tendency toward raceway spalling or cracking through, unlike M50 bearings, which exhibited both tendencies. I.S.

A93-11682**GETTING IT TOGETHER**

PETER BARRON (Huck Aerospace Fastener Div., Carson, CA) *Aerospace Materials* (ISSN 0967-4373) vol. 4, no. 3 Aug. 1992 p. 19, 21. Copyright

In response to the exacting weight and strength requirements for composite material fastening on the EFA a new all-titanium blind fastener has been developed. The Ti-Matic Blind-Bolt combines the desirable strength to weight properties of titanium with other composite-friendly features to produce a light, versatile product, replacing many existing fastener types and offering considerable weight savings. R.E.P.

A93-11810**ANALYSIS OF STRUCTURAL DYNAMIC RESPONSE FOR AIRCRAFT OPERATING IN THE ENVIRONMENT OF NUCLEAR EXPLOSION SHOCK WAVES**

SEN-LIN ZHANG *Acta Aeronautica et Astronautica Sinica* (ISSN 1000-6893) vol. 13, no. 9 Sept. 1992 p. A510-A515. In Chinese. refs

This paper focuses on the analysis of the problems relating to the dynamic response of the aircraft structure in nuclear explosion shock waves. Fundamental dynamic equations are derived, and methods for computing the unsteady aerodynamic load in the nuclear explosion shock waves described. Processes for analyzing and computing the structural dynamic response are given, methods for estimating the total structural safety boundary values for aircraft in the nuclear explosion shock waves presented, and existing problems discussed with the aim of providing references for aircraft already used or designed to carry nuclear weapons. Author

A93-12098**SUBHARMONIC BIFURCATION ANALYSIS OF WING WITH STORE FLUTTER**

YI-REN YANG and LING-CHENG ZHAO (Northwestern

Polytechnical Univ., Xian, China) *Journal of Sound and Vibration* (ISSN 0022-460X) vol. 157, no. 3 Sept. 22, 1992 p. 477-484. refs

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An approximate method is developed to analyze the subharmonic bifurcation of a wing with a store aeroelastic system, of which the junction stiffness is piecewise linear. The key point is to treat the store as a forced oscillator under harmonic excitation exerted through the junction from the wing in limit cycle flutter states. Then the criteria with respect to excitation frequency can be applied to predict subharmonic bifurcation. Both numerical integration and wind tunnel tests show that the approximate approach is feasible. Author

A93-12151**COMPUTATIONAL NONLINEAR MECHANICS IN AEROSPACE ENGINEERING**

SATYA N. ATLURI, ED. (Georgia Inst. of Technology, Atlanta) Washington American Institute of Aeronautics and Astronautics, Inc. (Progress in Astronautics and Aeronautics. Vol. 146) (ISSN 0079-6050) 1992 571 p. (ISBN 1-56347-044-6) Copyright

The present volume discusses simplified computational methods for elastic and elastoplastic fracture problems, the field-boundary element method for nonlinear solid mechanics, nonlinear problems of aeroelasticity, FEM simulation of compressible flows with shocks, a fast projection algorithm for unstructured meshes, and the control of numerical diffusion in computational modeling of vortex flows. Also discussed are stochastic computational mechanics for aerospace structures, boundary integral equation methods for aerodynamics, the theory and implementation of high-order adaptive 'hp' methods for analysis of incompressible viscous flows, the probabilistic evaluation of uncertainties and risks in aerospace components, FEM computation of incompressible flows, the dynamic response of rapidly heated space structures, the computation of viscous compressible flows using an upwind algorithm and unstructured meshes, and nonlinear aeroelasticity and chaos. (For individual items see A93-12152 to A93-12165) O.C.

A93-12153**NONLINEAR PROBLEMS OF AEROELASTICITY**

JOHN DUGUNDJI (MIT, Cambridge, MA) *In Computational nonlinear mechanics in aerospace engineering* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 127-155. refs Copyright

The presently treated nonlinear problems of aeroelasticity arise from both geometric and aerodynamic nonlinearities, and are characterized by the possibility of multiple solutions, chaos, and instabilities that often settle down to steady-state limit cycles. Structurally, nonlinearities can arise both geometrically and due to material nonlinearity that leads to nonlinear stiffness characteristics and hysteresis loops; from aerodynamics, nonlinearities are generated by high angles of attack and from bluff bodies, as well as from the transonic speed regime. O.C.

A93-12157**STOCHASTIC COMPUTATIONAL MECHANICS FOR AEROSPACE STRUCTURES**

W. K. LIU, T. BELYTSCHKO (Northwestern Univ., Evanston, IL), and Y. J. LUA (Applied Research Associates, Inc., Raleigh, NC) *In Computational nonlinear mechanics in aerospace engineering* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 245-278. refs Copyright

Stochastic computational mechanics is a methodology that furnishes a basis for the reliability/risk analysis of structures, mechanical components, and systems. Probabilistic FEM is presently outlined for both linear and nonlinear problems; time-invariant random material properties, geometric properties, and loads are all incorporated in terms of their fundamental statistics via second moments. On the basis of a second-order perturbation

approach, the random system equations are approximated by a set of identical deterministic system equations with an effective load that is dependent on the solution of all the lower-order equations. Attention is given to the application of computational reliability methods for brittle fracture and fatigue. A constrained optimization method for calculating the reliability index is formulated. O.C.

A93-12165

NONLINEAR AEROELASTICITY AND CHAOS

LAWRENCE N. VIRGIN and EARL H. DOWELL (Duke Univ., Durham, NC) *In* Computational nonlinear mechanics in aerospace engineering Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 531-546. refs

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An account is given of some of the possible dynamic responses observed during numerical simulation of the classical aeroelasticity problem in panel flutter, which is simplified in order to qualitatively highlight significant dynamical behaviors. These responses can be qualified in terms of time series, phase portraits, Poincare maps, autocorrelation functions, and power spectra. The types of behavior presently treated occur in numerous branches of science and engineering where nonlinearities arise in a system; they can be expected to become more prevalent as even the most deterministic aerospace systems are forced to operate in increasingly adverse environments. O.C.

A93-12229

AN EVALUATION SYSTEM FOR IMPACT DAMAGE AND EROSION OF CERAMIC GAS TURBINE COMPONENTS

SEIICHI HAMADA and TETSUO TERAMAE (Tokyo Electric Power Co., Engineering Research Center, Chofu, Japan) Japan Society of Materials Science, Journal (ISSN 0514-5163) vol. 41, no. 467 Aug. 1992 p. 1273-1278. In Japanese. refs

Copyright

A computational method has been developed in order to analyze the impact damage and erosion of ceramic gas turbine components in a gas flow mixed with solid particles. Blade-row flow analysis is supplemented by boundary layer calculations, particle trajectory analysis, and particle erosion analysis. The method's validity was verified by means of numerical simulations of spherical particle impact tests on ceramic plates. An empirical equation derived from elevated temperature erosion tests was implemented for blade-erosion analyses relevant to industrial gas turbines employing advanced fuels. O.C.

A93-12332

LIFTING FORCES ACTING ON MAGNETS PLACED ABOVE A SUPERCONDUCTING PLANE

Z. J. YANG (Tokyo Univ., Japan; Oslo Univ., Norway) Journal of Superconductivity (ISSN 0896-1107) vol. 5, no. 3 June 1992 p. 259-271. refs

Copyright

Based on the London model, we have calculated the lifting forces acting on permanent magnets placed above an infinite superconducting plane. The theory has also been applied to obtain theoretical estimates of the forces acting on the semispherical and conical-shaped tips of a magnetic force microscope over a high-Tc superconductor. Author

A93-12460

DRAG AND DRAG PARTITION ON ROUGH SURFACES

M. R. RAUPACH (CSIRO, Centre for Environmental Mechanics, Canberra, Australia) Boundary-Layer Meteorology (ISSN 0006-8314) vol. 60, no. 4 Sept. 1992 p. 375-395. refs

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An analytic treatment of drag and drag partition on rough surfaces is given. The aims are to provide simple predictive expressions for practical applications, and to rationalize existing laboratory and atmospheric data into a single framework. Using dimensional analysis and two physical hypotheses, theoretical predictions are developed for total stress (described by the square root of the canopy drag coefficient), stress partition (described by

the ratio $\tau(S)\tau$ of the stress $\tau(S)$ on the underlying ground surface to total stress τ), zero-plane displacement and roughness length. The stress partition prediction is the simple equation $\tau(S)\tau = 1/(1 + \beta(\lambda))$, where $\beta = CR/CS$ is the ratio of element and surface drag coefficients. This prediction agrees very well with data and is free of adjustable constants. Other predictions also agree well with a range of laboratory and atmospheric data. Author

A93-12784

VAPORIZER PERFORMANCE

C. H. LIU, B. M. PEREZ-ORTIZ, and J. H. WHITELAW (Imperial College of Science, Technology, and Medicine, London, United Kingdom) Institution of Mechanical Engineers, Proceedings, Part C - Journal of Mechanical Engineering Science (ISSN 0954-4062) vol. 206, no. C4 1992 p. 265-273. Research supported by Rolls-Royce, PLC refs

Copyright

This paper examines the nature of the flow leaving a vaporizer, its dependence on the flowrates of air and kerosene fuel, the inlet air temperature, and the possible consequences for the performance of a combustor fueled by the vaporizer. A phase Doppler velocimeter was used to examine the distribution of droplet diameters, velocities of the droplets, and the liquid-fuel flux at the exit. Measurements are also reported which show the nature of the two-phase flow away from the vaporizer exits and in important regions within a combustor corresponding to a one-sixth annular sector of a reverse-flow arrangement. The distribution of droplets within the combustor was observed and photographs of the combusting flow are presented. C.D.

A93-12800

NONLINEAR DEFORMATION MECHANICS OF MULTILAYER TRANSPARENCY ELEMENTS - GENERAL THEORY RELATIONS [NELINEINAI MEKHANIKA DEFORMIROVANIIA MNOGOSLOINYKH ELEMENTOV OSTEKLENI - SOOTNOSHENIIA OBSHCHEI TEORII]

A. I. KALASHNIKOV, V. N. PAIMUSHIN, and V. A. FIRSOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 3-6. In Russian. refs

Copyright

A resolvent system of equations of the noncoupled thermoelasticity problem is obtained for multilayer shells of varying thickness which are used as a computational model for a wide range of aircraft transparency elements. The system of resolvent equations is derived in the context of a discrete structural model of the deformation mechanics of layered media for physically and geometrically nonlinear deformation problems. V.L.

A93-12809

EFFECT OF THE PROXIMITY OF THE MACHINED SURFACE ON THE DISCHARGE COEFFICIENTS OF LASER CUTTER NOZZLES [VLIANIE BLIZOSTI OBRABATYVAEMOI POVERKHNOSTI NA KOEFFITSIENTY RASKHODA SOPLOVYKH USTROITV LAZERNYKH REZAKOV]

F. K. SMORODIN and G. V. ABALAKOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 1 1992 p. 41-45. In Russian. refs

Copyright

Results of an experimental study of the discharge coefficients of laser cutter nozzles are reported. It is found that the discharge coefficient of laser cutter nozzles is largely determined by the proximity of the machined surface, Reynolds number, and geometry of the nozzle flow path. V.L.

A93-12922

NONSTATIONARY FLOW OF A VISCOUS INCOMPRESSIBLE FLUID PAST AN AIRFOIL [NESTATSIONARNOE OTEKANIE PROFILIA POTOKOM VIAZKOI NESZHIMAEMOI ZHIDKOSTI]

M. N. ZAKHARENKO (Tsentral'nyi Aerogidrodinamicheskii Inst., Zhukovskii, Russia) Gidromekhanika (ISSN 0367-4088) no. 64 1991 p. 63-66. In Russian. refs

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The difficulties involved in the calculation of separated flow

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past airfoils are examined with particular reference to separated flow of a viscous incompressible fluid past a 12-percent Joukowski profile at Reynolds numbers of $10 \exp 3$ and $10 \exp 4$ and angles of attack of 15 and 5 degrees, respectively. The examples considered here illustrate the possibilities of computational aerodynamics in the study of vortex flows, formation of coherent structures, and flow separation. V.L.

A93-13343*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INFRARED FLOW VISUALIZATION OF V/STOL AIRCRAFT

LARRY D. BIRCKELBAW (NASA, Ames Research Center, Moffett Field, CA) and EDWARD L. NELSON (Virginia Polytechnic Inst. and State Univ., Blacksburg) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4253) Copyright

During low altitude operations of vertical/short takeoff and landing (V/STOVL) aircraft complex aeropropulsive flowfields are produced by the strong interactions between the engine exhaust jet or propeller wash and the runway and aircraft surfaces. Measurement of these unsteady 3 dimensional flowfields has not proven practical with conventional measurement techniques. It has been demonstrated that modern infrared imaging systems provide a practical means of obtaining flow visualization images of these complex aeropropulsive flowfields. Infrared images obtained with a dual wavelength scanning system are presented which provide detailed information on the flowfields about the NASA Ames XV-15 tiltrotor aircraft, the E-7 STOVL research model and the NASA Ames YAV-8B Harrier aircraft. It was found that the use of a dual wavelength infrared system provides valuable information about both the engine exhaust flowfield and the resulting heating of aircraft and runway surfaces. Author

A93-13362*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GROUND VORTEX FORMATION FOR UNIFORM AND NONUNIFORM JETS IMPINGING ON A GROUND PLANE

JOHN M. KUHLMAN and WILLIAM M. CAVAGE (West Virginia Univ., Morgantown) Aug. 1992 12 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (Contract NAG1-1245)

(AIAA PAPER 92-4251) Copyright

An experimental investigation of the impingement of a single circular jet on a ground plane in a cross flow is presented. This geometry is a simplified model of the interaction of propulsive jet exhaust from a V/STOL aircraft with the ground in forward flight. Variation of observed ground vortex size with cross flow-to-jet velocity ratio is consistent with previous observations. R.E.P.

A93-13403

THE MILITARY OPERATOR'S EXPERIENCE OF RELIABILITY AND MAINTAINABILITY CHARACTERISTICS

R. MCC. JONES (Ministry of Defence Logistic Executive, Andover, United Kingdom) *In* Rotorcraft reliability and maintainability: Future design requirements; Proceedings of the Conference, London, United Kingdom, Mar. 20, 1991 London Royal Aeronautical Society 1991 p. 2.1-2.6.

Copyright

An account is given of the British Army's approach to the achievement of high reliability and maintainability in rotorcraft during the procurement process. Attention is given to experience accumulated to date with the Gazelle, Scout, Agusta A109A, and Lynx helicopters; these offer lessons with respect to the Gem engine, fuel filtering, vibration, and an aircraft flight control system. O.C.

A93-13435* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SHEDDING NEW LIGHT ON GAS DYNAMICS

ROBERT L. MCKENZIE (NASA, Ames Research Center, Moffett Field, CA), RONALD K. HANSON (Stanford Univ., CA), and ALAN C. ECKBRETH (United Technologies Research Center, East

Hartford, CT) Aerospace America (ISSN 0740-722X) vol. 30, no. 11 Nov. 1992 p. 20-24.

Copyright

Modern laser-spectroscopic techniques usually incorporate one or more laser beams and depend on their radiative interaction with some spectroscopic feature of the gas. Attention is given to laser absorption, laser-induced fluorescence, Rayleigh scattering, and Raman scattering. Consideration is given to UV Rayleigh scattering applied to aerodynamic flows to obtain images of a supersonic boundary layer that show instantaneous turbulent structures at a level of detail not achieved by any other practical method. R.E.P.

A93-13437

PROBING QUESTIONS FOR AERODYNAMIC TESTING

JAMES P. CROWDER (Boeing Commercial Airplanes Group, Seattle, WA) and RICHARD S. CROOKS (General Dynamics Corp., San Diego, CA) Aerospace America (ISSN 0740-722X) vol. 30, no. 11 Nov. 1992 p. 30-33.

Copyright

Flow field and surface probe measurements offer important aeronautical applications, especially for aircraft testing. Attention is given to several recent advances that promise new aerodynamic measurement opportunities and increased testing productivity. Consideration is given to pressure distribution mapping, boundary layer transition detection, IR camera imaging, interferometric skin friction measurements, and advanced flow field survey techniques. R.E.P.

A93-13447

ELECTRONICS SHOW THEIR AGE

ALAN S. BROWN Aerospace America (ISSN 0740-722X) vol. 30, no. 10 Oct. 1992 p. 22-25, 42, 43.

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The paper examines the prevention and prediction of failures in avionics systems caused by persistent corrosion and vibration. Preventive maintenance of redundant avionics elements and subsystems is discussed in terms of corrosion initiated by water intrusion. Measures developed to mitigate electromagnetic interference can lead to corrosion such as the introduction of Al flakes into rubber gaskets. Hermetic seals are shown to be good for corrosion prevention under certain conditions, and the limitations of glues and rubbery organics are listed. Solder joints in avionics are shown to be vulnerable to accumulated vibration and shock, and techniques for force and temperature isolation can be used to extend the life of avionics. Simulations are described of flight vibration and shock demonstrating that resonance is a more serious problem than direct coupling, and vibration can also hasten the onset of overloads. C.C.S.

A93-13626

AERONAUTICAL FATIGUE: KEY TO SAFETY AND STRUCTURAL INTEGRITY; PROCEEDINGS OF THE 16TH ICAF SYMPOSIUM, TOKYO, JAPAN, MAY 22-24, 1991

AKIRA KOBAYASHI, ED. (Tokyo Univ., Japan) Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 490 p.

(ISBN 4-9900181-1-7) Copyright

The present conference on aeronautical fatigue examines its relationship to safety and structural integrity and encompasses multisite damage, aging aircraft, aluminum-lithium alloys, and composite materials. Specific issues addressed include an assessment of the C-141's structural life, fleet fatigue crack prediction, damage-tolerance analyses for several types of aircraft, rotor and gearbox fatigue, and general remarks on the maintenance of safety for an aging fleet of aircraft. Also addressed are the fatigue qualification of high-thickness composite rotor components, analyses of fatigue life for carbon-epoxy composites, a damage-tolerant Al-Li alloy 8090 sheet, the role of fatigue testing in aircraft design, development, and certification, and the effects of prior damage on crack propagation in Al alloys. (For individual items see A93-13627 to A93-13646) C.C.S.

A93-13638

ANALYSIS OF MULTIPLE CRACK PROPAGATION IN STIFFENED SHEET

H.-P. LEHRKE and A. SCHOEPEL (Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt, Germany) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 255-276. refs
Copyright

A model for crack growth prediction in stiffened sheets and joints with multiple cracks is presented. To determine the stress intensity factors, interactions between cracks, load redistribution, and influences of holes on cracks are considered. Limitations of the model are briefly discussed. The applicability of the model is demonstrated on configurations available in the literature and results are compared with data from crack growth experiments.

Author

A93-13639

BULGING OF FATIGUE CRACKS IN A PRESSURIZED AIRCRAFT FUSELAGE

D. CHEN and J. SCHIJVE (Delft Univ. of Technology, Netherlands) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 277-315. refs
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Empirical and theoretical treatment are given to the bulging of fatigue-crack edges in pressurized aircraft fuselages to obtain data for full-scale fatigue testing. Experimental tests are undertaken to investigate sheet specimens under biaxial loading, curved sheets under tensile loads, and sheet specimens with large radii of curvature that are loaded with internal pressure. The nonlinear behavior of sheet curvature and bulging at the crack edge are studied analytically in terms of K-values, and these results are compared to FEM computations. Crack-edge bulging in pressurized Al-alloy sheet specimens is observed, and unfavorable effects on fatigue-crack propagation are confirmed. Crack-edge bulging is found to be nonlinear, and a biaxial tension field can reduce the bulging deformation. Predictions based on analytical relations are generally supported by the literature on cracks in fuselage structures, although the effect of the longerons should be included for more complete analyses.

C.C.S.

A93-13646

FATIGUE QUALIFICATION OF HIGH THICKNESS COMPOSITE ROTOR COMPONENTS

M. RAGGI, U. MARIANI, and G. ZAFFARONI (Agusta S.p.A., Varese, Italy) *In* Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 Tokyo/Warley, United Kingdom Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd. 1991 p. 453-476. refs
Copyright

Fatigue qualification aspects of composite rotor components are presented according with the safe life procedure usually applied by helicopter manufacturers. Test activities are identified at three levels of specimen complexity: coupon, structural element and full scale component. Particular attention is given to high thickness laminates qualification as far as environmental exposure is concerned. A practical approach for an accelerated conditioning procedure is described. The application to a main rotor tension link is presented showing the negligible effect of the moisture absorption on its fatigue strength.

Author

N93-10052# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.

PERFORMANCE PARAMETERS AND ASSESSMENT

N. C. BAINES and H. CHEN *In* VKI, Radial Turbines 32 p 1992
Copyright Avail: CASI HC A03/MF A04

Some of the basic performance parameters for radial turbines, and the influence which the overall turbine design has on them, are considered. Particular attention is paid to the concept of stage loading, which is a somewhat neglected parameter in radial turbine design. Having established the loading coefficient definition, it is possible to use test data from a range of turbines to fix preliminary values. On this basis a simple one dimensional optimization procedure is derived which uses a minimum of empirical input.

ESA

N93-10056# Holset Engineering Co., Turnbridge (England). AERODYNAMIC INVESTIGATION OF RADIAL TURBINES USING COMPUTATIONAL METHODS

S. T. KITSON *In* VKI, Radial Turbines 45 p 1992
Copyright Avail: CASI HC A03/MF A04

A demonstration of how computational methods can be used to enable a designer to understand the flow phenomenon which takes place inside the machine is presented. Unfortunately the complicated three dimensional viscous programs take a prohibitive length of time to be used for every design iteration. Simpler, less CPU (Central Processor Unit) intensive programs, will continue to be used for some time in design. Therefore in order to assess the tradeoff between various levels of complexity of computational methods an interesting turbine flow is studied. The methods investigated are a simple streamline curvature analysis, a potential flow solver, an Euler code, and a three dimensional time marching viscous technique. In a time and computer limited design environment it is hoped to provide a guide on how to obtain the most CPU effective use of the range of computational methods available. The radial inflow turbine used was analyzed at 2.1:1 expansion ratio with an inlet prerotation set at 15.88 sq m/s. This results in an average of -33 deg of incidence onto the leading edge.

ESA

N93-10058# Ulstein Turbine A/S, Kongsberg (Norway). THE INTEGRATION OF GEOMETRIC MODELING INTO AN INVERSE DESIGN METHOD AND APPLICATION OF A PC-BASED INVERSE DESIGN METHOD AND COMPARISON WITH TEST RESULTS

IVAR HELGE SKOE *In* VKI, Radial Turbines 87 p 1992
Copyright Avail: CASI HC A05/MF A04

An 'engineering' approach to the inverse design problem where both aerodynamic and mechanical criteria are imposed is described. A novel exducer configuration, with slanted trailing edge, evolves during the iterative design procedure based on the introduction of the following: a realistic loss distribution; a prescribed rotor exit spanwise total pressure distribution; and with the imposed geometric restrictions. For a gas generator turbine, 'back to back' traverse results show reduced loss for the novel design as compared with a conventionally designed radial inflow turbine. Through extensive use of Bezier curves for the aerodynamically defined three dimensional geometry, the same 'solid model' is used to prepare the input files for the structural analysis ('meshing' for the finite element method) as well as the geometry definition for production.

ESA

N93-10059# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.

PARTIAL ADMISSION AND UNSTEADY FLOW IN RADIAL TURBINES

N. C. BAINES *In* VKI, Radial Turbines 31 p 1992
Copyright Avail: CASI HC A03/MF A04

The twin problems of partial admission (with stator nozzles and with vaneless stator) and unsteady flow in radial turbines are discussed. The performance of radial turbines is concluded to be significantly influenced by partial admission inlet conditions. Turbines with vane nozzles are suitable for circumferentially divided housings, but suffer significant end of sector and windage losses under partial admission. Housings with a meridional division are more approximate to nozzleless turbines, and the major influence is the interaction between the two streams as they mix upstream of the nozzle. Experiments have shown that the point of maximum efficiency occurs, not at equal admission, but when

the flow is biased towards the shroud side of the turbine. It is believed that this is connected with a strong secondary vortex in the rotor passage near the leading edge, which such a biased inlet flow can help to counter. When the inlet flow is unsteady, but varying at relatively low frequency, the turbine rotor behaves in a quasi steady manner and the working fluid remains in dynamic equilibrium. However, if the turbine housing has significant volume, this acts as a reservoir which introduces a time delay into the system, and makes the unsteady performance of the turbine depart from the steady flow by as much as 10 to 15 percent efficiency.

ESA

N93-10061*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RADIAL TURBINE COOLING

RICHARD J. ROELKE /in VKI, Radial Turbines 38 p 1992
Copyright Avail: CASI HC A03/MF A04

The technology of high temperature cooled radial turbines is reviewed. Aerodynamic performance considerations are described. Heat transfer and structural analysis are addressed, and in doing so the following topics are covered: cooling considerations, hot side convection, coolant side convection, and rotor mechanical analysis. Cooled rotor concepts and fabrication are described, and the following are covered in this context: internally cooled rotor, hot isostatic pressure bonded rotor, laminated rotor, split blade rotor, and the NASA radial turbine program.

ESA

N93-10087*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EVALUATION AND APPLICATION OF THE BALDWIN-LOMAX TURBULENCE MODEL IN TWO-DIMENSIONAL, UNSTEADY, COMPRESSIBLE BOUNDARY LAYERS WITH AND WITHOUT SEPARATION IN ENGINE INLETS

BARBARA SAKOWSKI, DOUGLAS DARLING, ROBERT L. ROACH (Georgia Inst. of Tech., Atlanta.), and ALLAN VANDEWALL (Case Western Reserve Univ., Cleveland, OH.) 1992 11 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; cosponsored by AIAA, SAE, ASME, and ASEE (Contract RTOP 505-62-20) (NASA-TM-105810; E-7241; NAS 1.15:105810) Avail: CASI HC A03/MF A01

There is a practical need to model high speed flows that exist in jet engine inlets. The boundary layers that form in these inlets may be turbulent or laminar and either separated or attached. Also, unsteady supersonic inlets may be subject to frequent changes in operating conditions. Some changes in the operating conditions of the inlets may include varying the inlet geometry, bleeds and bypasses, and rotating or translating the centerbody. In addition, the inlet may be either started or unstarted. Therefore, a CFD code, used to model these inlets, may have to run for several different cases. Also, since the flow conditions through an unsteady inlet may be continually fluctuating, the CFD code which models these flows may have to be run over many time steps. Therefore, it would be beneficial that the code run quickly. Many turbulence models, however, are cumbersome to implement and require a lot of computer time to run, since they add to the number of differential equations to be solved to model a flow. The Baldwin-Lomax turbulence model is a popular model. It is an algebraic, eddy viscosity model. The Baldwin-Lomax model is used in many CFD codes because it is quick and easy to implement. In this paper, we will discuss implementing the Baldwin-Lomax turbulence model for both steady and unsteady compressible flows. In addition, these flows may be either separated or attached. In order to apply this turbulence model to flows which may be subjected to these conditions, certain modifications should be made to the original Baldwin-Lomax model. We will discuss these modifications and determine whether the Baldwin-Lomax model is a viable turbulence model that produces reasonably accurate results for high speed flows that can be found in engine inlets.

Author

N93-10198# Royal Aircraft Establishment, Farnborough (England).

AN EVALUATION OF A METHOD OF RECONSTITUTING FATIGUE LOADING FROM RAINFLOW COUNTING

B. H. E. PERRETT 23 Nov. 1989 49 p
(RAE-TR-89057; BR113381) Copyright Avail: CASI HC A03/MF A01

On-line Rainflow analyses of load histories in structures may be used to reconstitute fatigue load sequences either for cycle-by-cycle damage analysis or for fatigue testing. This report describes work which used Rainflow counting and reversed Rainflow reconstitution to create 'extreme' sequences which have the same Rainflow count as the original sequence but which were intended to maximize and to minimize the rate at which fatigue damage accumulated. Fatigue life and crack propagation tests have been used to compare 'extreme' sequences derived from the two load sequences standards FALSTAFF and MINITWIST. In addition a method has been used which allows the direction of the Rainflow cycles to be reproduced in the reconstituted sequence in order to recreate the highly structured features of the randomized 'extreme' sequences. Increases in fatigue lives by factors of up to five have been measured for the 'extreme' highly structured reconstituted sequences while all of the randomized reconstituted sequences have been shown to produce fatigue lives which are statistically the same as those under the original sequences FALSTAFF and MINITWIST.

Author

N93-10304 Old Dominion Univ., Norfolk, VA. **EFFECT OF PASSIVE FLOW-CONTROL DEVICES ON TURBULENT LOW-SPEED BASE FLOW Ph.D. Thesis**

FARID HEIDARI-MIANDOAB 1991 174 p
Avail: Univ. Microfilms Order No. DA9130677

Some configurations of blunt trailing-edge airfoils are known to have a lower pressure drag compared to sharp trailing-edge airfoils. However, this advantage in addition to the structural advantage of a thick trailing-edge airfoil is offset by its high base drag. At subsonic velocities, this is attributed to the low-pressure base flow dominated by a Karman vortex street. In the limiting case, the steady separated flow over a rearward-facing step is attained if the periodically shed vortices from a blunt trailing-edge are suppressed by the addition of a base splitter-plate. Experimental studies in the Old Dominion University Low-Speed Closed-Circuit Wind Tunnel were conducted to examine the effect of several passive flow-control devices such as Wheeler doublets and wishbone vortex generators, longitudinal surface grooves, base cavities, and serrations on the characteristics of two- and three-dimensional base flows. Flow over flat-plate airfoil and rearward-facing step models was studied in the turbulent incompressible subsonic flow regime. Models with trailing-edge and step-sweep angles of 0, 30, and 45 degrees with respect to the crossflow direction were considered. Constant-temperature hot-wire anemometry, infrared surface thermography, and pitot-static probes were used to conduct flow measurements. The parameters measured included vortex shedding frequency, convective heat-transfer rates, base pressure, and flow reattachment distance. Surveys of mean velocity profiles in the wake were also conducted. Results have shown that most of the flow control devices tested increased the base pressure of the 2-D and 3-D flat-plate airfoils. Use of longitudinal surface grooves resulted in shorter flow reattachment distances and higher convective heat transfer rates downstream of the 2-D rearward-facing steps.

Dissert. Abstr.

N93-10305 Colorado Univ., Boulder. **FORCED UNSTEADY SEPARATED FLOWS ON A 45 DEGREE DELTA WING Ph.D. Thesis**

STEPHEN ALBERT HUYER 1991 192 p
Avail: Univ. Microfilms Order No. DA9132575

A great deal of current research activities has focused on possible exploitation of forced unsteady separated flows to provide enhanced lift and maneuvering characteristics. The formal and intentional utilization of these flows is currently being manifested in the form of the Advanced Tactical Fighter. The wing planform geometry of the ATF and other fighter aircraft is a delta wing.

Under steady conditions, leading edge vortices are formed on each side of a delta wing. These vortices are mostly responsible for the attainment of lift to high angles of attack. Unsteady motion histories will likely alter the characteristics of this vortex as well as its development history. This will then present new difficulties in terms of lift enhancement and control. In order to successfully predict and optimally exploit the flight regimes offered by the ATF, greater understanding of the underlying physical mechanisms responsible for these unsteady flow fields must be obtained. The vortex dominated flow fields produced by an oscillating 45 degree delta wing were examined across a wide range of unsteady motion histories. Still and high speed video photography were employed to document the flow development processes and vortex kinematics. Force balance data recorded the unsteady aerodynamic loading produced. These methods allowed for a thorough qualitative and quantitative examination of the flow fields elicited by a pitching delta wing. The wide range of motion histories employed were found to have a tremendous impact in terms of flow development lift enhancement, drag reduction, and overall aerodynamic performance. Integrations of the data permitted speculation regarding the underlying physical mechanisms responsible for the observed phenomena. Experimental evidence allowed for hypotheses regarding the physical mechanisms of vorticity production, accumulation, convection, and diffusion. Dissert. Abstr.

N93-10309 California Univ., Davis.

IMPROVED NUMERICAL SIMULATION OF EULER EQUATIONS

Ph.D. Thesis

DAVID BRUCKER 1991 161 p

Avail: Univ. Microfilms Order No. DA9125083

Numerical simulation of nonlinear partial differential equations has been viewed as a process by which a discrete solution is sought which satisfies the conservation laws on the discrete level, without requiring that higher order properties of the differential equation are conserved by the discrete system. For example when the two dimensional incompressible Euler equations in conservation form are solved, the discrete solution conserves mass and momentum, but not necessarily vorticity. Standard methods can lead to substantial errors as in the case of a flow over a blunt symmetric body at angle of attack where numerical solution of Euler equations results in substantial lift. In this thesis it is shown that a new algorithm designed to conserve higher order properties, can overcome these shortcomings. The algorithm has been tested for both incompressible and subsonic flows. For irrotational flow, the lift and drag calculated for cylinders and ellipses at angle of attack are zero. Results obtained by this method are superior to any other results available so far. Further study is required to extend the algorithm to three dimensional flows and complex geometries. Dissert. Abstr.

N93-10310# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

A STUDY UPON STRUCTURAL OPTIMIZATION OF ELASTIC ROTORS FOR MECHANICAL SYSTEMS M.S. Thesis [ESTUDO PARA OTIMIZACAO ESTRUTURAL DE ROTORES FLEXIVEIS EM SISTEMAS MECANICOS]

ROGERIO LACOURT RODRIGUES Oct. 1991 129 p In PORTUGUESE

(INPE-5376-TDI/471) Avail: CASI HC A07/MF A02

This work presents a methodology for performing structural optimization of axisymmetric shells. Two kinds of objective functions are treated: the structure mass or a quotient of its mass per inertia moment about the symmetry axis. The constraints deal with the eigenvalue of the fundamental vibration mode, displacements, and stresses at particular points in the structure and also its inertia properties. The structure is analyzed by means of a Finite Element Method, using a three-node axisymmetric shell element. The design variables are defined as shell thicknesses at these element nodes. The problem is included in the category of sizing optimization. The sensitivity analysis is achieved using the direct differentiation method. The non-linear programming problem thus established is solved employing the modified feasible directions method. The results of the application of this technique

in optimizing four different configurations of flywheels for an attitude control system actuator, a reaction wheel, are shown as examples. Author

N93-10367 Rahtikone Oy (Finland).

STEERING SYSTEM OF A VEHICLE, SUCH AS A SNOW REMOVING MACHINE FOR AIRFIELDS Patent

ESKO T. RANTALAHTI, inventor (to Rahtikone Oy) 17 Dec. 1991 9 p

(CA-PATENT-APPL-SN-1293201;

INT-PATENT-CLASS-B62D-5/12; CTN-92-60365) Copyright

Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC/MF

An improved steering system is disclosed for a vehicle comprising a cabin with front wheels, which are steered by a steering wheel, and a rearward portion carrying a drive unit and with driven rear wheels. The rearward portion is journalled about a vertical shaft to the forward portion of the vehicle, and a second separate steering mechanism is provided for steering the rearward portion. The second separate steering mechanism of the rearward portion comprises a control unit whereby it may be synchronized to operate in an opposite turning direction to that of the steering movements of the front wheels. The control unit is adapted to lock the rearward portion in a desired position, so that, for example, the vehicle can be driven diagonally with the side first. The second steering mechanism comprises a separate hydraulic system controlled from the control unit. Sensors are connected for sensing the steering angle of both the steering mechanisms, such that signals from the sensors may cause the steering of the rearward portion to follow the steering of the front wheels. The steering system of the invention is particularly applicable to snow removal machines used on airfields. In such machines, the front and rear wheel shafts are often 10-15 m distant from each other, but the invention enables easy and reliable linkage without the need for heavy shafts. The invention also enables a long snow-removing machine to turn on a very small radius, which speeds up movements and operation when clearing airfields. CISTI

N93-10368 Koa Oil Co. Ltd. (Japan).

AIR CELL Patent Application

OKIYOSHI OKAMURA, inventor (to Koa Oil Co. Ltd.), MASAYUKI WAKASA, inventor (to Koa Oil Co. Ltd.), and YOSHIHITO TAMANOI, inventor (to Koa Oil Co. Ltd.) 24 Apr. 1991 18 p

(CA-PATENT-APPL-SN-2001346;

INT-PATENT-CLASS-H01M-12/00;

INT-PATENT-CLASS-H01M-4/04;

INT-PATENT-CLASS-B29C-41/18; CTN-92-60390) Avail:

Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC/MF

The present invention relates to an air cell. This air cell provides a compact light-weight power source for model aircraft permitting them to fly for an extended period so that they may be used for such practical purposes as crop dusting, surveying, and photographing. The cell is comprised of a current collector so disposed between a magnesium, zinc, or aluminum alloy cathode and a petroleum graphite anode that it is in contact with the anode. The anode is formed by adding polytetrafluoroethylene dispersion liquid in a mixture of active carbon and graphite powder, pouring the mixture into a mold and heating it to form the anode. It is fabricated by a plurality of anode sections and is formed with at least one hole so that it can provide a cell which is compact in size and light in weight yet is capable of generating a high output. The anode, the cathode, and a separator are wetted by an electrolytic liquid. The electrolyte is continuously supplied through the life of the cell. CISTI

N93-10370 Pennsylvania State Univ., University Park.

EXPLICIT NAVIER-STOKES COMPUTATION OF TURBOMACHINERY FLOWS Ph.D. Thesis

ROBERT FRANCIS KUNZ 1991 252 p

Avail: Univ. Microfilms Order No. DA9204236

A new three-dimensional explicit Navier-Stokes procedure has been developed for computation of turbulent turbomachinery flows. Numerical strategies and modelling techniques have been developed and incorporated which enable convergent and accurate predictions of high Reynolds number flowfields across a wide range of Mach numbers. These include incorporation of a compressible low Reynolds number form of the k -epsilon turbulence model in a fully explicit fashion, appropriate stability bound treatment of the transport turbulence model and other physical and solution parameters, eigenvalue and local velocity artificial dissipation scalings, a compact flux evaluation procedure and a hybrid low Reynolds number k -epsilon/algebraic Reynolds stress model. Detailed stability and order of magnitude analyses are performed on the discrete system of seven governing equations. The results of these analyses and corroborative numerical experiments are provided. Conclusions are drawn concerning the influence of system rotation and turbulence transport source terms, grid clustering, effective diffusivity, artificial dissipation, convective acceleration terms, implicit source term treatment and the coupling of the discrete mean flow equation system to the turbulence model equations on the stability of the numerical scheme. Alternative local velocity and flux Jacobian eigenvalue scalings are provided for the dissipation operators. A hybrid k -epsilon/algebraic Reynolds stress model (ARSM) was developed. Two-dimensional results are provided for a supersonic compressor cascade operating at unique incidence condition and a low-subsonic double circular arc compressor cascade. Three-dimensional validation is provided by the results of an incompressible curved duct flow computation. A high Reynolds number axial rotor flow, for which extensive experimental data are also available, was computed. A backswept transonic centrifugal compressor flow, for which L2F meridional passage velocity measurements are available, was computed. Full Navier-Stokes solutions are presented which are shown to capture detailed viscous dominated flow features, including tip clearance and curvature induced and rotation induced secondary motions, with good accuracy. Results of impeller flowfield calculations using the hybrid model with and without the influence of system rotation are also provided and interpreted. Dissert. Abstr.

N93-10372* # Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
SAPNEW: PARALLEL FINITE ELEMENT CODE FOR THIN SHELL STRUCTURES ON THE ALLIANT FX/80
 MANOHAR P. KAMAT and BRIAN C. WATSON Feb. 1992
 40 p
 (Contract NAG3-895)
 (NASA-CR-190663; NAS 1.26:190663) Avail: CASI HC A03/MF A01

The results of a research activity aimed at providing a finite element capability for analyzing turbo-machinery bladed-disk assemblies in a vector/parallel processing environment are summarized. Analysis of aircraft turbofan engines is very computationally intensive. The performance limit of modern day computers with a single processing unit was estimated at 3 billions of floating point operations per second (3 gigaflops). In view of this limit of a sequential unit, performance rates higher than 3 gigaflops can be achieved only through vectorization and/or parallelization as on Alliant FX/80. Accordingly, the efforts of this critically needed research were geared towards developing and evaluating parallel finite element methods for static and vibration analysis. A special purpose code, named with the acronym SAPNEW, performs static and eigen analysis of multi-degree-of-freedom blade models built-up from flat thin shell elements. Author

N93-10472 Old Dominion Univ., Norfolk, VA.
A FINITE ELEMENT METHOD FOR NONLINEAR PANEL FLUTTER
 CHUH MEI and CARL E. GRAY, JR. (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.)
In Carleton Univ., Proceedings of the Twelfth Canadian Congress of Applied Mechanics, Volumes 1 and 2 p 118-119 May 1989

Copyright Avail: Canadian Society for Mechanical Engineering, 2050 Mansfield St., Suite 700, Montreal, Quebec H3A 1Z7 Canada

Panel flutter is the self excited oscillations of a plate in supersonic flow. Linear theory gives no information about the panel's deflections and stresses. Hence, the service life of the panel cannot be predicted by linear methods. Nonlinear structural theory determines the limit cycle oscillating frequency, and also panel deflections and stresses. Panel fatigue life, therefore, can be predicted. For a more thorough understanding of panel flutter behavior, the geometric nonlinearity effects due to large deflections must be considered in the formulation. The Galerkin's method was used in the investigation of limit cycle oscillations of panels in supersonic flow in the spatial domain, and the panel deflections. All nonlinear flutter methods and results presently available were limited to a linear or linearized aerodynamic theory. Extension of the finite element flutter formulation to include nonlinear hypersonic aerodynamic loading and finite element nonlinear panel flutter results are presented. Author (CISTI)

N93-10653# Industry, Science and Technology Canada, Toronto (Ontario).

DEFENCE ELECTRONICS INDUSTRY PROFILE, 1990-1991 [PROFIL DE L'INDUSTRIE ELECTRONIQUE DE DEFENSE, 1990-1991]

1991 22 p In ENGLISH and FRENCH Original contains color illustrations

(CTN-92-60515) Avail: CASI HC A03/MF A01

The defense electronics industry profiled in this review comprises an estimated 150 Canadian companies that develop, manufacture, and repair radio and communications equipment, radars for surveillance and navigation, air traffic control systems, acoustic and infrared sensors, computers for navigation and fire control, signal processors and display units, special-purpose electronic components, and systems engineering and associated software. Canadian defense electronics companies generally serve market niches and end users of their products are limited to the military, government agencies, or commercial airlines. Geographically, the industry is concentrated in Ontario and Quebec, where about 91 percent of the industry's production and employment is found. In 1989, the estimated revenue of the industry was \$2.36 billion, and exports totalled an estimated \$1.4 billion. Strengths and weaknesses of the industry are discussed in terms of such factors as the relatively small size of Canadian companies, the ability of Canadian firms to access research and development opportunities and export markets in the United States, the dependence on foreign-made components, and international competition. CISTI

N93-10874 Concordia Univ., Montreal (Quebec).
CHARACTERISTICS OF SEPARATED FLOWS INCLUDING CAVITATION EFFECTS Ph.D. Thesis

RAMASWAMI BALACHANDAR 1990 204 p
 Avail: Univ. Microfilms Order No. DANN59192

A program of study was performed to obtain the characteristics of two-dimensional separated flows including cavitation effects. The effects of wall interference and cavitation on the characteristics of flow past bluff bodies and backward facing steps were examined. Separated flows so generated can be a major source of flow induced vibration and noise. For non-cavitating flow past sharp-edged bluff bodies, a simplified procedure is developed to determine the effects of wall interference on the drag coefficient. The characteristics related to inception, choking, cavity geometry, and cavity pressure field were determined on the basis of experimental results for cavitating flow past bluff bodies. In this context, models based on theoretical considerations were also developed to determine the inception and choking cavitation characteristics. For sharp-edged bluff bodies, the length of vortex formation region was determined, recognizing it as a significant parameter which precedes the zone where cavitation damage is most probable. Visual observations of the length of formation region supported the view that cavitation stabilizes the vortex against its break-up. The effects of wall interference and cavitation on the

frequency of vortex shedding behind bluff bodies were also determined. The absence of the Karman vortex street was noted for flow past bluff bodies which were subject to very severe wall interference effects. At very large Reynolds numbers, the reattachment of two-dimensional separated shear layers downstream of backward facing steps were investigated. Two backward facing steps were used to study the influence of expansion ratio on incipient cavitation indices at various Reynolds numbers. The frequency of vortex shedding and pressure distribution downstream of separation were obtained for both cavitating and non-cavitating flow conditions. Dissert. Abstr.

N93-10891*# Texas A&M Univ., College Station. Turbomachinery Lab.

COMPRESSIBLE AND INCOMPRESSIBLE FLUID SEALS: INFLUENCE ON ROTORDYNAMIC RESPONSE AND STABILITY

HOWARD D. THAMES 1 Sep. 1992 31 p Sponsored by NASA. Lewis Research Center (Contract RF PROJ. 4502) (NASA-CR-190746; NAS 1.26:190746) Avail: CASI HC A03/MF A01

The flow field inside a whirling annular seal operating a Reynolds numbers of 12,000 and 24,000 and a Taylor number of 6,600 was measured. The rotor was mounted eccentric (50 percent) upon the facilities shaft which resulted in a circular orbit at a whirl ratio of 1.0. Three papers which summarize the work were written and are presented. Additional measurements were performed for the annular seal operating at an eccentricity ratio of 10 percent for $Re = 24,000$ and $Ta = 6,600$. A labyrinth seal was also installed into the facility and operated at an eccentricity ratio of 50 percent at the same Reynolds and Taylor numbers. These data are currently being reduced and analyzed.

N93-10892*# Texas A&M Univ., College Station. Turbomachinery Lab.

EXPERIMENTAL STUDY OF THE FLOW FIELD INSIDE A WHIRLING ANNULAR SEAL

GERALD L. MORRISON, ROBERT E. DEOTTE, JR., and H. DAVIS THAMES, III *In its Compressible and Incompressible Fluid Seals: Influence on Rotordynamic Response and Stability* 11 p 1 Sep. 1992 Presented at the 4th International Symposium on Transport Phenomena and Dynamics in Rotating Machinery, Honolulu, HI, 5-8 Apr. 1992 (Contract NAG3-181) Avail: CASI HC A03/MF A01

The flow field inside a whirling annular seal was measured using a 3-D Laser Doppler Anemometer (LDA) system. The seal investigated has a clearance of 1.27 mm, a length of 37.3 mm, and is mounted on a drive shaft with a 50 percent eccentricity ratio. This results in the rotor whirling at the same speed as the shaft rotation (whirl ratio ≈ 1.0). The seal is operated at Reynolds number of 12,000 and a Taylor number of 6,300 (3,600 rpm). The 3-D LDA system is equipped with a rotary encoding system which is used to produce phase averaged measurements of the entire mean velocity vector field and Reynolds stress tensor field from 0.13 mm upstream to 0.13 mm downstream of the seal. The mean velocity field reveals a highly three dimensional flow field with large radial velocities near the inlet of the seal as well as a recirculation zone on the rotor surface. The location of maximum mean axial velocity migrates from the pressure side of the rotor at the inlet to the suction side at turbulence kinetic energy. However, turbulence production and dissipation attain equilibrium fairly quickly with remaining relatively constant over the last half of the seal. Author

N93-10963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NONDESTRUCTIVE EVALUATION OF CERAMIC AND METAL MATRIX COMPOSITES FOR NASA'S HITEMP AND ENABLING PROPULSION MATERIALS PROGRAMS

EDWARD R. GENERAZIO Aug. 1992 27 p Presented at the 16th Annual Conference on Composites, Materials, and Structures,

Cocoa Beach, FL, 12-15 Jan. 1992

(Contract RTOP 510-01-50) (NASA-TM-105807; E-7238; NAS 1.15:105807) Avail: CASI HC A03/MF A01

In a preliminary study, ultrasonic, x-ray opaque, and fluorescent dye penetrants techniques were used to evaluate and characterize ceramic and metal matrix composites. Techniques are highlighted for identifying porosity, fiber alignment, fiber uniformity, matrix cracks, fiber fractures, unbonds or disbonds between laminae, and fiber-to-matrix bond variations. The nondestructive evaluations (NDE) were performed during processing and after thermomechanical testing. Specific examples are given for Si₃N₄/SiC (SCS-6 fiber), FeCrAlY/Al₂O₃ fibers, Ti-15-3/SiC (SCS-6 fiber) materials, and Si₃N₄/SiC (SCS-6 fiber) actively cooled panel components. Results of this study indicate that the choice of the NDE tools to be used can be optimized to yield a faithful and accurate evaluation of advanced composites. Author

N93-11014# Rolls-Royce Ltd., Derby (England). Materials Analysis Lab.

NEUTRON DIFFRACTION RESIDUAL STRESS STUDIES FOR AERO-ENGINE COMPONENT APPLICATIONS

K. CLAY and C. SMALL 5 Dec. 1991 30 p Presented at the British Crystallographic Association Industrial Group Meeting, Farnborough, England, 7 Nov. 1991 (PNR-90908; ETN-92-92198) Copyright Avail: CASI HC A03/MF A01

Computer graphics for a presentation describing how Rolls-Royce is refining the method of residual stress measurement by neutron diffraction to suit the characteristic stress fields of components are presented. Results to date are given. An outline of how this residual stress data is to be used in developing stress models for critical rotating components is given. ESA

N93-11025# Rolls-Royce Ltd., Derby (England).

THE PREDICTION OF CONVECTIVE HEAT TRANSFER IN ROTATING SQUARE DUCTS

T. BO (Manchester Univ., England), H. IACOVIDES (Manchester Univ., England), and B. E. LAUNDER (Manchester Univ., England) 30 Sep. 1991 7 p Presented at the 8th International Turbulence Shear Flows Symposium, Fed. Republic of Germany, 1 Sep. 1991 Previously announced in IAA as A92-40146 Sponsored by RAE (PNR-90929; ETN-92-92211) Copyright Avail: CASI HC A02/MF A01

A numerical study of developing flow through a heated duct of square cross section rotating in an orthogonal mode is presented. Two different turbulence models were employed. An Effective Viscosity Model (EVM) and an Algebraic Stress Model (ASM). In both cases simplified nearwall models were employed in which the solution of the epsilon transport equation was not carried out. At moderate rotational speeds the EVM heat transfer predictions are found to be in close agreement with existing measurements. At high rotational rates rotational buoyancy effects are shown to become important. EVM predicted heat transfer behavior, while still reasonable, begins to deviate from the experimental one. The ASM model with a simplified nearwall extension was found to be even less appropriate when rotational buoyancy is significant. ESA

N93-11034# Rolls-Royce Ltd., Derby (England).

ON THE BASIS OF EXPERIENCE: BUILT IN PRODUCT RELIABILITY

9 Feb. 1991 17 p Presented at the Reliability and Maintainability Symposium, Orlando, FL, 29-31 Jan. 1991 (PNR-90932; ETN-92-92212) Copyright Avail: CASI HC A03/MF A01

Rolls Royce product reliability is considered based on experience in supporting commercial gas turbine engines and airline customers during the years of its existence. Reliability on return on investment is addressed. The meaning of 'reliability' and 'return on investment' is discussed. ESA

N93-11054# Rolls-Royce Ltd., Derby (England). Manufacturing Engineering Gear Section.

THE APPLICATION OF MANUFACTURING SYSTEMS ENGINEERING FOR AERO ENGINE GEARS

STEPHEN M. S. PEWSEY (Rolls-Royce Ltd., Bristol, England)
31 Oct. 1991 9 p Presented at the Gear Manufacture and Quality Control Seminar, Bristol, England, 31 Oct. 1991
(PNR-90944; ETN-92-92221) Copyright Avail: CASI HC A02/MF A01

The adoption of manufacturing systems engineering principles in order to improve cost effectiveness of manufacturing operations is considered. The introduction of cells where families of parts are made from raw material to finished product using a team approach has been initiated. The benefits to date are significant in terms of lead time reductions, inventory, and nonconformance savings as well as improvements in work force motivation and morale. The overall corporate manufacturing strategy of gears is explained. Some of the problems encountered with the transfer of gear production from one site to another with minimum disruption are described. Some of the radical changes being made in the manufacture of gears in line with the strategy of making Rolls-Royce a total quality organization are also described. ESA

N93-11172*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SYSTEM AND METHOD FOR CANCELLING EXPANSION WAVES IN A WAVE ROTOR Patent Application

DANIEL E. PAXSON, inventor (to NASA) 26 May 1992 17 p
(NASA-CASE-LEW-15218-1; NAS 1.71:LEW-15218-1;
US-PATENT-APPL-SN-889003) Avail: CASI HC A03/MF A01

A wave rotor system that is comprised of a wave rotor coupled to first and second plates is described. Special ports are provided, one in each of the first and second end plates, to cancel expansion waves generated by the release of working fluid from the wave rotor. One of the expansion waves is reflected in the wave rotor from a reflecting portion and provided to the special port in the second end plate. Fluid present at the special port in the second end plate has a stagnation pressure and mass flow which is the same as that of the cells of the wave rotor communicating with such special port. This allows for cancellation of the expansion wave generated by the release of working fluid from the wave rotor. The special port in the second end plate has a first end corresponding to the head of the expansion wave and a second end corresponding to the tail of the expansion wave. Also, the special port is configured to continually change along the circumference of the second end plate to affect expansion wave cancellation. An expansion wave generated by a second release of working fluid from the wave rotor is cancelled in a similar manner to that described above using a special port in the first end plate. The cycle of operation of the wave rotor system is designed so that the stagnation pressure and mass flow of the fluid present at the special ports is the same so that the special ports may be connected by a common duct. NASA

N93-11220 Arizona State Univ., Tempe.
OPTIMAL OUTPUT FEEDBACK VIBRATION CONTROL OF ROTOR-BEARING SYSTEMS Ph.D. Thesis

GUANGWUU WILLIAM FAN 1991 140 p
Avail: Univ. Microfilms Order No. DA9210373

A procedure for the lateral vibration control of general high-order asymmetric discrete rotor-bearing systems is presented. It is found that the complex mode and balanced realization methods can be successively applied to a general linear high-order asymmetric system to obtain a further reduced-order model without loss of model accuracy. However, the balanced realization method, by itself, is not a good choice for such systems. The matrix transformations between the original high-order system and the reduced-order system are derived for the design of the Linear Quadratic Regulator (LQR). An LQR-based least-squares output feedback control procedure is introduced for the LQR control of high-order asymmetric discrete systems, and takes advantage of the fact that an 'almost' LQR control is possible without using an observer. Furthermore, the number of measured states can be

much less than the number of eigenvectors retained in the reduced-order model while acceptable performance and robustness of the controller are still maintained. The simulation result on a 52-degree-of-freedom rotor model shows that the lateral vibration can be effectively reduced by monitoring a single location along the shaft with the control inputs at horizontal and vertical directions at a single location for a certain spin speed. The spill-over problem of the LQR control system is also investigated for both collocated and non-collocated cases based on the same reduced-order model. Furthermore, the discussion of the robustness of the closed-loop control system against system parameters when including the actuator dynamics is also addressed by means of root-locus plots. The application of the well-known Linear Quadratic Gaussian (LQG) and LQG with Loop Transfer Recovery (LQC/LTR) techniques on two typical low-order rotor dynamic systems is discussed so that a comparison with an LQR-based least-squares output feedback controller can be made. Dissert. Abstr.

N93-11325 National Physical Lab., Teddington (England). Div. of Materials Metrology.

THE TECHNICAL BACKGROUND TO STANDARDS FOR SHACKLES

T. A. E. GORLEY and G. T. ANTHONY Mar. 1992 27 p
(Contract HSE-1533) (ISSN 0959-2423)
(NPL-DMM(A)-51; ETN-92-92256) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The technical background to British and international standards for shackles is documented in order to provide a reference for future drafting and revisions of standards. The following are discussed: the stress analysis of shackles, a test program for shackles, the work performed by a working group set up to rationalize the design of cage suspension gear, shackle design formula, the development of International Standards Organization (ISO) standards for shackles, and the development of revised British standards. Under the technical background to the revision of BS3032, the following are considered: marking, material and heat treatment, hardness, mechanical properties, form and dimensions, tolerances, and screw threads. The decisions upon which the revision of the BS3551 were based are described. ESA

N93-11326 National Physical Lab., Teddington (England). Div. of Materials Metrology.

A STUDY OF THE EFFECTS OF TOLERANCES ON RIGGING SCREWS, TURNBUCKLES, AND ASSOCIATED COMPONENTS IN BS4429: 1987

T. A. E. GORLEY Mar. 1992 12 p
(Contract HSE-1533) (ISSN 0959-2423)
(NPL-DMM(A)-53; ETN-92-92257) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The failure modes already examined in a previous paper are reanalyzed to include the worst effects of tolerances. The previous paper, entitled 'the technical background to the revision of BS4429:1969, specification for rigging screws and turnbuckle', should be read in conjunction with this paper. The following are discussed: estimation of stress in the rigging screw body; the failure load at the cross section through the Tommy bar hole in the rigging screw body; thread stripping load in the rigging screw body; failure of the core area of the thread of the rigging screw body; tensile failure of the turnbuckle arms; stripping of the thread in the 'nuts' at the ends of the turnbuckle body; the parting of the arms from the nut in the turnbuckle; failure of the screw threads of the accessories; the maximum stress on the eye of the elongated eye; screwed forks; screwed trapezoidal hooks; and locknuts. It is concluded that effect of tolerances is acceptable but the analysis reinforces the concern regarding the screwed end of the rigging screw body. The screwed end must be fully engaged in use and the manufacturer must take special care that the dimensions of this part of the rigging screw are adequate. A recommendation is made for amending the dimensional criteria for this part of the rigging screw body. ESA

N93-11327 National Physical Lab., Teddington (England). Div. of Materials Metrology.

THE TECHNICAL BACKGROUND TO STANDARDS FOR EYEBOLTS

T. A. E. GORLEY Mar. 1992 41 p
(Contract HSE-1533) (ISSN 0959-2423)
(NPL-DMM(A)-52; ETN-92-92258) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

Background to the drafting of a revised British standard, BS 4278:1984 and new International Organization Standard, ISO 3266, for eyebolts for general lifting processes is detailed. For the British standard, the following are considered: the alignment of the eye and the effects of inclined loads, the strength of eyebolts and the withdrawal of BS 529, mismatch of threads, and material selection. For the international standard, the following are considered: the recessing of the eyebolt into the load, inclined loading, and the joint between the shank and the eyebolt collar. Arguments are based upon experience obtained in using and manufacturing eyebolts to earlier standards. Theory is only used where it was considered necessary to confirm matters. Experience shows that eyebolts made properly in compliance with the standards will be sufficiently strong. A paper on the British test results of nonaxial loading of eyebolts is presented in the appendix. ESA

N93-11358 Civil Aviation Authority, London (England).

UK AIRMISSES INVOLVING COMMERCIAL AIR TRANSPORT, JANUARY-APRIL 1991

1991 33 p
(ISSN 0951-6301)
(ETN-92-92261) Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England

In the introduction the following are briefly discussed: origination of an airmiss; purpose of airmiss reports; investigation of airmiss reports; categorization of airmisses; involvement of commercial air transport aircraft; airmisses related to flying hours. Tabulated statistics of the following are presented: the number of incidents of commercial air transport airmisses; commercial air transport aircraft involved in airmisses; commercial air transport airmisses related to flying hours. Reports on the commercial air transport airmisses from Jan. - Apr. 1991 are presented. These contain summaries of: pilot reports, transcripts of relevant RT frequencies; radar video recordings, and reports from appropriate air traffic control and operating authorities. The working groups discussion is summarized, and the risk and cause assessed. ESA

N93-11383# Royal Signals and Radar Establishment, Malvern (England). Speech Research Unit.

THE DEVELOPMENT OF THE SPEAKER INDEPENDENT ARM CONTINUOUS SPEECH RECOGNITION SYSTEM

M. J. RUSSELL 15 Jan. 1992 30 p
(RSRE-MEMO-4473; BR308890; ETN-92-92316) Copyright
Avail: CASI HC A03/MF A01

The development of a speaker dependent continuous speech recognition system based on phoneme level hidden Markov models is described. The system is part of the Airborne Reconnaissance Mission (ARM) project, that aims at reaching the accurate recognition of continuously spoken airborne reconnaissance reports using a speech recognition system and Markov models. The system is configured to recognize continuously spoken airborne reconnaissance reports, a task which involves a vocabulary of approximately 500 words. On a test set of speech from 80 male subjects, the final system achieves a word accuracy of 74.1 percent with no explicit syntactic constraints. The evolution of the speaker independent ARM system, in terms of the performance of its various versions of the evaluation set, is summarized. Comparison of the final versions of the speaker dependent and speaker independent ARM systems shows that many of the empirically derived parameters are similar on both systems. ESA

N93-11384# Royal Signals and Radar Establishment, Malvern (England). Speech Research Unit.

PRELIMINARY RESULTS ON THE USE OF LINEAR DISCRIMINANT ANALYSIS IN THE ARM CONTINUOUS SPEECH RECOGNITION SYSTEM

S. M. PEELING and K. M. PONTING 16 Dec. 1991 26 p
Sponsored in part by IED
(RSRE-MEMO-4511; BR308899; ETN-92-92318) Copyright
Avail: CASI HC A03/MF A01

Linear discriminant analysis is used to generate speech data transformations. This transformed data is then used within the Airborne Reconnaissance Mission (ARM) continuous speech recognition system. The aim of the ARM project is accurate recognition of continuously spoken airborne reconnaissance reports using a speech recognition system based on phoneme level hidden Markov models. A fuller description of a linear discriminant analysis, which is applied to speaker dependent data in the ARM system, is given. Preliminary results are presented from experiments using transformed data alone and also in conjunction with one, or both, of the word transition penalties and variable frame rate analysis. Speaker dependent results are reported which are significantly better than the best obtained previously. ESA

N93-11385# Royal Signals and Radar Establishment, Malvern (England). Speech Research Unit.

THE USE OF LINEAR DISCRIMINANT ANALYSIS IN THE ARM CONTINUOUS SPEECH RECOGNITION SYSTEM

S. M. PEELING and K. M. PONTING 9 Jan. 1992 31 p
Sponsored in part by IED
(RSRE-MEMO-4512; BR308900; ETN-92-92319) Copyright
Avail: CASI HC A03/MF A01

Linear discriminant analysis is used to generate speech data transformations. This transformed data is then used within the Airborne Reconnaissance Mission (ARM) continuous speech recognition system. The aim of the ARM project is accurate recognition of continuously spoken airborne reconnaissance reports using a speech recognition system based on phoneme level hidden Markov models. A short description of a linear discriminant analysis, which is applied to speaker dependent data in the ARM system, is given. Experiments are described using transformed data in conjunction with variable frame rate analysis and word transition penalties. Speaker independent results are reported which are as good as the best obtained previously using cosine transformations and variable frame rate analysis. The two sets of results are compared. ESA

N93-11416# University of Southern California, Los Angeles. Dept. of Aerospace Engineering.

DYNAMICAL EFFECTS OF SUCTION/HEATING ON TURBULENCE BOUNDARY LAYERS Quarterly Report, 1 Oct. 1991 - 1 Jan. 1992

RON BLACKWELDER 1 Jan. 1992 13 p
(Contract N00014-92-J-1062)
(AD-A248459) Avail: CASI HC A03/MF A01

The main emphasis of this quarter has been to test the effects of suction in a controlled environment with the emulated wall eddy structure. A study of the curved working wall of the test section in the Goertler Wind Tunnel showed that there were sufficient stresses within the plexiglas that cutting elongated slits for suction would probably cause the surface to develop step-type roughnesses. Thus several individual holes were initially drilled along the streamline direction in a spanwise region between two vortices. Air was withdrawn through this series of holes to provide a semi-continuous region of suction. Differing rates of suction through these holes were used to explore the effects upon the eddy structure. These preliminary results were obtained using visualization; i.e., smoke as introduced via a smoke wire into the boundary layer. Images were captured using a video camera and analyzed to determine the best suction rates. The preliminary results showed that suction has a large effect upon individual streaks of low speed fluid. Without the suction, the low speed region lying in the upwelling zone between two streamwise vortices was broken down by a secondary instability. This instability typically

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caused the low speed fluid marked with the smoke to oscillate from side to side in a manifestation of an inflectional instability in the spanwise direction as found and reported earlier in this research. With increasing distance downstream, the oscillation amplitude grew very rapidly until it broke down into complete turbulence. GRA

N93-11460# Federal Aviation Administration, Atlantic City, NJ.
HIGH CAPACITY VOICE RECORDER (HCVR) OPERATIONAL TEST AND EVALUATION (OT/E) INTEGRATION TEST REPORT
WAYNE BELL, ANDY COLON, and EDWARD LIND Oct. 1992 42 p
(DOT/FAA/CT-TN92/30) Avail: CASI HC A03/MF A01

This report describes the Operational Test and Evaluation (OT&E) Integration tests performed by ACW-400A on the High Capacity Voice Recorder (HCVR) equipment. This Commercial Off-The-Shelf (COTS) equipment is being acquired to replace existing 152-channel voice recorders currently in use at Air Route Traffic Control Centers (ARTCC's) and the New York Terminal Radar Approach Control (TRACON) Facility. Tests to verify FAA-P-2878 (Purchase Description) requirements were performed at the Federal Aviation Administration (FAA) Technical Center. Tests to verify NAS-SS-1000, Volume 1, System Level Requirements, and Volume 4, Subsystem Level Requirements were performed at the Seattle ARTCC (the designated key test site). This equipment did not meet all FAA-P-2879 or NASA-SS-1000 requirements, primarily because it is COTS equipment and was not specifically designed to meet FAA requirements. The advantages of this equipment, however, outweigh the disadvantages, in the opinion of ACW-400A. The HCVR equipment is, therefore, recommended for deployment under the conditions cited in this report. Author

N93-11544*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.
RIGID BODY MODE IDENTIFICATION OF THE PAH-2 HELICOPTER USING THE EIGENSYSTEM REALIZATION ALGORITHM
AXEL SCHENK (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany) and RICHARD S. PAPPA Oct. 1992 52 p
(Contract RTOP 590-14-61-01)
(NASA-TM-107690; NAS 1.15:107690; DLR-IB-232-91/J07)
Avail: CASI HC A04/MF A01

The rigid body modes of the PAH-2 'Tiger' helicopter were identified using the Eigensystem Realization Algorithm (ERA). This work complements ground vibration tests performed using DLR's traditional phase resonance technique and the ISSPA (Identification of Structural System Parameters) method. Rigid body modal parameters are important for ground resonance prediction. Time-domain data for ERA were obtained by inverse Fourier transformation of frequency response functions measured with stepped-sine excitation. Mode purity (based on the Phase Resonance Criterion) was generally equal to or greater than corresponding results obtained in the ground vibration tests. All identified natural frequencies and mode shapes correlate well with corresponding ground vibration test results. The modal identification approach discussed in this report has become increasingly attractive in recent years due to the steadily declining cost and increased performance of scientific computers. As illustrated in this application, modern time-domain methods can be successfully applied to data acquired using DLR's existing test equipment. Some suggestions are made for future applications of time domain modal identification in this manner. Author

N93-11587# Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
USING NDT TECHNIQUES IN THE MAINTENANCE OF AERONAUTICAL PRODUCTS
PIERRE BARBIER and PASCAL BLONDET 1992 40 p
Presented at the Symposium on Aeronautical Maintenance and Logistics, Bordeaux, France, 13-17 Jan. 1992; sponsored by

Association Aeronautique et Astronautique de France and Sogerma Socea
(REPT-921-430-102; ETN-92-92350) Avail: CASI HC A03/MF A01

The use of nondestructive test (NDT) concepts in the maintenance and safety of aircraft and other aeronautical engines is discussed. Maintenance lies in the concept of damage tolerance, a concept introduced within the framework of the aeronautical regulation by the Federal Aviation Regulation and Jet Airworthiness Requirements. This concept lies in the fact that certain damages can evolve and must be detected by NDT before they reach a critical size beyond which the structure would not bear the applied critical loads. In this context, NDT plays a key role. Different NDT techniques used in aeronautical maintenance are presented, and the concept of reliability of NDT's, in terms of detection probability, is discussed. The automation of the NDT techniques applied to high performance turbine engine components is considered. The state of the art of the up to date solutions used for this kind of application is given. Information about the last developments of NDT techniques concerning the fields of computer tomography and holography are included. ESA

N93-11617# Federal Aviation Administration, Cambridge, MA.
MAGNETO-OPTIC IMAGING INSPECTION OF SELECTED CORROSION SPECIMENS
STEPHEN N. BOBO Jul. 1992 23 p
(DOT/FAA/CT-TN92/20; DOT-VNTSC-FA1H2-92) Avail: CASI HC A03/MF A01

A feasibility demonstration was conducted at the facilities of Physical Research Instrumentation Company (PRI) in Redmond, Washington. The purpose of the demonstration was to compare the effectiveness of the PRI Model 301-1 magneto-optic imaging (MOI) system with conventional eddy current methods of detecting corrosion in aircraft test panels, previously identified by eddy current scanning. The study indicated that MOI may not be able to detect gradual differences in thinning that are less than 10 percent of base metal thickness. Also, with MOI, it appears to be more difficult to provide quantitative estimates of residual thickness than is the case with eddy current scanning. On the other hand, MOI visualization of the extent of corrosion is simple and free of the labor intensive point-by-point mapping, which is required by eddy current scanning. Author

N93-11624*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.
DESIGN OF A HIGH-TEMPERATURE EXPERIMENT FOR EVALUATING ADVANCED STRUCTURAL MATERIALS
THEODORE T. MOCKLER, MARIO CASTRO-CEDENO, HERBERT J. GLADDEN, and ALBERT KAUFMAN (Analex Corp., Brook Park, OH.) Aug. 1992 35 p Original contains color illustrations
(Contract RTOP 510-01-50)
(NASA-TM-105833; E-6287; NAS 1.15:105833) Avail: CASI HC A03/MF A01; 16 functional color pages

This report describes the design of an experiment for evaluating monolithic and composite material specimens in a high-temperature environment and subject to big thermal gradients. The material specimens will be exposed to aerothermal loads that correspond to thermally similar engine operating conditions. Materials evaluated in this study were monolithic nickel alloys and silicon carbide. In addition, composites such as tungsten/copper were evaluated. A facility to provide the test environment has been assembled in the Engine Research Building at the Lewis Research Center. The test section of the facility will permit both regular and Schlieren photography, thermal imaging, and laser Doppler anemometry. The test environment will be products of hydrogen-air combustion at temperatures from about 1200 F to as high as 4000 F. The test chamber pressure will vary up to 60 psia, and the free-stream flow velocity can reach Mach 0.9. The data collected will be used to validate thermal and stress analysis models of the specimen. This process of modeling, testing, and validation is expected to yield enhancements to existing analysis tools and techniques. Author

N93-11698 Clarkson Univ., Potsdam, NY.
**AN EXPERIMENTAL STUDY OF FLOW PATTERNS AND
 ENDWALL HEAT TRANSFER UPSTREAM OF A
 SURFACE-MOUNTED RECTANGULAR OBSTRUCTION IN A
 TURBULENT BOUNDARY LAYER** Ph.D. Thesis

QUAN CHEN 1991 215 p
 Avail: Univ. Microfilms Order No. DA9201045

A seven-phase experimental investigation documented the three-dimensional separation region in front of a surface-mounted rectangular obstruction. The obstruction was centered between sidewalls of a wind tunnel in a turbulent approaching boundary layer. The major feature of this flow was a horseshoe vortex system near the junction. Real-time vortex structures were visualized with a laser sheet. Interior velocity, turbulence intensity and velocity power spectrum measurements were obtained with a Laser Doppler Anemometer (LDA) and a hot-wire anemometer. Ink dot surface flow visualizations and pressure measurements were acquired on the endwall under the vortex system. Endwall heat transfer coefficients were nonintrusively measured by an infrared imaging system. Laser sheet flow visualizations indicated a vortex system with random oscillations. In the time-averaged sense, ink-dot flow visualizations, LDA measurements and endwall pressure measurements indicated a well defined primary vortex. The separation region was 70 percent larger, in the streamwise direction, than that in front of a cylinder with a diameter the same as the obstruction width. The time-averaged primary vortex center, where maximum values of turbulence intensity were measured, was located farther away from the obstruction leading edge at higher freestream velocities. Endwall heat transfer coefficient distribution measurements on the endwall surface revealed that the obstruction established a complex heat transfer pattern. Local heat transfer rates as much as 80 percent greater than the undisturbed two-dimensional level were recorded upstream of the obstruction along the test section centerline. A local heat transfer coefficient peak was associated with the local maximum turbulence intensity measured near the endwall by LDA. Dissert. Abstr.

N93-11707# Oxford Univ. (England). Dept. of Engineering Science.

**TIME-FREQUENCY DOMAIN ANALYSIS OF VIBRATION
 SIGNALS FOR MACHINERY DIAGNOSTICS. 3: THE PRESENT
 POWER SPECTRAL DENSITY**

W. J. WANG and P. D. MCFADDEN 1992 41 p Sponsored by Science Research Council
 (OUEL-1911/92; ETN-92-92063) Avail: CASI HC A03/MF A01

The Present Power Spectral Density (PPSD), also referred to as the local power spectral density, is defined and its application to the calculation of the time frequency distribution of a nonstationary signal is examined. The PPSD distribution represents the energy distribution of the signal over the frequency domain at every instant of time. It can correctly reveal the presence of local changes in the signal, and avoids the disadvantages arising from the nonlinearity which is inherent in the Wigner-Ville distribution. The selection of the local emphasizing function is discussed, and it is shown that the Gaussian function is well suited to the calculation of the PPSD, giving a distribution which is free from ripple and easy to interpret. The application of the PPSD is demonstrated using numerically generated test signals and experimentally measured time domain averages of the gear meshing vibration from industrial and helicopter gearboxes. The results show that the PPSD provides a powerful tool for the early detection of local gear damage. ESA

N93-11716# University of Central Florida, Orlando. Dept. of Industrial Engineering and Management System.

**IMPLEMENTING SYSTEM SIMULATION OF C3 SYSTEMS
 USING AUTONOMOUS OBJECTS**

RALPH V. ROGERS 1987 6 p Sponsored in part by FAA
 (Contract NAG2-625)
 (NASA-CR-190845; NAS 1.26:190845) Avail: CASI HC A02/MF A01

The basis of all conflict recognition in simulation is a common frame of reference. Synchronous discrete-event simulation relies

on the fixed points in time as the basic frame of reference. Asynchronous discrete-event simulation relies on fixed-points in the model space as the basic frame of reference. Neither approach provides sufficient support for autonomous objects. The use of a spatial template as a frame of reference is proposed to address these insufficiencies. The concept of a spatial template is defined and an implementation approach offered. Discussed are the uses of this approach to analyze the integration of sensor data associated with Command, Control, and Communication systems.

Author

N93-11760# Federal Aviation Administration, Washington, DC.
FUTURE FAA TELECOMMUNICATIONS PLAN

Aug. 1991 677 p
 (AD-A249133) Avail: CASI HC A99/MF A06

The FDIO system is a subelement of the En Route Air Traffic Control Systems element of the NAS communications system. FDIO provides terminal and en route air traffic controllers with direct user input/output of flight plan and flight movement information and updates. FDIO replaces existing Flight Data Entry and Printout (FDEP) and Flight Strip Printer (FSP) systems, and also extends flight data services to terminal locations not presently served by FDEP. The FDIO system concept evolved from the need to increase the reliability and maintainability of the present system. Increases in flight traffic and resultant data loads have caused delays in the processing of data sent to and from FDEP sites, and to FSP's. FDIO will duplicate all of the functions of the FDEP and FSP system while providing extended capabilities. Flight strips will be displayed, as they are in the current system, by printing on the FAA flight strip forms. A CRT capability will be included as a function in all sites. Where no CRT is used, the display for message composition will be Remote Flight Strip Printers (Terminal) (RFSP(T)). A keyboard will provide for data entry and error display as in the current system. Two central control units will be used at each Central Computer Complex (CCC) and one remote control unit at each FDEP site. GRA

N93-11767# Los Alamos National Lab., NM.
**NUMERICAL ANALYSIS OF THE FLOW FIELDS IN A RQL
 GAS TURBINE COMBUSTOR**

MICHAEL C. CLINE, GERALD J. MICKLOW (Florida Univ., Gainesville.), S. L. YANG (Michigan Technological Univ., Houghton.), and H. L. NGUYEN (National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.) 1992 21 p Presented at the 28th Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
 (Contract W-7405-ENG-36)
 (DE92-017509; LA-UR-92-1964; CONF-920747-7) Avail: CASI HC A03/MF A01

The KIVA-2 code was modified to allow calculation of the flow field in a Richburn/Quick quench/Lean burn (RQL) staged gas turbine combustor including the airblast fuel nozzle. The results illustrate the complicated flow field present in RQL combustors. In particular the thermal protection requirements of the quick-quench mixer used in this study may be similar to those of the rich-burn combustor despite the presence of the cool dilution jet. Variation of the mass flow split between the fuel nozzle air passages has a significant effect on the flow as well as the level of the NO emissions. In addition, the slanted dilution slots form a counter-rotating flow field. From the results obtained to date, it appears that the modified KIVA-2 code can be used to study the effects of various RQL combustor design and operating conditions. DOE

N93-11802# Pacific Northwest Lab., Richland, WA.
**ULTRA WIDE BAND 3-D CROSS SECTION (RCS)
 HOLOGRAPHY**

H. D. COLLINS and T. E. HALL Jul. 1992 25 p Presented at the Review of Progress in Quantitative Non Destructive Evaluation, La Jolla, CA, 19-24 Jul. 1992
 (Contract DE-AC06-76RL-01830)
 (DE92-019133; PNL-SA-20954; CONF-920799-1) Avail: CASI HC A03/MF A01

Ultra wide band impulse holography is an exciting new concept for predictive radar cross section (RCS) evaluation employing near-field measurements. Reconstruction of the near-field hologram data maps the target's scattering areas, and uniquely identifies the 'hot spot' locations on the target. In addition, the target and calibration sphere's plane wave angular spectrums are computed (via digital algorithm) and used to generate the target's far-field RCS values in three dimensions for each frequency component in the impulse. Thin and thick targets are defined in terms of their near-field amplitude variations in range. Range gating and computer holographic techniques are applied to correct these variations. Preliminary experimental results on various targets verify the concept of RCS holography. The unique 3-D presentation (i.e., typically containing 524,288 RCS values for a 1024 (times) 512 sampled aperture for every frequency component) illustrates the efficacy of target recognition in terms of its far-field plane wave angular spectrum image. RCS images can then be viewed at different angles for target recognition, etc. DOE

N93-12140# Brookhaven National Lab., Upton, NY.
OPERATING EXPERIENCE USING VENTURI FLOW METERS AT LIQUID HELIUM TEMPERATURE

K. C. WU 1992 9 p Presented at the Instrument Society of America Conference, Houston, TX, 18-23 Oct. 1992 (Contract DE-AC02-76CH-00016) (DE92-014693; BNL-47507; CONF-921055-2) Avail: CASI HC A02/MF A01

Experiences using a commercial venturi to measure single phase helium flow near 4 K (degree Kelvin) for cooling superconducting magnets have been presented. The mass flow rate was calculated from the differential pressure and the helium density evaluated from measured pressure and temperature. The venturi flow meter, with a full range of 290 g/s (0.29 Kg/s) at design conditions, has been found to be reliable and accurate. The flow measurements have been used, with great success, for evaluating the performance of a cold centrifugal compressor, the thermal acoustic heat load of a cryogenic system, and the cooling of a superconducting magnet after quench. DOE

N93-12162# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.

LAMINAR BOUNDARY-LAYER BREAKDOWN Final Report, 1 Oct. 1990 - 30 Sep. 1991

ALI H. NAYFEH 7 Jul. 1992 9 p (Contract N00014-91-J-1309)

(AD-A254489) Avail: CASI HC A02/MF A01

The objective of the work is to use dynamical system theory to determine the mechanisms that are responsible for the breakdown of laminar flows and to investigate the possibility of modifying the transition process to affect the subsequent well-developed turbulence structure. Experiments performed in low-disturbance wind-tunnels established two scenarios for the laminar-boundary-layer breakdown: the fundamental- and subharmonic-modes of breakdown. The experimental observations of the subharmonic breakdown are very similar to our observations of the breakdown of regular motions in metallic and composite structural systems into chaotic motions. Therefore, we used dynamical system theory to conduct an analysis for the subharmonic breakdown in boundary layers similar to the one we successfully used to explain the breakdown in the response of the structural systems. The results can be used to modify the breakdown process and hence the resulting turbulent motion. GRA

N93-12197# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DYNAMIC ANALYSIS OF A PRE-AND-POST ICE IMPACTED BLADE

G. H. ABUMERI (Sverdrup Technology, Inc., Brook Park, OH.), E. S. REDDY (Sverdrup Technology, Inc., Brook Park, OH.), P. L. N. MURTHY, and C. C. CHAMIS Oct. 1992 20 p Presented at the Aircraft Design Systems Meeting, Hilton Head, SC, 24-26 Aug. 1992; sponsored by AIAA

(Contract RTOP 505-68-1C)

(NASA-TM-105829; E-7264; NAS 1.15:105829) Avail: CASI HC A03/MF A01

The dynamic characteristics of an engine blade are evaluated under pre-and-post ice impact conditions using the NASA in-house computer code BLASIM. The ice impacts the leading edge of the blade causing severe local damage. The local structural response of the blade due to the ice impact is predicted via a transient response analysis by modeling only a local patch around the impact region. After ice impact, the global geometry of the blade is updated using deformations of the local patch and a free vibration analysis is performed. The effects of ice impact location, size and ice velocity on the blade mode shapes and natural frequencies are investigated. The results indicate that basic nature of the mode shapes remains unchanged after impact and that the maximum variation in natural frequencies occurs for the twisting mode of the blade. Author

N93-12277# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STOCHASTIC SENSITIVITY MEASURE FOR MISTUNED HIGH-PERFORMANCE TURBINES

DURBHA V. MURTHY (Toledo Univ., OH.) and CHRISTOPHE PIERRE (Michigan Univ., Ann Arbor.) Aug. 1992 21 p Presented at the Fourth International Symposium on Transport Phenomena and Dynamics of Rotating Machinery, Honolulu, HI, 5-9 Apr. 1992 (Contract NAG3-742; NAG3-1163; RTOP 505-62-21)

(NASA-TM-105821; ICOMP-92-13; E-7252; NAS 1.15:105821) Avail: CASI HC A03/MF A01

A stochastic measure of sensitivity is developed in order to predict the effects of small random blade mistuning on the dynamic aeroelastic response of turbomachinery blade assemblies. This sensitivity measure is based solely on the nominal system design (i.e., on tuned system information), which makes it extremely easy and inexpensive to calculate. The measure has the potential to become a valuable design tool that will enable designers to evaluate mistuning effects at a preliminary design stage and thus assess the need for a full mistuned rotor analysis. The predictive capability of the sensitivity measure is illustrated by examining the effects of mistuning on the aeroelastic modes of the first stage of the oxidizer turbopump in the Space Shuttle Main Engine. Results from a full analysis mistuned systems confirm that the simple stochastic sensitivity measure predicts consistently the drastic changes due to mistuning and the localization of aeroelastic vibration to a few blades. Author

N93-12329# Eloret Corp., Palo Alto, CA.

SOLUTION OF NONLINEAR FLOW EQUATIONS FOR COMPLEX AERODYNAMIC SHAPES Final Technical Report, 1 Sep. 1990 - 30 Sep. 1992

M. JAHED DJOMEHRI 4 Nov. 1992 10 p (Contract NCC2-689)

(NASA-CR-190979; NAS 1.26:190979) Avail: CASI HC A02/MF A01

Solution-adaptive CFD codes based on unstructured methods for 3-D complex geometries in subsonic to supersonic regimes were investigated, and the computed solution data were analyzed in conjunction with experimental data obtained from wind tunnel measurements in order to assess and validate the predictability of the code. Specifically, the FELISA code was assessed and improved in cooperation with NASA Langley and Imperial College, Swansea, U.K. Author

N93-12340# Cree Research, Inc., Durham, NC.

HIGH TEMPERATURE RECTIFIERS AND MOS DEVICES IN 6H-SILICON CARBIDE Final Report, 1 Jul. 1991 - 31 Jan. 1992

J. W. PALMOUR, J. A. EDMOND, and C. H. CARTER, JR. 27 Apr. 1992 34 p

(Contract DAAL03-91-C-0046) (AD-A254725) Avail: CASI HC A03/MF A01

A major emphasis in the aerospace industry has been to increase the performance and efficiency of aircraft engines (including helicopters). Most of the improvements require the engine

to run hotter, be more compact and more precisely controlled. All of these requirements increase the temperature of an increasing number of electronic components on the engine. This contract involved the development of two types of solid state devices for use in various engine applications using silicon carbide which is the premiere semiconductor material for high temperature (and other) applications. One device is a high voltage, low current rectifier which can operate to at least 350 deg C for use in an igniter circuit. The developments required involved decreasing the doping level of the background layer in epitaxial growth, improving the passivation and packaging to withstand the high voltage and high temperature. The other is a 350 deg C small signal MOSFET which can be used as an amplifier for a variety of sensors. For this portion of the research, the major focus was on characterization of the thermal oxide and the oxide interface through fabrication and characterization of MOS capacitors and various MOSFET designs. GRA

N93-12365# National Aerospace Lab., Tokyo (Japan). Control Systems Div.

ACCURACY IMPROVEMENT OF LINEAR ESTIMATED MOTION USING DIFFERENTIAL TYPE SENSORS [BIBUNGATA SENA DOUNYUU NI YORU UNDOU SUITEI SEIDO NO KOUJOU]
SHUICHI SASA, MASAHIKO NAGAYASU, MASAOKI YANAGIHARA, and TAKASHI SHIMOMURA Dec. 1991 19 p
In JAPANESE
(ISSN 0389-4010)
(NAL-TR-1135; JTN-92-80403) Avail: CASI HC A03/MF A01

Linear motion estimation was performed by application of a Kalman filter in conjunction with position, velocity, and acceleration sensors. The relationship between the sensor accuracy and the accuracy of the estimated motion was investigated. Motion estimation accuracy was evaluated using the Riccati equation covariance matrix obtained from the Kalman filter. The relation between the accuracy of the velocity and acceleration sensors and the motion estimation accuracy was subsequently derived numerically. The problem was analyzed for both discrete and continuous time systems with the sensor accuracy that is necessary to attain the specified motion estimation accuracy then being derived. Author (NASDA)

N93-12401*# Alabama Univ., Huntsville. Materials Processing Lab.

MATERIALS PROCESSING IN LOW GRAVITY Final Report

GARY L. WORKMAN 28 Nov. 1990 23 p
(Contract NAS8-36955)
(NASA-CR-184421; NAS 1.26:184421) Avail: CASI HC A03/MF A01

The final report of the Materials Processing in Low Gravity Program in which The University of Alabama in Huntsville designed, fabricated and performed various low gravity experiments in materials processing from November 7, 1989 through November 6, 1990 is presented. The facilities used in these short duration low gravity experiments include the Drop Tube and Drop Tower at Marshall Space Flight Center (MSFC), and the KC-135 aircraft at Ellington Field. During the performance of this contract, the utilization of these ground-based low gravity facilities for materials processing experiments have been instrumental in providing the opportunity to determine the feasibility of performing a number of experiments in the microgravity of Space, without the expense of a space-based experiment. Since the KC-135 was out for repairs during the latter part of the reporting period, a number of the KC-135 activities concentrated on repair and maintenance of the equipment that normally is flown on the aircraft. A number of periodic reports were given to the TCOR during the course of this contract, hence this final report is meant only to summarize the many activities performed and not redundantly cover materials already submitted. L.R.R.

N93-12411*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Engineering Science and Mechanics.

VERIFICATION OF RAIN-FLOW RECONSTRUCTIONS OF A VARIABLE AMPLITUDE LOAD HISTORY M.S. Thesis, 1990

Final Report

JOHN D. CLOTHIAUX and NORMAN E. DOWLING Oct. 1992 107 p

(Contract NAG1-822; RTOP 505-63-50-04)

(NASA-CR-189670; NAS 1.26:189670) Avail: CASI HC A06/MF A02

The suitability of using rain-flow reconstructions as an alternative to an original loading spectrum for component fatigue life testing is investigated. A modified helicopter maneuver history is used for the rain-flow cycle counting and history regenerations. Experimental testing on a notched test specimen over a wide range of loads produces similar lives for the original history and the reconstructions. The test lives also agree with a simplified local strain analysis performed on the specimen utilizing the rain-flow cycle count. The rain-flow reconstruction technique is shown to be a viable test spectrum alternative to storing the complete original load history, especially in saving computer storage space and processing time. A description of the regeneration method, the simplified life prediction analysis, and the experimental methods are included in the investigation. Author

N93-12460*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THERMOSTRUCTURAL APPLICATIONS OF HEAT PIPES FOR COOLING LEADING EDGES OF HIGH-SPEED AEROSPACE VEHICLES

CHARLES J. CAMARDA and DAVID E. GLASS (Analytical Services and Materials, Inc., Hampton, VA.) *In its* Current Technology for Thermal Protection Systems p 291-318 Oct. 1992
Avail: CASI HC A03/MF A03

Heat pipes have been considered for use on wing leading edge for over 20 years. Early concepts envisioned metal heat pipes cooling a metallic leading edge. Several superalloy/sodium heat pipes were fabricated and successfully tested for wing leading edge cooling. Results of radiant heat and aerothermal testing indicate the feasibility of using heat pipes to cool the stagnation region of shuttle-type space transportation systems. The test model withstood a total seven radiant heating tests, eight aerothermal tests, and twenty-seven supplemental radiant heating tests. Cold-wall heating rates ranged from 21 to 57 Btu/sq ft-s and maximum operating temperatures ranged from 1090 to 1520 F. Follow-on studies investigated the application of heat pipes to cool the stagnation regions of single-stage-to-orbit and advanced shuttle vehicles. Results of those studies indicate that a 'D-shaped' structural design can reduce the mass of the heat-pipe concept by over 44 percent compared to a circular heat-pipe geometry. Simple analytical models for heat-pipe startup from the frozen state (working fluid initially frozen) were adequate to approximate transient, startup, and steady-state heat-pipe performance. Improvement in analysis methods has resulted in the development of a finite-element analysis technique to predict heat-pipe startup from the frozen state. However, current requirements of light-weight design and reliability suggest that metallic heat pipes embedded in a refractory composite material should be used. This concept is the concept presently being evaluated for NASP. A refractory-composite/heat-pipe-cooled wing leading edge is currently being considered for the National Aero-Space Plane (NASP). This concept uses high-temperature refractory-metal/lithium heat pipes embedded within a refractory-composite structure and is significantly lighter than an actively cooled wing leading edge because it eliminates the need for active cooling during ascent and descent. Since the NASP vehicle uses cryogenic hydrogen to cool structural components and then burns this fuel in the combustor, hydrogen necessary for descent cooling only, when the vehicle is unpowered, is considered to be a weight penalty. Details of the design of the refractory-composite/heat-pipe-cooled wing leading edge are currently being investigated. Issues such as thermal contact

resistance and thermal stress are also being investigated.

Author

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A93-10098

USING ULTRALIGHT FLIGHT VEHICLES FOR LARGE-SCALE AERIAL PHOTOGRAPHY [OPYT PRIMENENIIA SVERKHLEGGKOGO LETATEL'NOGO APPARATA DLIA KRUPNOMASSHTABNOI AEROFOTOS'EMKI]

V. G. AFREMOV, S. S. NEKHIN, A. G. VANIN, and V. A. MIRKIN
Geodeziia i Kartografiia (ISSN 0016-7126) no. 5 May 1992 p. 27-31. In Russian. refs

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The paper discusses the type of ultralight flight vehicles (SFV) most suitable for large-scale (1:500 to 1:5000) aerial photography, together with technical and cost characteristics of cameras for large-scale stereotopography. Special attention is given to a newly developed motodeltaplane (MDPA) variant suitable for large-scale aerial photography of small but widely separated areas. This MDPA consists of a motodeltaplane Poisk-06 with a specially developed camera (AfreMOV et al., 1990) which can accommodate 18 x 18 cm films. Photography on the scales between 1:1500 and 1:6000 can be carried out at different altitudes, in the absence of turbulence. The qualitative characteristics of photographs obtained by this DPA model are presented. Compared with surface photography, the efficiency of stereotopography obtained by the use of this MDPA system is increased twofold. I.S.

A93-10730

EUROPEAN ENVIRONMENTAL STUDIES FOCUS ON IMPACT OF ENGINE EMISSIONS

COLIN THAME (Department of Transport, London, United Kingdom) ICAO Journal (ISSN 0018-8778) vol. 47, no. 8 Aug. 1992 p. 7-10.

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Collaborative study of the nature and effects of NO(x) emissions from subsonic aircraft is undertaken by European countries. NO(x) is shown to result in ozone formation depending primarily upon altitude, and data indicate that new aircraft with high combustion temperatures lead to increased levels of oxides of nitrogen. A project called 'Aeronox' is outlined which involves: (1) studying the precise quantities of emissions at altitude; (2) analyzing the evolution of the emissions from ejection to dispersion; and (3) modeling the transport and reactions of NO(x) emissions under these conditions. The project is also dedicated to a global inventory of aircraft emissions at present and about two decades from now. Also planned are studies of noise levels and the environmental impact of engine-design changes to reduce emissions. The studies are expected to result in revised certification standards for European aircraft that are based on environmental projections. C.C.S.

A93-11028

MAINTAINING HIGH ACCURACY GPS POSITIONING 'ON THE FLY'

M. WEI, M. E. CANNON, and K. P. SCHWARZ (Calgary Univ., Canada) In IEEE PLANS '92 - Position Location and Navigation Symposium, Monterey, CA, Mar. 24-27, 1992, Record New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 403-411. Research supported by Canada Centre for Surveying refs

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A series of airborne GPS (Global Positioning System) tests

using the Ashtech XII receivers was used to demonstrate the effect of cycle slips and erroneous data on the positioning accuracy. The overall achievable accuracy is in the order 20 cm; however, errors of several decimeters were detected in some instances. Traverse closures and residual analysis are used to assess the occurrence and magnitude of these errors. The addition of an inertial navigation system in the aircraft, which provides accurate relative positions, is also used to detect cycle slips and outliers in the GPS data. Strategies to achieve consistent accuracies are discussed, and results for different alternatives are presented. I.E.

A93-11404

LARGE-EDDY SIMULATION OF TURBULENT FLOW ABOVE AND WITHIN A FOREST

ROGER H. SHAW (California Univ., Davis) and ULRICH SCHUMANN (DLR, Inst. fuer Physik der Atmosphaere, Oberpfaffenhofen, Germany) Boundary-Layer Meteorology (ISSN 0006-8314) vol. 61, no. 1-2 Oct. 1992 p. 47-64. refs
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A large-eddy simulation has been performed of an atmospheric surface layer in which the lower third of the domain is occupied by a drag layer and heat sources to represent a forest. Subgrid-scale processes are treated using second-order closure techniques. Lateral boundaries are periodic, while the upper boundary is a frictionless fixed lid. Mean vertical profiles of wind velocity derived from the output are realistic in their shape and response to forest density. Similarly, vertical profiles of Reynolds stress, turbulent kinetic energy and velocity skewness match observations, at least in a qualitative sense. The limited vertical extent of the domain and the artificial upper boundary, however, cause some departures from measured turbulence profiles in real forests. Instantaneous turbulent velocity and scalar fields are presented which show some of the features obtained by tower instrumentation in the field and in wind tunnels, such as the vertical coherence of vertical velocity and the slope of structures revealed by temperature patterns. Author

A93-12364

USE OF NASA LS (1) GENERAL AVIATION AIRFOIL FOR A SMALL WIND TURBINE - AN EXPERIENCE IN DENMARK

KUNAL GHOSH (Indian Inst. of Technology, Kanpur, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 2 May 1992 p. 105-109. Research supported by Folkecenter for Vedvarende Energi of Denmark refs

The suitability of some airfoil designs for use in a high-speed wind turbine is considered with attention given to the use of a NASA airfoil for a small facility. The choice of an airfoil section is shown to be dictated by aerodynamic considerations and the construction/material techniques used to develop the blade. The NASA LS (1) general aviation airfoil is shown to be adequate for use in the small wind turbines especially when the airfoil is constructed from wood with blunt trailing edges in the design. C.C.S.

A93-12407

STUDY ON AIRCRAFT MICROWAVE REMOTE SENSING OF SEA-WATER SURFACE SALINITY

ZHENDONG LEI, YUAN ZENG, SHIJIE LIN, and LIANCHANG LIAO (Huazhong Univ. of Science and Technology, Wuhan, China) Chinese Society of Astronautics, Journal (ISSN 1000-1328) no. 2 1992 p. 62-67. In Chinese. refs

Utilizing models of the complex dielectric constant for sea-water, the influence of sea-water salinity on microwave radiation brightness temperature of sea-water has been calculated, and the alternative of optimum frequency and incidence angle for remote sensing of sea-water salinity is presented. An airborne L-band microwave radiometer system with high precision is developed and utilized for aircraft remote sensing of sea-water salinity. The accuracy of remote sensing salinity is shown to be within two percent. R.E.P.

A93-12643

THE COMPOSITE SHAPE AND STRUCTURE OF COHERENT EDDIES IN THE CONVECTIVE BOUNDARY LAYER

A. G. WILLIAMS and J. M. HACKER (South Australia, Flinders Univ., Adelaide, Australia) *Boundary-Layer Meteorology* (ISSN 0006-8314) vol. 61, no. 3 Nov. 1992 p. 213-245. Research supported by Australian Research Council and Commonwealth Postgraduate Research Award refs

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Conditional sampling is used to locate coherent structures in a large data set obtained from flights by an instrumented light aircraft in convective boundary layers over Eyre Peninsula, South Australia. A compositing technique is used to construct averaged traverses through coherent structures located within aircraft data runs of different altitudes and directions. In addition to the well-known along-wind features of surface-layer plumes, a strong, consistent inflow/entrainment pattern is evident in the lateral direction. Air from the horizontal plane channels around the sides and then in behind the microfront present at the upstream edge. Forces set up by the driving instability in the along-wind and vertical directions are counter-balanced by organized flow in the across-wind direction. It is found that mixed-layer thermal towers have a relatively simple form, consisting primarily of large columns of warm, upward-moving turbulent air, which may occasionally be in a state of slow rotation.

Author

A93-13262# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

JOINT NASA/USAF AIRBORNE FIELD MILL PROGRAM - OPERATION AND SAFETY CONSIDERATIONS DURING FLIGHTS OF A LEAR 28 AIRPLANE IN ADVERSE WEATHER

BRUCE D. FISHER, MICHAEL R. PHILLIPS (NASA, Langley Research Center, Hampton, VA), and LAUNA M. MAIER (NASA, Kennedy Space Center, Cocoa Beach, FL) Aug. 1992 17 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4093) Copyright

A NASA Langley Research Center Learjet 28 research airplane was flown in various adverse weather conditions in the vicinity of the NASA Kennedy Space Center from 1990-1992 to measure airborne electric fields during the Joint NASA/USAF Airborne Field Mill Program. The objective of this program was to characterize the electrical activity in various weather phenomena common to the NASA-Kennedy area in order to refine Launch Commit Criteria for natural and triggered lightning. The purpose of the program was to safely relax the existing launch commit criteria, thereby increasing launch availability and reducing the chance for weather holds and delays. This paper discusses the operational conduct of the flight test, including environmental/safety considerations, aircraft instrumentation and modification, test limitations, flight procedures, and the procedures and responsibilities of the personnel in the ground station. Airborne field mill data were collected for all the Launch Commit Criteria during two summer and two winter deployments. These data are now being analyzed.

Author

N93-11096*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

PREDICTED AIRCRAFT EFFECTS ON STRATOSPHERIC OZONE

MALCOLM K. W. KO (Atmospheric and Environmental Research, Inc., Cambridge, MA.), STEVE WOFYSY (Harvard Univ., Cambridge, MA.), DIETER KLEY (Kernforschungsanlage, Juelich, Germany), EVGENY A. ZHADIN (Central Aerological Observatory, Dolgoprudnyi, USSR), COLIN JOHNSON (United Kingdom Atomic Energy Authority, Harwell, England), DEBRA WEISENSTEIN (Atmospheric and Environmental Research, Inc., Cambridge, MA.), MICHAEL J. PRATHER (National Aeronautics and Space Administration, Goddard Inst. for Space Studies, New York, NY.), and DONALD J. WUEBBLES (Lawrence Livermore National Lab., CA.) *In* NASA, Washington, Scientific Assessment of Ozone Depletion: 1991 18 p 1991

Avail: CASI MF A03; print copy available at WMO, Geneva, Switzerland; 1 functional color page

The possibility that the current fleet of subsonic aircraft may already have caused detectable changes in both the troposphere and stratosphere has raised concerns about the impact of such operations on stratospheric ozone and climate. Recent interest in the operation of supersonic aircraft in the lower stratosphere has heightened such concerns. Previous assessments of impacts from proposed supersonic aircraft were based mostly on one-dimensional model results although a limited number of multidimensional models were used. In the past 15 years, our understanding of the processes that control the atmospheric concentrations of trace gases has changed dramatically. This better understanding was achieved through accumulation of kinetic data and field observations as well as development of new models. It would be beneficial to start examining the impact of subsonic aircraft to identify opportunities to study and validate the mechanisms that were proposed to explain the ozone responses. The two major concerns are the potential for a decrease in the column abundance of ozone leading to an increase in ultraviolet radiation at the ground, and redistribution of ozone in the lower stratosphere and upper troposphere leading to changes in the Earth's climate. Two-dimensional models were used extensively for ozone assessment studies, with a focus on responses to chlorine perturbations. There are problems specific to the aircraft issues that are not adequately addressed by the current models. This chapter reviews the current status of the research on aircraft impact on ozone with emphasis on immediate model improvements necessary for extending our understanding. The discussion will be limited to current and projected commercial aircraft that are equipped with air-breathing engines using conventional jet fuel. The impacts are discussed in terms of the anticipated fuel use at cruise altitude.

Author

N93-11144# Federal Aviation Administration, Washington, DC. Surveillance Office.

SUMMARY OF FINDINGS FROM THE PIREP-BASED ANALYSES CONDUCTED DURING THE 1988 TO 1990 EVALUATIONS OF TDWR-BASED AND TDWR/LLWAS-BASED ALERT SERVICES PROVIDED TO LANDING/DEPARTING PILOTS Final Report, Mar. 1988 - Aug. 1991

LLOYD STEVENSON Jul. 1992 59 p (AD-A253859; DOT-VNTSC-FAA-91-15; DOT/FAA/NR/92-6) Avail: CASI HC A04/MF A01

The Federal Aviation Administration (FAA) is developing the Terminal Doppler Weather Radar (TDWR). Starting in 1988 the TDWR Program conducted a series of evaluations of a TDWR-based alert service to provide wind shear and microburst alerts to landing and departing pilots. Starting in 1989, a second series of evaluations was initiated involving an integrated alert service consisting of TDWR and the Phase 3 Low Level Wind Shear Alert System (LLWAS). Evaluations are expected to continue through 1992. The radio communications between local control and landing and departing pilots were analyzed for 224 of the 323 alert periods that occurred during 1989 through 1990 and represents one component of the overall investigation that took place. A key element of the communications were the pilot reports (PIREP's) of weather-related encounters and observations made during the alert periods. PIREP's were used to evaluate the accuracy of the issued alerts from the pilot's viewpoint as to the location and intensity of the wind-related encounters, and to identify situations in which pilots reported wind-related encounters that were not provided alert coverage.

GRA

N93-11702# Florida Univ., Gainesville. Dept. of Coastal and Oceanographic Engineering.

PHYSICAL EFFECTS OF VEGETATION ON WIND-BLOWN SAND IN THE COASTAL ENVIRONMENTS OF FLORIDA Final Report

D. M. SHEPPARD and A. W. NIEDORODA Feb. 1992 52 p Prepared in cooperation with Environmental Science and Engineering, Inc., Gainesville, FL

13 GEOSCIENCES

(Contract UF PROJ. 4910451123312)
(PB92-188424; UPN-90100411) Avail: CASI HC A04/MF A01

One and two-dimensional, second order turbulence plant canopy flow models were developed for the purpose of estimating the effect of coastal vegetation on wind blown sand transport. The computer program that solves the governing differential equations uses measured leaf area density profiles and drag coefficients for crop plants similar in shape and size to the more common coastal vegetation in Florida. GRA

N93-11803# National Weather Service, Kansas City, MO.
PROCEEDINGS OF THE NATIONAL WEATHER SERVICE AVIATION WORKSHOP: POSTPRINT VOLUME
B. LAMBERT Mar. 1992 430 p Workshop held in Kansas City, MO, 10-13 Dec. 1991
(PB92-176148; NOAA-TM-NWS-CR-102) Avail: CASI HC A19/MF A04

Papers presented at the National Weather Service Aviation Workshop (Dec. 10-13, 1991) are provided. The topics covered by these papers include aviation user requirements; fog and stratus forecasting; forecasting mesoscale en-route weather; special aviation related services; present terminal forecast procedures; Doppler radar and downbursts; profilers, Meteorological Data Collection and Reporting System (MDCRS), and LDS; Automated Surface Observations (ASOS); using computer generated products and satellite data; and the future of aviation weather. GRA

N93-12075# Sandia National Labs., Albuquerque, NM.
MEASURED DATA FOR THE SANDIA 34-METER VERTICAL AXIS WIND TURBINE
T. D. ASHWILL Jul. 1992 119 p
(Contract DE-AC04-76DP-00789)
(DE92-019807; SAND-91-2228) Avail: CASI HC A06/MF A02

The 34-meter Test Bed is a research-oriented, variable-speed vertical-axis wind turbine located at the USDA Agricultural Research Station in Bushland, Texas. Sandia National Laboratories designed and built this machine to perform research in structural dynamics, aerodynamics, and fatigue. Testing to determine its performance in various wind conditions and rotation rates has been ongoing for over three years. This report documents a broad range of test data and includes comparisons to analytical results. DOE

N93-12104# California Univ., Berkeley. Lawrence Berkeley Lab.
STRATOSPHERIC AIRCRAFT: IMPACT ON THE STRATOSPHERE?
H. JOHNSTON Feb. 1992 28 p Presented at the CHEMRAWN 7: World Conference on the Chemistry of the Atmosphere: Its Impact on Global Changes, Baltimore, MD, 2-6 Dec. 1991
(Contract DE-AC03-76SF-00098)
(DE92-016997; LBL-31884; CONF-911212-2) Avail: CASI HC A03/MF A01

The steady-state distribution of natural stratospheric ozone is primarily maintained through production by ultraviolet photolysis of molecular oxygen, destruction by a catalytic cycle involving nitrogen oxides (NO(sub x)), and relocation by air motions within the stratosphere. Nitrogen oxides from the exhausts of a commercially viable fleet of supersonic transports would exceed the natural source of stratospheric nitrogen oxides if the t should be equipped with 1990 technology jet engines. This model-free comparison between a vital natural global ingredient and a proposed new industrial product shows that building a large fleet of passenger stratospheric aircraft poses a significant global problem. NASA and aircraft industries have recognized this problem and are studying the redesign of jet aircraft engines in order to reduce the nitrogen oxides emissions. In 1989 atmospheric models identified two other paths by which the ozone destroying effects of stratospheric aircraft might be reduced or eliminated: (1) Use relatively low supersonic Mach numbers and flight altitudes. For a given rate of nitrogen oxides injection into the stratosphere, the calculated reduction of total ozone is a strong function of altitude, and flight altitudes well below 20 kilometers give relatively low calculated ozone reductions. (2) Include heterogeneous chemistry

in the two-dimensional model calculations. Necessary conditions for answering the question on the title above are to improve the quality of our understanding of the lower stratosphere and to broaden our knowledge of heterogeneous stratospheric chemistry. This article reviews recently proposed new mechanisms for heterogeneous reactions on the global stratospheric sulfate aerosols. DOE

N93-12299*# Aerodyne Research, Inc., Billerica, MA.
STRATOSPHERIC AIRCRAFT EXHAUST PLUME AND WAKE CHEMISTRY STUDIES
R. C. MIAKE-LYE, M. MARTINEZ-SANCHEZ, R. C. BROWN, C. E. KOLB, D. R. WORSNOP, M. S. ZAHNISER, G. N. ROBINSON, J. M. RODRIGUEZ, M. K. W. KO, R-L. SHIA et al. Oct. 1992 109 p
(Contract NAS1-19161; RTOP 537-01-20-01)
(NASA-CR-189688; NAS 1.26:189688; ARI-RR-902) Avail: CASI HC A06/MF A02

This report documents progress to date in an ongoing study to analyze and model emissions leaving a proposed High Speed Civil Transport (HSCT) from when the exhaust gases leave the engine until they are deposited at atmospheric scales in the stratosphere. Estimates are given for the emissions, summarizing relevant earlier work (CIAP) and reviewing current propulsion research efforts. The chemical evolution and the mixing and vortical motion of the exhaust are analyzed to track the exhaust and its speciation as the emissions are mixed to atmospheric scales. The species tracked include those that could be heterogeneously reactive on the surfaces of the condensed solid water (ice) particles and on exhaust soot particle surfaces. Dispersion and reaction of chemical constituents in the far wake are studied with a Lagrangian air parcel model, in conjunction with a radiation code to calculate the net heating/cooling. Laboratory measurements of heterogeneous chemistry of aqueous sulfuric acid and nitric acid hydrates are also described. Results include the solubility of HCl in sulfuric acid which is a key parameter for modeling stratospheric processing. We also report initial results for condensation of nitric acid trihydrate from gas phase H₂O and HNO₃. Author

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A93-10042
SOFTWARE FOR THE CONTROL OF MEASUREMENT DATA ACQUISITION, PROCESSING, AND MONITORING DURING STRENGTH TESTINGS [MATEMATICHESKOE OBESPECHENIE UPRAVLENIIA SBOROM, OBRABOTKOI I KONTROLEM IZMERITEL'NOI INFORMATSII V PROTSESSE ISPYTANII NA PROCHNOST']

I. I. ALEKSANDROVA, A. G. KHARCHENKO, and V. T. SHILOV
/n Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 105-111. In Russian. refs
Copyright

The software for a data processing and measuring system used in the mechanical testing of flight vehicles is described. The principal functions of the software support are the execution of transducer output measuring programs, real-time processing of experimental data, and visual and automatic monitoring of data processing results in real time. The developed software structures make it possible to generate data processing and monitoring programs for systems of different capacities based on one or more computers. V.L.

A93-10045

A STUDY OF THE POSSIBILITY OF THE PARALLEL EXECUTION OF A PROGRAM FOR CALCULATING THE AERODYNAMIC CHARACTERISTICS OF FLIGHT VEHICLES USING AN IMPROVED PANEL METHOD [ISSLEDOVANIJE VOZMOZHNOСТИ RASPARALLELVANIJA PROGRAMMY RASCHETA AERODINAMICHESKIKH KHARAKTERISTIK LETATEL'NYKH APPARATOV USOVERSHENSTVOVANNYM PANEL'NYM METODOM]

A. G. ZAKHAROV and M. P. KONOSHENKO *In* Collection of works on measuring and computing systems for research on the aerodynamics, dynamics, and strength of flight vehicles Moscow Tsentral'nyi Aerogidrodinamicheskii Institut 1990 p. 132-140. In Russian. refs
Copyright

An approach to the development of a program for calculating the aerodynamic characteristics of subsonic and supersonic flight vehicles is presented. A method is also proposed for the parallel execution of such a program on a two-processor computing system with a common bus and virtual memory using an improved version of the panel method. The results of the study can be easily extended to multiprocessor systems of the MIMD type. V.L.

A93-10741

VIBRATION CONTROL ALGORITHMS FOR FLEXIBLE ROTORS

D. JANECKI (Inst. of Fundamental Technological Research, Kielce, Poland) and Z. GOSIEWSKI (Koszalin Technical Univ., Poland) *Journal of Sound and Vibration* (ISSN 0022-460X) vol. 157, no. 2 Sept. 8, 1992 p. 205-219. refs
Copyright

A general vibration control method for flexible rotors with unknown and/or slowly varying parameters is presented. A digital controller has a built-in filter. This allows the rotor model to be reduced to several controller vibration modes. Unmeasured second order derivatives are eliminated during parameterization of the rotor model. A modified weighted least squares recursive algorithm is used for the estimation of rotor parameters. Author

A93-11085

TWO MODIFIED VERSIONS OF HSU-LEE'S ELLIPTIC SOLVER OF GRID GENERATION

YIH N. JENG and YUAN C. LIOU (National Cheng Kung Univ., Tainan, Taiwan) *Numerical Heat Transfer, Part B: Fundamentals* (ISSN 1040-7790) vol. 22, no. 2 Sept.-Oct. 1992 p. 125-140. Research supported by NSCRC refs
Copyright

Two modifications of the Hsu and Lee elliptic grid generation method (which is, in turn, a modified Sorenson method) are developed. The first modification specifies the control functions along all of the boundaries in terms of grid distribution, grid size, and angle of intersection. The interior control functions are interpolated by transfinite interpolation. The second modification successfully employs one of the control functions in order to specify the grid size distribution line by line between two opposite boundaries, the other control function being retained for orthogonality control. By linking the arc length specification with the weighting function of Dwyer et al., the second method is extended to become an adaptive grid scheme. Author

A93-11258#

REAL-TIME CAPTURE, ARCHIVING, RETRIEVAL, PROCESSING, AND PRESENTATION OF LARGE QUANTITIES OF FLIGHT TEST/RESEARCH INFORMATION

MICHAEL A. SCARDELLO, MICHAEL C. NESEL, and DUANE L. WHEATON (Perimeter Computer Systems, Inc., Lancaster, CA) *In* AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 44-53. refs (AIAA PAPER 92-4073) Copyright

An architectural approach that greatly increases the capability to handle the increasingly large quantity of flight test/research data is presented. Attention is given to new and emerging

technologies in the mass storage arena, the continuous increases in computational performance, and commercially available analysis and display tools. Consideration is given to the capture, archiving, responsive retrieval, efficient and accurate processing, and presentation of these large quantities of information in a convenient and cost effective manner. R.E.P.

A93-11261#

PHASE I FLIGHT TEST OF MIAG ADVANCED DEVELOPMENT MODEL

SCOTT ROBERTSON and AMY HARTFIELD (USAF, Wright Lab., Wright-Patterson AFB, OH) *In* AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers Washington American Institute of Aeronautics and Astronautics 1992 p. 71-76. (AIAA PAPER 92-4076)

The hardware configuration and results of the Modular Integrated Avionics Group (MIAG) advanced development model (ADM) are presented. The goal of the MIAG program is to define an expandable, modular, single unit vehicle management system that will provide flight control, guidance, navigation, and payload control functions for multiple classes of nonlethal UAVs. Attention is given to the the ADM that was programmed completely in Ada. R.E.P.

A93-11791

THE APPLICATION OF OPTIMAL ROBUST CONTROL IN CONTROL SYSTEM DESIGN OF FLYING VEHICLES

MAOLIN NI (Beijing Inst. of Control Engineering, China) and ZICAI WANG (Harbin Inst. of Technology, China) *Chinese Society of Astronautics, Journal* (ISSN 1000-1328) no. 3 1990 p. 23-27. In Chinese. refs

Based on the relation between the weighting matrices in linear quadratic optimal regulator and closed loop poles, a combined design method is presented for the optimal system with excellent dynamical characteristics and robustness. When this method is applied in the design of control system of a certain flying vehicle, the performance is significantly improved. Author

A93-12322

DESIGN OF AN ADAPTIVE FLIGHT CONTROL SYSTEM WITH UNCERTAINTIES

SHIGERU UCHIKADO, KIMIO KANAI, and TAKESI YOSIDUKA *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663) vol. 40, no. 458 1992 p. 143-149. In Japanese. refs

This paper presents a design approach to an adaptive control system for the unknown system which has more general time-varying parameter uncertainties in the form of a polynomial time function. The proposed method is applied to the flight control system for aircraft longitudinal short-period motion. To demonstrate its effectiveness, some simulations are conducted using the hypothetical F-4C fighter. Author

A93-12732

A MAXIMUM LIKELIHOOD METHOD FOR FLIGHT TEST DATA COMPATIBILITY CHECK

ZHONGKE SHI (Northwestern Polytechnical Univ., Xian, China) *In* Aerospace - Collected translations of selected papers, 1992 Xian, China *Northwestern Polytechnical University* 1992 8 p. Translation. Previously cited in issue 07, p. 1097, Accession no. A91-22373 refs

A93-12821

A NOMOGRAPHIC MODEL FOR MULTICRITERIAL OPTIMIZATION DURING THE DESIGN OF A FLIGHT VEHICLE POWERPLANT [NOMOGRAFICHESKAIA MODEL' DLIA MNOGOKRITERIAL'NOI OPTIMIZATSII PRI PROEKTIROVANII DVIGATELIA LA]

E. A. DAUTOV *Aviatsionnaia Tekhnika* (ISSN 0579-2975) no. 1 1992 p. 88-91. In Russian. refs

Copyright

The use of nomographic models in systems for the mathematical

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modeling of the powerplants of flight vehicles is examined. A nomographic model is considered in which the values of particular criteria are represented in a natural manner through scale coordinate functions combined in a single geometrical model. When displayed on a computer monitor, the positions of the curvilinear critical scales relative to the t-sub-a scale (where t sub a is the engine operation time) are immediately apparent. V.L.

A93-12977

A COMPARATIVE ANALYSIS OF ALGORITHMS FOR SOLVING SYSTEMS OF HIGH-ORDER LINEAR ALGEBRAIC EQUATIONS [SRAVNITEL'NYI ANALIZ ALGORITMOV RESHENIIA SISTEM LINEINYKH ALGEBRAICHESKIKH URAVNIENII VYSOKOGO PORIADKA]

S. G. IGNAT'EV, L. L. TEPERIN, and L. I. SHUSTOVA TsAGI, Trudy no. 2493 1990 p. 16-26. In Russian. refs
Copyright

Iterative methods for solving systems of linear algebraic equations are described which are used in the numerical implementation of problems concerned with flow past aircraft elements using the method of hydrodynamic singularities. The efficiency of the methods considered here is evaluated using examples that include equations relevant to flow past a thin airfoil, a thin lifting surface, and an engine nacelle. Subroutines in which these algorithms have been implemented are described. V.L.

A93-13007

DISCRETE TIME H(INFINITY) CONTROL LAWS FOR A HIGH PERFORMANCE HELICOPTER

D. WALKER and I. POSTLETHWAITE (Leicester Univ., United Kingdom) *In* IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 1 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 128, 129. refs
Copyright

An application of the 2 Riccati equation theory for discrete-time H(infinity) optimization is presented. Two helicopter flight control laws are designed. The first design is based on a normalized coprime factor stabilization. The second uses a standard 2-block sensitivity and robustness formulation. The designs presented here are novel in that the problem is posed from the outset as a discrete-time (DT) problem which is solved using recent game-theoretic formulae for DT H(infinity) optimization. It is shown that by suitable choice of weighting functions it is possible to obtain directly DT controllers that give good levels of performance and robustness. I.E.

A93-13011

MULTILEVEL CONTROL OF DYNAMICAL SYSTEMS USING NEURAL NETWORKS

KUMPATI S. NARENDRA and SNEHASIS MUKHOPADHYAY (Yale Univ., New Haven, CT) *In* IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 1 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 170, 171. refs
Copyright

The concepts related to multilevel control are investigated in the context of a greatly simplified hypothetical aircraft control problem. A general fault detection and control problem is considered. The problem deals with the case where a nonlinear plant is suitably parameterized and each of the different configurations contains an unknown parameter which lies in a compact interval. In this case, it is assumed that a nominal plant in each configuration can be identified off-line using neural networks. A stabilizing controller is assumed to exist for all the plants belonging to a configuration and was designed off-line using neural networks. The fault detection problem was carried out at the higher level by a neural network used as a pattern recognizer. The simulation results shown illustrate the operation of the entire system when a fault is assumed to occur. An adaptive controller was used online to compensate for the uncertainty in the parameters. I.E.

A93-13078

SPECIFICATION OF A CLASS OF DISCRETE EVENT PROCESSES AND THEIR CONTROLLERS

H. MORTAZAVIAN and F. LIN (Wayne State Univ., Detroit, MI) *In* IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 2 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 1529, 1530. refs
(Contract NSF ECS-90-08947)
Copyright

The authors attempt to determine what can be done if the only thing that is known about a process is the number of times each event has occurred in the life of the process up to a moment in time. More precisely, they attempt to define what class of discrete event systems may be modeled and controlled using only this minimal information. This question is of practical significance because a model requiring only such data is the simplest possible model. It is also computationally very efficient as it only requires some arithmetic operations. An example involving air-traffic control is presented. The example is worked out (almost) entirely using a counter that records the number of times each event has occurred as time goes on. The design of an active or forceful controller that ensures five operating rules is considered. I.E.

A93-13079

AN APPLICATION OF FUZZY LOGIC AND DEMPSTER-SHAFER THEORY TO FAILURE DETECTION AND IDENTIFICATION

H. KANG, J. CHENG, I. KIM, and G. VACHTSEVANOS (Georgia Inst. of Technology, Atlanta) *In* IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 2 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 1555-1560. refs
(Contract N00014-89-K-3113)
Copyright

A novel approach to failure detection and identification (FDI) is proposed which combines an analytic estimation method and an intelligent identification scheme in such a way that sensitivity to true failure modes is enhanced, while the possibility of false alarms is reduced. The authors use a real-time recursive parameter estimation algorithm with covariance resetting which triggers the FDI routine only when potential failure modes are anticipated. A possibilistic scheme based on fuzzy set theory is applied to the identification part of the FDI algorithm with computational efficiency. At the final stage of the algorithm, an index is computed—the degree of certainty-based on Dempster-Shafer theory, which measures the reliability of the decision. The FDI algorithm has been applied successfully to the detection of rotating stall and surge instabilities in axial flow compressors. I.E.

A93-13177

OUTPUT FEEDBACK CONTROL FOR OUTPUT TRACKING OF NONLINEAR UNCERTAIN SYSTEMS

PETER W. GIBBENS and MINYUE FU (Newcastle Univ., Australia) *In* IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2509-2514. refs
Copyright

The problem of robust output via dynamic output feedback for nonlinear systems which are subject to both uncertainty in system functions and input noise is addressed. The notion of beta-tracking, which refers to the property of the system output to follow a reference trajectory within a beta neighborhood in finite time, is adopted. With some matching conditions, minimum phase condition, Lipschitz bounds, and some other mild assumptions, it is shown that, if beta-tracking of a nominal system can be achieved via a linear-cone bounded state feedback controller, then similar tracking can be achieved for the nonlinear uncertain system via dynamic output feedback. The resulting controller is linear-cone bounded or can be purely linear with the tradeoff of high gain if desired. The present approach utilizes and generalizes results on robust

tracking and stabilization via state feedback and robust observer design via loop transfer recovery theory. I.E.

A93-13197
ROBUST CONTROL OF AN AEROELASTIC SYSTEM
MODELED BY A SINGULAR INTEGRO-DIFFERENTIAL
EQUATION

HITAY OZBAY (Ohio State Univ., Columbus) and JANOS TURI (Texas Univ. at Dallas, Richardson) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2682-2686. refs (Contract NSF DMS-89-07019)
 Copyright

An aeroelastic system whose state space model described by a singular integro-differential equation is considered. The focus is on the so-called indicial problem where the initial conditions are zero. A finite-dimensional controller stabilizing this infinite-dimensional system is designed. The problem of reducing the closed-loop system sensitivity to disturbances is also discussed. Frequency-domain $H(\infty)$ design techniques are used to achieve the control objectives. I.E.

A93-13230* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

NONLINEAR TIME-SERIES-BASED ADAPTIVE CONTROL
APPLICATIONS

R. R. MOHLER, V. RAJKUMAR, and R. R. ZAKRZEWSKI (Oregon State Univ., Corvallis) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2917-2919. Research supported by EPRI refs (Contract NSF ECS-89-13773; NAG1-1081; DE-BI79-90BO-08243)
 Copyright

A control design methodology based on a nonlinear time-series reference model is presented. It is indicated by highly nonlinear simulations that such designs successfully stabilize troublesome aircraft maneuvers undergoing large changes in angle of attack as well as large electric power transients due to line faults. In both applications, the nonlinear controller was significantly better than the corresponding linear adaptive controller. For the electric power network, a flexible AC transmission system with series capacitor power feedback control is studied. A bilinear autoregressive moving average reference model is identified from system data, and the feedback control is manipulated according to a desired reference state. The control is optimized according to a predictive one-step quadratic performance index. A similar algorithm is derived for control of rapid changes in aircraft angle of attack over a normally unstable flight regime. In the latter case, however, a generalization of a bilinear time-series model reference includes quadratic and cubic terms in angle of attack. I.E.

A93-13233
NEURAL-NETWORK-BASED CATASTROPHE AVOIDANCE
CONTROL SYSTEMS

RUI J. P. DEFIGUEIREDO and ALLEN R. STUBBERUD (California Univ., Irvine) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2936-2938. refs (Contract N00014-91-J-1072)
 Copyright

A novel approach based on interpolative neural networks is proposed for catastrophic fault detection and isolation, and system reconfiguration to accommodate the fault. The neural networks are from a class of recently developed interpolative neural networks, based on a generalized Fock space. The technique is designed to make use of secondary control configurations, assuming only partial system operation, as may be obtained by simulation and test results at design time (information not used by current adaptive controllers). I.E.

A93-13241
CONTROL DESIGN FOR ROBUST EIGENSTRUCTURE
ASSIGNMENT IN LINEAR UNCERTAIN SYSTEMS

ROBERT F. WILSON, JAMES R. CLOUTIER (USAF, Wright Lab., Eglin AFB, FL), and R. K. YEDAVALLI (Ohio State Univ., Columbus) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 2982-2987. refs
 Copyright

A generalized eigenstructure assignment procedure is presented for designing a controller which has the best eigenstructure achievable while simultaneously maintaining stability robustness to time-varying parametric variations. The approach taken is the constrained minimization of the difference between the actual and desired eigenstructure. This minimization is made subject to the constraints of the eigenstructure equation and the closed-loop Lyapunov equation. The capability of the formulation is illustrated in the design of a mode-decoupling roll-yaw autopilot for a generic, nonaxisymmetrical airframe. I.E.

A93-13246
FINITE MEMORY APPROXIMATIONS FOR A SINGULAR
NEUTRAL SYSTEM ARISING IN AEROELASTICITY

E. M. CLIFF, TERRY L. HERDMAN (Virginia Polytechnic Inst. and State Univ., Blacksburg), and JANOS TURI (Texas Univ. at Dallas, Richardson) /n IEEE Conference on Decision and Control, 30th, Brighton, United Kingdom, Dec. 11-13, 1991, Proceedings. Vol. 3 New York Institute of Electrical and Electronics Engineers, Inc. 1991 p. 3014-3019. Research supported by DARPA refs (Contract AF-AFOSR-89-0001; AF-AFOSR-88-0074; F49620-87-C-0016)
 Copyright

An approach to finding numerical solutions of certain initial-value problems involving infinite-delay, singular neutral differential equations is presented. Such systems arise in the study of the motions of airfoils placed in two-dimensional unsteady flows and play an important role in controller design for aircraft flutter suppression. The two-step procedure starts with truncating the infinite-delay term and is dependent on the specified initial data. For the second step, a fully discretized approximation scheme that can be used to find approximate solutions for the associated finite delay equation is outlined. I.E.

A93-13264*# National Aeronautics and Space Administration, Hugh L. Dryden Flight Research Facility, Edwards, CA.
DESIGN AND UTILIZATION OF A FLIGHT TEST
ENGINEERING DATABASE MANAGEMENT SYSTEM AT THE
NASA DRYDEN FLIGHT RESEARCH FACILITY
 DONNA L. KNIGHTON (NASA, Flight Research Center, Edwards, CA) Aug. 1992 18 p. AIAA, Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4072) Copyright

A Flight Test Engineering Database Management System (FTE DBMS) was designed and implemented at the NASA Dryden Flight Research Facility. The X-29 Forward Swept Wing Advanced Technology Demonstrator flight research program was chosen for the initial system development and implementation. The FTE DBMS greatly assisted in planning and 'mass production' card preparation for an accelerated X-29 research program. Improved Test Plan tracking and maneuver management for a high flight-rate program were proven, and flight rates of up to three flights per day, two times per week were maintained. Author

A93-13354#
RDS - A PC-BASED AIRCRAFT DESIGN, SIZING, AND
PERFORMANCE SYSTEM

DANIEL P. RAYMER (Conceptual Research Corp., Sylmar, CA) Aug. 1992 11 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4226) Copyright

RDS is an aircraft design and analysis system written primarily as an instructional aid and complement to the AIAA textbook

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'Aircraft Design: A Conceptual Approach'. RDS features a 3-D CAD module for design layout, and has analysis modules for aerodynamics, weights, propulsion, and cost. RDS includes capabilities for aircraft sizing, mission analysis, and performance analysis including takeoff, landing, rate of climb, Ps, fs, turn rate, and acceleration. RDS also provides graphical output for drag polars, L/D ratio, thrust curves, flight envelope, range parameter, and more. While RDS was written as a student analysis tool, it has proven accurate in benchmark tests, with sizing and performance results usually within about five percent of 'correct' results when given accurate aerodynamic, weights, and propulsion inputs. The RDC analysis modules for these inputs are less accurate being first-order methods, but track reasonably well with actual data. Author

A93-13420

OPTIMAL VIBRATION CONTROL FOR A FLEXIBLE ROTOR WITH GYROSCOPIC EFFECTS

AN-CHEN LEE and SONG-TSUEN CHEN (National Chiao Tung Univ., Hsinchu, Taiwan) JSME International Journal, Series III (ISSN 0914-8825) vol. 35, no. 3 Sept. 1992 p. 446-455. refs

(Contract NSCRC-80-0401-E009-04)

Copyright

The paper investigates the features of the active vibration control of flexible rotor systems with gyroscopic effects. Based on the finite-element formulation for the mathematical model of flexible rotors, an optimal independent modal-space control system and a new rotating-velocity-dependent output-feedback controller are proposed to suppress the vibration level and, thus, achieve better operating conditions. Simulation results are presented which demonstrate the effectiveness of the proposed controller. I.S.

N93-11463# Naval Air Development Center, Warminster, PA. A PRIMER ON POLYNOMIAL RESULTANTS Final Report, Mar. - Dec. 1991

RONALD F. GLEESON and ROBERT M. WILLIAMS 5 Dec. 1991 27 p

(AD-A246883; NADC-91112-50) Avail: CASI HC A03/MF A01

Nonlinearity is one of the most stubborn difficulties of contemporary engineering and science. In this paper we are concerned with a broadly useful tool, the resultant, for manipulating polynomial nonlinearities, and we review several techniques for solving systems of nonlinear polynomial equations. The resultant, a classical algebraic tool, has become much more practical recently with the advent of symbolic software (such as Mathematics and Maple) which can evaluate 10x10 symbolic determinants in a matter of minutes on a desktop computer. While much of this paper is concerned with applying resultants to systems of univariate equations, the last section considers the generalization to the multivariate situation. Nonlinear multivariate applications appear in various areas of engineering such as chaos, signal processing, circuit theory, robotics and control theory. Two illustrations of the power of the resultant formalism are provided. First, the problem of finding the coordinates on the Earth's surface viewed by each pixel of a reconnaissance aircraft camera is discussed. Second, the Lorenz model of chaos theory is considered. GRA

N93-11931*# Systems Control Technology, Inc., Palo Alto, CA. INTELLIGENT DIAGNOSTICS SYSTEMS Abstract Only

BARBARA M. MCQUISTON and RONALD L. DEHOFF /in NASA. Lyndon B. Johnson Space Center, Fifth Annual Workshop on Space Operations Applications and Research (SOAR 1991), Volume 1 p 67 Jan. 1992

Avail: CASI HC A01/MF A04

Intelligent systems have been applied to today's problems and could also be applied to space operations integrity. One of these systems is the XMAN tool designed for 'troubleshooting' jet engines. XMAN is the eXpert MAiNtenance tool developed to be an expert information analysis tool which stores trending and diagnostic data on Air Force engines. XMAN operates with a 'network topology' which follows a flow chart containing engine management information reports required by the governments

technical order procedures. With XMAN technology, the user is able to identify engine problems by presenting the assertions of the fault isolation logic and attempting to satisfy individual assertions by referring to the databases created by an engine monitoring system. The troubleshooting process requires interaction between the technician and the computer to acquire new evidence from auxiliary maintenance tests corroboration of analytical results to accurately diagnose equipment malfunctions. This same technology will be required for systems which are functioning in space either with an onboard crew, or with an unmanned system. The technology and lessons learned developing this technology while suggesting definite applications for its use with developing space systems are addressed. Author

N93-11947*# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

DESIGN OF AN ADA EXPERT SYSTEM SHELL FOR THE VHSIC AVIONIC MODULAR FLIGHT PROCESSOR Abstract Only

F. JESSE FANNING /in NASA. Lyndon B. Johnson Space Center, Fifth Annual Workshop on Space Operations Applications and Research (SOAR 1991), Volume 1 p 178 Jan. 1992

Avail: CASI HC A01/MF A04

The Embedded Computer System Expert System Shell (ES Shell) is an Ada-based expert system shell developed at the Avionics Laboratory for use on the VHSIC Avionic Modular Processor (VAMP) running under the Ada Avionics Real-Time Software (AARTS) Operating System. The ES Shell provides the interface between the expert system and the avionics environment, and controls execution of the expert system. Testing of the ES Shell in the Avionics Laboratory's Integrated Test Bed (ITB) has demonstrated its ability to control a non-deterministic software application executing on the VAMP's which can control the ITB's real-time closed-loop aircraft simulation. The results of these tests and the conclusions reached in the design and development of the ES Shell have played an important role in the formulation of the requirements for a production-quality expert system inference engine, an ingredient necessary for the successful use of expert systems on the VAMP embedded avionic flight processor. Author

N93-12258# California Univ., Davis.

COMPUTATIONAL NONLINEAR CONTROL Annual Technical Report No. 1

A. J. KRENER 31 May 1992 8 p

(Contract AF-AFOSR-0228-91)

(AD-A253547; REPT-3-448724-22529; AFOSR-92-0728TR)

Avail: CASI HC A02/MF A01

The goal of this research is to develop a computationally feasible approach to the design of compensators for nonlinear plants such as high performance aircraft and robots. The basic approach is to take parts of the current theory of nonlinear control, and extend and modify them as needed so as to develop numerical algorithms. To date the emphasis has been on a perturbational approach developed from well-established linear methodologies. We have written a MATLAB based set of algorithms which accomplish feedback linearization, input-output injection linearization and nonlinear regulation. These are incorporated into a Nonlinear-System-Toolbox which is available via telnet. GRA

N93-12346*# Boeing Co., Seattle, WA. Defense and Space Group.

FORMAL REPRESENTATION OF THE REQUIREMENTS FOR AN ADVANCED SUBSONIC CIVIL TRANSPORT (ASCT) FLIGHT CONTROL SYSTEM

DEBORAH FRINCKE (California Polytechnic State Univ., San Luis Obispo.), DAVE WOLBER (California Polytechnic State Univ., San Luis Obispo.), GENE FISHER (California Polytechnic State Univ., San Luis Obispo.), GERALD C. COHEN, and R. E. MCLEES 1 Nov. 1992 46 p

(Contract NAS1-18586; RTOP 505-64-10-07)

(NASA-CR-189699; NAS 1.26:189699) Avail: CASI HC A03/MF A01

A partial requirement specification for an Advanced Subsonic Civil Transport (ASCT) Flight Control System is described. The example was adopted from requirements given in a NASA Contractor report. The language used to describe the requirements, Requirements Specification Language (RSL), is described in a companion document. Author

N93-12538*# Boeing Military Airplane Development, Seattle, WA.

FORMAL DESIGN SPECIFICATION OF A PROCESSOR INTERFACE UNIT

DAVID A. FURA, PHILLIP J. WINDLEY (Idaho Univ., Moscow.), and GERALD C. COHEN 1 Nov. 1992 253 p
(Contract NAS1-18586; RTOP 505-64-10-07)
(NASA-CR-189698; NAS 1.26:189698) Avail: CASI HC A12/MF A03

This report describes work to formally specify the requirements and design of a processor interface unit (PIU), a single-chip subsystem providing memory-interface bus-interface, and additional support services for a commercial microprocessor within a fault-tolerant computer system. This system, the Fault-Tolerant Embedded Processor (FTEP), is targeted towards applications in avionics and space requiring extremely high levels of mission reliability, extended maintenance-free operation, or both. The need for high-quality design assurance in such applications is an undisputed fact, given the disastrous consequences that even a single design flaw can produce. Thus, the further development and application of formal methods to fault-tolerant systems is of critical importance as these systems see increasing use in modern society. Author

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PHYSICS

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

A93-10731 EVOLVING NOISE ISSUE COULD PERSIST INTO THE NEXT CENTURY

M. J. T. SMITH (Rolls-Royce, PLC, Derby, United Kingdom) ICAO Journal (ISSN 0018-8778) vol. 47, no. 8 Aug. 1992 p. 11-13. Copyright

Trends in noise control for aircraft are evaluated given the anticipated trend in incorporating turbofans in all commercial European aircraft. It is theorized that the benefits of a fleet comprised exclusively of turbofans could be offset by increases in the size and number of aircraft. The development of ultrahigh-bypass-ratio ducted fans and open-rotor propfans is expected to afford some reductions in noise generation, although the gains can be offset by increased noise from the interacting components. C.C.S.

N93-10458*# Cornell Univ., Ithaca, NY.

TILT ROTOR HOVER AEROACOUSTICS

CHARLES DAVID COFFEN Jun. 1992 193 p
(Contract NAG2-554)
(NASA-CR-177598; A-92143; NAS 1.26:177598) Avail: CASI HC A09/MF A03

The methodology, results, and conclusions of a study of tilt rotor hover aeroacoustics and aerodynamics are presented. Flow visualization and hot wire velocity measurement were performed on a 1/12-scale model of the XV-15 Tilt Rotor Aircraft in hover. The wing and fuselage below the rotor cause a complex recirculating flow. Results indicate the physical dimensions and details of the flow including the relative unsteadiness and turbulence characteristics of the flow. Discrete frequency harmonic thickness and the loading noise mechanism were predicted using

WOPWOP for the standard metal blades and the Advanced Technology Blades. The recirculating flow created by the wing below the rotor is a primary sound mechanism for a hovering tilt rotor. The effects of dynamic blade response should be included for fountain flow conditions which produce impulsive blade loading. Broadband noise mechanisms were studied using Amiet's method with azimuthally varying turbulence characteristics derived from the measurements. The recirculating fountain flow with high turbulence levels in the recirculating zone is the dominant source of broadband noise for a hovering rotor. It is shown that tilt rotor hover aeroacoustic noise mechanisms are now understood. Noise predictions can be made based on reasonably accurate aerodynamic models developed here. Author

N93-10642# Purcell (Anthony) Consultants, Luenburg (Nova Scotia).

ACOUSTIC NOISE GENERATION AT THE AIR/OCEAN BOUNDARY

ANTHONY J. PURCELL Oct. 1990 60 p
(Contract DREA-W7707-9-0036-01-OSC)
(DREA-CR-90-445; CTN-92-60388) Avail: CASI HC A04/MF A01

The downwash from a hovering aircraft generates acoustic sources at the ocean surface through the same mechanisms as wind generated ambient noise-wave breaking and spray generated radially pulsing bubbles which in turn act as dipole sources because of the pressure release ocean surface. The empirically known dependence of wind generated ambient noise on the wind velocity is used to give the acoustic source strength as a function of the downwash velocity on the ocean surface. The velocity field of the rotor downwash can be deduced through Froude-Rankine actuator disc theory combined with a cylindrical vortex model to account for the ground effect. By integrating the resulting (variable) source strength over the ocean surface, quantities such as the noise level, the received intensity per unit solid angle, and the correlation functions are completely determined. Author (CISTI)

N93-10672# National Research Council of Canada, Ottawa (Ontario). Inst. for Mechanical Engineering.

NOISE STUDIES FOR ENVIRONMENTAL IMPACT ASSESSMENT OF AN OUTDOOR ENGINE TEST FACILITY

G. KRISHNAPPA In AGARD, Combat Aircraft Noise 8 p Apr. 1992

Copyright Avail: CASI HC A02/MF A03

The potential impact of noise in the community surrounding a proposed outdoor test facility in the Ottawa area was evaluated. The test stand was planned for the testing of high performance gas turbine engines. Theoretical predictions based on the outdoor sound propagation model were made for the noise generated from a General Electric F404 engine. The results were verified by carrying measurements of noise generated from a single engine of a parked CF-18 aircraft. The measured results qualitatively confirmed the validity of theoretical predictions. However, the tests clearly demonstrated the strong influence of the atmospheric conditions in the observed noise levels in the surrounding community. The usefulness of the theoretical predictions in devising noise control measures in the test area and for the scheduling of tests in favorable weather conditions to minimize noise impact in the surrounding area were discussed. Author

N93-10673*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NON-PROPULSIVE AERODYNAMIC NOISE

WILLIAM L. WILLSHIRE, JR. and MAUREEN B. TRACY In AGARD, Combat Aircraft Noise 24 p Apr. 1992
Copyright Avail: CASI HC A03/MF A03

In the first part of the paper, the contribution of airframe noise to total aircraft noise on approach is assessed for a large current technology transport and for the same airframe powered with bypass ratio 10 engines with an additional 5 dB noise suppression applied to the fan and turbine noise sources. The airframe noise of the envisioned advanced subsonic transport is 2 EPNdB less than the largest contributor to the total aircraft noise, the fan inlet. The noise impact of the airframe noise, as measured

by noise contour area, is 1/4 that of fan noise. Further fan noise reduction efforts should not view airframe noise as an absolute noise floor. In the second part of the paper, the results from one recent cavity noise wind tunnel experiment is reported. A cavity of dimensions 11.25 in. (28.58 cm) long, 2.5 in. (6.35 cm) wide, and variable depth was tested in the Mach number range of .20 through .90. Reynolds number varied from 5 to 100 million per foot (16 to 328 million per meter). The 1/d ratio was varied from 4.4 to 20.0. The model was tested at yaw angles from 0 to 15 degrees. In general, the deeper the cavity, the greater the amplitude of the acoustic tones. Reynolds number appeared to have little effect on acoustic tone amplitudes. Tone amplitude and bandwidth changed with Mach number. The effect of yaw on acoustic tones varied with Reynolds number, Mach number, 1/h, and mode number. At Mach number 0.90, increased yaw shifted the tone frequencies of the higher modal frequencies to lower frequencies. As cavity depth decreased, the effect of yaw decreased. Author

N93-10674# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. fuer Entwurfsaerodynamik.

COMPARISON OF FLYOVER NOISE DATA FROM AIRCRAFT AT HIGH SUBSONIC SPEEDS WITH PREDICTION

JAN BOETTCHER and ULF MICHEL (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin, Germany) *In* AGARD, Combat Aircraft Noise 12 p Apr. 1992 Sponsored in part by Bundesministerium der Verteidigung
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Flyover noise measurements are evaluated for four different military jet aircraft types flying at low altitudes. Flight Mach numbers ranged from 0.5 to 0.9. The analysis shows that noise emission is caused by jet mixing and broadband shock associated noise. Based on the experimental results, existing noise prediction schemes are extended toward higher subsonic flight Mach numbers. The novel prediction schemes describe the observed acoustic signatures quite accurately. This holds for the overall sound pressure level independently of the emission angle, for sound-pressure level time histories and for one-third-octave spectra. Author

N93-10681# Illinois Inst. of Tech., Chicago. Dept. of Mechanical and Aerospace Engineering.

NOZZLE INSTALLATION EFFECTS ON THE NOISE FROM SUPERSONIC EXHAUST PLUMES

R. W. WLEZIEN *In* AGARD, Combat Aircraft Noise 11 p Apr. 1992

Copyright Avail: CASI HC A03/MF A03

The sensitivity of screech coupling in supersonic jets to nozzle installation geometry is explored as a function of nozzle shape, spacing, and orientation. The coupling phenomenon is shown to be a function of geometry for a variety of twin axisymmetric and rectangular nozzle configurations as well as for a single jet in proximity to a solid surface. Rapid plume merging or close proximity to a wall are shown to minimize the noise increment due to coupling. Twin impinging supersonic plumes experience more complex aeroacoustic interactions. The acoustic near field is dominated by screech and impingement tones, but the fuselage undersurface dynamic loads are primarily due to impingement of the unsteady upwash fountain flow on the fuselage undersurface. Author

N93-10682*# California Inst. of Tech., Pasadena.

COMBUSTION NOISE AND COMBUSTION INSTABILITIES IN PROPULSION SYSTEMS

F. E. C. CULICK, L. PAPANIZOS (Carnegie-Mellon Univ., Pittsburgh, PA.), J. STERLING, and V. BURNLEY *In* AGARD, Combat Aircraft Noise 27 p Apr. 1992 Sponsored in part by NASA, California Inst. of Technology; Navy; and AF
Copyright Avail: CASI HC A03/MF A03

This paper is concerned with some aspects of non-linear behavior of unsteady motions in combustion chambers. The emphasis is on conditions under which organized oscillations having discrete frequencies may exist in the presence of random motions. In order to treat the two types of motions together, and particularly to investigate coupling between noise and combustion instabilities,

the unsteady field is represented as a synthesis of acoustic modes having time-varying amplitudes. Each of the amplitudes are written as the sum of two parts, one associated with the random field and the remainder representing the organized oscillations. After spatial averaging, the general problem is reduced to solution of a set of second-order ordinary differential equations whose structure depends on the sorts of nonlinear processes accounted for. This formulation accommodates any physical process; in particular, terms are included to represent noise sources, although only limited modeling is discussed. Our results suggest that random sources of noise have only small effects on combustion instabilities and seem not to be a cause of unstable motions. However, the coupling between the two sorts of unsteady motions may be important as an essential process in a proposed scheme for noise control. It is now a familiar observation that many nonlinear deterministic systems are capable of exhibiting apparently random motions called 'chaos.' This is a particularly interesting possibility for systems which also executed non-deterministic random motions. In combustion chambers, a nonlinear deterministic system (acoustical motions) exists in the presence of noise produced by flow separation, turbulent motions, and energy released by combustion processes. The last part of the paper is directed to the matter of discovering whether or not chaotic motions exist in combustion systems. Analysis has not progressed sufficiently far to answer the question. We report here recent results of processing data taken in one combustor to determine the dimensions of any attractors in the motions. No evidence has been found for chaos in the strict sense, but the method seems to be an important means of investigating the nonlinear behavior of combustion systems. Author

N93-10684*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.

THE PREDICTION OF NOISE RADIATION FROM SUPERSONIC ELLIPTIC JETS

PHILIP J. MORRIS and THONSE R. S. BHAT *In* AGARD, Combat Aircraft Noise 12 p Apr. 1992
(Contract NAG1-1047)

Copyright Avail: CASI HC A03/MF A03

This paper describes the prediction of noise radiation from supersonic elliptic jets. The noise is associated with the large scale structures in the jet mixing layer. These structures are described as instability waves. The local characteristics of the instability waves are determined from a compressible, linear, analysis. The jet mean velocity and density are described in elliptic cylindrical coordinates. The local eigensolution for the instability waves is determined from a finite difference solution of the non-separable boundary value problem. This inner solution which is formulated in terms of the method of multiple scales is matched with the radiated field using the method of matched asymptotic expansions. The form of the far-field directivity is derived. Predictions are presented for the noise radiation by the several modes of instability in the elliptic jet. The radiated field is not axisymmetric and certain modes radiate strongly in the directions of the major and minor axes of the jet. The extension of the present work to other geometries and flow fields is discussed. Author

N93-10685# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin (Germany). Inst. fuer Experimentelle Stroemungsmechanik.

PREDICTION OF JET MIXING NOISE FOR HIGH SUBSONIC FLIGHT SPEEDS

ULF MICHEL and JAN BOETTCHER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany) *In* AGARD, Combat Aircraft Noise 9 p Apr. 1992
Copyright Avail: CASI HC A02/MF A03

A method for the prediction of single stream jet mixing noise in flight is presented that can be used for flight Mach numbers up to 0.9. The method is similar to the empirical SAE method. However, two important results of the theoretical scaling law of Michalke and Michel are incorporated: (1) the total noise of heated jets is separated into quadrupole and dipole noise components because

they are influenced differently by the flight Mach number and, (2) the influence of the stretching of the jet plume in flight on the overall sound pressure and the frequency of the emitted sound is considered. A relative velocity exponent law is used to correlate experimental flyover data. The correlation is based on all available data for combat aircraft with fuselage mounted engines and flight Mach numbers between 0.5 and 0.9. The difference between predictions with this new method and measured overall flyover levels is generally less than two decibels. The spectra are also well predicted. Author

N93-10688# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

MECHANISMS OF SOUND GENERATION IN SUBSONIC JETS

E. CAMPOS and F. MALLÉN /in AGARD, Combat Aircraft Noise 18 p Apr. 1992

Copyright Avail: CASI HC A03/MF A03

This paper gives an overview of some important features of the process of sound generation in subsonic jets. The outstanding aerodynamic theories are briefly reviewed and some distinguished phenomena relevant to jet noise, like both the effects of source convection and temperature are explained. Finally some mechanisms of sound generation by turbulent jets reported in the literature on the topic are examined. Author

N93-10692# Messerschmitt-Boelkow G.m.b.H., Munich (Germany). Aeroacoustics.

REDUCTION OF PROPELLER NOISE BY ACTIVE NOISE CONTROL

O. BSCHORR and D. KUBANKE /in AGARD, Combat Aircraft Noise 10 p Apr. 1992

Copyright Avail: CASI HC A02/MF A03

Active noise control, a method of cancelling noise by means of interference with a secondary anti-noise source, is now in full development. The first commercial application of this technique is in the case of active electronically controlled head sets. The next step will be the active noise cancellation in air ducts and in passenger cabins. The aim of this paper is to assess the possibilities of the anti-noise technique for reducing propeller noise. First, by a mathematical simulation the theoretical noise reduction on the ground was calculated and found to be promising for further investigations. In the case of the periodic engine and propeller noise, for example, with only a single anti-noise source, the noise foot prints of the lower propeller harmonics can be reduced by up to 10 dB. In laboratory tests the theoretical values will be confirmed experimentally. For cancellation of the periodic noise one can use synchronous anti-noise generators. Compared with the engine and propeller noise the reduction of jet noise by the anti-noise technique is much more difficult. Therefore a sensor and controlling unit are necessary because of the stochastic nature of jet noise. Since aircraft noise is a severe problem, all methods are to be considered. Author

N93-10805# Royal Aircraft Establishment, Farnborough (England).

FURTHER NOISE MEASUREMENTS IN A SLOTTED CRYOGENIC WIND TUNNEL

D. G. MABEY 13 Dec. 1990 34 p (RAE-TM-AERO-2201; BR116372) Copyright Avail: CASI HC A03/MF A01

Some noise measurements in a cryogenic wind tunnel with slotted walls at subsonic and transonic speeds are described. Pressure fluctuations were measured at three positions on the sidewall of the working section, the downstream end of the plenum chamber, and near the inlet and outlet of the first diffuser. Analysis of the measurements suggests that the diffuser noise field can be represented by the superposition of monopole, dipole, and quadrupole sources. The existence of these sources suggests that the diffuser flow may be separated for a significant portion of its length, either because of poor entry conditions or the presence of the model support strut. As expected, a small model at a small angle of incidence generally has a small effect on the noise

measurements in the working section. Recommendations are made for further research. Author

N93-11156# Centro Italiano Ricerche Aerospaziali, Naples. **NUMERICAL STUDY FOR THE STUDY OF MEDIUM SPEED INTERNAL NOISE PROBLEMS (METODI NUMERICI PER LO STUDIO DELLE PROBLEMATICHE DI RUMPRE INTERNO NEI MEZZI VELOCI)**

L. LECCE (Naples Univ., Italy), F. MARULO (Naples Univ., Italy), S. DEROSA, G. PEZZULLO, and A. PAONESSA (Alenia Spazio S.p.A., Naples, Italy) 31 Jul. 1991 23 p In ITALIAN Presented at the Symposium on High Speed Marine Vehicles (DILC-EST-TN-200; ETN-92-92409) Avail: CASI HC A03/MF A01

Specific problems of marine vehicle internal noise are summarized and a review of some numerical techniques available for vibroacoustic transport vehicle analysis is given: FEM/BEM (Finite/Boundary Element Method), and SEA (Statistical Energy Analysis). The more significant FEM is described in detail and with reference to aerospace vehicles. Practical examples of this technique are given with numerical/experimental comparison results, showing the usefulness of this technique at least for the medium to low frequency range (0 to 500 Hz). Active control of internal noise is discussed along with significant noise reduction results. ESA

N93-11204# Rolls-Royce Ltd., Derby (England). Noise Research Group.

THE DESIGN AND COMMISSIONING OF AN ACOUSTIC LINER FOR PROPELLER NOISE TESTING IN THE ARA TRANSONIC WIND TUNNEL

M. E. WOOD (Aircraft Research Association Ltd., Bedford, England) and D. A. NEUMAN 1 Dec. 1991 40 p (PNR-90880; ETN-92-92188) Copyright Avail: CASI HC A03/MF A01

An acoustic liner was designed and manufactured for use in a transonic wind tunnel to provide an acoustically acceptable environment for propeller noise testing up to high subsonic Mach number. Details of the aerodynamic design and development are presented and calibration of the liner with propeller model support systems is included. It is shown how the design of the acoustic treatment was aided by the use of a theoretical model for the tunnel reverberant field. An acoustic development program was undertaken involving horn tests to improve the quality of the liner. The success of this is demonstrated by propeller noise results. These results also provided the basis for definition of the practical acoustic regime of a lined tunnel suitable for the accurate measurement of propeller noise. ESA

N93-11370# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A CONCEPT FOR A COUNTERROTATING FAN WITH REDUCED TONE NOISE

JAMES H. DITTMAR Aug. 1992 11 p (Contract RTOP 535-03-10) (NASA-TM-105736; E-7138; NAS 1.15:105736) Avail: CASI HC A03/MF A01

As subsonic jet engine designs incorporate higher bypass ratios to reduce jet noise and increase engine cycle efficiency, the fan noise becomes a significant part of the perceived total noise. The conventional method of reducing fan tone noise is to design a low tip-speed device. An alternative approach of using a counterrotating fan with a high number of rotor blades is investigated in this report. The source of noise at the blade passing frequency of this device is the rotor-only mechanism, which is cut off for a subsonic tip speed rotor. The interaction noise occurs at twice the blade passing frequency, which, for this fan, was shifted high enough in frequency to be above the perceived noise rating range. The result was a counterrotating fan which had more potential for tone noise reduction than does the conventional fan. A potential broadband noise reduction was also indicated.

Author

N93-11620*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

LABORATORY STUDY OF EFFECTS OF SONIC BOOM SHAPING ON SUBJECTIVE LOUDNESS AND ACCEPTABILITY
JACK D. LEATHERWOOD and BRENDA M. SULLIVAN (Lockheed Engineering and Sciences Co., Hampton, VA.) Oct. 1992 28 p (Contract RTOP 537-03-21-03) (NASA-TP-3269; L-17050; NAS 1.60:3269) Avail: CASI HC A03/MF A01

A laboratory study was conducted to determine the effects of sonic boom signature shaping on subjective loudness and acceptability. The study utilized the sonic boom simulator at the Langley Research Center. A wide range of symmetrical, front-shock-minimized signature shapes were investigated together with a limited number of asymmetrical signatures. Subjective loudness judgments were obtained from 60 test subjects by using an 11-point numerical category scale. Acceptability judgments were obtained using the method of constant stimuli. Results were used to assess the relative predictive ability of several noise metrics, determine the loudness benefits of detailed boom shaping, and derive laboratory sonic boom acceptability criteria. These results indicated that the A-weighted sound exposure level, the Stevens Mark 7 Perceived Level, and the Zwicker Loudness Level metrics all performed well. Significant reductions in loudness were obtained by increasing front-shock rise time and/or decreasing front-shock overpressure of the front-shock minimized signatures. In addition, the asymmetrical signatures were rated to be slightly quieter than the symmetrical front-shock-minimized signatures of equal A-weighted sound exposure level. However, this result was based on a limited number of asymmetric signatures. The comparison of laboratory acceptability results with acceptability data obtained in more realistic situations also indicated good agreement. Author

N93-12021*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

A GENERAL INTRODUCTION TO AEROACOUSTICS AND ATMOSPHERIC SOUND Final Report
JAMES LIGHTHILL (University Coll., London, England) Oct. 1992 35 p Presented at the ICASE/NASA Langley Research Center Workshop on Aeroacoustics, 6-9 Apr. 1992 (Contract NAS1-18605; RTOP 505-90-52-01) (NASA-CR-189717; NAS 1.26:189717; ICASE-92-52) Avail: CASI HC A03/MF A01

A single unifying principle (based upon the nonlinear 'momentum-flux' effects produced when different components of a motion transport different components of its momentum) is used to give a broad scientific background to several aspects of the interaction between airflows and atmospheric sound. First, it treats the generation of sound by airflows of many different types. These include, for example, jet-like flows involving convected turbulent motions (with the resulting aeroacoustic radiation sensitively dependent on the Mach number of convection) and they include, as an extreme case, the supersonic 'boom' (shock waves generated by a supersonically convected flow pattern). Next, an analysis is given of sound propagation through nonuniformly moving airflows, and the exchange is quantified of energy between flow and sound; while, finally, problems are examined of how sound waves 'on their own' may generate the airflows known as acoustic streaming. Author

N93-12080*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

PUBLICATIONS ON ACOUSTICS RESEARCH AT THE LANGLEY RESEARCH CENTER, JANUARY 1987 - SEPTEMBER 1992

LINDA W. SUTHERLAND, comp. Sep. 1992 70 p (Contract RTOP 535-03-11-03) (NASA-TM-107674; NAS 1.15:107674) Avail: CASI HC A04/MF A01

This report is a compilation of publications from acoustics research at the Langley Research Center. The reports listed are in chronological order and summarize the research output of the

Acoustics Division for the period January 1987 - September 1992.

Author

N93-12375# National Aerospace Lab., Tokyo (Japan). Thermofluid Dynamics Div.

EVALUATION OF ACOUSTIC IMPEDANCE MODELS FOR A PERFORATED PLATE [TAKOUBAN NI TAISURU ONKYOU INPIDANSU MODERU NO HYOUKA]

MINORU WATANABE Dec. 1991 38 p In JAPANESE (ISSN 0389-4010)

(NAL-TR-1133; JTN-92-80401) Avail: CASI HC A03/MF A01

The construction formed by bonding a perforated plate to honeycomb backed by an impervious plate has been widely used to acoustically line aircraft engine ducts. Several semiempirical models have been proposed to predict the acoustic impedance of perforated plates. In this study, the impedance models were used to theoretically estimate the sound attenuations in a two dimensional duct with sheared flow. A reasonable impedance model was recommended by comparing the estimated and the experimental attenuation observed using a flow duct facility. A practical calculation method of acoustic impedance is also described. Author (NASDA)

N93-12490# United Technologies Research Center, East Hartford, CT.

INVESTIGATION OF HOT STREAK MIGRATION AND FILM COOLING EFFECTS ON HEAT TRANSFER IN ROTOR/STATOR INTERACTING FLOWS, REPORT 1 Final Report, 1 Nov. 1988 - 1 Apr. 1992

DANIEL J. DORNEY, ROGER L. DAVIS, and DAVID E. EDWARDS 1 Apr. 1992 221 p (Contract N00140-88-C-0677)

(AD-A250688; UTRC-91-29-REPT-1) Avail: CASI HC A10/MF A03

Experimental data taken from turbine engines has shown that hot streaks exiting combustors can have a significant impact upon the secondary flow and wall temperature of the first stage turbine rotor. Understanding the secondary flow and heat transfer effects due to combustor hot streaks is essential to turbine designers attempting to optimize turbine cooling systems. A numerical investigation has been performed which addresses the issues of multi-blade count ratio and three-dimensionality effects on the prediction of combustor hot streak migration in a turbine stage. The two- and three-dimensional Navier-Stokes analyses are used to predict unsteady viscous rotor-stator interacting flow in the presence of a combustor hot streak with heat transfer and film cooling. Predicted results are presented for a two-dimensional 3-stator/4-rotor and a three-dimensional 1-stator/1-rotor simulations of streak migration through a turbine stage. Comparison of these results with experimental data demonstrates the capability of the three-dimensional procedure to capture most of the flow physics associated with hot streak migration including the effects of combustor hot streaks on turbine rotor surface temperatures. GRA

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A93-11256#

FLIGHT TESTING IN THE 90'S

SEAN C. ROBERTS and WENDELL H. SHAWLER (National Test Pilot School, Mojave, CA) In AIAA Biennial Flight Test Conference, 6th, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers

Washington American Institute of Aeronautics and Astronautics
1992 p. 33-36.

(AIAA PAPER 92-4123) Copyright

An overview is presented of the National Test Pilot School organized to meet the training needs for flight test in the decade of the 90s. This training will improve the flight testing organizations and permit a safer approach to the test pilot profession. Attention is given to the test pilot and flight test engineer professional course, the developmental flight test course, the FAA certification course, and the operational test and evaluation course. R.E.P.

A93-11411

HANDLING THE LEGAL CONSEQUENCES OF AVIATION DISASTERS - PASSENGER COMPENSATION

IAN AWFORD (Barlow Lyde and Gilbert, London, United Kingdom) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 1 March 1992 p. 17-40. (ISBN 3-452-22293-4) Copyright

The present anomalous passenger legal liability position of the carrier in aircraft disasters is examined, stressing its unfairness not only to passengers but also to the carrier's codefendants. Legal liability theories affecting some of the other potential defendants in aviation disaster situations are briefly considered. It is concluded that, for a variety of reasons, that the current limitation on the liability of air carriers does not fit the modern world since it no longer has any moral, social, or economic justification. It is shown that there is an unfortunate absence of international uniformity in mode of carriage, leading to forum shopping which exacerbates the already unpredictable and disparate results that the current liability scenario produces. C.D.

A93-11412

EUROPEAN MERGER CONTROL IN THE AIR TRANSPORT INDUSTRY - COMMENTS ON THE DELTA AIR LINES/PAN AM DECISION OF THE EUROPEAN COMMISSION

DIETER G. LANGE and ANDREAS WEITBRECHT (Wilmer, Cutler & Pickering, London, United Kingdom) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 1 March 1992 p. 41-50. refs

(ISBN 3-452-22293-4) Copyright

Aspects of the European Commission's decision to allow Delta Air Lines to take over the European operations of Pan American which are of particular relevance to mergers involving European airlines are examined. Three possible ways of allocating undertakings geographically are reviewed and the definition of the relevant market for European airline mergers is addressed. The possibility that a dominant position will be created or strengthened is considered. C.D.

A93-12560

SPECIFIC EDUCATIONAL ASPECTS OF AIRPORT ENGINEERING IN SPAIN AND THE HISPANIC WORLD [ASPECTOS ESPECIFICOS DE LA FORMACION EN INGENIERIA AEROPORTUARIA EN ESPANA Y EL AMBITO HISPANICO]

MARCOS GARCIA CRUZADO (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) Ingenieria Aeronautica y Astronautica (ISSN 0020-1006) no. 329 Oct. 1992 p. 43-45. In Spanish.

Copyright

A historic overview of airport design and engineering in Spain is given emphasizing technical progress and the potential for collaboration with other Spanish speaking countries. The historical requirements for professional competence in the field are examined to demonstrate the rationales behind established pedagogical plans for Spanish airport engineers. Specific classes are discussed in the context of the theoretical and practical demands of airport design, and a three-course program is proposed for airport-engineering students following general preparation. Courses in propulsion, air navigation, geodesy, airport planning, construction techniques, and management are among the course types in the three-level program. C.C.S.

A93-12718

CRITICAL CONSIDERATIONS ON EUROPEAN AIR TRANSPORT POLITICS [KRITISCHE ERWAEGUNGEN ZUR EUROPAEISCHEN LUFTVERKEHRSPOLITIK]

ULRICH MEIER (Deutsche Lufthansa AG, Hamburg, Germany) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 3 Sept. 1992 p. 203-218. In German. refs

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Various aspects of air transport politics in the EC are considered. The politics involved in economic competition and in air traffic-related infrastructure are emphasized. The effects of this politics on the development of the EC and on its relations with other countries and international organizations are examined. C.D.

A93-12719

SOUTH AMERICAN LATEST DEVELOPMENTS IN THE AIR LAW AND AIR POLICY FIELDS

ELIZABETH M. FREIDENBERG (Freidenberg and Freidenberg, Buenos Aires, Argentina) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 3 Sept. 1992 p. 219-225.

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The effect on air law and air policy of recent developments in South America are addressed. The Mercosur Treaty between Argentina, Paraguay, Uruguay, and Brazil for establishing a common market is considered along with the effect of the privatization and deregulation process now going on in South America. The most relevant rules of a proposed World Aviation Code now in process of publication are presented. C.D.

A93-13363#

TEACHING AIRCRAFT PRELIMINARY DESIGN - THE FIRST THREE YEARS

JOSE L. RODRIGUEZ (Embry-Riddle Aeronautical Univ., Daytona Beach, FL) Aug. 1992 12 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4257) Copyright

Pedagogical issues related to teaching aircraft preliminary design are discussed to develop the basis for an effective design-education methodology. The conceptual nature of preliminary design is contrasted with the analytical character of the engineering curriculum that serves as the foundation for the students in question. Specific attention is given to the differences between industry and academic approaches to aircraft preliminary design. Lessons learned during the actual educational process are described anecdotally with emphasis placed on the requirements for the design presentation. Model building and testing in wind tunnels are shown to be important pedagogical tools, although these methods are constrained by time considerations. Industry cooperation, the expansion of aircraft tables, and extended design problems are identified as key initiatives for more effective teaching. C.C.S.

A93-13369#

GENERAL AVIATION TURBINE MARKETS - AN ECONOMIC OVERVIEW

GERALD MCDUGALL, DONG CHO, and PHILIP L. HERSCH (Wichita State Univ., KS) Aug. 1992 15 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4191) Copyright

A survey of markets for the general aviation industry is undertaken to evaluate changes and possible directions in the turbine sector and related areas. Trends in the shipment and use of turboprop and jet aircraft are examined, and peak turbine production is identified for the period around 1981. A model of general aviation is applied to the analysis of the turbine market, and the structure of the industry shows that key changes have occurred recently. Important links are identified that connect the markets for new and used aircraft, and fleet expansion is shown to be slowing. The U.S. domestic market for turboprop technologies is expected to grow by a maximum of eight percent annually. The general aviation turbine industry is expected to rely increasingly

on business jet activity for continued growth. The maturing U.S. domestic market demonstrates the need for new products and contained price increases for future growth of the domestic fleet.
C.C.S.

A93-13423

THE CREATION OF A COMMUNITY CABOTAGE AREA IN THE EUROPEAN COMMUNITY AND ITS IMPLICATIONS FOR THE US BILATERAL AVIATION SYSTEM

JEFFREY R. PLATT Air & Space Law (ISSN 0927-3379) vol. 17, no. 4-5 Sept. 1992 p. 183-198. refs
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This paper reviews the rules in the European Community concerning air transport, the legality of the cabotage area under the Chicago Convention, U.S. remedies to the violation of that convention, and the merits of the various ways this problem can be resolved. The creation of a Community cabotage area would mean that all the traffic within and between Member States would be considered to be the equivalent of cabotage and therefore reserved to Community carriers.
R.E.P.

A93-13424

AIR TRANSPORT WITHIN THE EUROPEAN SINGLE MARKET - HOW WILL IT LOOK AFTER 1992? A SUGGESTED VIEW ON THE FUTURE

RONALD SCHMID (Aero Lloyd Flugreisen GmbH & Co., Frankfurt am Main, Germany) Air & Space Law (ISSN 0927-3379) vol. 17, no. 4-5 Sept. 1992 p. 199-205. refs
Copyright

An overview is presented of the air transport market that is beginning to make preparations for the new situation that will exist from 1993 by forming alliances of many different kinds. Economists take the view that depression is or could be a consequence of a deregulated market economy. In an attempt to avoid such consequences one should not set aside all regulations but instead only those that prevent or hinder the development of competition.
R.E.P.

N93-10610# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.

AGARD INDEX OF PUBLICATIONS, 1989-1991 [INDEX DES PUBLICATIONS, 1989-1991]

Jul. 1992 520 p
(AGARD-INDEX-89-91; ISBN-92-835-0682-0) Copyright Avail: CASI HC A22/MF A04

This volume provides abstracts and indexes for AGARD unclassified publications published during the period 1989-1991. Full bibliographical citations and abstracts for all the documents in this publication are given in the abstract section, which is organized in the major subject divisions and specific categories used by NASA in abstract journals and bibliographies. The major subject divisions are listed, together with a note for each that defines its scope and provides any cross-references. Category breaks in the abstract section are identified by category number and title, and a scope note. Within each category, the abstracts are arranged by series and year. Six indexes -- subject (based on NASA Thesaurus nomenclature), personal author, corporate source, panel, report/accession number, and accession number -- are included. Sample entries are shown on the first page of each index.
Author

N93-10815*# National Aeronautics and Space Administration, Washington, DC.

INDEX TO NASA NEWS RELEASES AND SPEECHES, 1991

Apr. 1992 67 p
(NASA-TM-108004; NAS 1.15:108004) Avail: CASI HC A04/MF A01

This issue of the annual index to NASA Releases and Speeches contains a listing of news releases distributed by the Office of Public Affairs, NASA Headquarters, and a selected listing of speeches presented by members of the Headquarters staff during

1991. The index is arranged in six sections: Subject Index, Personal Name Index, News Release Number Index, Accession Number Index, and Speeches and News Releases Indices.
R.L.B.

N93-10872*# National Aeronautics and Space Administration, Washington, DC.

INDEX TO NASA NEWS RELEASES AND SPEECHES, 1990

Apr. 1991 62 p
(NASA-TM-108003; NAS 1.15:108003) Avail: CASI HC A04/MF A01

This issue of the annual Index to NASA News Releases and Speeches contains a listing of news releases distributed by the Office of Public Affairs, NASA Headquarters, and a selected listing of speeches presented by members of headquarters staff during 1990. The index is arranged in six sections: Subject Index, Personal Names Index, News Release Number Index, Accession Number, Speeches, and New Releases Indices.
R.L.B.

N93-11710# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.

DIRECTORY OF FACTUAL AND NUMERIC DATABASES OF RELEVANCE TO AEROSPACE AND DEFENCE R AND D [REPertoire DE BASES DE DONNEES FACTUELLES OU NUMERIQUES D'INTERET POUR LA R ET D]

Jul. 1992 110 p
(AGARD-R-777; ISBN-92-835-0680-4) Copyright Avail: CASI HC A06/MF A02

Information is presented on nearly 100 unclassified factual or numeric databases of potential interest to aerospace and defense research and development. Information given in this directory includes the name of the organization and a point of contact, the title of the databank and the type of data included, a description of its coverage, information on the form of output available, and details of software used. The directory is listed in order by NASA subject category. This publication was sponsored by the Technical Information Panel of AGARD.
Author

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GENERAL

A93-11300

HISTORY OF AERIAL POLAR NAVIGATION

JOSEPH N. PORTNEY (Litton Industries, Guidance and Control Systems Div., Woodland Hills, CA) Navigation (ISSN 0028-1522) vol. 39, no. 2 Summer 1992 p. 255-264. refs
Copyright

A review is presented of the evolution of aerial polar navigation from the first attempt to the present time. The validity of the Byrd/Bennett first aerial conquest of the North Pole, using solely a mariner's sextant (with a bubble level), sun compass and drift sight is also resolved.
R.E.P.

N93-11100* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

WINDS OF CHANGE: EXPANDING THE FRONTIERS OF FLIGHT. LANGLEY RESEARCH CENTER'S 75 YEARS OF ACCOMPLISHMENT, 1917-1992

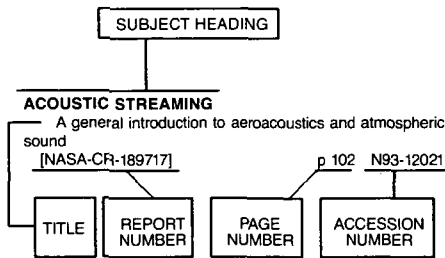
JAMES SCHULTZ 1992 146 p LIMITED REPRODUCIBILITY: More than 20 percent of this document may be affected by color photographs original contains color illustrations
(NASA-NP-130; NAS 1.83:130; ISBN-0-16-037924-5) Avail: CASI HC A07; SOD HC; 52 functional color pages

This commemorative volume highlights in pictures and text seventy five years of accomplishments of the Langley Research Center. The introductory matter features wind tunnels and their contribution to the development of aeronautics. A chronological

survey details four different periods in Langley's history. The first period, 1917-1939, is subtitled 'Perfecting the Plane' which details Langley's contribution to early aeronautics with examples from specific aircraft. The second period, 1940-1957, focuses on the development of military aircraft during and after World War II. The third period, 1958-1969, tells the story of Langley's involvement with NASA and the satellite and Apollo era. The fourth period, entitled 'Charting New Courses: 1970-1992 and Beyond', treats various new topics from aerospace planes to Mars landing, as well as older topics such as the Space Shuttle and research spinoffs.

R.L.B.

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence.

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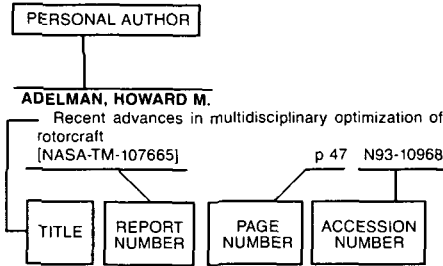
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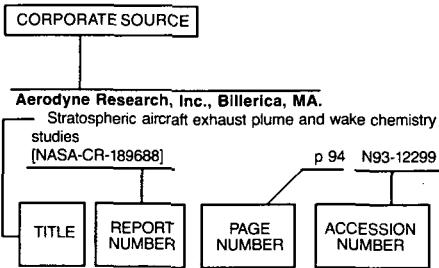
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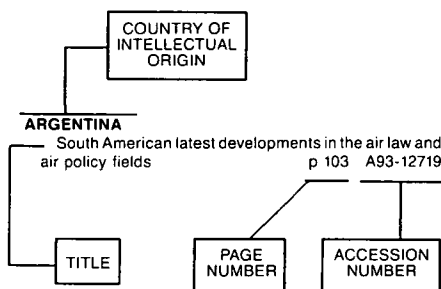
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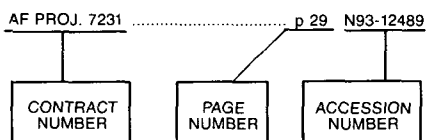
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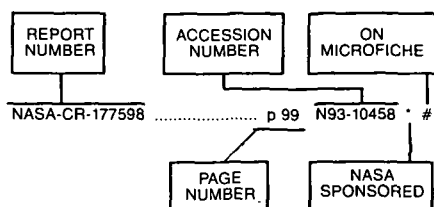
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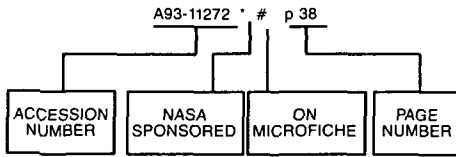
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