NASA SP-7037 (281)
August 1992

P-167

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
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NASA SP-7037 (281)
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AERONAUTICAL ENGINEERING

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

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 596 reports, journal articles, and other documents originally announced in July 1992 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N92-22096 — N92-24070
IAA (A-10000 Series)	A92-32535 — A92-36524

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

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

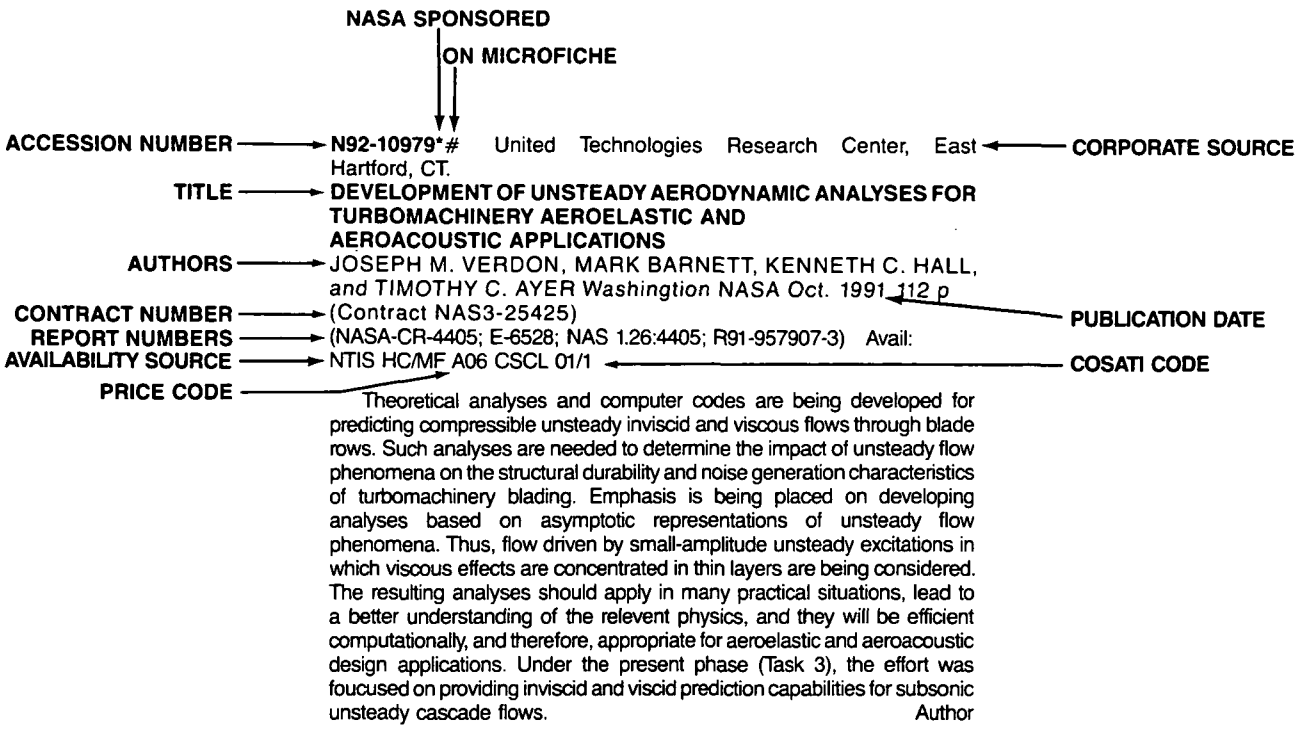
Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1992 will be published in early 1993.

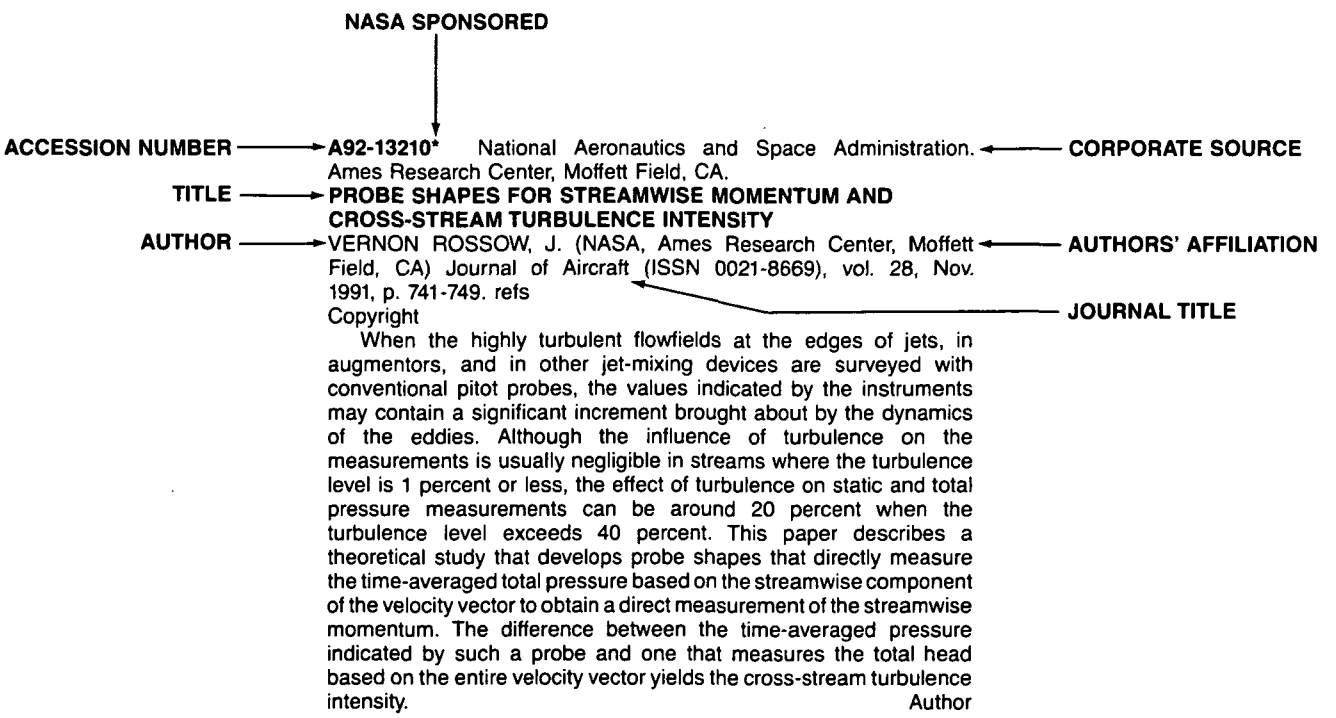
Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 281)

August 1992

01

AERONAUTICS (GENERAL)

A92-33198#
SYSTEMS ENGINEERING AS APPLIED TO THE BOEING 777
T. J. PETERSEN and P. L. SUTCLIFFE (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 6 p.
(AIAA PAPER 92-1010) Copyright

The paper discusses the application of systems engineering in the development of the Boeing 777. Discussions are included on what is systems engineering, why a more explicit 'system' approach is necessary, the basic organizational environment during an airplane development and what systems engineering approaches are being applied. Author

A92-33254#
AN ALTERNATIVE SOURCE OF FLIGHT TEST SERVICES
WILLIAM G. SCHWEIKHARD and PAUL A. BAKER (KohIman Systems Research, Inc., Lawrence, KS) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 7 p.
(AIAA PAPER 92-1088)

The decision to conduct in-house flight testing or contract for such services with an independent organization is presently approached from the standpoint that the economic viability of in-house efforts are fundamentally conditioned by ongoing costs that accumulate between major flight test schedules, especially in staffing levels. A framework is developed for the determination as to when an independent flight-test organization should be resorted to. The character of the organization thus contracted is also treated. O.C.

A92-33339#
DAMAGE TOLERANCE AND REPAIR EXPERIENCE OF COMPOSITE STRUCTURES
NIKOLAOS CARAVASOS (Boeing Co., Helicopters Div., Philadelphia, PA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p. refs
(AIAA PAPER 92-1256) Copyright

The advantages of advanced composite structures regarding damage tolerance are summarized, and a pragmatic approach to composite structures repairability is presented. Tests on various structural composite components (rotor blades, flex straps, and major structures) for the CH-47, V-22, YUH-61, and Model 360 programs reveal excellent damage fatigue characteristics of the composites. After sustaining armor piercing and high explosive projectile damage, these components continued to carry flight loads. Field repairability of composite components has proven to be achievable and successful in returning structural integrity to the damaged part. These materials are considered to be superior to metals in terms of increased capability to survive ballistic hits, improve mission and safety reliability, and lower maintenance. O.G.

A92-33430
AN AIRCRAFT MANUFACTURER'S PERSPECTIVE
O. F. BLEEKER and E. JESSEE (Fokker Aircraft, Amsterdam, Netherlands) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 91-100.
Copyright

The viable aircraft proposition for the 2000 year market developed by Fokker Aircraft, Netherlands, is discussed with particular attention given to air transport market and air traffic management developments. The future 50-80 passenger air transport mission is characterized by 150-300 nautical miles, at operating cost levels of current turbo-propeller aircraft, with excellent dependability and high productivity. Cost, speed, and time are the major factors in the future aircraft proposition, but the time aspect is considered to be a key element in a successful regional airline market and it is in this area where manufacturers, operators, and the air traffic management have to coordinate their efforts to provide solutions. O.G.

A92-33460
AUSTRALIAN AERONAUTICS, 1989-90
Mascot, Australia, Royal Aeronautical Society in Australia, 1991, 79 p. For individual items see A92-33461 to A92-33463.

The present overview of Australian aeronautics encompasses issues of significance in the aerospace sector emphasizing the major issues facing the industrial sector, references to the existing and future air-transport considerations, descriptions of specific military projects, and reviews of research projects, legal concerns, and aeronautics history. Specific issues addressed include a review of aircraft production at GAF/ASTA, economic development and the roles of government and industry, an illustration of the BAe1000 aircraft, a high-density jet for nonstop transcontinental flights, a Navy helicopter project, and air-traffic control in the next century. Also addressed are Australian aerospace research and technology, the law in Australia relating to negligence of aircrew and engineers, the development of several historical aircraft, and the history of the early Australian airline industry. C.C.S.

A92-33461
NEW WAY OF FLYING (1990 SIR CHARLES KINGSFORD SMITH LECTURE)
BERNARD ZIEGLER (Airbus Industrie, Blagnac, France) IN: Australian aeronautics, 1989-90. Mascot, Australia, Royal Aeronautical Society in Australia, 1991, p. 1-6.

Changes in aerospace technology and aviation in general are examined in this review of the requirements of air transportation. Specific attention is given to system cost and efficiency, passenger comfort, environmental constraints, and flight safety. Flight-control technology is shown to be advancing in the fields of electronics-assisted aerodynamic stability, and some examples of novel optronic and electronic systems are examined. The importance of effective flight scheduling and traffic control are mentioned, and the role of automatic systems in flight safety is analyzed. The role of automatic systems is characterized by the three subgroups of regulation, protection, and piloting. It is concluded that automatic systems can be incorporated to a greater degree in existing and developing aircraft, and that automation can improve many of the characteristics of air transport. C.C.S.

A92-33462
HALFWAY AROUND THE WORLD IS FAR ENOUGH
DAVID MASSY-GREENE (Qantas Airways, Ltd., Sydney, Australia) IN: Australian aeronautics, 1989-90. Mascot, Australia, Royal Aeronautical Society in Australia, 1991, p. 23-26.

Long-range commercial aviation is considered from the historical and technological perspectives of the Australian aviation industry. The use of flying boats in the 1930s and 1940s is described as an introduction to the present nonstop service between Australia and England. The assumptions and constraints associated with these 24-hr flights are listed with attention given to optimizing route efficiency and aircraft weight. The original flight parameters for the London/Sydney route include a track distance of 9639 nautical miles, a total aircraft weight of about 385,000 lbs, with a fuel capacity of 57,785 gallons. Presently the typical corresponding parameters include a cruising speed of Mach 0.80-0.85, total fuel of 183,500 kgs, and an actual brake-release weight of 357,866 kgs. Anecdotal data are given regarding common problems associated with typical long-range flights, and record times for the long-range flights are discussed. C.C.S.

A92-34775
TAKE IT ALL OFF - WITH WATER
ALAN S. BROWN Aerospace America (ISSN 0740-722X), vol. 30, April 1992, p. 48, 49.
Copyright

A review is presented of some of the more complex and costly methods employed to remove eroded coatings of used machine parts and a description of a new method using high-pressure waterjet stripping. In this technique, intensifiers boost water pressure to 50-60 ksi, driving it through minute orifices at Mach 3 with a force powerful enough to shatter most metal and ceramic coatings. R.E.P.

A92-35574
REMOVING AIRCRAFT SURFACE COATINGS
Aerospace Engineering (ISSN 0736-2536), vol. 12, no. 4, April 1992, p. 9-11.
Copyright

The paper discusses the details of the plastic media blasting (PMB) process for removing coatings from aircraft surfaces, which represents a fast, safe, and economical alternative to such conventional processes as the use of chemical strippers, burning, or sandblasting or sanding. It was found that, under select operating conditions, PMB can be used to strip protective coatings from fiberglass, graphite, and Kevlar substrates, without sustaining fiber breakout or visible surface damage; that PMB does not etch, warp, stretch, or remove any metal; and that it will not harm bearings, seals, or other components. I.S.

A92-35575
WATERJETS FOR REMOVING ENGINE COATINGS
Aerospace Engineering (ISSN 0736-2536), vol. 12, no. 4, April 1992, p. 13, 14.
Copyright

The details of water-jet coating removal process for routine cleaning of aircraft components are described with special attention given to the components of a coating removal system for use on jet engine components. It is pointed out that water-jet coating removal eliminates the use of hazardous chemicals; moreover, the incorporation of filtering subsystems into a coating removal system results in more effective control of waste coating material. I.S.

A92-35727
SMART STRUCTURES FOR HELICOPTERS
S. HANAGUD, G. L. N. BABU, C. C. WON, and M. B. OBAL (Georgia Institute of Technology, Atlanta) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. refs
(Contract DAAG29-82-K-0094)

In this paper, applications of smart or adaptive structure concepts to helicopter structures are discussed. Definitions of smart, adaptive or intelligent structures and their application to vibration suppression, health monitoring of structures and possible performance improvement are discussed. Available sensors, actuators and their application to a specific problem of health monitoring, a specific problem of vibration control by use of the concept of adaptive structure are presented. Author

A92-35918
ENGINE MAINTENANCE TECHNOLOGY AND ITS DEVELOPMENT
SHIN KOGANE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 224-228. In Japanese. refs

Monitoring technology for aircraft engines is presented. The aircraft integrated monitoring system (AIMS), the aircraft condition monitoring system (ACMS), the central maintenance computer system (CMCS), and the ARINC communication addressing and reporting system (ACARS) are discussed. Y.P.Q.

A92-35926
SOCIETY OF FLIGHT TEST ENGINEERS, ANNUAL SYMPOSIUM, 21ST, GARDEN GROVE, CA, AUG. 6-10, 1990, PROCEEDINGS
Symposium sponsored by Society of Flight Test Engineers, Boeing Aircraft Co., Endevco, et al. Lancaster, CA, Society of Flight Test Engineers, 1990, 300 p. For individual items see A92-35927 to A92-35953.
Copyright

The present conference on flight testing encompasses avionics, flight-testing programs, technologies for flight-test predictions and measurements, testing tools, analysis methods, targeting techniques, and flightline testing. Specific issues addressed include flight testing of a digital terrain-following system, a digital Doppler rate-of-descent indicator, a high-technology testbed, a low-altitude air-refueling flight-test program, techniques for in-flight frequency-response testing for helicopters, limit-cycle oscillation and flight-flutter testing, and the research flight test of a scaled unmanned air vehicle. Also addressed are AV-8B V/STOL performance analysis, incorporating pilot-response time in failure-case testing, the development of pitot static flightline testing, targeting techniques for ground-based hover testing, a low-profile microsensor for aerodynamic pressure measurement, and the use of a variable-capacitance accelerometer for flight-test measurements. C.C.S.

N92-22659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESEARCH AND TECHNOLOGY, 1991
1991 169 p
(NASA-TM-105320; E-6677; NAS 1.15:105320) Avail: NTIS HC/MF A08 CSCL 01/2

NASA Lewis' research and technology accomplishments are summarized for the fiscal year 1991. Approximately 150 articles are presented which were submitted by the technical directorates. There are six major sections: Aeronautics; Aerospace technology; Space flight systems; Space Station Freedom; Engineering and Computational support; and Lewis Research Academy. A table of contents by subject was developed to assist the reader in finding articles of special interest. For each article, a Lewis contact person is identified, and where possible, a reference document is listed so that additional information can be easily obtained. The diversity of topics attests to the breadth of research and technology being pursued and to the skill mix of the staff that makes it possible. Author

02

AERODYNAMICS

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

A92-33206#
AN INVERSE METHOD FOR THE DESIGN OF TRANSONIC WINGS
D. H. SILVA (Embraer - Empresa Brasileira de Aeronautica, S.A., Sao Jose dos Campos, Brazil) and L. N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(AIAA PAPER 92-1025) Copyright

A computational code for the analysis and design of thick swept transonic wing configurations is presented. The flowfield is computed by solving the steady three-dimensional full potential equation using a strongly implicit approximate factorization algorithm. The design mode uses an extension of the classical Garabedian McFadden inverse method. The present method was used to perform the transonic analysis of a wing-alone configuration and the numerical results were compared to experimental data. The same wing configuration was redesigned, showing a substantial improvement of its aerodynamic efficiency at transonic conditions. Author

A92-33240*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LOW-SPEED CRUISE AERODYNAMICS OF THE STOPPED ROTOR/DISK ROTORCRAFT CONCEPT
STEPHEN M. SWANSON (NASA, Ames Research Center; Sterling Software, Inc., Moffett Field, CA) and ROBERT H. STROUB (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 14 p. refs
(AIAA PAPER 92-1067) Copyright

A low-speed wind tunnel test was completed in support of ongoing conceptual design studies of the Stopped Rotor/Disk rotorcraft concept. A one-fifth scale model was tested in the NASA Ames Low-Speed 7- by 10-Foot Wind Tunnel #1 to evaluate the low-speed cruise performance. The primary test objective was to compare performance characteristics for three possible conceptual designs of the Stopped Rotor/Disk cruise configuration: the large hub fairing (disk) alone, the disk/extended blades configuration, and the disk/conventional wing configuration. Results showed that the disk/extended blades configuration was the most efficient in low-speed cruise. Other test objecives included making parametric changes by varying the geometry of the disk and by varying the extended blade incidence angles. Studies were also conducted to examine the aerodynamic interaction between the disk and a conventional wing. An examination was made into the effects of the disk on static longitudinal stability. The wake generated by the disk impinged on a T-tail of the model and thus degraded longitudinal stability. Alternative tail geometries are required in order to improve the concept's static stability. Author

A92-33314#
APPLICATIONS OF BUSEMANN INLET DESIGNS FOR FLIGHT AT HYPERSONIC SPEEDS
D. M. VAN WIE (Johns Hopkins University, Laurel, MD) and S. MOLDER (Ryerson Polytechnical Institute, Toronto, Canada) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 13 p. refs
(AIAA PAPER 92-1210) Copyright

The Busemann inlet is an axisymmetric, internal contraction inlet which has very low inviscid losses as well as a small ratio of flow cross-sectional area to wetted surface area. The procedure used in the design of Busemann inlet is presented and sample inlet designs are generated. Verification of the basic Busemann inlet flowfield is shown in test results obtained at Mach 8 in the Joint Ryerson/University of Toronto gun tunnel and in the Calspan 48-in shock tunnel. Modifications to the Busemann inlet design are also discussed including tandem Busemann and Busemann-cone inlet designs. The application of streamline tracing in Busemann inlet flowfields for the generation of hypersonic powered vehicles designs is discussed. Examples of the streamline tracing technique are provided. Author

A92-33320*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DESIGN AND ANALYSIS OF REENGINE BOEING 727-100 CENTER INLET S DUCT BY A REDUCED NAVIER-STOKES CODE
PAO S. HUANG, ANTONIO PICCOLO, WILLIAM PASCHAL (Dee Howard Co., San Antonio, TX), and BERNHARD H. ANDERSON (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 8 p. refs
(AIAA PAPER 92-1221) Copyright

This paper describes the application of a three-dimensional reduced Navier-Stokes code to perform design and analysis of the reengine Boeing 727-100 center engine inlet S duct. This computer code is shown to be cost effective, accurate and easy to use to design the optimal S duct geometries, predict its aerodynamic performance and provide the detailed flowfield information. Author

A92-34466#
SUBCRITICAL FLUTTER CHARACTERISTICS OF A SWEPT-BACK WING IN A TURBULENT SUPERSONIC FLOW - COMPARISON BETWEEN ANALYSIS AND EXPERIMENT
HIROSHI TORII (Meijo University, Nagoya, Japan) and YUJI MATSUZAKI (Nagoya University, Japan) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1870-1877. refs
(AIAA PAPER 92-2393) Copyright

Using FEM, subcritical flutter characteristics of a cantilever swept-back wing which was tested in a turbulent increasing supersonic flow are investigated. Comparison between the nonstationary analysis and the experiment shows that the variance of the estimated Jury's stability parameter of the wing in a turbulent flow decreases toward zero as the dynamic pressure approaches the flutter boundary, whereas the variance of the estimated damping remains large. The flutter boundary is predictable by the intersection of the upper straight line of the envelope enclosing the scattered values of Jury's (1964) stability parameter with the horizontal coordinate. The flutter prediction method based on Jury's stability parameters is more effective in practical application with flow turbulence than the conventional damping method. Author

A92-34469*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NACA 0012 BENCHMARK MODEL EXPERIMENTAL FLUTTER RESULTS WITH UNSTEADY PRESSURE DISTRIBUTIONS
JOSE A. RIVERA, JR., BRYAN E. DANSBERRY, ROBERT M. BENNETT, MICHAEL H. DURHAM, and WALTER A. SILVA (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1898-1908. refs
(AIAA PAPER 92-2396) Copyright

The Structural Dynamics Division at NASA Langley Research Center has started a wind tunnel activity referred to as the Benchmark Models Program. The primary objective of the program is to acquire measured dynamic instability and corresponding pressure data that will be useful for developing and evaluating aeroelastic type CFD codes currently in use or under development. The program is a multi-year activity that will involve testing of several different models to investigate various aeroelastic phenomena. This paper describes results obtained from a second wind tunnel test of the first model in the Benchmark Models Program. This first model consisted of a rigid semispan wing having

a rectangular planform and a NACA 0012 airfoil shape which was mounted on a flexible two degree-of-freedom mount system. Experimental flutter boundaries and corresponding unsteady pressure distribution data acquired over two model chords located at the 60 and 95 percent span stations are presented. Author

A92-34497#
CONVERGENCE OF SUBSONIC UNSTEADY AERODYNAMICS EVALUATED BY A FINITE ELEMENT CONCEPT BASED ON HUYGEUNS' WAVE PROPAGATION
JACK M. II (Boeing Co., Seattle, WA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2167-2179. refs
(AIAA PAPER 92-2502) Copyright

This paper describes a study of the wavy character of the oscillatory pressure distribution refering to the Huygen's wave propagation and the acoustic Doppler effect, which are inherent to the aerodynamic influence coefficient method. Once the enigmas of the wavy and fluctuating pressures on the lifting surface in these regimes are clarified, the criteria of the occurrence of the phenomena are determined. The criteria are extended to determine the maximum dimension of the chordwise finite element grid placed on the lifting surface in the flow environment. Author

A92-34498*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXTENDING A TRANSONIC SMALL DISTURBANCE CODE TO TREAT SWEPT VERTICAL SURFACES
MICHAEL D. GIBBONS (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2193-2202. Research sponsored by NASA. refs
(AIAA PAPER 92-2503)

A flexible-swept vertical surface capability has been developed and implemented within the CAP-TSD transonic small disturbance (TSD) code. The new capability required a modification to the TSD equation and a grid transformation for swept vertical surfaces. Modifications to the vertical surface boundary conditions allow it to be treated as a flexible surface. The new capability extends the range of problems which the code can treat. In order to assess the accuracy of the modifications, calculations were performed for a rectangular T-tail configuration and an AGARD T-tail configuration. Unsteady forces and moments are presented for the rectangular T-tail oscillating in yaw for a range of reduced frequencies. Comparisons are presented with linear theory and experiment. Steady and unsteady surface pressures are presented for the AGARD T-tail along with generalized aerodynamic forces. Comparisons are made with linear theory. The comparisons demonstrate the accuracy of the vertical surface modifications. Author

A92-34499# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
UNSTEADY TRANSONIC EULER SOLUTIONS USING FINITE ELEMENTS
GARY A. DAVIS and ODDVAR O. BENDIKSEN (California, University, Los Angeles) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2203-2213. refs
(Contract NCC2-374; NAS3-25574)
(AIAA PAPER 92-2504) Copyright

A finite element solution of the unsteady Euler equations is presented and demonstrated for 2D airfoil configurations oscillating in transonic flows. Computations are performed by spatially discretizing the conservation equations using the Galerkin weighted residual method and then employing a multistage Runge-Kutta scheme to march forward in time. A mesh deformation scheme has been developed to efficiently move interior points in a smooth fashion as the airfoil undergoes rigid body pitch and plunge motion. Both steady and unsteady results are presented, and a comparison is made with solutions obtained using finite-volume techniques. The effects of using either a lumped or consistent mass matrix are presented; the finite element method provides an accurate solution for unsteady transonic flows about isolated airfoils. Author

A92-34501#
UNSTEADY AERODYNAMIC CHARACTERISTICS OF A DUAL-ELEMENT AIRFOIL
ISMAIL H. TUNCER and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2225-2233. refs
(Contract N62269-90-C-0246)
(AIAA PAPER 92-2508) Copyright

Unsteady aerodynamic behavior and load characteristics of a VR-7 slat/airfoil combination oscillating sinusoidally between 5 and 25 degrees have been studied. The unsteady, compressible Navier-Stokes equations are solved on a multi-block grid using an approximate factorization finite difference scheme. In the case of a single airfoil, a massive flow separation and formation of a strong vortex is observed. The vortex induced suction and the shedding of the vortex into the wake is responsible for high aerodynamic loads and the subsequent stall of the airfoil. In the case of a slat/airfoil combination, the suction peak at the leading edge of the airfoil is reduced significantly in comparison to the single airfoil. Flow separation is confined to the trailing edge of the main airfoil and the formation of a strong vortical structure is not observed. The slat/airfoil combination does not experience a massive flow separation and the aerodynamic lift does not undergo the characteristic deep dynamic stall hysteresis loops. Author

A92-34517#
CHAOTIC AND NONLINEAR DYNAMIC RESPONSE OF AEROSURFACES WITH STRUCTURAL NONLINEARITIES
ANTHONY J. HAUENSTEIN, JAMES A. ZARA (McDonnell Douglas Missile Systems Co., Saint Louis, MO), WALTER EVERSMAN, and IYAD K. QUMEI (Missouri-Rolla, University, Rolla) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2367-2375. refs
(Contract F49620-88-C-0047)
(AIAA PAPER 92-2547) Copyright

An analytical and experimental investigation of aerodynamic surfaces with discrete root structural nonlinearities was performed. This paper discusses the design, development, analysis, and wind tunnel testing of the rigid aerosurface used. The objective of the activity was to assess the influence of various system parameters and aerodynamic conditions on nonlinear response, including chaotic behavior. Five types of response were observed in both analytical and experimental results. These were damped decay, chaos, nonharmonic response, periodic limit cycle, and flutter. The type and intensity of the response is highly dependent on magnitudes of freeplay and the degree of coupling between aerosurface pitch and plunge motion, and airspeed. The overall correlation between analytical and experimental results was generally good. Author

A92-34597*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DETERMINING DESIGN GUST LOADS FOR NONLINEAR AIRCRAFT SIMILARITY BETWEEN METHODS BASED ON MATCHED FILTER THEORY AND ON STOCHASTIC SIMULATION
ROBERT C. SCOTT (NASA, Langley Research Center, Hampton, VA), ANTHONY S. POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA), and BOYD PERRY, III (NASA, Langley

Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3131-3138. refs
(AIAA PAPER 92-2369) Copyright

This is a work-in-progress paper. It explores the similarity between the results from two different analysis methods - one deterministic, the other stochastic - for computing maximized and time-correlated gust loads for nonlinear aircraft. To date, numerical studies have been performed using two different nonlinear aircraft configurations. These studies demonstrate that results from the deterministic analysis method are realizable in the stochastic analysis method. Author

A92-34683* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AEROBRAKE AEROTHERMODYNAMIC ENVIRONMENT PREDICTIONS IN SUPPORT OF THE AEROASSIST FLIGHT EXPERIMENT
JOHN F. FAY, GANESH N. KUMAR (NASA, Marshall Space Flight Center; Sverdrup Technology, Inc., Huntsville, AL), and C. M. SEAFORD (NASA, Marshall Space Flight Center, Huntsville, AL) IN: TABES 91 - Annual Technical and Business Exhibition and Symposium, 7th, Huntsville, AL, May 14, 15, 1991, Submitted Papers. Huntsville, AL, Huntsville Association of Technical Societies, 1991, p. 42-48. refs
(TABES PAPER 91-278) Copyright

A computational fluid dynamic (CFD) simulation of the flow past an Aeroassist Flight Experiment (AFE) aerobrake under wind tunnel test conditions has been made. The Navier-Stokes equations in three dimensions were solved numerically using a finite-volume, implicit approach. Comparisons with experimental data include surface pressures and heat transfer rates and aerodynamic coefficients. Agreement with experiment is shown to be excellent. The dependence of the solution on the computational grid is explored. The present work is preliminary to simulation of the flow past the AFE under flight conditions, which at present cannot be duplicated with ground-based experimental facilities. Author

A92-34826* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATION OF 3-D SHEAR FLOWS AROUND A NOZZLE-AFTERBODY AT HIGH SPEEDS
OKTAY BAYSAL and WENDY B. HOFFMAN (Old Dominion University, Norfolk, VA) IN: Advances in numerical simulation of turbulent flows; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 63-70. refs
(Contract NAG1-811)
Copyright

3D, compressible, unsteady, Reynolds-averaged Navier-Stokes equations are presently solved by a finite-volume and alternating-direction-implicit method in order to simulate supersonic and hypersonic turbulent shear flows. The effect of turbulence is incorporated via a modified Baldwin-Lomax eddy viscosity model which reflects the influence of high-speed compressibility, multiple walls, near-wall vortices, and turbulent memory effects, as well as local equilibrium effects. Attention is given to the simulation of the flow around the nozzle-afterbody of a generic, scramjet-propelled hypersonic vehicle; computed pressure distributions are consonant with experimental surface and off-surface flow surveys. O.C.

A92-35444
COMPUTATIONAL FLUID DYNAMICS AS A TOOL FOR AERODYNAMIC ANALYSIS OF EJECTION SEATS
PETER AYOUB and THOMAS J. MARQUETTE (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 125-129. refs
Copyright

Computational fluid dynamics (CFD) for escape system applications is considered. The process of obtaining CFD solutions is described in three steps: grid generation, flow solutions, and data postprocessing. Applications of CFD for escape systems include ejection seats with yaw stabilization fins, windblast protection, evaluation of pitot sensors, drogue parachute analysis, aerodynamic heating of flight equipment, trajectory simulations, and escape capsule analysis. It is noted that although preliminary CFD results are in good agreement with wind tunnel tests, further modifications in modeling capabilities are needed before CFD can be relied upon for all ejection seat analysis. O.G.

A92-35543
THE EXPERIMENTAL INVESTIGATION ON THE DIFFUSER FLOW DISTORTION
WANGXING SHI (Nanjing Aeronautical Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 2, April 1992, p. 26-32. In Chinese. refs

The distortion flowfield produced by interaction between the normal shock and the boundary layer in the convergence-divergence diffuser is investigated in this paper. The effect of the geometrical parameters on the distortion factors is analyzed, and the regulation method of the circular distortion factor is discussed. Experiments show that the configuration of the center body, boundary layer separation from the wall, and the turbulence mix in the wake region of the center body affect the distortion factor considerably and total pressure recovery and average turbulence slightly. The circular distortion factor can be regulated by turning the tail end of the center body. Author

A92-35544
EXPERIMENTAL INVESTIGATION ON PERFORMANCES OF TWO-DIMENSIONAL INLET AT SUPERSONIC SPEED
CHUANMIN ZHANG and JUNBO XING (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 2, April 1992, p. 33-40. In Chinese. refs

The experimental results of a 2D inlet with a boundary-layer bleed slot installed at the upstream of the geometry throat are presented in this paper. The slot has different types of swept endwall, slot widths, and slot exit areas. The experiment was performed at freestream Mach numbers from 1.793 through 2.557 and at angle of attack from -6 through 10 degrees. The flow pattern and the performance of inlets with and without bleed are compared at a zero angle of attack. The effects of the boundary-layer bleed flow and endwall on the performance of the inlet are discussed. The shock patterns in the inlet varied with the increase of downstream pressure are described. Video record shows that within the range of the bleed flow the experimental inlet demonstrates continuity in aerodynamic characteristic.
Author

A92-35571
A DIRECT-PROBLEM CALCULATION METHOD FOR GAS TURBINES WITH BOWED AND TWISTED BLADES
ZHONGQI WANG, HONG YANG, FENGJUN LIU, YINGHONG HUANG, and GUOTAI FENG (Harbin Institute of Technology, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 177-180. In Chinese. refs

The necessity of direct-problem calculation in aerodynamic design of gas turbines with bowed and twisted blades is discussed and a practical direct-problem calculation program is developed for the S2 stream surface transonic flow in a multistage gas turbine. In the calculation, the shape of the mean S2 stream surface is taken as that of the blade mean camber surface which is modified properly to guarantee a reasonable S2 stream surface shape, and the circulation is specified by the stream surface shape and the axial velocity. Meanwhile, the effects of different blade-bowing methods on the radial distribution of gas parameters are analyzed. The calculation results demonstrate the improvement on the flow pattern in the turbine cascade with bowed and twisted blades and the necessity of the proof calculation with the direct-problem

method. Finally, several instructive opinions about the aerodynamic design of the bowed and twisted turbine blades are proposed. Author

A92-35689*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FINITE ELEMENT EULER CALCULATIONS OF UNSTEADY TRANSONIC CASCADE FLOWS
CHINGTENG HSIAO and ODDVAR O. BENDIKSEN (California, University, Los Angeles) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 389-400. refs
(Contract NAS3-25574)
(AIAA PAPER 92-2120) Copyright

A Galerkin finite element procedure incorporating an explicit Runge-Kutta time-stepping scheme has been developed in this work to solve unsteady transonic flow in cascades. The computational domain is discretized by a globally unstructured but locally structured blade-fitted deformable mesh. The Galerkin approximation is applied to the unsteady Euler equations based on a mixed Eulerian-Lagrangian description. The semi-discretized equations are integrated forward in time using a multistage Runge-Kutta scheme. An artificial dissipation operator of the type proposed by Jameson is adapted in the current scheme to capture shocks and suppress nonphysical oscillations. Phase-shifted boundary conditions are used to reduce the computational domain to a single reference passage. Results for both steady and unsteady transonic flows through cascades are presented and compared to existing finite volume solutions. Author

A92-35690*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ROLE OF SHOCK DYNAMICS IN TRANSONIC FLUTTER
ODDVAR O. BENDIKSEN (California, University, Los Angeles) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 401-414. Research supported by NSF. refs
(Contract NCC2-374)
(AIAA PAPER 92-2121) Copyright

A computational study of the influence of shock motion on flutter and divergence in transonic flow is presented. The numerical scheme models the entire fluid-structure system as a single continuum dynamics problem, by using a mixed Eulerian-Lagrangian formulation. No assumptions of small displacements are made, but the effect of viscosity is neglected. The results from this study indicate that the shock dynamics gives rise to limit cycles and highly nonlinear aeroelastic phenomena, such as weak divergence and flutter-divergence interactions. Although the shocks typically are destabilizing at the linear flutter boundary, they often have a strongly stabilizing effect for moderate-amplitude motions. The shocks are thus capable of quenching an emerging bending-torsion flutter motion and turning it into limit cycle flutter. The usefulness of classical flutter and divergence boundary diagrams is severely limited in transonic flow, because much of the global dynamic stability information is lost in such a presentation. Author

A92-35694#
BUFFET LOAD MEASUREMENTS ON AN F/A-18 VERTICAL FIN AT HIGH-ANGLE-OF-ATTACK
B. H. K. LEE and F. C. TANG (National Research Council of Canada, Institute for Aerospace Research, Ottawa) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 455-466. Research supported by DND and National Research Council of Canada. refs
(AIAA PAPER 92-2127) Copyright

A wind tunnel investigation of buffeting on the vertical fin of a rigid 6 percent model of the F/A-18 has been conducted in the Institute for Aerospace Research 1.5 m trisonic blowdown wind tunnel. The buffet loads were determined from pressure measurements on the vertical fin using 24 fast response transducers on each surface. Acceleration of the vertical fin at high-angle-of-attack was measured. Spectral analyses of the buffet loads were carried out and the probability densities were evaluated. Space-time correlation of the transducer signals was performed to determine the eddy scale and convection pattern of the pressure field. The investigation was carried out with LEX fences 'on' and 'off' to note their effect on tail buffet loads. Author

A92-35728
VISUALIZATION AND MEASUREMENT OF HELICOPTER ROTOR FLOW USING PROJECTED SMOKE FILAMENTS AND DIGITAL IMAGE PROCESSING
REINERT H. G. MUELLER European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. Research supported by DFG, University of Tennessee, and Johanna-und-Fritz-Buch-Gedaechtnis-Stiftung. refs

This paper presents an application of a new flow visualization method to complex flows over helicopter rotor blades. With the method, qualitative determination as well as quantitative measurements of the airflow are possible. The basic idea of the method is to produce thin, sharp-edged smoke trails by shooting very small burning metal pellets through the region of interest at high speed. These smoke traces can be placed as initially straight lines in any region of the helicopter rotor, even intersecting the rotor disk. After they are produced, the smoke traces follow the flow. The images of these traces in multiexposure or multiflash photographs then give a visualization of the flowfield. The complicated nature of the helicopter rotor flow which can be visualized with the technique will be presented by several photographs showing, for example, the early stages of development of a tip vortex and turbulent flow patterns. In addition, the possibility of obtaining quantitative information about the flowfield will be described. Author

A92-35753
CALCULATION OF PITCH-LINK LOADS IN DEEP STALL USING STATE-OF-THE-ART METHODOLOGY
JING G. YEN and MITHAT YUCE (Bell Helicopter Textron, Inc., Fort Worth, TX) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. refs

Pitch-link loads for bearingless rotors in deep stall are calculated using a unified state-of-the-art methodology. The methodology includes a modern free wake model for blade-vortex interaction, advanced unsteady-aerodynamic and dynamic-stall models, and a state-of-the-art rotor dynamics modeling for redundant load paths on bearingless rotors. Validation of the methodology is briefly discussed. Correlations of theory with measured pitch-link loads are presented. The measured data are from wind tunnel tests of two 1/5 Mach-scaled rotor models with the same bearingless hub but with blades having different torsional rigidities, and from flight tests of three full-scale bearingless rotors with different torsional frequencies and solidities. Data are presented as functions of advance ratios and rotor thrust coefficients, and also in time-history waveforms. Effects of blade-vortex interaction, blade torsional stiffness, unsteady aerodynamics, and solidity on pitch-link loads in deep stall are discussed. Author

A92-35755
COMPLETE EULER-SOLUTION FOR A ROTOR IN HOVER AND A PROPELLER IN FORWARD FLIGHT
J. HERTEL, E. KRAEMER, and S. WAGNER (Muenchen, Universitaet der Bundeswehr, Neubiberg, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. Research supported by MBB GmbH. refs

An Euler procedure that is optimized for application on steady rotor flow is presented. For calculation of the flowfield of a rotor in hover the initial condition is provided by a prescribed wake model, which allows a significant reduction of the computational domain. The complete rotor or propeller flow field is calculated exclusively by the Euler procedure. Computational results for a model rotor in hover and for a propeller with highly twisted blades

in hover as well as in forward flight are presented. The theory is compared with experimental data for the model rotor. Very high angles of attack occur in the root region of the propeller blade. The expected flow separation in this region is reproduced in a qualitatively correct manner. Author

A92-35758
NAVIER-STOKES ANALYSIS OF BLADE TIP SHAPE IN HOVER
TAKASHI AOYAMA (Tokyo, University, Japan), SHIGERU SAITO (National Aerospace Laboratory, Chofu, Japan), and KEIJI KAWACHI (Tokyo, University, Japan) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. refs

The 3D Navier-Stokes equations are solved to analyze the flowfield around blade tips of hovering rotors. The eddy viscosity is calculated by employing the q-omega two-equation turbulence model developed by Coakley. An implicit finite-difference method is used to solve the equations and the algebraic method is adopted to generate the grids. The effect of wake outside of the grid is taken into calculation by correcting the equivalent geometric angle of attack along the blade radius. Its value is estimated by using Local Circulation Method. The pressure distributions of rectangular tip shape predicted by the present method are in good agreement with the experimental data. The computed results for swept or tapered tip shapes by the present NS code are compared with our Euler results at subsonic condition. Differences between the results obtained by the viscous and inviscid analyses are shown. Author

A92-35783
ON THE INFLUENCE OF BLADE-VORTEX-INTERACTIONS ON VORTEX STRUCTURE
B. M. J. BEESTEN (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. refs
(Contract DFG-SFB-25)

Results of an experimental investigation of the distortions of tip vortices because of blade-vortex interactions (BVI) are presented. For the interaction with rotor blades, a strong vortex was generated as tip vortex of a special wing arrangement. Two kinds of investigations were carried out: a flow visualization technique to obtain the deformations of the vortex trajectory, and velocity measurements, using split fiber probes, to estimate the influence of BVI on the axial and tangential velocity profiles on the vortex. Tests with different vortices were conducted to examine the influence of vortex strength and structure. Under certain conditions, the vortex trajectory was turned into a corkscrew or spiral shape. The influence of various parameters on the geometry of the spiral is presented. In the case of the velocity profile, the maximum tangential velocity and the axial velocity defect are of special importance. For very close interactions, the flow visualization shows a vortex bursting in the form of a short spiral. P.D.

A92-35784
THE EFFECTS OF INNER WAKE MODELLING ON BLADE AIRLOADS
R. H. MILLER, S. C. ELLIS (MIT, Cambridge, MA), and L. DADONE (Boeing Co., Helicopters Div., Philadelphia, PA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 11 p. refs

The effect of inner wake modeling on blade airloads is investigated by modeling the wake with a time marching model described by Miller et al. (1986), with the sheet modeled by a series of vortex filaments. The time history of the tip-vortex roll-up was computed over time intervals corresponding to those required for following blades to encounter this wake. Results indicate that the higher harmonic airloads on a rotor occurring in a high-speed forward flight are relatively insensitive to inner wake modeling. I.S.

A92-35787
MEASUREMENTS OF A ROTOR FLOWFIELD AND THE EFFECTS ON A FUSELAGE IN FORWARD FLIGHT
J. G. LEISHMAN and NAI-PEI BI (Maryland, University, College Park) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. Research supported by University of Maryland. refs
(Contract DAAL03-88-C-0002)

Results of wind tunnel experiments conducted to quantify the induced flowfield in the vicinity of a helicopter rotor in forward flight are presented. Tests were performed with an isolated rotor and with a rotor/fuselage combination at advance ratios of 0.075, 0.10, and 0.20. Measurements of the time-averaged total pressure, dynamic pressure, and flow angularity were made using an array of miniature seven-hole probes. It is shown that the rotor produces significant increases in total pressure within the boundaries of the rotor wake. The total pressure was distributed in a highly nonuniform manner, both laterally and longitudinally, and was biased primarily toward the rear of the disk. At low advance ratios, the rotor-induced velocities were principally downward and produced a download on the fuselage. As advance ratio was increased, the induced velocities became quickly streamwise and resulted in an upforce on the fuselage. P.D.

A92-35788
THEORETICAL MODEL TO CALCULATE AERODYNAMIC INTERFERENCE EFFECTS BETWEEN ROTOR AND WING OF TILTROTORS
A. LESCHING and S. WAGNER (Muenchen, Universitaet der Bundeswehr, Neubiberg, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. Research supported by BMVg. refs

The aerodynamic interactions between the rotor and the wing of a tiltrotor configuration are discussed in both hover and forward flight. The procedure contains a vortex lattice representation of the wing and the rotor and is fully coupled to get the loads on both systems. Results are presented for hover and forward flight condition for the isolated rotor and the rotor plus wing configuration. It is shown that the interaction has a significant effect on the integrated wing and rotor loading. On the other hand, the effect on the power required is small. The flowfield in the region of possible tail location is represented. Author

A92-35913
CURRENT TOPICS CONNECTED WITH ROTATING STALL
HIROYUKI TAKATA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 195-201. In Japanese. refs

The characteristics of rotating stall and actuator disk theory are described. A vortex model for rotating stall is given and the velocity distribution is discussed. The coefficients of active stall control are analyzed. Y.P.Q.

A92-35988
EXPERIMENTAL DESIGN OF A SUPERSONIC SHOCK WAVE/VORTEX INTERACTION AT MACH 3
JAMES WEGER (U.S. Army, Safety Center, Fort Rucker, AL) and NDAONA CHOKANI (North Carolina State University, Raleigh) IN: Forum on Turbulent Flows - 1991; ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991, Proceedings. New York, American Society of Mechanical Engineers, 1991, p. 17-22. refs

Research was performed to develop an experimental design for the quantitative and qualitative examination of a supersonic shock wave/vortex interaction. The test design, mounting of shock wave and vortex generators upon a flat plate, gives the capability of examining the oblique shock wave/vortex interaction. Design features include the minimization of interaction interference from shock and expansion waves emanating off the test section models, prevention of tunnel blockage, and the minimization of any 3D effects. Results indicate a successful design, as the interaction was obtained. R.E.P.

A92-35992
INVERSE SOLUTION OF 3D INCOMPRESSIBLE TURBULENT BOUNDARY LAYER WITH SEPARATED BUBBLES
CHAO YAN, YULIN WU, and ZUYAN MEI (Tsinghua University, Beijing, People's Republic of China) IN: Forum on Turbulent Flows - 1991; ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991, Proceedings. New York, American Society of Mechanical Engineers, 1991, p. 57-61. refs
Copyright

A method for the calculation of a three-dimensional boundary layer with separated bubbles in the inverse mode is presented. In the present computation, governing equations in semiorthogonal curvilinear coordinates and an algebraic turbulence model considering the anisotropy of Reynolds stresses are employed. Calculated results are found in good agreement with measured data. Author

A92-35995
AN ANALYTICAL EVALUATION OF THE AERODYNAMIC FORCES ACTING ON A CIRCULAR CYLINDER IN A UNIFORM SHEAR FLOW
TSUTOMO HAYASHI, FUMIO YOSHINO, and RYOJI WAKA (Tottori University, Japan) IN: Forum on Turbulent Flows - 1991; ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991, Proceedings. New York, American Society of Mechanical Engineers, 1991, p. 83-88. refs
Copyright

In this paper, a new technical method is presented for quantitative evaluation of the lift and drag coefficients on the circular cylinder in a uniform shear flow. The displacement effect originating from a shift of the stagnation streamline, the asymmetry of the pressure distribution on the circular cylinder, and the increase in base pressure caused by differences in the turbulence intensity in the free stream, in the aspect ratio and in the blockage ratio are considered as analytical elements. It is confirmed that in using this technique for the evaluation, the lift force of the circular cylinder is always directed from the higher velocity side to the lower velocity side of the shear flow. Author

A92-35997
CHANGE OF FLOW ABOUT AN ELONGATED RECTANGULAR CYLINDER IN A RANGE OF REYNOLDS NUMBERS OF 200 TO 0.7 X 10 EXP 4
ATSUSHI OKAJIMA (Kanazawa University, Japan) IN: Forum on Turbulent Flows - 1991; ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991, Proceedings. New York, American Society of Mechanical Engineers, 1991, p. 107-113. refs
Copyright

Flow characteristics for elongated cylinders with the side ratio of 4 to 15 are measured in the relatively wide range of Reynolds numbers between 200 and 0.7 x 10 exp 4 in a wind tunnel and flow around cylinders is visualized using the electrolytic-precipitation technique in a water tank. A new critical value of 6.5 of a side ratio for a rectangular cross section is seen to exist at high Reynolds numbers. The measured results of a reduction of a base pressure at the Reynolds number of approximately 500 are simulated by the computations, and a synchronization between movements of separation bubbles and a wake creates the reduction of the base pressure for the cylinders with the side ratio over six. R.E.P.

A92-36021
THE EFFECTS OF WALL SUCTION ON LAMINAR-TURBULENT TRANSITION IN THREE-DIMENSIONAL FLOW
D. ARNAL, J. C. JUILLEN, and G. CASALIS (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Boundary layer stability and transition to turbulence; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 155-162. refs
Copyright

This paper is devoted to an experimental theoretical study of the wall suction effects on transition in three-dimensional flow. The experiments are performed on an 'infinite' swept wing placed in a subsonic wind tunnel. The movement of the transition onset is measured for different wind tunnel speeds and different suction rates. Typical boundary layer profiles are also presented. The prediction of the transition location is made by using empirical criteria and the en method. The n factor is computed from the spatial theory with a strategy developed at ONERA/CERT. It is shown that a fairly acceptable agreement is obtained with a constant value of the n factor, even if the computations overestimate the transition location in some cases. The measurements are also compared with other stability results obtained with different codes. Author

A92-36023
SUPERSONIC AND HYPERSONIC BOUNDARY-LAYER TRANSITION INDUCED BY DISCRETE TRIPS
ANTHONY DEMETRIADES (Montana State University, Bozeman) IN: Boundary layer stability and transition to turbulence; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 173-178. refs
Copyright

Attempts to induce artificial turbulence have been made in supersonic and hypersonic boundary layers, using discrete trips from one to several times as tall as the laminar boundary layer. Downstream measurements aimed at assessing both the trip efficiency and the flowfield distortions. Ramp-like trips produced grossly distorted downstream flows and vortex-induced turbulent wakes with fast growth rates. By contrast, wedge trips deflecting the flow parallel to the surface were very efficient in producing normal turbulent boundary layers downstream. Author

A92-36026
A COMPARISON OF TRANSITION REYNOLDS NUMBER MEASURED IN A WIND TUNNEL AND IN FLIGHT
D. W. SINCLAIR (Calspan Corp., Arnold AFB, TN) IN: Boundary layer stability and transition to turbulence; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 207-215. refs
Copyright

The effect of wind tunnel noise on the location of the boundary-layer transition was studied at Mach numbers 0.6-1.6 and unit Reynolds numbers from 1.67 to 5.5 million per foot at three lateral locations. The transition Reynolds number is found to decrease slightly as the free-stream Reynolds number increases. The transition Reynolds number is essentially independent of the free-stream Mach number over most of the operating range. It is also found that the transition Reynolds number decreases slightly on either side of the tunnel centerline. The wind tunnel transition results are compared with flight test data. V.L.

A92-36028
NUMERICAL SIMULATIONS IN TURBOMACHINERY; PROCEEDINGS OF THE SYMPOSIUM, ASME AND JSME JOINT FLUIDS ENGINEERING CONFERENCE, 1ST, PORTLAND, OR, JUNE 23-27, 1991
AWATEF A. HAMED, ED. (Cincinnati, University, OH) Conference sponsored by ASME and JSME. New York, American Society of Mechanical Engineers, 1991, 155 p. For individual items see A92-36029 to A92-36039.
(ISBN 0-7918-0714-2) Copyright

Various papers on numerical simulations in turbomachinery are presented. Some individual topics addressed are: arbitrary blade section design based on viscous considerations, total analysis of overall performance and axial thrust of rocket pump, refined analytical method for designing high pressure ratio centrifugal impellers, inverse inviscid method for the design of quasi-3D turbomachinery cascades, quasi-3D flow analysis in turbomachinery, inviscid and viscous quasi-3D flow solutions in a transonic turbine cascade, unsteady Navier-Stokes simulation of

turbulent flows through a supersonic compressor cascade, outflow boundary conditions for Euler analysis of flow in turbine scroll. Also discussed are: finite-element perturbation approach to fluid/rotor interaction in turbomachinery elements, flow behavior around stay and guide vanes of a Francis turbine, computational simulation of Francis water runner with pseudo-compressibility, Dawes code applied to a high pressure ratio centrifugal compressor, numerical simulations of the flow through cascades with tip clearance, probabilistic simulation of fragment dynamics and their surface impacts in SSME turbopump. C.D.

A92-36029
ARBITRARY BLADE SECTION DESIGN BASED ON VISCOUS CONSIDERATIONS - BACKGROUND INFORMATION
B. BOURAS, F. KARAGIANNIS, G. LEOUTSAKOS, K. GIANNAKOGLOU, and K. D. PAPAILIOU (Athens, National Technical University, Greece) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 1-14. refs
(Contract EEC-EN3W-0035-GR)
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Background information is presented on an arbitrary blade section design method is presented. The method itself is outlined in a joint paper. This information concerns the assumptions, the development, and the predictive capabilities of the viscous flow calculation tool used in the design procedure. The prediction of the design and off design performance of an arbitrary cascade is discussed as well. Finally, the general properties of the laminar and turbulent unseparated or separated compressible shear layers necessary for the blade optimization procedure are established. Author

A92-36030
ARBITRARY BLADE SECTION DESIGN BASED ON VISCOUS CONSIDERATIONS - BLADE OPTIMIZATION
B. BOURAS, F. KARAGIANNIS, P. CHAVIAROPOULOS, and K. D. PAPAILIOU (Athens, National Technical University, Greece) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, 1st ASME and JSME Joint Fluids Engineering Conference, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 15-27. refs
(Contract EEC-EN3W-0035-GR)
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A design procedure for calculating arbitrary blade sections for turbomachinery applications is presented. The completely inverse procedure takes the effects of viscosity into account and establishes a number of elements which can be used for optimization. Representative examples are given. C.D.

A92-36033
AN INVERSE INVISCID METHOD FOR THE DESIGN OF QUASI-THREE DIMENSIONAL TURBOMACHINERY CASCADES
E. BONATAKI, P. CHAVIAROPOULOS, and K. D. PAPAILIOU (Athens, National Technical University, Greece) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 45-55. Research supported by EEC. Previously announced in STAR as N92-13942. refs
Copyright

A new inverse inviscid method suitable for the design of rotating blade sections lying on an arbitrary axisymmetric stream-surface with varying streamtube width is presented. The geometry of the axisymmetric stream-surface and the streamtube width variation with meridional distance, the number of blades, the inlet flow conditions, the rotational speed and the suction and pressure side velocity distributions as functions of the normalized arc-length are given. The flow is considered irrotational in the absolute frame of reference and compressible. The output of the computation is the blade section that satisfies the above data. The method solves the flow equations on a (phi 1, psi) potential function-streamfunction plane for the velocity modulus, W and the flow angle beta; the blade section shape can then be obtained as part of the physical plane geometry by integrating the flow angle distribution along streamlines. The (phi 1, psi) plane is defined so that the monotonic behavior of the potential function is guaranteed even in cases with high peripheral velocities. The method is validated on a rotating turbine case and used to design new blades. To obtain a closed blade, a set of closure conditions were developed and referred. Author

A92-36035
INVISCID AND VISCOUS QUASI-THREE-DIMENSIONAL FLOW SOLUTIONS IN A TRANSONIC TURBINE CASCADE
J. J. YEUAN, W. TABAKOFF, and A. HAMED (Cincinnati, University, OH) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 65-72. refs
Copyright

A computer code has been developed for the numerical solution of the turbomachinery flows on a blade-to-blade stream surface. A finite volume approach is used to integrate the governing equations for quadrilateral mesh in the body-fitted coordinate system. The derived differencing formulation of the full Navier-Stokes quasi-3D equations satisfies local conservation. An explicit two-stage Runge-Kutta scheme coupled with linear interpolation procedure and local time step are used for computational efficiency. The results of computations using a two-layer turbulence model are presented for transonic turbine cascades and compared with experimental results. C.D.

A92-36036
UNSTEADY NAVIER-STOKES SIMULATION OF TURBULENT FLOWS THROUGH A SUPERSONIC COMPRESSOR CASCADE
SATORU YAMAMOTO and HISAAKI DAIGUJI (Tohoku University, Sendai, Japan) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 73-79. refs
Copyright

The purpose of the present paper is to investigate unsteady turbulent flows through a supersonic compressor cascade using the methods proposed by the authors in which efficient numerical schemes for unsteady calculation, shock capturing, and turbulent quantities are used. The numerical results calculated by the present method show that oblique shocks, normal shocks, and their induced boundary layer separations can be captured more accurately compared with ordinary numerical results, agreement with the experimental data is better. Finally, limitations of the present method for unsteady calculation are discussed. Author

A92-36038
NUMERICAL SIMULATIONS OF THE FLOW THROUGH CASCADES WITH TIP CLEARANCE
TOSHINORI WATANABE (Tokyo University of Agriculture and Technology, Japan), OSAMU NOZAKI, KAZUO KIKUCHI, and ATSUHIRO TAMURA (National Aerospace Laboratory, Tokyo, Japan) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 131-139. refs
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Three-dimensional flowfields through cascades with tip clearance were numerically simulated by solving the Navier-Stokes equations with LU-ADI scheme. The computational grid was generated by a zonal method. A fundamental cascade composed of flat plates was adopted to develop the appropriate solution method. The computed results showed good agreement with experimental data and the reliability of the method was verified. The detailed flow phenomena around blade tip, such as the formation of separation bubbles on tip surface, were clearly

described. The method was further applied successfully to a stationary turbine, a rotating fan blade, and a rotating turbine blade. Author

A92-36100
UNSTEADY HYPERSONIC BOUNDARY LAYERS FOR SLENDER AXISYMMETRIC BODIES WITH LARGE INJECTION RATES
S. ROY and G. NATH (Indian Institute of Science, Bangalore, India) International Journal of Engineering Science (ISSN 0020-7225), vol. 30, no. 6, June 1992, p. 793-803. refs
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A semisimilar solution of an unsteady hypersonic laminar compressible boundary layer flow over a slender axisymmetric body with massive blowing has been obtained when the free stream velocity varies arbitrarily with time. The governing partial differential equations have been solved numerically by combining the implicit finite difference scheme with the quasi-linearization technique. The results have been obtained for an accelerating/decelerating stream and a fluctuating stream. The skin friction responds to the fluctuation in the free stream compared to the heat transfer. It is observed that the effect of large injection (blowing) rates is to move the viscous boundary layer away from the surface. The effect of the variation of the density-viscosity product across the boundary layer is found to be negligible for large blowing rates. Massive blowing reduces significantly the values of skin friction and heat transfer but the effect of the transverse curvature parameter is just reverse. Location of the dividing streamline increases as injection rate increases, but decreases with the increase of the transverse curvature parameter. Author

A92-36151
ANALYSIS OF SLENDER BODIES OF REVOLUTION WITH CURVED-GROUND EFFECT AND WAVING-WATER EFFECT
QIAN-XI WANG (University of Science and Technology of China, Hefei, People's Republic of China) Fluid Dynamics Research (ISSN 0169-5983), vol. 9, no. 5-6, April 1992, p. 235-254. refs
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The problems involved in a slender body of revolution (BOR) moving in very close proximity to curved ground and waving water surfaces are formulated using the method of matched asymptotic expansions. It is shown that, when a slender BOR translates horizontally near a curved-ground or (waving-water) surface, there will always be an attractive force tending to attract the BOR toward the ground (or water surface), irrespective of whether its angle of attack is positive or negative. This attractive force increases monotonically as the body is brought closer to the ground (or water surface), and the absolute value of the angle of attack rises. Furthermore, for the body with curved-ground effect, the convex or (concave) ground generally strengthens or (weakens) the ground effect. For the BOR with waving-water effect, the attractive force is nearly in phase with the wave height beneath the center of the BOR and its amplitude increases with the relative velocity between the body and water wave motion. C.D.

A92-36186* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NUMERICAL STUDIES OF TRANSVERSE CURVATURE EFFECTS ON TRANSONIC FLOW STABILITY
M. G. MACARAEG (NASA, Langley Research Center, Hampton, VA) and Q. I. DAUDPOTA (Old Dominion University Research Foundation, Norfolk, VA) Physics of Fluids A (ISSN 0899-8213), vol. 4, no. 5, May 1992, p. 975-983. refs
Copyright

A numerical study of transverse curvature effects on compressible flow temporal stability for transonic to low supersonic Mach numbers is presented for axisymmetric modes. The mean flows studied include a similar boundary-layer profile and a nonsimilar axisymmetric boundary-layer solution. The effect of neglecting curvature in the mean flow produces only small quantitative changes in the disturbance growth rate. For transonic Mach numbers (1-1.4) and aerodynamically relevant Reynolds numbers (5000-10,000 based on displacement thickness), the maximum growth rate is found to increase with curvature - the maximum occurring at a nondimensional radius (based on displacement thickness) between 30 and 100. Author

A92-36357
NUMERICAL SIMULATION OF OPPOSING SONIC JETS
H. NOMURA, S. ASO, and M. NISHIDA (Kyushu University, Fukuoka, Japan) (Japan-Soviet Union Joint Symposium on Computational Fluid Dynamics, 2nd, Tsukuba, Japan, Aug. 27-31, 1990) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 2, April 1992, p. 229-233. refs
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This paper describes the numerical simulation of an opposing sonic jet exhausting against a supersonic free stream of Mach number 3. The flow is axisymmetric and inviscid, and the jet and free stream are composed of the same kind of gas. The numerical method employs the Harten-Yee second-order upwind TVD scheme. The numerical results have been compared with the flow visualization pictures taken by the laser-induced fluorescence method and satisfactorily good agreement has been obtained. Author

A92-36359* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPECTRAL SOLUTION OF INVISCID SUPERSONIC FLOWS OVER WEDGES AND AXISYMMETRIC CONES
DAVID A. KOPRIVA (Florida State University, Tallahassee) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 2, April 1992, p. 247-266. refs
(Contract NAG1-862; DE-FC05-85ER-25000)
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A shock-fitted multidomain spectral collocation method is used to solve both steady and unsteady inviscid supersonic flows over bodies. New aspects of the method include two subdomain interface types and a zonal solution procedure to get efficient convergence to steady-state in supersonic regions. Steady-state examples include flow over a sharp cone, a hyperbolic cone and a hyperbolic wedge. For the cone, the exact flow solution is used to show that the method is spectrally accurate. As an example of an unsteady flow, a calculation of the interaction of a free-stream hot ring with the flow over a sharp cone is presented. Author

A92-36420
STRUCTURE OF THE SEPARATED FLOW REGION IN A DIHEDRAL CORNER IN FRONT OF AN OBSTACLE IN SUPERSONIC FLOW [STRUKTURA OBLASTI OTRYVNOGO TECHENIIA V DVUGRANNOM UGLE PERED PREPIATSTVIEM, OBTEKAEMYM SVERKHZVUKOVYM POTOKOM]
A. I. ZUBKOV, B. E. LIAGUSHIN, and IU. A. PANOV Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), no. 1, Jan.-Feb. 1992, p. 107-110. In Russian. refs
Copyright

The paper is concerned with supersonic flow past an obstacle located at an inner side of a dihedral corner. In particular, wind tunnel test results are presented for a model in the form of a 90-deg dihedral angle formed by two tapered 170x300-mm plates, with a cylindrical obstacle introduced through a hole in one of the plates. The structure and size of the separated flow region are determined. V.L.

N92-22179# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
CONTRIBUTIONS OF MBB-FE211 TO THE 2ND ANTIBES WORKSHOP ON HYPERSONIC FLOWS
FRANCOIS MONNOYER 30 Apr. 1991 99 p Presented at Workshop on Hypersonic Flows for Reentry Problems, Part 2, Antibes, France, 15-19 Apr. 1991
(MBB-FE211-S-PUB-449; ETN-92-90619) Copyright Avail: NTIS HC/MF A05

Calculations performed with the finite volume Navier-Stokes code NSFLEX (an implicit relaxation method for the Navier-Stokes equations for a wide range of Mach numbers) on the following are illustrated: flow over a two dimensional ramp; double ellipsoid;

and a delta wing. Euler boundary layer calculations for ellipsoid and blunt nose delta wing are illustrated.
ESA

N92-22181# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
CASES 6.1 AND 6.8 DOUBLE ELLIPSOID: NAVIER-STOKES CALCULATION
M. SCHMATZ and R. HOELD *In its* Contributions of MBB-FE211 to the 2nd Antibes Workshop on Hypersonic Flows p 18-37 30 Apr. 1991
Copyright Avail: NTIS HC/MF A05

Calculations of flow over a double ellipsoid using the finite volume Navier-Stokes code NSFLEX (an implicit relaxation method for a wide range of Mach number) are illustrated. The inviscid fluxes are calculated at the volume faces with a Riemann solver. A third order accurate local characteristic flux extrapolation scheme is used with van Albada sensors to detect nonmonotonous behavior of the flow variables. At very strong shocks, a modified hybrid Steger-Warming local characteristic flux is applied. The viscous fluxes are constructed with central differencing at the cell faces. The unfactored time-dependent implicit equations are converged in time with a point Gauss-Seidel relaxation algorithm. ESA

N92-22182# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
CASE 7.4 DELTA WING: NAVIER-STOKES CALCULATION
R. HOELD and M. SCHMATZ *In its* Contributions of MBB-FE211 to the 2nd Antibes Workshop on Hypersonic Flows p 38-57 30 Apr. 1991
Copyright Avail: NTIS HC/MF A05

Calculations of flow over a delta wing using the finite volume Navier-Stokes code NSFLEX (an implicit relaxation method for a wide of range of Mach numbers) are illustrated. The inviscid fluxes are calculated at the volume faces with a Riemann solver. A third order accurate local characteristic flux extrapolation scheme is used with van Albada sensors to detect nonmonotonous behavior of the flow variables. At very strong shocks, a modified hybrid Steger-Warming local characteristic flux is applied. The viscous fluxes are constructed with central differencing at the cell faces. The unfactored time-dependent implicit equations are converged in time with a point Gauss-Seidel relaxation algorithm. ESA

N92-22184# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
CASE 7.4: BLUNT NOSE DELTA WING EULER-BOUNDARY LAYER CALCULATION
FRANCOIS MONNOYER *In its* Contributions of MBB-FE211 to the 2nd Antibes Workshop on Hypersonic Flows p 78-96 30 Apr. 1991
Copyright Avail: NTIS HC/MF A05

Flow around the blunt nose of a delta wing is presented. The model applied is a coupled Euler boundary layer method. The use of boundary layer theory makes it possible to predict the flow around a body with a combination of viscous and inviscid models applied in their regions of validity and combined with each other at their common boundary. Perfect matching of the inner boundary layer and the inviscid external flow is obtained by the use of defect formulation. ESA

N92-22193# Cambridge Univ. (England). Dept. of Engineering.
A THEORETICAL INVESTIGATION OF THE INDUCED DRAG OF WING OF FINITE ASPECT RATIO
F. LAM Dec. 1991 50 p Sponsored in part by Croucher Foundation and Trustees
(CUED/A-AERO/TR-17(1991); ISSN-0309-7293) Avail: NTIS HC/MF A03

The Lanchester-Prandtl lifting-line theory for finite aspect ratio wings has been revised with an entirely new model of trailing vortex wake which takes into account the mean effect of the roll-up of the trailing vortex sheet. Comparison with the original planar model shows that the downwash induced by the proposed wake can be usefully low for given loadings over a range of downstream distance, within which a trailing vortex sheet has reached a state of concentrated vortices. The induced drag is consequently lowered due to the favorable upwash generated by the roll-up vortices. There exists an optimum downstream location for the completion of the roll-up process which gives rise to a minimum drag in each loading case examined in this paper. This minimum is even lower than the least drag predicted by the classical lifting-line theory. Author

N92-22196*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA LANGLEY LAMINAR-FLOW-CONTROL EXPERIMENT ON A SWEPT, SUPERCRITICAL AIRFOIL: EVALUATION OF INITIAL PERFORATED CONFIGURATION
CHARLES D. HARRIS, CUYLER W. BROOKS, JR., PATRICIA G. CLUKEY, and JOHN P. STACK Apr. 1992 125 p
(Contract RTOP 505-61-21-03)
(NASA-TM-4309; L-16856; NAS 1.15:4309) Avail: NTIS HC/MF A06 CSCL 01/1

The initial evaluation of a large-chord, swept, supercritical airfoil incorporating an active laminar-flow-control (LFC) suction system with a perforated upper surface is documented in a chronological manner, and the deficiencies in the suction capability of the perforated panels as designed are described. The experiment was conducted in the Langley 8-Foot Transonic Pressure Tunnel. Also included is an evaluation of the influence of the proximity of the tunnel liner to the upper surface of the airfoil pressure distribution. Author

N92-22215*# Maryland Univ., College Park. Dept. of Aerospace Engineering.
HEAT TRANSFER CHARACTERISTICS OF HYPERSONIC WAVERIDERS WITH AN EMPHASIS ON THE LEADING EDGE EFFECTS M.S. Thesis, 1991
DENIS O. VANMOL and JOHN D. ANDERSON, JR. Mar. 1992 126 p
(Contract NAG1-1192; RTOP 505-59-40-10)
(NASA-CR-189586; NAS 1.26:189586; UM-AERO-91-42) Avail: NTIS HC/MF A07 CSCL 01/1

The heat transfer characteristics in surface radiative equilibrium and the aerodynamic performance of blunted hypersonic waveriders are studied along two constant dynamic pressure trajectories for four different Mach numbers. The inviscid leading edge drag was found to be a small (4 to 8 percent) but not negligible fraction of the inviscid drag of the vehicle. Although the viscous drag at the leading edge can be neglected, the presence of the leading edge will influence the transition pattern of the upper and the lower surfaces and therefore affect the viscous drag of the entire vehicle. For an application similar to the National Aerospace Plane (NASP), the present study demonstrates that the waverider remains a valuable concept at high Mach numbers if a state-of-the-art active cooling device is used along the leading edge. At low Mach number (less than 5), the study shows the surface radiative cooling might be sufficient. In all cases, radiative cooling is sufficient for the upper and lower surfaces of the vehicle if ceramic composites are used as thermal protection. Author

N92-22232*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL STUDY OF A GENERIC HIGH-SPEED CIVIL TRANSPORT: TABULATED DATA
PAMELA S. BELTON and RICHARD L. CAMPBELL Mar. 1992 91 p
(Contract RTOP 505-59-10-03)
(NASA-TM-104216; NAS 1.15:104216) Avail: NTIS HC/MF A05 CSCL 01/1

An experimental study of a generic high-speed civil transport was conducted in LaRC's 8-Foot Transonic Pressure Tunnel. The data base was obtained for the purpose of assessing the accuracy of various levels of computational analysis. Two models differing only in wing tip geometry were tested with and without flow-through nacelles. The baseline model has a curved or crescent wing tip shape while the second model has a more conventional straight

wing tip shape. The study was conducted at Mach numbers from 0.30-1.19. Force data were obtained on both the straight and curved wing tip models. Only the curved wing tip model was instrumented for measuring pressures. Longitudinal and lateral-directional aerodynamic data are presented without analysis in tabulated form. Pressure coefficients for the curved wing tip model are also presented in tabulated form. Author

N92-22233# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
MODERNIZED MBB PANEL CODE: USER'S GUIDE INCLUDING BACKGROUND THEORY
E. SALMINEN 28 Aug. 1991 49 p
(PB92-136431; SER-B-91-B33; ISBN-951-22-0763-X) Avail: NTIS HC/MF A03 CSCL 01/1

A modernized version of the MMB low-order panel method program written originally at the beginning of the 1970's is described. The new features of the combined version are the capability to read list-directed input, the capability to handle transpiration velocities through panel surfaces, and the capability to handle comment lines in an input file. The new version is also easier to use and easier to port to different types of machines than the original one. In addition to the combining process, the program was also linked to a specialized flow visualization program in order to expedite the pre- and post-processing. The link makes it possible to check the model and analyze the results using high-performance graphics workstations. Some DISSPLA-based plotting routines were also written for inspecting the model and representing the results on graphical terminals. A user's guide and a background theory are included. GRA

N92-22240*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FURTHER INVESTIGATIONS OF THE AEROELASTIC BEHAVIOR OF THE AFW WIND-TUNNEL MODEL USING TRANSONIC SMALL DISTURBANCE THEORY
WALTER A. SILVA and ROBERT M. BENNETT Mar. 1992 12 p Presented at the Dynamics Specialists Conference, Dallas, TX, 16-17 Apr. 1992
(Contract RTOP 505-63-50-12)
(NASA-TM-107576; NAS 1.15:107576) Avail: NTIS HC/MF A03 CSCL 01/1

The Computational Aeroelasticity Program-Transonic Small Disturbance (CAP-TSD) code, developed at LaRC, is applied to the active flexible wing wind-tunnel model for prediction of transonic aeroelastic behavior. A semi-span computational model is used for evaluation of symmetric motions, and a full-span model is used for evaluation of antisymmetric motions, and a full-span model is used for evaluation of antisymmetric motions. Static aeroelastic solutions using CAP-TSD are computed. Dynamic deformations are presented as flutter boundaries in terms of Mach number and dynamic pressure. Flutter boundaries that take into account modal refinements, vorticity and entropy corrections, antisymmetric motion, and sensitivity to the modeling of the wing tip ballast stores are also presented with experimental flutter results. Author

N92-22249*# Sverdrup Technology, Inc., Brook Park, OH.
***THREE-DIMENSIONAL COMPRESSIBLE TURBULENT* COMPUTATIONS FOR A DIFFUSING S-DUCT**
C. F. SMITH, J. E. BRUNS, G. J. HARLOFF, and J. R. DEBONIS Washington NASA Apr. 1992 37 p
(Contract NAS3-25266; RTOP 533-02-30)
(NASA-CR-4392; E-6172; NAS 1.26:4392) Avail: NTIS HC/MF A03 CSCL 01/1

The purpose of the present study was to evaluate the capability of the computational fluid dynamics computer program PARC3D to model flow in a typical diffusing subsonic S-duct, with strong secondary flows. This evaluation is needed to provide confidence in the analysis of aircraft inlets, which have similar geometries. The performance predictions include total pressure profiles, static pressures, velocity profiles, boundary layer data, and skin friction data. Flow in the S-duct is subsonic, and the boundary layers are assumed to be turbulent. The results for both H and O grid solutions, are compared with existing test data. Author

N92-22506*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLOW FIELD OVER THE WING OF A DELTA-WING FIGHTER MODEL WITH VORTEX CONTROL DEVICES AT MACH 0.6 TO 1.2
E. ANN BARE, DAVID E. REUBUSH, and RAYMOND C. HADDAD (McDonnell-Douglas Corp., Saint Louis, MO.) Apr. 1992 126 p
(Contract RTOP 505-68-91-06)
(NASA-TM-4296; L-16834; NAS 1.15:4296) Avail: NTIS HC/MF A07 CSCL 01/1

As part of a cooperative research program between NASA, McDonnell Douglas Corporation, and Wright Research and Development Center, a flow field investigation was conducted on a 7.52 percent scale windtunnel model of an advanced fighter aircraft design. The investigation was conducted in the Langley 16 ft Transonic Tunnel at Mach numbers of 0.6, 0.9, and 1.2. Angle of attack was varied from -4 degrees to 30 degrees and the model was tested at angles of sideslip of 0, 5, and -5 degrees. Data for the over the wing flow field were obtained at four axial survey stations by the use of six 5 hole conical probes mounted on a survey mechanism. The wing leading edge primary vortex exerted the greatest influence in terms of total pressure loss on the over the wing flow field in the area surveyed. A number of vortex control devices were also investigated. They included two different apex flaps, wing leading edge vortex flaps, and small large wing fences. The vortex flap and both apex flaps were beneficial in controlling the wing leading edge primary vortex. Author

N92-22507*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NACA0012 BENCHMARK MODEL EXPERIMENTAL FLUTTER RESULTS WITH UNSTEADY PRESSURE DISTRIBUTIONS
JOSE A. RIVERA, JR., BRYAN E. DANSBERRY, ROBERT M. BENNETT, MICHAEL H. DURHAM, and WALTER A. SILVA Mar. 1992 13 p Presented at the 33rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(Contract RTOP 505-63-50)
(NASA-TM-107581; NAS 1.15:107581) Avail: NTIS HC/MF A03 CSCL 01/1

The Structural Dynamics Division at NASA Langley Research Center has started a wind tunnel activity referred to as the Benchmark Models Program. The primary objective of this program is to acquire measured dynamic instability and corresponding pressure data that will be useful for developing and evaluating aeroelastic type computational fluid dynamics codes currently in use or under development. The program is a multi-year activity that will involve testing of several different models to investigate various aeroelastic phenomena. This paper describes results obtained from a second wind tunnel test of the first model in the Benchmark Models Program. This first model consisted of a rigid semispan wing having a rectangular planform and a NACA 0012 airfoil shape which was mounted on a flexible two degree of freedom mount system. Experimental flutter boundaries and corresponding unsteady pressure distribution data acquired over two model chords located at the 60 and 95 percent span stations are presented. Author

N92-22648*# Boeing Computer Services Co., Seattle, WA.
PAN AIR: A COMPUTER PROGRAM FOR PREDICTING SUBSONIC OR SUPERSONIC LINEAR POTENTIAL FLOWS ABOUT ARBITRARY CONFIGURATIONS USING A HIGHER ORDER PANEL METHOD. VOLUME 1: THEORY DOCUMENT (VERSION 3.0) Report, Oct. 1984 - Sep. 1987
MICHAEL A. EPTON and ALFRED E. MAGNUS 1990 599 p Revised Sponsored in part by ASD; AFWAL; and Naval Coastal Systems Center

(Contract NAS2-12036)
(NASA-CR-3251; NAS 1.26:3251) Avail: NTIS HC/MF A25 CSCL 01/1

An outline of the derivation of the differential equation governing linear subsonic and supersonic potential flow is given. The use of Green's Theorem to obtain an integral equation over the boundary surface is discussed. The engineering techniques incorporated in the Panel Aerodynamics (PAN AIR) program (a discretization method which solves the integral equation for arbitrary first order boundary conditions) are then discussed in detail. Items discussed include the construction of the compressibility transformation, splining techniques, imposition of the boundary conditions, influence coefficient computation (including the concept of the finite part of an integral), computation of pressure coefficients, and computation of forces and moments. Principal revisions to version 3.0 are the following: (1) appendices H and K more fully describe the Aerodynamic Influence Coefficient (AIC) construction; (2) appendix L now provides a complete description of the AIC solution process; (3) appendix P is new and discusses the theory for the new FDP module (which calculates streamlines and offbody points); and (4) numerous small corrections and revisions reflecting the MAG module rewrite. Author

N92-22865*# Boeing Military Airplane Development, Seattle, WA.
PAN AIR: A COMPUTER PROGRAM FOR PREDICTING SUBSONIC OR SUPERSONIC LINEAR POTENTIAL FLOWS ABOUT ARBITRARY CONFIGURATIONS USING A HIGHER ORDER PANEL METHOD. VOLUME 2: USER'S MANUAL (VERSION 3.0) Report, Oct. 1984 - Sep. 1987
KENNETH W. SIDWELL, PRANAB K. BARUAH, JOHN E. BUSSOLETTI, RICHARD T. MEDAN, R. S. CONNER, and DAVID J. PURDON 1990 834 p Revised Sponsored in part by ASD; AFWAL; and Naval Coastal Systems Center
(Contract NAS2-12036)
(NASA-CR-3252; NAS 1.26:3252) Avail: NTIS HC/MF A99 CSCL 01/1

A comprehensive description of user problem definition for the PAN AIR (Panel Aerodynamics) system is given. PAN AIR solves the 3-D linear integral equations of subsonic and supersonic flow. Influence coefficient methods are used which employ source and doublet panels as boundary surfaces. Both analysis and design boundary conditions can be used. This User's Manual describes the information needed to use the PAN AIR system. The structure and organization of PAN AIR are described, including the job control and module execution control languages for execution of the program system. The engineering input data are described, including the mathematical and physical modeling requirements. Version 3.0 strictly applies only to PAN AIR version 3.0. The major revisions include: (1) inputs and guidelines for the new FDP module (which calculates streamlines and offbody points); (2) nine new class 1 and class 2 boundary conditions to cover commonly used modeling practices, in particular the vorticity matching Kutta condition; (3) use of the CRAY solid state Storage Device (SSD); and (4) incorporation of errata and typo's together with additional explanation and guidelines. Author

N92-23095*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATIC PERFORMANCE OF A CRUCIFORM NOZZLE WITH MULTIAXIS THRUST-VECTORING AND REVERSE-THRUST CAPABILITIES
DAVID J. WING and SCOTT C. ASBURY Apr. 1992 82 p
(Contract RTOP 505-62-30-01)
(NASA-TP-3188; L-16958; NAS 1.60:3188) Avail: NTIS HC/MF A05 CSCL 01/1

A multiaxis thrust vectoring nozzle designed to have equal flow turning capability in pitch and yaw was conceived and experimentally tested for internal, static performance. The cruciform-shaped convergent-divergent nozzle turned the flow for thrust vectoring by deflecting the divergent surfaces of the nozzle, called flaps. Methods for eliminating physical interference between pitch and yaw flaps at the larger multiaxis deflection angles was studied. These methods included restricting the pitch flaps from the path of the yaw flaps and shifting the flow path at the throat off the nozzle centerline to permit larger pitch-flap deflections without interfering with the operation of the yaw flaps. Two flap widths were tested at both dry and afterburning settings. Vertical and reverse thrust configurations at dry power were also tested. Comparison with two dimensional convergent-divergent nozzles showed lower but still competitive thrust performance and thrust vectoring capability. Author

N92-23103*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
HIGH SPEED TRANSPORT CRUISE DRAG
LEONARD ROBERTS Apr. 1992 12 p
(NASA-CR-190248; NAS 1.26:190248; JIAA-TR-106) Avail: NTIS HC/MF A03 CSCL 01/1

This report provides scaling laws for the cruise aerodynamics of high speed transport wings based on the results of Navier-Stokes computations. Expressions for the various drag components are found, together with the corresponding values (L/D)(sub m) for various values of the geometric parameter s/l which allow for simple optimization of the wing configurations with respect to the span. It is found that linear theory expressions can be used for this purpose provided the coefficients of these experiments for C(sub D) and (L/D)(sub m) are available using Navier-Stokes results. Author

N92-23105*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA'S AIRCRAFT ICING TECHNOLOGY PROGRAM
JOHN J. REINMANN 1991 12 p Presented at the 1991 Winter Annual Meeting of the ASME, Atlanta, GA, 1-6 Dec. 1991 Previously announced as N91-20120
(Contract RTOP 505-68-11)
(NASA-TM-104518; E-6388; NAS 1.15:104518) Avail: NTIS HC/MF A03 CSCL 01/1

NASA' Aircraft Icing Technology program is aimed at developing innovative technologies for safe and efficient flight into forecasted icing. The program addresses the needs of all aircraft classes and supports both commercial and military applications. The program is guided by three key strategic objectives: (1) numerically simulate an aircraft's response to an in-flight icing encounter, (2) provide improved experimental icing simulation facilities and testing techniques, and (3) offer innovative approaches to ice protection. Our research focuses on topics that directly support stated industry needs, and we work closely with industry to assure a rapid and smooth transfer of technology. This paper presents selected results that illustrate progress towards the three strategic objectives, and it provides a comprehensive list of references on the NASA icing program. Author

N92-23116*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THREE-DIMENSIONAL TIME-MARCHING AEROELASTIC ANALYSES USING AN UNSTRUCTURED-GRID EULER METHOD
RUSS D. RAUSCH, JOHN T. BATINA, and HENRY T. Y. YANG (Purdue Univ., West Lafayette, IN.) Mar. 1992 13 p Presented at the 33d AIAA, ASME, ASCE, AHS, ASC Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(Contract RTOP 505-63-50-12)
(NASA-TM-107567; NAS 1.15:107567) Avail: NTIS HC/MF A03 CSCL 01/1

Modifications to a three dimensional, implicit, upwind, unstructured-grid Euler code for aeroelastic analysis of complete aircraft configurations are described. The modifications involve the addition of the structural equations of motion for their simultaneous time integration with the governing flow equations. The paper presents a detailed description of the time marching aeroelastic procedure and presents comparisons with experimental data to provide an assessment of the capability. Flutter results are shown for an isolated 45 degree swept-back wing and a supersonic transport configuration with a fuselage, clipped delta wing, and

two identical rearward-mounted nacelles. Comparisons between computed and experimental flutter characteristics show good agreement, giving confidence in the accuracy of the aeroelastic capability that was developed. Author

N92-23168# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
HYPERSONIC LAMINAR FLOW COMPUTATIONS OVER A BLUNT LEADING EDGED DELTA WING AT THREE DIFFERENT CHORD REYNOLDS NUMBERS
SHIVAKUMAR SRINIVASAN, PETER ELIASSON, and ARTHUR RIZZI Oct. 1991 17 p
(Contract VUB-8356/89/NL/FG(SG))
(FFA-TN-1991-40; ETN-92-91194) Avail: NTIS HC/MF A03

The hypersonic flow past a blunt leading edged and a blunt nosed delta wing was simulated numerically by solving the three dimensional Navier-Stokes equation. The laminar flow simulations were performed for three different chord Reynolds numbers. The Navier-Stokes equations were solved using the explicit finite volume four stage Runge-Kutta scheme. The intent is to reach a reasonable understanding of the separation characteristics of the flow in the leeside. It was observed that in the case of blunt edged delta wings at high angles of attack, the hypersonic flow is dominated by a shear layer that separates just past the blunt leading edge forming a more distributed vortical region over the wing, rather than a concentrated vortex structure as observed at lower speeds. As the Reynolds number increases, the separation characteristic on the lee side of the wing changes from a primary separation near the wing mid semi span to a primary separation close to the leading edge and a secondary separation near the wing mid semi span. The shape of the wing apex determines the location of the chords plane where the separation begins. The solutions were not compared with experimental data due to the nonavailability of the data at the time of writing. Sensitivity of the flow field to mesh refinement was investigated for the low Reynolds number case and it was found that the characteristics of the flow field remains the same even after mesh refinement. ESA

N92-23533*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GRID GENERATION AND FLOW SOLUTION METHOD FOR EULER EQUATIONS ON UNSTRUCTURED GRIDS
W. KYLE ANDERSON Apr. 1992 20 p
(Contract RTOP 505-59-53-01)
(NASA-TM-4295; L16986; NAS 1.15:4295) Avail: NTIS HC/MF A03 CSCL 01/1

A grid generation and flow solution algorithm for the Euler equations on unstructured grids is presented. The grid generation scheme, which uses Delaunay triangulation, generates the field points for the mesh based on cell aspect ratios and allows clustering of grid points near solid surfaces. The flow solution method is an implicit algorithm in which the linear set of equations arising at each time step is solved using a Gauss-Seidel procedure that is completely vectorizable. Also, a study is conducted to examine the number of subiterations required for good convergence of the overall algorithm. Grid generation results are shown in two dimensions for an NACA 0012 airfoil as well as a two element configuration. Flow solution results are shown for a two dimensional flow over the NACA 0012 airfoil and for a two element configuration in which the solution was obtained through an adaptation procedure and compared with an exact solution. Preliminary three dimensional results also are shown in which the subsonic flow over a business jet is computed. Author

N92-23563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTERACTIVE SOLUTION-ADAPTIVE GRID GENERATION PROCEDURE
TODD L. HENDERSON, YUNG K. CHOO, and KI D. LEE (Illinois Univ., Urbana.) Apr. 1992 28 p Original contains color illustrations
(Contract RTOP 505-62-52)
(NASA-TM-105432; E-6853; NAS 1.15:105432) Avail: NTIS HC/MF A03; 10 functional color pages CSCL 01/1

TURBO-AD is an interactive solution adaptive grid generation program under development. The program combines an interactive algebraic grid generation technique and a solution adaptive grid generation technique into a single interactive package. The control point form uses a sparse collection of control points to algebraically generate a field grid. This technique provides local grid control capability and is well suited to interactive work due to its speed and efficiency. A mapping from the physical domain to a parametric domain was used to improve difficulties encountered near outwardly concave boundaries in the control point technique. Therefore, all grid modifications are performed on the unit square in the parametric domain, and the new adapted grid is then mapped back to the physical domain. The grid adaption is achieved by adapting the control points to a numerical solution in the parametric domain using control sources obtained from the flow properties. Then a new modified grid is generated from the adapted control net. This process is efficient because the number of control points is much less than the number of grid points and the generation of the grid is an efficient algebraic process. TURBO-AD provides the user with both local and global controls. Author

N92-23717 Virginia Polytechnic Inst. and State Univ., Blacksburg.
EFFICIENT AND ROBUST DESIGN OPTIMIZATION OF TRANSONIC AIRFOILS Ph.D. Thesis
CHANGYEOL JOH 1991 153 p
Avail: Univ. Microfilms Order No. DA9136288

Numerical optimization procedures were employed for the design of airfoils in transonic flow based on the transonic small-disturbance (TSD) and Euler equations. A sequential approximation optimization technique was implemented for solving the design problem of lift maximization with wave drag and area constraints. A simple linear approximation was used for the approximation of the lift. Accurate approximations for sensitivity derivatives of the wave drag were obtained through the use of Nixon's coordinate straining approach. A modification of the Euler surface boundary conditions was implemented in order to efficiently compute design sensitivities without recreating the grid. Our design procedures experienced convergence problems for some TSD solutions, where the wave drag was found not to vary smoothly with the design parameters and consequently create local optimum problems. A procedure interchanging the role of the objective function and constraint, initially minimizing drag with a constraint on the lift, was found to be effective in producing converged designs, usually in approximately 10 global iterations. This procedure was also shown to be robust and efficient for cases where the drag varied smoothly, such as with the Euler solutions. Dissert. Abstr.

N92-23956*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH ANGLE OF ATTACK: AERODYNAMICS
JOHN E. LAMAR *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 39 p Jan. 1992
 Avail: NTIS HC/MF A11; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01/1

The ability to predict high angle of attack, nonlinear, aerodynamic characteristics of flight vehicles, including aircraft, has made significant progress in the last 25 years using computational tools and analyses. The key technological element which has made these analyses possible is the ability to account for the influence of the shed vortical flow, prevalent in this angle of attack range, on geometries of interest. Using selected analysis techniques, applications have also been made to wing design in order to improve their high speed maneuver performance. Various techniques, associated with different levels of accuracy, exist to model this vortical flow influence. The ones included in this paper cover: suction analogy with extensions; free vortex filaments; free vortex sheet modeling; and Euler and Navier-Stokes solutions.

Associated relevant features of vortices are also addressed, including: the wing and flow conditions which cause vortex formation; and how the vortex strength varies with angle of attack and wing sweep. Author

03

AIR TRANSPORTATION AND SAFETY

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

A92-32982
INERTIA REELS FOR AIRCREW RESTRAINT SYSTEMS
MICHAEL SCHULTZ (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 84-89. Research sponsored by U.S. Navy and USAF. refs
Copyright

New dynamic testing requirements are proposed for inertia reels used in helicopter aircrew restraint systems. The need for improved qualification testing is a consequence of MA-6/MA-8 inertia reels failing to adequately perform during recent dynamic testing of aircrew seats and during in-service helicopter mishaps. Dynamic tests were performed at the Naval Air Development Center's Horizontal Accelerator Facility, demonstrating feasibility of improved reels and standardizing proposed dynamic test methodology. Author

A92-32983
CANADIAN CF-18 AIRCRAFT EJECTION SEAT PARACHUTE UPDATE
DAVID B. WEBB (Irvin Industries Canada, Ltd., Fort Erie) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 96-101. refs
Copyright

The existing ejection seat for the F-18 aircraft (including the Canadian CF-18) is the standard Martin-Baker MK10. This seat has a good overall record, however, in 1985 the U.S. Navy identified areas of parachute performance which could be improved with state-of-the-art technology. The main improvements desired were reduction of parachute inflation forces in high speed deployments and reduced horizontal drive and descent rate to improve ground impact energy levels. Here, results of a parachute improvement program conducted by the Canadian Forces are reported. The results include a significant reduction in applied g loading to the ejected aircrew during 600 knot ejections (from 25 to 17 g) together with a reduction in the ejected trajectory distance of 16 percent. Author

A92-32984
COMPOSITE CYLINDER BLAST OVERPRESSURE TESTING
DOUGLAS J. DAWSON (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 111-114.
Copyright

An apparatus and method are described for testing composite cylinders designed to store compressed gas under conditions that can cause explosions. A steel enclosure, fitted with pressure transducers, holds a test cylinder fitted with a transducer to monitor internal pressure, and shots are fired at the cylinder to determine resultant overpressures. The failure of oxygen-charged composite cylinders leads to a much greater overpressure than that associated with a conventional steel cylinder. C.C.S.

A92-32998
STANDARDIZATION OF NATOPS EMERGENCY EGRESS PROCEDURES
CLAUDIA J. LEE (U.S. Navy, Naval Aerospace Medical Institute, Pensacola, FL) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 196-202. refs
Copyright

The standard emergency egress procedures for the Naval Air Training and Operating Procedures Standardization manual are presented and discussed. Standardized egress concepts and layouts are provided for generic jet, helicopter, and propeller aircraft, and topics addressed include underwater ejections, parachute deployment, and special protective gear. The standard layouts are expected to promote efficiency, aircrew training, and aviation safety and to ultimately protect crewmembers. C.C.S.

A92-32999
U.S. COAST GUARD AVIATION LIFE SUPPORT AND RESCUE EQUIPMENT
DAVID A. GIZA (USCG, Washington, DC) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 204-208.
Copyright

This review of rescue and life-support equipment examines methods for optimizing the reliability and durability of the equipment in harsh conditions and with limited support. Descriptions are given of particular strategies for survivability for such equipment as: antiexposure coveralls, helmets, liferafts, desalination kits, parachute bailout systems, and rescue litters. C.C.S.

A92-33799
CANADA MAKING MANY CHANGES IN WAKE OF DRYDEN CRASH REPORT
DAVID HUGHES Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, April 13, 1992, p. 34, 38.
Copyright

The substantial changes being made to many air safety rules and procedures in Canada prompted by the 1989 Fokker F-28 accident at Dryden, Ontario are reviewed. Though the basic cause of the accident is directly attributed to snow/ice accumulation on the wings at takeoff, numerous other physical and human related factors are considered contributory to the accident. Specific operational recommendations considered or implemented include the stationing of inspectors to visually check aircraft wings prior to takeoff and radio warning to the pilot when safe deicing time limits are approaching. Other deficient areas to be addressed for correction include, maintenance operations, flight dispatch, training, and crash fire rescue teams. R.E.P.

A92-34253* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF ACCIDENTS DURING INSTRUMENT APPROACHES
C. T. BENNETT (NASA, Ames Research Center, Moffett Field, CA) and M. SCHWIRZKE (San Jose State University, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, April 1992, p. 253-261. refs
Copyright

General aviation and air taxi approach phase accidents, which occurred during VFR and IFR, respectively over the last 25 years, were analyzed. The data suggest that there is a 204 percent higher risk during the approach and landing phase of VFR flights, than during similar IFR operations (14.82 vs 7.27 accidents/100,000 approaches). Alarmingly, the night single pilot IFR (SPIFR) accident rate is almost 8 times the rate of day IFR, 35.43 vs 4.47 accidents/100,000 approaches, and two and a half times that of day VFR approaches, 35.43 vs 14.82 accidents/100,000 approaches. Surprisingly, the overall SPIFR accident rates are not much higher than dual-pilot IFR (DPIFR), 7.27 vs 6.48 accidents/100,000 approaches. The generally static ratio of the statistics for SPIFR/DPIFR accident rates may be accounted for

by little or no change in general aviation cockpit technology during the last 25 years, and because IFR operational flight task management training has not kept pace. Author

A92-35759
HELICOPTER FOG FLYING TRIALS
N. TALBOT and M. L. WEBBER (Civil Aviation Authority, Gatwick, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 17 p. refs

Results are presented from a helicopter fog flying trial carried out to establish the basis for the BCAR, All Weather Operations requirements for the airworthiness and operations of helicopters. The trial utilized simulators and an SA 365N Dauphin helicopter and used a large number of approaches in the simulators and in the helicopter in both clear weather and fog conditions. It was found that, under conditions of clear visibility, helicopter could land from large offsets, but this maneuverability could not be used in conditions of restricted visual cues. The best technique for landing a helicopter in fog conditions was determined. Recommendations for further research are made together with provisional recommendations for lateral offset limits and visual segment requirements. I.S.

A92-35760
S-76B CERTIFICATION FOR VERTICAL TAKE-OFF AND LANDING OPERATIONS FROM CONFINED AREAS
J. M. G. F. STEVENS and H. J. G. C. VODEGEL (National Aerospace Laboratory, Amsterdam, Netherlands) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. refs

Results are presented from theoretical and flight test investigations carried out to establish procedures for vertical take-off and landing operations from confined areas for the S-76B helicopter. Pressure altitude, outside air temperature, and wind velocity were varied to give a representation of the prevailing weather conditions in the Netherlands. Results show that the S-76B is capable of performing the Category-A vertical operations at weights up to about 11,000 lbs for the no-wind condition and up to 11,700 lbs for the 20 kts wind condition. I.S.

A92-36200
WHY NOT A SAFETY RATING?
RICHARD H. SMITH Aerospace (UK) (ISSN 0305-0831), vol. 19, no. 4, April 1992, p. 8-11.
Copyright

An overview is presented of the aviation safety record in Australia where no fatal passenger injuries have occurred since the inception of commercial jet aircraft service over 20 years ago. The various factors involved in establishing safety regulations are discussed and efficiencies of scale (construction cost savings per seat and operating cost savings per seat) are considered. Attention is given to an innovative aviation safety rating based on the type of operation conducted by specific civil aircraft types. R.E.P.

A92-36349
UNITED 232 - COPING WITH THE 'ONE-IN-A-BILLION' LOSS OF ALL FLIGHT CONTROLS
ALFRED C. HAYNES (United Airlines, Chicago, IL) SAFE Journal, vol. 22, no. 2, Mar.-Apr. 1992, p. 37-46.
Copyright

Attention is given to a flight made on July 19, 1989, in which the uncontained disintegration of the No. 2 engine's fan rotor caused the loss of all three of the aircraft's redundant hydraulic flight control systems and made the aircraft almost uncontrollable. The major factors involved in making it possible to cope with a major inflight emergency such as the one-in-a-billion loss of all flight controls are discussed. They are: luck, communications, preparation, execution, and cooperation. P.D.

N92-22408# Loughborough Univ. of Technology (England). Dept. of Electrical and Electronic Engineering.
AN INVESTIGATION INTO THE FEASIBILITY OF PROVIDING A PROXIMITY WARNING DEVICE FOR SEARCH AND RESCUE HELICOPTERS M.S. Thesis
R. M. ADAMS 1990 132 p Prepared in cooperation with Royal Air Force Coll., Cranwell, England
(ETN-92-91057) Copyright Avail: NTIS HC/MF A07

An investigation and system feasibility analysis for the design of a rotor blade proximity warning facility for helicopters operating at slow speeds and in hover in poor visibility and weather conditions is presented. To achieve this, sensor options operating over the microwave to electrooptic frequencies are considered for their suitability to resolve low radar cross section targets in range, velocity, and azimuth displacement. The optimum system is deduced from the abilities of various strategies, their practical limitations and the available technology. The requirement of an active or passive system, the choice of wavelength, fundamental radar principle to be applied, and the anticipated performance estimation based on the radar range equation are addressed. ESA

N92-23596# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: RUNWAY COLLISION OF USAIR FLIGHT 1493, BOEING 737 AND SKYWEST FLIGHT 5569 FAIRCHILD METROLINER, LOS ANGELES INTERNATIONAL AIRPORT, LOS ANGELES, CA, FEBRUARY 1, 1991
22 Oct. 1991 168 p
(PB91-910409; NTSB/AAR-91/08) Avail: NTIS HC/MF A08; paper copy available on Standing Order, deposit account required (minimum deposit $100 US, Canada, and Mexico; all others $200) CSCL 01/3

On 1 Feb. 1991, at 1807 Pacific standard time, USAir flight 1493, a Boeing 737-300, collided with Skywest flight 5569, a Fairchild Metroliner, while USA1493 was landing at L.A. International Airport (LAX), Calif. Flight 5569 was positioned on the same runway, at intersection 45, awaiting clearance for takeoff. The NTSB determines that the probable cause of the accident was the failure of the LA Air Traffic Facility Management to implement procedures that provided redundancy comparable to the requirements contained in the National Operational Position Standards and the failure of the FAA Air Traffic Service to provide adequate policy direction and oversight to its air traffic control facility managers. These failures created an environment in the LA ATC tower that ultimately led to the failure of the local controller 2 to maintain an awareness of the traffic situation, culminating in the inappropriate clearances and subsequent collision of the aircrafts. Author

N92-23597# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: RYAN INTERNATIONAL AIRLINES DC-9-15, N565PC, LOSS OF CONTROL ON TAKEOFF, CLEVELAND-HOPKINS INTERNATIONAL AIRPORT, CLEVELAND, OHIO, FEBRUARY 17, 1991
16 Nov. 1991 106 p
(PB91-910410; NTSB/AAR-91/09) Avail: NTIS HC/MF A06; available on Standing Order, deposit account required (minimum deposit $100 US, Canada, and Mexico; all others $200) CSCL 01/3

The crash on takeoff of Ryan International Airlines flight 590 at Cleveland, Ohio, on 17 Feb. 1991 is examined. Ryan International Airlines flight 590, a DC-9 series 10 airplane, crashed while taking off from Cleveland-Hopkins International Airport. The flight crew consisted of two pilots. There were no other crewmembers or passengers on the flight, which was contracted to carry mail for the U.S. Postal Service. Both pilots were fatally injured, and the airplane was destroyed as a result of the accident. The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to detect and

remove ice contamination on the airplane's wings. The ice formation led to wing stall and loss of control during the attempted takeoff. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A92-33204#
A KNOWLEDGE ACQUISITION APPROACH FOR AN ON-BOARD MISSION PLANNER
MARK S. ROBINSON (IBM Corp., Federal Sector Div., Owego, NY) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p.
(AIAA PAPER 92-1021) Copyright

The present evaluation of knowledge-acquisition tools for supporting aircraft onboard mission planning gives attention to a methodology for the integration of acquired knowledge into all phases of system design and development. The major functions of the mission planning system are those of route planner, a waypoint planner, velocity profiler, and a fuel profiler. The selection of experts from which planning knowledge is acquired is straightforward in the case of 'physical' knowledge, but more subjective in the case of heuristic knowledge. Attention is given to the character of the knowledge data base and its representational techniques. O.C.

A92-33426
RADIO TECHNICAL COMMISSION FOR AERONAUTICS, TECHNICAL SYMPOSIUM, WASHINGTON, DC, NOV. 18-20, 1991, PROCEEDINGS
STEPHANIE WRIGHT, ED. (Radio Technical Commission for Aeronautics, Washington, DC) Washington, DC, Radio Technical Commission for Aeronautics, 1991, 184 p. For individual items see A92-33427 to A92-33432.
Copyright

Consideration is given to perspectives on the cooperative air traffic management (ATM) concept; operational requirements to design and operation of the ATM system; application of new communication, navigation, and surveillance technology; and implementation issues of the ATM concept. Particular attention is given to a European perspective in the cooperative air traffic management concept, an aircraft manufacture's perspective, the technological revolution in oceanic air traffic control, a concept for integrating airborne and ground-based automation for managing arrival traffic, and future ATM. O.G.

A92-33427
A EUROPEAN PERSPECTIVE ON THE CO-OPERATIVE AIR TRAFFIC MANAGEMENT CONCEPT
GEORGE A. PAULSON (Civil Aviation Authority, London, England) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 37-47.
Copyright

European initiatives in creating the cooperative air traffic management system are addressed focusing on the key program for progressive integration of the various states' air traffic control systems and the Eurocontrol program for enhanced air traffic management and mode S implementation in Europe. The future cooperative air traffic management system in Europe is being realized in three major areas: integration of disparate ATC systems under the 10-billion ECU harmonization and integration program; exploitation of the air-ground digital data interchange technology to provide a more cooperative and closer-coupled air-ground controller-pilot air traffic management environment; and strengthening the traditional cooperation between ATS providers and industry, and increasing the industry's role in the concept development project definition and systems operation. O.G.

A92-33429
CATMAC - A WAY TO INTEGRATE GROUND ATC AND AIRBORNE SYSTEMS
NILS BRANDT (Deutsche Lufthansa AG, Cologne, Federal Republic of Germany) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 69-83.
Copyright

The cooperative air trafic management concept (CATMAC) is briefly discussed. The CATMAC operational concept based on the recommendations of the ICAO future air navigation system takes into account the work of international specialist working groups. The CATMAC encompasses strategic planning, tactical planning, short-term planning, and monitoring and control, and assigns a number of relevant ATC tasks to the aircraft. The latter include exact calculation of the 4D flight profile, exact adherence to the profile, automatic notification of deviation trends from negotiated profile, and information about the performance possibilities of the aircraft for new negotiations. O.G.

A92-33431
THE TECHNOLOGICAL REVOLUTION IN OCEANIC AIR TRAFFIC CONTROL
JOSEPH J. FEE (FAA, Washington, DC) and WALLACE R. FEERRAR (Mitre Corp., McLean, VA) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 108-114.
Copyright

Technology standards developments in oceanic air trafic control (ATC) are addressed. A combination of user needs and technological opportunities will facilitate the rapid improvement of oceanic ATC. Major changes for the future ATC include modernization of the oceanic control centers to match the improved capability of the air transport fleet; development of a new airspace structure that will be capable of providing the capacity and flexibility to permit user preferred routing; and development of enhanced air traffic management capabilities to automate the transfer of air traffic control and optimize the flow of traffic. It is noted that the coordination of the overlapping standards development activities is a major challenge for the entire aviation community. O.G.

A92-33432 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PROFILE NEGOTIATION - A CONCEPT FOR INTEGRATING AIRBORNE AND GROUND-BASED AUTOMATION FOR MANAGING ARRIVAL TRAFFIC
STEVEN M. GREEN (NASA, Ames Research Center, Moffett Field, CA), WIM DEN BRAVEN (National Aerospace Laboratory, Amsterdam, Netherlands), and DAVID H. WILLIAMS (NASA, Langley Research Center, Hampton, VA) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 115-133. refs
Copyright

The profile negotiation process (PNP) concept as applied to the management of arrival traffic within the extended terminal area is presented, focusing on functional issues from the ground-based perspective. The PNP is an interactive process between an aircraft and air traffic control (ATC) which combines airborne and ground-based automation capabilities to determine conflict-free trajectories that are as close to an aircraft's preference as possible. Preliminary results from a real-time simulation study show that the controller teams are able to consistently and effectively negotiate conflict-free vertical profiles with 4D-equipped aircraft. The ability of the airborne 4D flight management system to adapt to ATC specified 4D trajectory constraints is found to be a requirement for successful execution of the PNP. It is recommended that the

conventional method of cost index iteration for obtaining the minimum fuel 4D trajectory be supplemented by a method which constrains the profile speeds to those desired by ATC. O.G.

A92-33433
FUTURE AIR TRAFFIC CONTROL AND NAVIGATION SYSTEMS; PROCEEDINGS OF THE AIAA INTERNATIONAL CIVIL AVIATION SEMINAR, PARIS, FRANCE, JUNE 12, 1991
JAMES E. FRENCH, ED. (AIAA, Washington, DC) Seminar sponsored by AIAA and Mitre Corp. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 161 p. In English and French. For individual items see A92-33434 to A92-33441. (AIAA SP-050-1991) Copyright

Topics presented include a global vision of air transportation, the ICAO Future Air Navigation System, future air navigation systems for Africa, and FANS technology and the future of air traffic services. Also presented are the harmonization and integration of air traffic control in Europe, a view from the Pacific Basin, and international standardization. R.E.P.

A92-33434
AIR TRANSPORTATION - THE GLOBAL VISION
JAMES B. BUSEY (FAA, Washington, DC) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 5-10.
Copyright

An overview is presented of the proposals currently in progress to build the worldwide air traffic control and navigation system of the future. The planning concept for this global system is based primarily on the work developed by the ICAO Future Air Navigation System (FANS) Committee. Attention is given to the investigations leading to the FANS Committee's conclusion that satellite technology offers the best way to achieve worldwide improvements in aviation, navigation, communications and surveillance. R.E.P.

A92-33435
THE ICAO FUTURE AIR NAVIGATION SYSTEM
H. B. O'KEEFFE (Civil Aviation Authority, Canberra, Australia) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 11-18.
Copyright

A review is presented of the Future Air Navigation Systems (FANS) Committee established by ICAO in 1983 with the task of identifying and assessing new concepts and new technology to overcome the limitations of the existing systems to meet the present and future needs of civil aviation. The FANS Committee was drawn from 32 ICAO states and international organizations who brought enormous resources to the goal of global implementation of a system concept for communication, navigation, and surveillance based largely on satellites and for the evolution of air traffic management. Consideration is given to the limitations of the present system, the FANS System concept, air traffic management, and the FANS system integration. R.E.P.

A92-33436
FANS TECHNOLOGY AND THE FUTURE OF AIR TRAFFIC SERVICES
EDWARD C. BRADY (Mitre Corp., Bedford, MA) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 19-22.
Copyright

A report is presented on the application of the ICAO Future Air Navigation System (FANS) architecture that incorporates significant improvements in communications, navigation and surveillance that will have a major impact on how business is conducted in the civil aviation community. The FANS Committee has delineated a global navigation satellite capability that would accommodate both the GPS and GLONASS, and in addition has required the use of the ground-based MLS, which is based on time-referenced scanning beam technology as the primary international landing system. The FANS architecture focuses on economical implementation and operation to ensure continuous, reliable and safe air traffic service. R.E.P.

A92-33437
HARMONISATION AND INTEGRATION OF AIR TRAFFIC CONTROL IN EUROPE
PEDRO ROSA (EUROCONTROL, Brussels, Belgium) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 23-33.
Copyright

The problems that have confronted air traffic control integration in Europe over recent years and the significant enhancements that are currently programmed to solve these problems are reviewed. Attention is given to harmonization, integration/unification, the involvement of Eurocontrol experts in national ATC planning, and the Eurocontrol Central Flow Management Unit. The use of satellites, and plans for traffic sequencing and metering into terminal areas based on flight profile control beyond the boundaries of individual states are considered. R.E.P.

A92-33438
THE VIEW FROM THE AIRPORT
PHILIPPE ROCHAT (Geneva Airport Authority, Switzerland) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 35-38.
Copyright

An overview of how airport operations can benefit from the capabilities offered by the Future Air Navigation System (FANS) worldwide is presented. From the airport perspective, the following elements of the FANS concept of particular importance include: improved navigation enroute and particularly in terminal areas using GLONASS, achievement of airport surface navigation, surveillance guidance and control systems, and development of satellite communication and other Automatic Dependant Surveillance techniques for terminal areas. FANS will probably contribute much more than other means to the universal implementation of air navigation plans and international standards for the regularity, safety, and efficiency of civil air transport. R.E.P.

A92-33439
FUTURE AIR NAVIGATION SYSTEMS FOR AFRICA
MAURICE RAJAOFETRA (Agence pour la Securite de la Navigation Aerienne d'Afrique et de Madagascar, Dakar, Senegal) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 39-41.
Copyright

The needs of the African Flight Information region in the field of future navigation systems are reviewed. The overall solution of navigation and communication enhancement in Africa is seen to be in point surveillance and automatic position reports of the basic Automatic Dependant Surveillance techniques. R.E.P.

A92-33440
A VIEW FROM THE PACIFIC BASIN
JONE KOROITAMANA (Civil Aviation Authority of Fiji, Nandi) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 43-51.
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An overview is presented of the civil transportation activities of Fiji and how the Future Air Navigation System (FANS) will

affect it and the other Pacific islands of the region. The CAA of Fiji is presently conducting trials with GPS low-cost navigation equipment for possible use on domestic routes even before it has been fully accepted on a worldwide basis. Should the implementation of the FANS concept require provision of an earth station in the South Pacific for management of the Flight Information Region, Fiji will have the manpower and the technical resources to do so. R.E.P.

A92-33441
INTERNATIONAL STANDARDIZATION
CHRISTIAN EIGL (International Civil Aviation Organization, Montreal, Canada) IN: Future air traffic control and navigation systems; Proceedings of the AIAA International Civil Aviation Seminar, Paris, France, June 12, 1991. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 53-58.
Copyright

A historical review is presented of the development, integration and standardization of the global committees and organizations that have been formed and leading up to the Special Committee on Future Air Navigation Systems (FANS). In its long-term projection for the coordinated evolutionary development of air navigation for international civil aviation, satellite-based continuous (CNS) systems, complementary to certain terrestrial systems, will be the key to worldwide improvements. Included in the benefits are those that arise from cost avoidance resulting from the elimination of existing systems and related equipment maintenance made redundant by the future CNS systems. R.E.P.

A92-33622
SLENDERNESS APPROXIMATIONS IN RCS ESTIMATION - THE SIMPLEST 2-D CASE
RICHARD M. JAMES (Boeing Co., Seattle, WA) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. 40, Feb. 1992, p. 149-155. Research supported by Boeing Co.
Copyright

A slender approximation for 2-D perturbations about an infinite conducting ground plane is derived and shown to lead to extremely simple final formulas for scattering width, certainly simple enough for design (inverse) analysis and optimization. The theory has been used extensively as part of code validation studies. Comparison with nonslender methods shows that the slender theory is surprisingly accurate and very robust. I.E.

A92-33632
RCS OF FOUR FUSELAGE-LIKE SCATTERERS AT HF FREQUENCIES
C. W. TRUEMAN, S. J. KUBINA (Concordia University, Montreal, Canada), S. R. MISHRA, and C. LAROSE (Canadian Space Agency, David Florida Laboratory, Ottawa, Canada) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. 40, Feb. 1992, p. 236-240. Research supported by Defence Research Establishment Ottawa and NSERC. refs
Copyright

Coastal HF radar in the ground-wave mode may be useful for monitoring the movement of ships, aircraft, and icebergs over vast areas of ocean. At HF frequencies an aircraft is in the Åresonance range' of size. The radar cross section (RCS) of four fuselagelike scatterers of resonant size, illuminated end-on (noise-on for the aircraft), and broadside is studied. The RCS is determined both by direct measurement and by wire-grid modeling, with good agreement. The RCS is studied as a function of frequency for scatterer lengths from 0.5 to 3.5 the wavelength. The RCS behaves quite differently for end-on incidence than for broadside incidence. I.E.

A92-35726
AN EXPLORATORY INVESTIGATION INTO THE DEFINITION OF TRACKING STANDARDS FOR IFR HELICOPTER APPROACHES TO REDUCED MINIMA
STEWART W. BAILLIE, STAN KERELIUK (National Research Council of Canada, Institute for Aerospace Research, Ottawa), and ROGER HOH (Hoh Aeronautics, Inc., Lomita, CA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 9 p. refs

The Canadian Institute for Aerospace Research Airborne Simulator helicopter was used to conduct an in-flight evaluation of the magnitude of tracking errors that are tolerable at 'decision height' for a steep, decelerating instrument approach to reduced minima in a rotorcraft. Errors in the glideslope and/or speed desired for the experimental data base were obtained by feeding biases into the command signal for the flight director. Handling-qualities evaluations indicated the need for a tradeoff between allowable altitude and speed errors. O.C.

A92-35740
HETERODYNE TECHNIQUES IN THE I.R. BANDWIDTH FOR LASER OBSTACLE DETECTION
C. CHIOZZINI (Agusta S.p.A., Gallarate, Italy), L. IDEO, R. MARCHETTI (Agusta S.p.A., Rome, Italy), and A. BIANCHI (Agusta S.p.A., Tradate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 5 p. refs

An evaluation is made of results obtained by a study of coherent monostatic lidar operating at 10.6 microns for obstacle avoidance functions aboard helicopters. Attention is given to operating margins. It is found that, in the case of normal atmospheric turbulence, system designers will have to overestimate operating margins in order to cover a sufficiently wide range of helicopter operation scenarios. O.C.

A92-35928
APPROACH FLIGHT TRIALS IN THE NETHERLANDS FOR THE NAVSTAR GPS JOINT PROGRAM OFFICE INTERNATIONAL TEST PROGRAM
ROBERT KRIJN and NICO VAN DRIEL (National Aerospace Laboratory, Amsterdam, Netherlands) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 1.2-1 to 1.2-11. refs
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A differential P-code GPS is tested to evaluate its use in determining precision aircraft approaches with emphasis placed on available position accuracy. Two GPS high-dynamics 3A receivers are employed with one on the research aircraft and one located at a surveyed position to transmit differential GPS corrections. ILS-like localizer and glide-slope deviation signals are generated by means of processing the GPS data with the differential corrections on the aircraft. The system is tested for different runway/approach configurations by having an evaluation pilot analyze the GPS signals on the primary flight display of the electronic flight-instrument system. The differential P-code GPS is shown to give mean altitude and horizontal-position errors of -10.2 and 1.7 m respectively, and the system is found to be comparable to the ILS system. The lateral-guidance information is shown to be accurate and stable, although glide-slope tracking is considered more difficult with the present system. C.C.S.

A92-35931
ACCEPTANCE OF TWO IDENTICAL RADARS IN THE ABSENCE OF A PRECISION REFERENCE
BRIAN BRACHIO and RICHARD TOWNES (Grumman Corp., Bethpage, NY) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 1.5-1 to 1.5-6.
Copyright

This paper describes the tools and methods used in a 'two-radar' acceptance test performed without a precision reference system. The calibration procedures are described, and a compilation of the results of several balloon runs is included. The analysis includes an estimate of tracking accuracy based upon the root mean square (rms) of the differences between the two radars in a common coordinate system. Author

A92-36076
EUROPEAN ATC INTEGRATION FACES DUAL CHALLENGES
BRUCE D. NORDWALL Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, no. 18, May 4, 1992, p. 58-60.
Copyright

A report on the political and technical challenges confronting the harmonized system integration of ATC in Europe is presented. The European ATC Harmonization and Integration Program has as its goal the standardization of software and hardware of the various national systems that exist today. Attention is given to a plan to improve the telecommunications system by integrating all telephone switches into a common network and replacing the current analog signaling system with digital. R.E.P.

A92-36124
GROWING NEED TO REPLACE ILS CAN BEST BE MET BY MLS
DAVID UNDERWOOD (Micronav International, Inc., Sydney, Canada) ICAO Journal (ISSN 0018-8778), vol. 47, no. 3, March 1992, p. 15-18.
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A review is presented of the future air navigation system 'seamless' integration of en route and terminal navigation guidance provided by a global navigation satellite system (GNSS) coupled with precision runway approach guidance from the MLS that has been adopted by ICAO as the successor to today's ILS. It is expected that GNSS, combined with the Category III capability of MLS, will provide all airspace users with efficient and safe navigation guidance anywhere in the world. Consideration is given to a variant of HUD whereby improved technology could allow pilots to 'see' the runway through the intervening weather and fly the virtual equivalent of a visual approach without the need for MLS or ILS guidance. R.E.P.

N92-22104# Mitre Corp., Bedford, MA.
TECHNICAL FEASIBILITY OF DIGITAL THREE-DIMENSIONAL CELLULAR COMMUNICATIONS FOR AIR TRAFFIC CONTROL APPLICATIONS. VOLUME 1: INTRODUCTION AND SUMMARY
B. E. WHITE, M. LEITER, R. I. MILLAR, J. L. RAMSEY, and R. D. SAKAMOTO Dec. 1991 42 p
(AD-A244573; M91-122-VOL-1) Avail: NTIS HC/MF A03 CSCL 25/4

MITRE's Center for Advanced Aviation System Development (CAASD) has proposed a set of concepts for improving VHF communications for air traffic control applications. One idea, called CTAG for Cellular Trunked Air Ground (CTAG) communications is to extend land-mobile cellular-trunked digital communications technology to air-ground communication between pilots and controllers. This study was aimed at addressing the technical feasibility of this approach. Detailed results show that significant benefits can indeed be obtained in not only automating routine communications functions but also in reducing the number of frequency channels required compared with existing analog voice-only procedures. Further work is required to quantify potential system costs, particularly those associated with the ground portions of the CTAG network. Author (GRA)

N92-22105# Mitre Corp., Bedford, MA.
TECHNICAL FEASIBILITY OF DIGITAL THREE-DIMENSIONAL CELLULAR COMMUNICATIONS FOR AIR TRAFFIC CONTROL APPLICATIONS. VOLUME 2: EXAMPLE SYSTEM DESIGN DETAILS
M. LEITER, R. I. MILLAR, J. L. RAMSEY, B. E. WHITE, and W. J. WILSON Dec. 1991 138 p
(AD-A244574; M91-122-VOL-2) Avail: NTIS HC/MF A07 CSCL 25/4

MITRE's Center for Advanced Aviation System Development (CAASD) has proposed a set of concepts for improving VHF communications for air traffic control applications. One idea, called CTAG for Cellular Trunked Air Ground (CTAG) communications is to extend land-mobile cellular-trunked digital communications technology to air-ground communication between pilots and controllers. This study was aimed at addressing the technical feasibility of this approach. Detailed results show that significant benefits can indeed be obtained in not only automating routine communications functions but also in reducing the number of frequency channels required compared with existing analog voice-only procedures. Further work is required to quantify potential system costs, particularly those associated with the ground portions of the CTAG network. Author (GRA)

N92-22106# Mitre Corp., Bedford, MA.
TECHNICAL FEASIBILITY OF DIGITAL THREE-DIMENSIONAL CELLULAR COMMUNICATIONS FOR AIR TRAFFIC CONTROL APPLICATIONS. VOLUME 3: GROUND NETWORK ARCHITECTURE
M. LEITER, R. I. MILLAR, J. L. RAMSEY, R. D. SAKAMOTOR, and B. E. WHITE Dec. 1991 51 p
(AD-A244575; M91-122-VOL-3) Avail: NTIS HC/MF A04 CSCL 25/4

MITRE's Center for Advanced Aviation System Development (CAASD) has proposed a set of concepts for improving VHF communications for air traffic control applications. One idea, called CTAG for Cellular Trunked Air Ground (CTAG) communications is to extend land-mobile cellular-trunked digital communications technology to air-ground communication between pilots and controllers. This study was aimed at addressing the technical feasibility of this approach. Detailed results show that significant benefits can indeed be obtained in not only automating routine communications functions but also in reducing the number of frequency channels required compared with existing analog voice-only procedures. Further work is required to quantify potential system costs, particularly those associated with the ground portions of the CTAG network. GRA

N92-22210# Federal Aviation Administration, Atlantic City, NJ.
COMPARISON OF THE PERFORMANCE OF A MICROWAVE LANDING SYSTEM ELEVATION STATION WITH THE INSTRUMENT LANDING SYSTEM END-FIRE GLIDE SLOPE AT YEAGER AIRPORT, CHARLESTON, WEST VIRGINIA Technical Report, Apr. 1991
CLIFFORD MACKIN and EDMUND ZYZYS Mar. 1992 28 p
(Contract FAA-T0604-S)
(DOT/FAA/CT-TN91/22; ACD-330) Avail: NTIS HC/MF A03

A comparison is made between microwave landing systems (MLS) and instrument landing systems (ILS) by installing an MLS elevation station collocated with the ILS basic end-fire glide slope (EFGS) on a runway. The EFGS is the only type of ILS glide slope antenna that will provide operationally usable performance at the site because of limited flat terrain in front of the antenna and a valley with hills in approach to the runway. The MLS testbed, consisting of a 1.5 degree beamwidth elevation station and a 2 degree beamwidth azimuth station, was transported to and installed at Yeager Airport on runway 23. The MLS station did not affect the performance of the ILS station as verified by a flight check. During ground tracked partial orbits and inbound level runs and approaches, Both ILS and MLS data were simultaneously recorded. The MLS data showed improved performance over the ILS based on EFGS. Author

N92-22389# National Aeronautical Lab., Bangalore (India).
PC BASED FLIGHT PATH RECONSTRUCTION USING UD FACTORIZATION FILTERING ALGORITHM
GIRIJA GOPALRATNAM and J. R. RAOL Feb. 1992 36 p
(NAL-PD-FC-9201) Avail: NTIS HC/MF A03

Described here are the results of a UD based flight path reconstruction algorithm implemented using PC-MATLAB. It is validated using simulated and real data for linear and nonlinear systems. The bounds on states and parameters are also given. Author

N92-22436*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
GLOBAL POSITIONING SYSTEM SUPPORTED PILOT'S DISPLAY
MARSHALL M. SCOTT, JR., TEMEL ERDOGAN, ANDREW P.

SCHWALB, and CHARLES H. CURLEY (Boeing Aerospace Co., Kennedy Space Center, FL.) *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 1 p 101-108 Dec. 1991
Avail: NTIS HC/MF A23 CSCL 17/7

The hardware, software, and operation of the Microwave Scanning Beam Landing System (MSBLS) Flight Inspection System Pilot's Display is discussed. The Pilot's Display is used in conjunction with flight inspection tests that certify the Microwave Scanning Beam Landing System used at Space Shuttle landing facilities throughout the world. The Pilot's Display was developed for the pilot of test aircraft to set up and fly a given test flight path determined by the flight inspection test engineers. This display also aids the aircraft pilot when hazy or cloud cover conditions exist that limit the pilot's visibility of the Shuttle runway during the flight inspection. The aircraft position is calculated using the Global Positioning System and displayed in the cockpit on a graphical display. Author

N92-23096# Computer Resource Management, Inc., Herndon, VA.
NATIONAL AIRSPACE SYSTEM: SYSTEM EFFECTIVENESS OPERATIONAL CONCEPT NAS-SR-138
WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON, JR. Apr. 1992 48 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-92/2) Avail: NTIS HC/MF A03

A requirement for the National Airspace System (NAS) is to provide for system effectiveness as identified in the NAS Systems Requirements Specifications (NASSRS). This operational concept will describe the operation of the NAS when the projected upgrade is complete (i.e., 'end state'). These documents will assist in linking the requirements specified in the NASSRS with the NAS design. This concept and seven other operational concepts will complete the description of the system requirements as described in the NASSRS. Author

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-32553
DESIGN, ANALYSIS, TESTING, AND CERTIFICATION OF COMPOSITE PRIMARY STRUCTURE FOR THE PIAGGIO P-180 AVANTI
JERRY JOHNSON (Dow-United Technologies Composite Products, Inc., Wallingford, CT) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-A-1 to 2-A-10. refs

The composite structural components of the P-180 Avanti include the forward wing (canard), horizontal stabilizer, vertical fin, rudder, tail cone, engine nacelles, wing central trailing edge, radome, and baggage bay and landing gear doors. These components make extensive use of cocured structures to minimize both weights and costs. The unique design requirements for these composite structures were established via full-scale structural testing as well as extensive analytical verification; attention is presently given to the design, test, and analysis procedures used to determine structural behavior under combined static and fatigue loading, as well as to such failure mode interaction-related issues as buckling and material failure. O.C.

A92-32554
DESIGN, ANALYSIS, AND TESTING OF INTEGRALLY STIFFENED COMPOSITE CENTRE FUSELAGE SKIN FOR FUTURE FIGHTER AIRCRAFT
L. LEMMER and H. LONSINGER (MBB GmbH, Munich, Federal Republic of Germany) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-B-1 to 2-B-13. Previously announced in STAR as N92-18333.

A center fuselage skin made of one piece carbon fiber composite monocoque with double curvature, stiffened with simultaneous curved frames and longerons, is described. The basic design, material selection and stressing of typical features are discussed and compared with test results. The design is assessed in terms of weight reduction and production cost considerations. Author

A92-32979
RECENT ADVANCES IN RESTRAINT TECHNOLOGY
DAVID A. LORENZ (Pacific Scientific Co., HTL/Kin-Tech Div., Yorba Linda, CA) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 29-34. refs
Copyright

An emphasis of future aviation cockpit design will be improved crash survivability. Recent advances in restraint technology and hardware can provide maximum crash protection along with improved crash survivability. In today's fast attack, nap of the earth flights, and during ground support missions, pilots and gunners do not have the liberty to brace themselves or prelock their restraints prior to impact. This problem is compounded by the close strike envelope such as the optical relay tube on the AH-64, and the heads up display in the C-17. Author

A92-33182#
COMMERCIAL AIRPLANE AIR DISTRIBUTION SYSTEM DEVELOPMENT THROUGH THE USE OF COMPUTATIONAL FLUID DYNAMICS
ALAN W. DEJAGER and DREW B. LYTLE (Boeing Co., Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p. refs
(AIAA PAPER 92-0987) Copyright

To aid in the design of the main cabin air supply nozzle of a commercial airplane, computational fluid dynamics was used to analyze the air flow patterns and velocity magnitudes of potential nozzle configurations. Both two- and three-dimensional models were constructed. Heat transfer was included in some of the models to study the buoyancy effects experienced during heating and cooling modes. Author

A92-33193*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IMPACT OF STRUCTURAL OPTIMIZATION WITH AEROELASTIC/MULTIDISCIPLINARY CONSTRAINTS ON HELICOPTER ROTOR DESIGN
PERETZ P. FRIEDMANN (California, University, Los Angeles) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 23 p. refs
(Contract NAG1-833)
(AIAA PAPER 92-1001) Copyright

This paper presents a review of the state-of-the-art in the field of structural optimization when applied to vibration reduction of helicopters in forward flight with aeroelastic and multidisciplinary constraints. It emphasizes the application of the modern approach where the optimization is formulated as a mathematical programming problem and the objective function consists of the vibration levels at the hub and behavior constraints are imposed on the blade frequencies, aeroelastic stability margins as well as on a number of additional ingredients which can have a significant effect on the overall performance and flight mechanics of the helicopter. It is shown that the integrated multidisciplinary optimization of rotorcraft offers the potential for substantial

improvements which can be achieved by careful preliminary design and analysis without requiring additional hardware such as rotor vibration absorbers or isolation systems. Author

A92-33194#
MULTIDISCIPLINARY DESIGN OPTIMIZATION OF A LARGE TRANSPORT AIRCRAFT WING
T. J. TZONG, G. D. SIKES, and M. J. LOIKKANEN (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p. refs
(AIAA PAPER 92-1002) Copyright

A large order aeroelastic design optimization tool, ADOP, recently developed at McDonnell Douglas has been demonstrated. Two structural models, a small and a large transport aircraft wing, were optimized for minimum weight subject to simultaneous stress and flutter constraints. Design variable linking was used to reduce the problem sizes, so that numerical optimization could be performed in a smaller design space. Both wing structures were initially resized using the fully stressed design technique, and panel buckling and two-bay crack stress allowables were included in the stress optimization. Preliminary results from this study show the feasibility of using ADOP as an advanced structural design tool. Author

A92-33196*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRELIMINARY RESULTS FROM THE HIGH SPEED AIRFRAME INTEGRATION RESEARCH PROJECT
PETER G. COEN, JAROSLAW SOBIESZCZANSKI-SOBIESKI, and SAMUEL M. DOLLYHIGH (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(AIAA PAPER 92-1004) Copyright

A review is presented of the accomplishment of the near term objectives of developing an analysis system and optimization methods during the first year of the NASA Langley High Speed Airframe Integration Research (HiSAIR) project. The characteristics of a Mach 3 HSCT transport have been analyzed utilizing the newly developed process. In addition to showing more detailed information about the aerodynamic and structural coupling for this type of vehicle, this exercise aided in further refining the data requirements for the analysis process. R.E.P.

A92-33208*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A STUDY OF ALTITUDE-CONSTRAINED SUPERSONIC CRUISE TRANSPORT CONCEPTS
DAVID C. TICE and GLENN L. MARTIN (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 8 p. refs
(Contract NAS1-1900)
(AIAA PAPER 92-1027) Copyright

The effect of restricting maximum cruise altitude on the mission performance of two supersonic transport concepts across a selection of cruise Mach numbers is studied. Results indicate that a trapezoidal wing concept can be competitive with an arrow wing depending on the altitude and Mach number constraints imposed. The higher wing loading of trapezoidal wing configurations gives them an appreciably lower average cruise altitude than the lower wing loading of the arrow wing configurations, and this advantage increases as the maximum allowable cruise altitude is reduced. R.E.P.

A92-33219#
AGILE RESPONSIVE EFFECTIVE SUPPORT - DESIGN AND TESTING OF THE ARES CONCEPT DEMONSTRATOR AIRCRAFT
DOUGLAS B. SHANE (Scaled Composites, Inc., Mojave, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p. refs
(AIAA PAPER 92-1038) Copyright

This paper presents an overview of the Scaled Composites ARES demonstrator aircraft. Discussed are program origins, design considerations and features, and results of testing, including the effects of live firings with a 25 mm cannon on both handling qualities and the composite structure. Its asymmetric fuselage configuration shows promising results in the ability to tailor handling qualities to minimize dispersion during gun firing, and in the ability to protect the engine inlet from gun gas ingestion. Loads encountered from both gun recoil (average 7000 lb) and blast pressure (with peaks over 100 psi) are well below the structure's allowable limits. The ARES is a single-engine, single-seat concept demonstrator for a multimission aircraft capable of anti-helicopter, light anti-armor, border patrol, tactics training, and other missions. It is canard-configured, has a wingspan of 35 ft, an empty weight of approximately 3600 lb, and is powered by a Pratt and Whitney of Canada JT15D-5 turbofan engine. Author

A92-33239#
CONCEPTUAL DESIGN AND ANALYSIS OF A SPECIAL OPERATIONS TRANSPORT
ANTHONY RUSCELLO (USAF, Directorate of Design Analysis, Wright-Patterson AFB, OH) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p.
(AIAA PAPER 92-1066)

A conceptual design study has been conducted to define an aircraft configuration well suited for the insertion and extraction of troops and equipment upon deep, fast, low-level penetration into hostile territory. Mission unrefueled radius was to be 1000 n mi, hovering and VTOL operation in the target area was deemed essential, and the aircraft had to be self-deployable from either land bases or aircraft carriers. A novel and unique configuration, the 'tilt-wing-rotor', was found uniquely able to meet design requirements at the lowest gross weight; it was also noted to possess significant off-design performance capability. O.C.

A92-33249#
STUDY OF MATERIALS AND STRUCTURES FOR THE HIGH-SPEED CIVIL TRANSPORT
PETER G. RIMBOS (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 5 p.
(AIAA PAPER 92-1080) Copyright

While commercial feasibility studies have shown that commercial aircraft designed to fly at Mach 2.0-2.5 with 250-300 passengers over 5000 n mi ranges can meet economic objectives, technology-feasibility studies show that present technology is inadequate for these requirements. The Low-Cost Airplane Trade Study was conducted to identify the technical requirements for design and construction of large, low-cost structures from advanced, high-temperature materials. After evaluating structural, material, and manufacturing concepts for a year 2005-certification development effort, reference baseline concepts were evaluated to identify the most attractive combination of design features, materials, and manufacturing and assembly techniques. O.C.

A92-33250#
DESIGN FOR THE RELIEF OF THERMAL STRESSES IN A LARGE HIGH-SPEED WING
A. VELICKI and D. A. BARKEY (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 6 p.
(AIAA PAPER 92-1082) Copyright

Unlike current commercial aircraft, the high-speed civil transport (HSCT) will be subjected to a complex combination of mechanical and thermal loads. Designing for the interaction of these forces will require improved materials and structures, along with a stringent requirement for innovative structural concepts capable of relieving the thermal stress distributions caused by thermal gradients and linear expansions. Not only is a radical departure from conventionally designed structures required, it is an essential fundamental to ensure the overall fatigue life of the aircraft. To illustrate the thermal design challenges, some of the considerations used to develop an HSCT conceptual wing design are reviewed. Author

A92-33251#
DESIGN OF ADVANCED COMPOSITE COMPONENTS FOR MAINTAINABILITY BASED ON INSERVICE EXPERIENCE
DONALD JOYNES (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p.
(AIAA PAPER 92-1085) Copyright

This paper gives a brief account of the introduction of composite materials, their usage on Boeing airplanes, and some examples of in-service experience. Based on the in-service experience, suggestions are made to enhance their maintainability. It is shown that the advanced composites met their original design objectives to reduce component weight. However, lessons learned from the first generation of components must be incorporated into future designs if they are to enhance the total airplane performance for the operational life of the airplane. Author

A92-33252#
THE U-2A FLIGHT TEST PROGRAM
THOMAS S. PUGH (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 8 p.
(AIAA PAPER 92-1086) Copyright

This paper discusses the U-2A flight test program. Information and data is extracted from flight test reports prepared following the test program in the mid-1950s. Specific plot data are excluded from the paper, as it is intended to be a comprehensive summary of the program rather than a detailed technical presentation. The paper covers basic design of the U-2A and flight testing of certain portions of the total program, including instrumentation systems utilized during the period. The objective of the paper is to present previously unavailable information on the U-2A test program as a historical perspective. The approach to testing, appropriate to the time, carries many lessons applicable to current programs. Author

A92-33253#
YF-22A PROTOTYPE ADVANCED TACTICAL FIGHTER DEMONSTRATION/VALIDATION FLIGHT TEST PROGRAM OVERVIEW
THOMAS A. MORGENFELD (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p.
(AIAA PAPER 92-1087) Copyright

A total of 91.6 hours were logged over the course of 74 demonstration/evaluation flights by both prototypes of the YF-22A ATF aircraft. These tests, which were to demonstrate aircraft capabilities, prioritized the use of the aircraft as demonstrators over their use as development tools and were in addition intended to generate all test data required for the ATF Engineering and Manufacturing Development proposal. Attention is given to lessons learned with respect to program management, bureaucratic communications, test planning, and personnel use. Throughout this hectic test schedule, no safety problems or foreign-object damage were encountered. O.C.

A92-33271#
APPLICATION OF A LOCAL PANEL BUCKLING CONSTRAINT WITHIN AUTOMATED MULTIDISCIPLINARY STRUCTURAL ANALYSIS AND DESIGN
J. D. AUSMAN (Northrop Corp., Pico Rivera, CA), J. A. HANGEN, and D. A. ACEVEDO (Northrop Corp., Hawthorne, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p. Research supported by Northrop Corp. refs
(AIAA PAPER 92-1116) Copyright

Given the stringent performance requirements of next-generation aircraft, the demand for lightweight structural technologies is increasing. Thin-gage, stiffened shell structures have often been shown to be panel buckling critical. This paper describes the implementation of a semi-empirical, local panel buckling constraint into ASTROS (Automated Structural Optimization System). This paper first presents background information which motivated the development of this new constraint, followed by technical discussions of the calculation of the buckling constraint and the constraint gradient. Two examples are presented to illustrate the use and importance of this new feature. Author

A92-33280#
STRUCTURAL AIRWORTHINESS OF AGING BOEING JET TRANSPORTS - 747 FUSELAGE FATIGUE TEST PROGRAM
K. V. GOPINATH (Boeing Commercial Airplane Group, Everett, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 8 p.
(AIAA PAPER 92-1128) Copyright

The fuselage of a retired 747-100 fuselage that had experienced 20,000 full-pressure cycles has been subjected to extended cyclic-pressure testing in order to evaluate structural durability beyond the 20,000-flight/60,000 hour design objectives of this aircraft. A practical fuselage inspection program was formulated on the basis of test results obtained for damage growth. The extended cycling tests then performed on a 747-400 forward fuselage verified the effectiveness of design improvements incorporated on the basis of fleet operating experience; the 747-400 variant will require far less fatigue-related maintenance than earlier 747s in over-20,000-pressure cycle operation. O.C.

A92-33281#
STRUCTURAL DESIGN FOR DURABILITY - LESSONS LEARNED FROM SERVICE AND TEST DATA
C. GINGRICH and W. RAZETO (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 7 p. refs
(AIAA PAPER 92-1129) Copyright

A continuous process of updating structural design and durability of Boeing aircraft using service and test data is described. The Boeing approach to structural design is characterized by incorporation of current fatigue considerations into structural details at an early stage of the design process. The durability system provides a continuously updated history of past designs in a flexible format that enables designers to learn from past experience. A reference manual containing a catalog of details creates a comprehensive inventory of service and test-proven design practices. Results of service data and full-scale fatigue tests confirm that combining the existing inventory with an update process is a mature and successful process. O.G.

A92-33307#
APPLICATION OF MULTIDISCIPLINARY OPTIMIZATION TO CONCEPTUAL AIRCRAFT DESIGN AT ROCKWELL INTERNATIONAL - A STATUS REPORT
S. HOLLOWELL and R. BITTEN (Rockwell International Corp., Los Angeles, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. Research supported by Rockwell International Independent Research and Development Program. refs
(AIAA PAPER 92-1196) Copyright

This paper discusses some characteristics of the conceptual aircraft design process and compares optimization techniques for applicability to the conceptual design process. A proof of concept optimization problem, with a single goal and multiple performance constraints, applicable to the Multi-Role Fighter was analyzed using several of the more promising optimization techniques. The results showed good agreement in the ability to predict the goal (takeoff gross weight), as well as range, maximum Mach number, and specific excess power performance constraints. Somewhat poorer agreement was encountered for sustained and instantaneous load factor constraints. Considerations and techniques for use in large scale optimizations with interdisciplinary coupling are also discussed. Author

A92-33313*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DESIGN TRADEOFFS ON ENGINE-INTEGRATED HYPERSONIC VEHICLES
MARY KAE L. O'NEILL and MARK J. LEWIS (Maryland, University,

College Park) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 13 p. Research sponsored by NASA. refs
(AIAA PAPER 92-1205) Copyright

Two classes of airbreathing hypersonic vehicle concepts, one for primarily cruise missions and the other for accelerator type missions, are presented. Both are designed with waverider airframes and hydrogen-fueled scramjet engine modules. Cruise configurations are optimized for the product of I(sp) and L/D while matching lift to weight and thrust to drag at some equivalence ratio. Accelerator configurations are optimized for effective specific impulse while matching lift to weight at an equivalence ratio of one. The method and computer code developed to optimize the configurations are discussed. The features and design tradeoffs for each class of vehicles are described. Recently available weight estimates for all-body waveriders have had a significant impact on the integrated configurations. Mach 8 vehicles at 40 km altitude optimized with the cruise objective function have L/Ds of 2.55 to 2.92 and I(sp)s of 2850 to 2940 sec. A Mach 14 vehicle at 40-km altitude optimized with the accelerator objective function has an I(sp) sub eff of 189 sec, and a Mach 10 vehicle an I(sp) sub eff of 880 sec. Author

A92-33326#
SENTINEL 1000 FLIGHT TEST PROGRAMME OVERVIEW AND PRELIMINARY RESULTS
K. R. NIPPRESS and B. WILSON (Westinghouse Surveillance Systems, England) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p. refs
(AIAA PAPER 92-1229) Copyright

This paper presents an overview of the Sentinel 1000 flight test program and discusses some of the results obtained from the initial phase. The Sentinel 1000 airship is the largest and most advanced nonrigid airship in the world under active flight development. Some of the peculiarities of testing a lighter-than-air vehicle, which cause complications compared with conventional aircraft work, are explained in describing the work. There is significant commonality between this airship and the much larger and more complex Sentinel 5000 airship currently being designed under U.S. Government contract. The Sentinel 1000 is considered to have potential design risk reduction for this project. Author

A92-33327#
ES-3A FLIGHT TEST PROGRAM
JAMES P. FITZGERALD (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p.
(AIAA PAPER 92-1230) Copyright

This paper describes a relatively small scale flight test program conducted on the first fully mission-capable ES-3A carrier-based Electronic Surveillance aircraft by Lockheed Advanced Development Company. Details of the required modifications to the airframe are included, as well as a description of the test program planning, accomplishments, test results, and lessons learned. Author

A92-33333#
FLIGHT TESTING A HIGH PERFORMANCE KIT BUILT AIRCRAFT
RICHARD J. GRITTER (Questair, Inc., Greensboro, NC) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 7 p. refs
(AIAA PAPER 92-1240) Copyright

The Questair Venture was developed as a two place, all metal, kit built aircraft with the design mission of fast, all weather cross country travel. As a result of its small physical size and large operating envelope several interesting challenges were encountered during the flight testing of the aircraft. The longitudinal flying qualities were tailored to provide the feel of a much larger aircraft through the use of an artificial feel system which also incorporates a trim function. The low speed and stalling characteristics of the aircraft were greatly improved by using a wing leading edge modification. The high speed/flutter characteristics of the aircraft were tested and verified using ground vibration tests and instrumented flight tests. Author

A92-33342#
THE C-17 - MODERN AIRLIFT TECHNOLOGY
LEONARD R. TAVERNETTI (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 13 p.
(AIAA PAPER 92-1262) Copyright

An update on the C-17 program is presented. Topics discussed include a technology adapted from commercial aircraft for military airlift; the military requirement to move large cargo items long distances and land on short runways, which drove C-17 design; and significant design alternatives and solutions selected. O.G.

A92-33343#
LOW REYNOLDS NUMBER, LONG ENDURANCE AIRCRAFT DESIGN
RICHARD J. FOCH and KEVIN G. AILINGER (U.S. Navy, Naval Research Laboratory, Washington, DC) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p. refs
(AIAA PAPER 92-1263) Copyright

Airplanes are typically designed to maximize range at the highest practical cruising speed. However, several missions require extended duration rather than range, and favor the slowest possible cruise speed. Such missions include surveillance, radio relay, and ship's electronic decoy. These missions are ideally suited for advanced technology unmanned aircraft, either remotely piloted or autonomous. Feasibility studies have been conducted and flight demonstrator prototypes of such unique aircraft have been under steady research and development at the Naval Research Laboratory since 1978. This paper discusses the design aspects and tradeoffs unique to small, slow speed long endurance unmanned aircraft operating at wing chord Reynolds numbers between 150,000 and 500,000. Additionally, many of these low Reynolds number-driven design features have applicability to high altitude, long endurance aircraft. Author

A92-33800
SAAB 2000 BEGINS 1,200-HR. TEST PROGRAM AT SKAVSTA SITE
CAROLE A. SHIFRIN Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, April 13, 1992, p. 40, 41, 43.
Copyright

A review is presented of the initial test flights of the new Swedish Saab 2000 50-seat regional transport at the new Saab flight test facility at Skavsta Airport near Nykoping, Sweden. The maiden flight on 26 March lasted one hour and 27 minutes, reaching an altitude of 15,000 feet and a speed of 160 knots with all preprogrammed test points achieved. A total of three prototypes will be utilized in the test program with full certification expected in the first quarter of 1993. Two additional airframes will be used for structural testing, one for fatigue testing and the second for static loading tests. Attention is given to the aircraft powerplants, avionics, propellers, and the environmental control system.
R.E.P.

A92-33919
AIRCRAFT PERFORMANCE
W. A. MAIR (Cambridge, University, England) and DAVID L. BIRDSALL (Bristol, University, England) Cambridge, England and New York, Cambridge University Press (Cambridge Aerospace Series, No. 5), 1992, 320 p. refs
(ISBN 0-521-36264-4) Copyright

Aircraft performance estimation studies entail calculation of such factors as rates of climb, maximum and cruise speeds, range for a given mass of fuel, and runway lengths required for takeoff and landing. A comprehensive account is presently given of the relationships between these quantities and the design characteristics of an aircraft and its powerplant, with emphasis on the derivation of simple analytical expression which depend solely on such fundamental aircraft properties as mass, wind tunnel or flight test-derived lift and drag coefficients, and engine thrust

characteristics over the given range of speeds and altitudes. Only fixed-wing aircraft are considered, and little prior knowledge of aircraft is assumed. O.C.

A92-34358*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A DEMONSTRATION OF PASSIVE BLADE TWIST CONTROL USING EXTENSION-TWIST COUPLING
R. C. LAKE, M. W. NIXON, M. L. WILBUR, J. D. SINGLETON, and P. H. MIRICK (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 774-781. refs
(AIAA PAPER 92-2468)

The feasibility of passive blade twist control using an extension-twist-coupled composite rotor blade design has been demonstrated. A set of low-twist model-scale helicopter rotor blades has been manufactured from existing molds with the objective of demonstrating this control concept. Hover testing of the set of blades demonstrated maximum twist changes of 5.24 deg for the ballasted blade configuration, and 2.54 deg for the unballasted configurations in the atmospheric test condition. These results compared well with those obtained from a detailed FEM analysis of the rotor blade. Aerodynamic-induced effects on the blade elastic twist were found to be minimal. L.M.

A92-34362*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL AND ANALYTICAL STUDY OF THE EFFECTS OF FLOOR LOCATION ON RESPONSE OF COMPOSITE FUSELAGE FRAMES
LISA E. JONES, MARTHA ROBINSON (NASA, Langley Research Center, Hampton, VA), EDWIN L. FASANELLA (Lockheed Engineering and Sciences Co., Hampton, VA), and RICHARD L. BOITNOTT (U.S. Army, Aerostructures Directorate, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 809-817. refs
(AIAA PAPER 92-2473) Copyright

Experimental and analytical results are presented of the effects of floor placement on the structural response and strength of I-cross section, semi-circular fuselage frames constructed of graphite-epoxy composite material. The composite frame configuration is representative of current conventional aircraft design. Experimental strain distributions are presented from static loading tests of the composite frames and compared with finite element structural models and closed form solutions. An understanding of floor location effects can aid dynamists in predicting the crash behavior of these conventional structures, and may assist the designer in developing crashworthy structures for future aircraft. Author

A92-34373#
EFFECT OF ADAPTIVE MATERIAL PROPERTIES ON STATIC AEROELASTIC CONTROL
STEVEN M. EHLERS (McDonnell Douglas Technologies, Inc., San Diego, CA) and TERRENCE A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 914-924. refs
(AIAA PAPER 92-2526) Copyright

The relationship between adaptive material properties and flight vehicle aeroelastic performance and size is investigated. An adaptive laminated beam model is combined with strip theory aerodynamics to represent an adaptive wing. The model is used to derive relationships between piezoelectric material properties and flight vehicle performance. Examples are used to illustrate the relationship. Wing loading is a function of wing planform, stiffness and properties of the active material layers. Currently available piezoelectric materials limit the range of wing loadings for which aeroelastic performance change is possible. Goals for new materials and composites are suggested. Author

A92-34390*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - A GOVERNMENT OVERVIEW
RAYMOND G. KVATERNIK (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1103-1112. refs
(AIAA PAPER 92-2200) Copyright

An overview is presented of government contributions to the program called Design Analysis Methods for Vibrations (DAMV) which attempted to develop finite-element-based analyses of rotorcraft vibrations. NASA initiated the program with a finite-element modeling program for the CH-47D tandem-rotor helicopter. The DAMV program emphasized four areas including: airframe finite-element modeling, difficult components studies, coupled rotor-airframe vibrations, and airframe structural optimization. Key accomplishments of the program include industrywide standards for modeling metal and composite airframes, improved industrial designs for vibrations, and the identification of critical structural contributors to airframe vibratory responses. The program also demonstrated the value of incorporating secondary modeling details to improving correlation, and the findings provide the basis for an improved finite-element-based dynamics design-analysis capability. C.C.S.

A92-34391#
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - BELL HELICOPTER TEXTRON ACCOMPLISHMENTS
JAMES D. CRONKHITE (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1113-1125. refs
(AIAA PAPER 92-2201) Copyright

R&D efforts are described which relate to the prediction of the higher-frequency vibrations for metallic and composite helicopter airframes in the context of the Design Analysis Methods for Vibration program. The present organization conducted NASTRAN finite-element modeling, ground vibration testing, and correlations of metallic and composite airframes. The testing is directed at isolating the effects of various components on the overall airframe vibratory response by studying configurations with specific removed elements. An investigation of difficult components is conducted experimentally by utilizing a stripped-down version of the D292 helicopter and adding elements in subsequent tests. Metallic and composite airframes are found to have comparable vibration correlations and measured modal damping. The incorporation of secondary structure in the testing and analysis results in improved higher-frequency correlations suggesting that the effects of the secondary structure should be considered in the design phase. C.C.S.

A92-34392*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - BOEING HELICOPTERS AIRFRAME FINITE ELEMENT MODELING
R. GABEL, P. LANG, and D. REED (Boeing Co., Helicopters Div., Philadelphia, PA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p.

1126-1137. refs
(Contract NAS1-16460; NAS1-17497)
(AIAA PAPER 92-2202) Copyright

Finite-element modeling of the airframe vibration of the Army/Boeing CH-47D helicopter is conducted with comparisons to experimental data in an effort to improve the design process. A NASTRAN FEM is developed that is fully representative of the test configuration and includes the support fixture, shakers, and the aircraft/shaker suspension system. The analysis is conducted with specific attention given to the prediction of reasonable forced amplitudes throughout the airframe. Reasonable correlation is noted between the FEM and experimental results, although improved correlation can be obtained by including more accurate damping values and secondary effects such as stringer shear loading. It is shown that the general stress model does not provide an adequate dynamic analysis on which to base design improvements. A more detailed model is required that emphasizes highly detailed helicopter elements and employs a finer mesh particularly in the description of the mass distribution. C.C.S.

A92-34393#
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - MCDONNELL DOUGLAS HELICOPTER COMPANY ACHIEVEMENTS
MOSTAFA TOOSSI, RICHARD WEISENBURGER, and MOSTAFA HASHEMI-KIA (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1138-1148. refs
(AIAA PAPER 92-2203) Copyright

This paper presents a summary of some of the work performed by McDonnell Douglas Helicopter Company under NASA Langley-sponsored rotorcraft structural dynamics program known as DAMVIBS (Design Analysis Methods for VIBrationS). A set of guidelines which is applicable to dynamic modeling, analysis, testing, and correlation of both helicopter airframes and a large variety of structural finite element models is presented. Utilization of these guidelines and the key features of their applications to vibration modeling of helicopter airframes are discussed. Correlation studies with the test data, together with the development and applications of a set of efficient finite element model checkout procedures, are demonstrated on a large helicopter airframe finite element model. Finally, the lessons learned and the benefits resulting from this program are summarized. Author

A92-34394#
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - SIKORSKY AIRCRAFT - ADVANCES TOWARD INTERACTING WITH THE AIRFRAME DESIGN PROCESS
WILLIAM J. TWOMEY (Sikorsky Aircraft, Stratford, CT) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1149-1158. refs
(AIAA PAPER 92-2204) Copyright

A short history is traced of the work done at Sikorsky Aircraft under the NASA/industry DAMVIBS program. This includes both work directly funded by the program as well as work which was internally funded but which received its initial impetus from DAMVIBS. The development of a finite element model of the UH-60A airframe having a marked improvement in vibration-predicting ability is described. A new program, PAREDYM, developed at Sikorsky, which automatically adjusts an FEM so that its modal characteristics match test values, is described, as well as the part this program played in the improvement of the UH-60A model. Effects of the bungee suspension system on the shake test data used for model verification are described. The impetus given by the modeling improvement, as well as the recent availability of PAREDYM, has brought for the first time the introduction of low-vibration design into the design cycle at Sikorsky. Author

A92-34411#
COMPARISON BETWEEN IMPOSED-PERIODICITY AND MARCHING-IN-TIME SOLUTIONS OF HELICOPTER ROTOR BLADE STEADY-STATE RESPONSE PROBLEM
GRZEGORZ KAWIECKI (Tennessee, University, Knoxville), NITHIAM T. SIVANERI (West Virginia University, Morgantown), and TAD JANIK (Tennessee, University, Knoxville) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1340-1349. refs
(AIAA PAPER 92-2256) Copyright

This paper discusses the comparison between the steady-state response of a helicopter rotor blade in forward flight computed using marching-in-time algorithms and computed using imposed-periodicity algorithm. The blade is represented as a two-degree-of-freedom rigid body. The motion of the blade is modeled with a system of ordinary, nonlinear, differential equations. Runge-Kutta and predictor-corrector methods are used for marching-in-time solutions. Time finite element method based on bilinear formulation is used for imposed-periodicity solutions. Differences between the steady-state solutions obtained using marching-in-time and imposed-periodicity methods has been observed. These differences affect also the results of motion about steady-state stability analysis. The same phenomenon has been observed for a simple two-degree-of-freedom, nonlinear mass-damper-spring system. Author

A92-34412#
NONLINEAR LARGE AMPLITUDE AEROELASTIC BEHAVIOR OF COMPOSITE ROTOR BLADES AT LARGE STATIC DEFLECTION
TAEHYOUN KIM and JOHN DUGUNDJI (MIT, Cambridge, MA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1350-1360. refs
(AIAA PAPER 92-2257) Copyright

An investigation is made of the nonlinear, large amplitude aeroelastic behavior of rotor blades during hover. The aeroelastic model is capable of dealing with large vibration amplitudes as well as large static deflections, and is based on an Euler angle formation together with a harmonic balance, finite difference, and Newton-Raphson technique. Numerical results for an illustrative graphite-epoxy composite case indicate that the dynamic stall is predominant in a moderate range of amplitudes, but the nonlinear static-dynamic couplings in the structure could be equally important in large amplitude ranges. Author

A92-34413*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYTICAL AEROELASTIC STABILITY CONSIDERATIONS AND CONVERSION LOADS FOR AN XV-15 TILT-ROTOR IN A WIND TUNNEL SIMULATION
SESI KOTTAPALLI (NASA, Ames Research Center, Moffett Field, CA) and VICTOR MEZA (California Polytechnic State University, San Luis Obispo) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1361-1370. refs
(AIAA PAPER 92-2258) Copyright

A rotorcraft analysis is conducted to assess tilt-rotor stability and conversion loads for the XV-15 rotor with metal blades within its specified test envelope. A 38-DOF flutter analysis based on the code by Johnson (1988) is developed to simulate a wind-tunnel test in which the rotor torque is constant and thereby study stability. The same analytical model provides the simulated loads including hub loads, blade loads, and oscillatory pitch-link loads with attention given to the nonuniform inflow through the proprotor in the presence of the wing. Tilt-rotor stability during the cruise mode is found to be sensitive to coupling effects in the control system stiffness, and a stability problem is identified in the XV-15 Advanced

Technology Blades. The present analysis demonstrates that the tilt-rotor is stable within the specified test envelope of the NASA 40 x 80-ft wind tunnel. C.C.S.

A92-34414*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NEW AEROELASTIC MODEL FOR COMPOSITE ROTOR BLADES WITH STRAIGHT AND SWEPT TIPS
KUO-AN YUAN, PERETZ P. FRIEDMANN, and COMANDUR VENKATESAN (California, University, Los Angeles) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1371-1390. refs
(Contract NAG1-833)
(AIAA PAPER 92-2259) Copyright

An analytical model for predicting the aeroelastic behavior of composite rotor blades with straight and swept tips is presented. The blade is modeled by beam type finite elements along the elastic axis. A single finite element is used to model the swept tip. The nonlinear equations of motion for the finite element model are derived using Hamilton's principle and based on a moderate deflection theory and accounts for: arbitrary cross-sectional shape, pretwist, generally anisotropic material behavior, transverse shears and out-of-plane warping. Numerical results illustrating the effects of tip sweep, anhedral and composite ply orientation on blade aeroelastic behavior are presented. Tip sweep can induce aeroelastic instability by flap-twist coupling. Tip anhedral causes lag-torsion and flap-axial couplings, however, its effects on blade stability is less pronounced than the effect due to sweep. Composite ply orientation has a substantial effect on blade stability. Author

A92-34415#
A STUDY ON THE FEASIBILITY OF USING ADAPTIVE STRUCTURES IN THE ATTENUATION OF VIBRATION CHARACTERISTICS OF ROTARY WINGS
F. NITZSCHE and E. BREITBACH (DLR, Institut fuer Aeroelastik, Goettingen, Federal Republic of Germany) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1391-1402. refs
(AIAA PAPER 92-2452) Copyright

The feasibility of employing adaptive material to build both sensors and actuators that attenuate the higher harmonic loads developed by helicopter rotor blades, using the individual blade control (IBC) concept, is investigated. IBC, based on a collocated actuator-sensor arrangement along the blade, and tailored to act specifically on the bending and torsion modes, is expected to bring further improvements to the reduction of the overall dynamic response of helicopters. The results indicate that there are already real situations for which the adaptive material has enough power to accomplish the task without saturation of the applied electric field. Author

A92-34417#
JOINED-WING MODEL VIBRATIONS USING PC-BASED MODAL TESTING AND FINITE ELEMENT ANALYSIS
BENHE QU and MALCOLM A. CUTCHINS (Auburn University, AL) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1407-1414. Research supported by Pratt & Whitney of China, Inc. refs
(AIAA PAPER 92-2260) Copyright

An experimental modal analysis of a unique aluminum joined-wing model has been conducted in order to identify its basic vibrational characteristics. Excitation of the model at multiple points is provided by an impulse force hammer and the responses are measured by an accelerometer. The test data are acquired and processed with a dual channel FFT analyzer housed in a COMPAQ PORTABLE 386 personal computer. Eight resonance responses in the frequency range from 0 to 800 Hz are found, and the natural frequencies and mode shapes agree reasonably well with the finite element analysis results obtained using MSC/NASTRAN. Comments about the modal testing software and instruments are also presented. Emphasis is placed on the experimental modal analysis. Author

A92-34468#
FAMUSS - A NEW AEROSERVOELASTIC MODELING TOOL
DALE M. PITT and CHARLES E. GOODMAN (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1887-1897. refs
(AIAA PAPER 92-2395) Copyright

The Flexible Aircraft Modeling Using State Space (FAMUSS) computer code implements a novel technique for the aeroservoelastic (ASE) analysis of aircraft that is based on the determination of an equivalent system which matches the transfer function frequency response. Attention is presently given to FAMUSS' mathematical bases, as well as to examples of state models for fighter aircraft test cases; the size and accuracy of the latter are compared with models generated via conventional rational-function aerodynamics and the minimum-state representation. The FAMUSS model's low order (matrix size) is advantageous in an ASE analysis, in that it improves stability-assessment robustness. O.C.

A92-34471#
AEROTHERMOELASTIC ANALYSIS OF A NASP-LIKE VERTICAL FIN
JOHN P. RODGERS (Duke University, Durham, NC) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1913-1923. refs
(AIAA PAPER 92-2400) Copyright

Several aeroelastic stability analyses for a vertical fin similar to that of the National Aero-Space Plane are described. The objectives of the study were to design and obtain an experimental data base for a supersonic wind-tunnel model of the fin in order to examine the effects of thermal loading on the flutter characteristics. This paper describes the preliminary efforts to design the wind-tunnel model, including several of the geometric parameter variations that were analyzed. The dominant flutter mechanism involved a flap vibration mode and a fin bending mode. Variation of the thicknesses of flap and root flexures, used to attach the flap to the fin, and the fin to a support, significantly affected the flutter boundary. Uniform thermal loads, affecting only material properties, had little effect, as did the application of different uniform temperatures to each side of the fin. In contrast, the application of significant chord-wise thermal gradients induced stresses which reduced the flutter dynamic pressure by as much as 37 percent. For less extreme distributed loading, the low-aspect ratio fin was relatively unaffected. Author

A92-34476*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BLADE ROOT TORSIONAL DAMPERS TO REDUCE HUB LOADS
SESI KOTTAPALLI (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1952-1960. refs
(AIAA PAPER 92-2449) Copyright

A new method of reducing helicopter rotor hub loads and marginally improving rotor performance by the introduction of large values of blade root torsional damping is presented. Basic theoretical considerations imply that these benefits in hub loads can come about by changes to the blade elastic torsional deflection. This basic theory was analytically verified by using a fully coupled aeroelastic rotorcraft analysis as applied to a modern, articulated

rotor blade, namely that of the Sikorsky S-76. From an implementation standpoint, a rotor-based torsional damping device may be more practical than one that involves a major portion of the blade span. Also, a root-based device may allow for the retrofitting of existing helicopter rotor blade/hub configurations.
Author

A92-34477*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF OPEN LOOP HIGHER HARMONIC CONTROL AT HIGH AIRSPEEDS ON A MODERN FOUR-BLADED ARTICULATED ROTOR
SESI KOTTAPALLI and JANE LEYLAND (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1961-1974. Previously announced in STAR as N92-11000. refs
(AIAA PAPER 92-2450) Copyright

The effects of open loop higher harmonic control (HHC) on rotor hub loads, performance, and push rod loads of a Sikorsky S-76 helicopter rotor at high airspeeds (up to 200 knots) and moderate lift (10,000 lbs) were studied analytically. The present analysis was performed as a part of a wind tunnel pre-test prediction and preparation procedure, as well as to provide analytical results for post-test correlation efforts. The test associated with this study is to be concluded in the 40- by 80-Foot Wind Tunnel of the National Full-Scale Aerodynamics Complex (NFAC) at the NASA Ames Research Center. The results from this analytical study show that benefits from HHC can be achieved at high airspeeds. These results clear the way for conducting (with the requirement of safe pushrod loads) an open loop HHC test at high airspeeds in the 40- by 80-Foot Wind Tunnel using an S-76 rotor as the test article.
Author

A92-34500# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THREE-DIMENSIONAL TIME-MARCHING AEROELASTIC ANALYSES USING AN UNSTRUCTURED-GRID EULER METHOD
RUSS D. RAUSCH (Purdue University, West Lafayette, IN), JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA), and HENRY T. Y. YANG (Purdue University, West Lafayette, IN) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2214-2224. refs
(Contract NGT-50406)
(AIAA PAPER 92-2506) Copyright

The modifications to a 3D implicit, upwind, unstructured-grid Euler code for aeroelastic analysis of complete aircraft configurations described involve the addition of structural equations of motion for their simultaneous time integration with the governing flow equations. A detailed description of the time-marching aeroelastic procedure and comparisons with experimental data are presented, to provide an assessment of capabilities. Flutter results are shown for an isolated 45-deg sweptback wing and an SST with a fuselage, clipped delta wing, and two identical rearward-mounted nacelles. Comparisons between computed and experimental flutter characteristics show good agreement.
Author

A92-34543#
APPLICATION OF ANALYTICAL AND DESIGN TOOLS FOR FIGHTER WING AEROELASTIC TAILORING
JONATHAN BOHLMANN, MICHAEL H. LOVE, DANIEL BARKER, K., WILLIAM A. ROGERS (General Dynamics Corp., Fort Worth, TX), and BETH E. PAUL (Dayton, University, OH) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2625-2639. refs
(AIAA PAPER 92-2373) Copyright

Results of wing analysis and design studies performed for the Validation of Aeroelastic Tailoring (VAT) configuration are reported. The VAT results are found to be in good agreement with static prediction for ELAPS, a Ritz structural analysis code. ASTROS, a new multidisciplinary finite element optimization code is also used for static and dynamic analyses of the VAT. In particular, ASTROS has been used to optimize the composite wing skin of the VAT for strength and displacement constraints simulating aeroelastic loads. Results obtained for 1/9-scale and 1/4-scale VAT models are presented.
V.L.

A92-34544*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FULLY INTEGRATED AERODYNAMIC/DYNAMIC OPTIMIZATION OF HELICOPTER ROTOR BLADES
JOANNE L. WALSH (NASA, Langley Research Center, Hampton, VA), WILLIAM J. LAMARSH, II (Unisys Corp., Hampton, VA), and HOWARD M. ADELMAN (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2640-2655. refs
(AIAA PAPER 92-2374) Copyright

This paper describes a fully integrated aerodynamic/dynamic optimization procedure for helicopter rotor blades. The procedure combines performance and dynamics analyses with a general purpose optimizer. The procedure minimizes a linear combination of power required (in hover, forward flight, and maneuver) and vibratory hub shear. The design variables include pretwist, taper initiation, taper ratio, root chord, blade stiffnesses, tuning masses, and tuning mass locations. Aerodynamic constraints consist of limits on power required in hover, forward flight and maneuver; airfoil section stall; drag divergence Mach number; minimum tip chord; and trim. Dynamic constraints are on frequencies, minimum autorotational inertia, and maximum blade weight. The procedure is demonstrated for two cases. In the first case the objective function involves power required (in hover, forward flight, and maneuver) and dynamics. The second case involves only hover power and dynamics. The designs from the integrated procedure are compared with designs from a sequential optimization approach in which the blade is first optimized for performance and then for dynamics. In both cases, the integrated approach is superior.
Author

A92-34545#
A DESIGN OPTIMIZATION PROCEDURE FOR HIGH-SPEED PROP-ROTORS
ADITI CHATTOPADHYAY (Arizona State University, Tempe) and JOHNNY R. NARAYAN (MCAT Institute, San Jose, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2656-2662. refs
(AIAA PAPER 92-2375) Copyright

An optimization procedure has been developed to address the complex and conflicting design requirements associated with high-speed prop-rotor design. The procedure involves the couplings of aerodynamic performance and aeroelastic stability inside a closed-loop procedure. Both high-speed cruise and hover design requirements are addressed. The objective is to maximize the propulsive efficiency in axial flight while maintaining a significant figure of merit in hover. Constraints are also imposed on the aeroelastic stability in axial flight. Both structural and planform design variables are used. The optimization procedure yields significant improvements in the aerodynamic characteristics of the rotor.
Author

A92-34546*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTIMIZING TUNING MASSES FOR HELICOPTER ROTOR BLADE VIBRATION REDUCTION INCLUDING COMPUTED AIRLOADS AND COMPARISON WITH TEST DATA

JOCELYN I. PRITCHARD, HOWARD M. ADELMAN, JOANNE L. WALSH, and MATTHEW L. WILBUR (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2663-2671. refs
(AIAA PAPER 92-2376)

An optimization procedure is developed for locating tuning masses on a rotor blade so that vibratory loads are minimized and hub-shear harmonics are reduced without adding a large mass penalty. The airloads are computed by means of a helicopter analysis for the cases of three vs six tuning masses, with attention given to the prediction of changes in airloads. Frequencies, airloads, and hub loads are computed with the CAMRAD/JA helicopter analysis code and the Conmin general-purpose optimization program. The hub shear is found to be significantly reduced in both cases with the added mass, and the reduction of hub shear is demonstrated under three flight conditions. Comparisons with wind-tunnel data demonstrate that the correlation of mass location is good and the relationship between mass location and flight speed is predicted well by the model. C.C.S.

A92-34592*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROELASTIC OPTIMIZATION OF AN ADVANCED GEOMETRY HELICOPTER ROTOR
RANJAN GANGULI and INDERJIT CHOPRA (Maryland, University, College Park) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3072-3085. refs
(Contract NAG1-739)
(AIAA PAPER 92-2360) Copyright

Sensitivity derivatives of blade loads and aeroelastic stability of a helicopter rotor in forward flight are calculated as an integral part of a basic aeroelastic analysis using a direct analytical approach. Design variables include nonstructural mass and its placement, chordwise offset of blade center of gravity and aerodynamic center from the elastic axis, blade bending stiffnesses (flap, lag, torsion), and tip geometry (sweep, anhedral, pretwist and planform taper). By means of a sensitivity study, the importance of different design variables on oscillatory hub loads and damping of blade modes is examined. Aeroelastic and sensitivity analyses of the rotor based on a finite element method in space and time are linked with automated optimization algorithms to perform optimization studies of rotor blades. Optimum design solutions, calculated for a four-bladed, soft-inplane hingeless rotor achieved a reduction of 25-60 percent of all 4/rev loads. Author

A92-34593#
A STRUCTURAL DESIGN AND OPTIMIZATION TOOL FOR DUCTED ROTOR/WING BLADES
WILLIAM A. CROSSLEY, DAVID H. LAANANEN (Arizona State University, Tempe), and JOHN W. RUTHERFORD (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3086-3095. Research sponsored by McDonnell Douglas Helicopter Co. refs
(AIAA PAPER 92-2361) Copyright

This paper discusses a design tool used to aid in the conceptual development of the Rotor/Wing high-speed rotorcraft concept. By using this tool, a minimum weight blade design can be found. Optimization of the blade is carried out by varying the thickness of structural components in the blade for three different configurations. The blades must perform under two distinct loading conditions, subject to constraints on strength, buckling, displacement, and geometry. A composite box beam models the blade for analysis. Results from a sample case are included to show the capability of the design tool. It was shown that the tool works well, and it demonstrates practical applications of anisotropic beam modeling and composite strength analyses. Author

A92-34599#
DETERMINATION OF TIRE-WHEEL INTERFACE LOADS FOR AIRCRAFT WHEELS
S. KANDARPA, B. F. SPENCER, JR., D. J. KIRKNER (Notre Dame, University, IN), and M. CHAMPION (USAF, Flight Dynamics Directorate, Wright-Patterson AFB, OH) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3163-3171. Research supported by USAF. refs
(AIAA PAPER 92-2482) Copyright

A numerical tool is developed for determining the pressure distribution at the tire-wheel interface of an aircraft wheel from experimentally obtained strains. The methodology employs an axisymmetric finite element model which is subjected to asymmetric loading. The loading is represented as a double Fourier series, and the components are determined by a least squares fit using the experimentally determined strains. A finite element code was developed to perform this analysis. Sample experiments are presented to illustrate the validity and the robustness of the algorithm. Finally, the limitations of this type of analysis are discussed and future directions are indicated. Author

A92-34650
MASS-TRANSPORTER
SIMON ELLIOTT Flight International (ISSN 0015-3710), vol. 141, April 1, 1992, p. 22, 23, 26-28.
Copyright

A critical survey is presented of next-generation high passenger capacity commercial aircraft configurations currently under evaluation, with attention to the ovoid, circular, horizontal 'double-bubble', and 'clover leaf' fuselage cross-sectional shapes through which seating-arrangement densities are to be maximized. The configurations, at their most conservative, expand existing B 747 and Airbus airframes to reach 600 passengers; all-new designs are expected to be able to seat as many as 1000 passengers. Nearly all configurations are four-engined, attempt to fit existing airport-infrastructure dimensions, and use double-deck seating. O.C.

A92-35434
JPATS ESCAPE SYSTEM DEVELOPMENT
KEN R. YATES (Martin-Baker Aircraft Co., Ltd., Middlesex, England) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 36-42.
Copyright

The Joint Primary Aircraft Training System (JPATS) program is discussed with particular attention given to the development of the MK16L ejection seat. The MK16L lightweight variant ejection seat is a twin catapult, fully automatic cartridge operated seat with rocket assistance, which provides safe escape throughout the envelopes stipulated in MIL-S-9479B and MIL-S-18471F. It is based on the latest advances in seat propulsion, stabilization, and recovery technology in conjunction with the JPATS requirements for accommodation of the full percentile range of male and female aircrew with minimum installed weight and low cost. O.G.

A92-35436
COMPUTATIONAL ANALYSIS OF INERTIAL EFFECTS ON THE STABILITY OF AN ACES-II EJECTION SEAT
LAWRENCE C. ROGERS (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 57-62. refs
Copyright

This study examines the quantitative effects on ejection seat performance of altering its mass properties. The study is done by

altering the mass properties of a computer model of an ACES-II ejection seat. The computer model provides an analytical answer to the dynamic competition of inertial and applied forces acting on each mass altered seat condition. The results and method used can optimize performance upgrades and ejection seat design in the future along with providing a more than intuitive answer to the question 'Why is a heavier ejection seat more stable?'.
Author

A92-35437
STRUCTURAL TESTING OF COMMERCIAL ROTORCRAFT SEATS - AN OVERVIEW
S. P. DESJARDINS and S. J. SHANE (Simula, Inc., Phoenix, AZ) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 63-81. refs
Copyright
Structural testing of commercial rotorcraft seats is reviewed. Topics discussed include static and dynamic tests, dynamic overshoot, test requirements, documentation of results, test equipment, and dynamic test facilities. It is noted that, because of the complexity of testing required for certification, very detailed test plans are a necessity. These test plans should include descriptions of the test articles (the aircraft attachments and the restraint system), the facilities (the equipment, instrumentation, and calibration procedures) and the complete procedures for the testing. O.G.

A92-35441
METHODS FOR PREDICTING SUCCESSFUL EJECTION SEAT CANOPY PENETRATION
PETER AYOUB and PETER YOST (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 98-103.
Copyright
The techniques and methods currently being developed under NADC's SBIR program to help understand the canopy penetration process are discussed. Preliminary results prove the feasibility of using fracture mechanisms and finite element models to predict crack propagation in a transparency. The use of analytical tools in conjunction with simple and effective test methods should produce an optimum canopy penetration system which will be less time-consuming and less expensive. O.G.

A92-35452
ENERGY ATTENUATION FOR CRASHWORTHY SEATING SYSTEMS - PAST, PRESENT, AND POSSIBLE FUTURE DEVELOPMENT
J. D. GLATZ (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 174-181. refs
Copyright
Consideration is given to past efforts that have led to successful operational use of energy attenuators for seating systems, recent research, and possible concepts for future development. Energy-attenuating seating systems are considered to be the most effective location for providing occupant energy protection in operational aircraft. They have been developed with new aircraft, including CH-46E Sea Knight, UH-60A Black Hawk, SH-60B Seahawk, and AH-64A Apache. The performance of energy-attenuating seating systems is less vulnerable to impact attitude and surface than energy attenuating landing gear or subfloor structure. O.G.

A92-35679#
DYNAMICS OF HELICOPTERS IN GROUND RESONANCE WITH AND WITHOUT BLADE DISSIMILARITIES
JAMES M. WANG and INDERJIT CHOPRA (Maryland, University, College Park) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 273-291. refs
(AIAA PAPER 92-2108) Copyright
The realistic problem of how blade-to-blade dissimilarities modify helicopter ground resonance stability is examined for articulated, hingeless and bearingless rotors. The effects of blade-to-blade dissimilarities, such as one or more lag dampers inoperative, unbalance in blade mass, and dissimilarities in blade inplane stiffness are shown. The paper also explains and compares the physics of ground and air resonance for articulated, hingeless and bearingless rotors. A simple rigid blade model including only lag motion and two body motions is used to illustrate the governing physics of ground resonance with and without blade dissimilarities. Then, a study on blade dissimilarity is carried out for a hingeless and a bearingless rotor using a finite element analysis that includes rotor aerodynamics, elastic blade deformations, and body pitch and roll motions. Author

A92-35680#
COUPLED ROTOR-FUSELAGE DYNAMICS AND AEROELASTICITY IN TURNING FLIGHT
ANNE M. SPENCE and ROBERTO CELI (Maryland, University, College Park) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 292-301. refs
(Contract DAAL03-88-C-002)
(AIAA PAPER 92-2109) Copyright
This paper describes the results of a numerical study of the air resonance stability of a soft-in-plane, hingeless rotor helicopter undergoing a coordinated steady turn. The mathematical model of the blade includes nonlinearities due to moderately large elastic deflections. The fuselage is described by nonlinear Euler equations valid for large fuselage attitudes and rates. The combined effects to turn rate, aircraft speed, flight path angle, and direction of turn are discussed. The results indicate that steady level turns stabilize the lag modes, but the rotor-fuselage coupling is destabilizing. Descending turns are destabilizing and may limit the maneuver envelope of the helicopter because regressive lag mode instabilities may occur. The model contains the main ingredients required for flight dynamic analyses. The effect of turn rate on the aircraft poles in forward flight is presented as an illustrative example.
Author

A92-35681#
IDENTIFICATION OF HELICOPTER COMPONENT LOADS USING MULTIPLE REGRESSION
DAVID J. HAAS and ROBIN IMBER (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 302-314. refs
(AIAA PAPER 92-2110)
Multiple regression analysis of helicopter flight data is used to develop prediction models for rotating system component loads from parameters measured in the fixed system. The data base that is analyzed contains load measurements for a helicopter performing several types of flight maneuvers, including symmetric pull outs, rolling pull outs, climbing turns, and level flight. The data are divided into two parts: one for model development and one to serve as a blind test of the model. For steady level flight, linear and nonlinear regression analyses are performed to predict main rotor pushrod and blade normal bending vibratory loads. Correlations above 95 percent were achieved on the test data for the steady level flight condition. For comparison, analytical results calculated using the CAMRAD/JA rotor analysis computer code for the helicopter in level flight are included. Regression models to predict vibratory loads during maneuvering flight are also developed. Evaluations on the test data indicate that correlations ranging from 79 to 95 percent are possible for the types of maneuvers contained in the data base. Author

A92-35682#
AN EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF WING FLUTTER ON A TRAIL ROTOR V/STOL AIRCRAFT

DAVID L. SOISTMANN (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 315-325. refs (AIAA PAPER 92-2112)

A wind tunnel model based on a trail rotor vehicle concept was tested for wing flutter in the subsonic flow regime. The wind tunnel model was flutter tested in the forward flight mode only. From this test it was determined that this conceptual vehicle may be susceptible to wing flutter. However, the flutter encountered was not catastrophic but was of the limited amplitude type. The trailing rotor blades were found to have a positive aerodynamic damping effect on flutter. The flutter mechanism involved a coupling of the first wing bending and first wing torsion vibration modes. A current flutter analysis method was used to make predictions of the flutter boundary. Good correlation between the analysis and the experimental data was shown. Author

A92-35731
FREQUENCY DOMAIN TESTING OF HELICOPTER DYNAMICS USING AUTOMATED INPUT SIGNALS

R. J. PATTON (York, University, Heslington, England), P. TAYLOR (Westland Helicopters, Ltd., Power Systems Dept., Yeovil, England), and P. YOUNG (British Aerospace, PLC, Dynamics Group, Filton, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. Research supported by Ministry of Defence of England. refs
(Contract SERC-GR/XG/107732)

A collaborative research project between Westland Helicopters and York University to provide a characterization of all significant dynamic phenomena arising from flight tests on a helicopter flow by Westland is described. Logarithmic swept sinewave test signals were applied to the series actuators of an agile prototype helicopter during flight testing. Gain and phase data derived from auto- and cross-spectral estimates are examined to validate mathematical models used in flight simulation and to provide information about significant nonlinearities not accounted for in the simulation models. It is concluded that the Schroeder phased signal shows great promise for future flight application. The logarithmic swept sinewave is adequate for flight application, and frequency domain testing is, in general a viable method for identifying the physical phenomena of the system under examination. P.D.

A92-35733
NOISE LEVEL REDUCTION INSIDE HELICOPTER CABINS

E. LAUDIEN and G. NIESL (MBB GmbH, Munich, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 11 p. refs

A number of measures to reduce the noise level in helicopter cabins are discussed. Laboratory test results of various panelings are presented as well as the insulation capacities of different panel mounts. Experiments in acoustic facilities - anechoic chamber and reverberation room - with the original cabin door and its frame led to an optimization of the transmission losses of door components such as window, sealing, and frame. The reduction of the cabin noise level by adding absorption is illustrated in the case of a honeycomb bulkhead with Helmholtz resonators. These sound absorption elements were designed to damp discrete gearbox frequencies. Cabin noise comfort can be improved by eliminating discrete frequencies, which was achieved in an experimental set-up where properly tuned resonators were placed as close as possible to the passengers' ear in the headrest of the seat. In order to reduce structure-borne transmission system noise, ground and flight test data of gearbox strut impedance were used for the design of specially tuned vibration absorbers. P.D.

A92-35734
THE DEVELOPMENT OF A NEW LIGHT, SINGLE ENGINE HELICOPTER FAMILY

M. RUSSIER and B. PLISSONNEAU (Aerospatiale, Division Helicopteres, Marignane, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. refs

The paper describes the design and development of P 120L, the first product of the P 120 light single-engine helicopter family, which will include most advanced light-helicopter proprietary technologies. Consideration is given to the operational needs of the helicopter and the proposed characteristics; the technological concepts, the P 120L architecture, and the hub technology; the main rotor blade and the fenestron rail rotor designs; the fenestron technology; the engine; and the avionics of P 120L. I.S.

A92-35735
ENGINE AIR PARTICLE SEPARATOR PANELS FOR HELICOPTER ENGINE PROTECTION

JEFF STAMP (Aircraft Porous Media Europe, Ltd., Portsmouth, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p.

The principles governing the operation, design, installation, and performance of an engine air particle separator (EAPS) are examined. The major environment problems of helicopter operation and their effect on engines and air inlet systems are defined. Operational limitations, cost of ownership, and failure modes data are presented. A summary of the approach taken by airframe and engine manufacturers to the problems is given. EAPS design requirements are defined, and details of the development of the product and photographs of a number of helicopter installations are presented. The performance details include flow/pressure loss characteristics, engine inlet flow distortion, dust and foreign object separation efficiency, salt spray removal, water removal, and icing performance data. The development potential for the EAPS and methods for enhancing engine protection, improving helicopter installed performance, and reducing flight restrictions are described. A comparison between EAPS and engine-mounted particle separators is presented, with both installation design constraints and performance data considered. P.D.

A92-35736
THE DEVELOPMENT OF AN ENGINE AIR PARTICLE SEPARATOR SYSTEM FOR THE CH-47 HELICOPTER

PAUL STALLARD (Aircraft Porous Media Europe, Ltd., Portsmouth, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 9 p. refs

The operating principle, design features, development, testing, and performance of a unique separator system for the CH-47 helicopter are described. Details of the basic separator module and its by-pass system, together with the mounting arrangements on the helicopter fuselage, are given. Features of the separator electrical control system are described, including the cockpit switch and indicator panel, safety systems, and monitoring devices. Bench and flight testing were successfully completed, and resulted in the qualification of the separator system; the installation and performance of the separator were entirely satisfactory. The separator system was found to effectively reduce engine erosion, reduce overhaul costs, and maintain power in an erosive operating environment. The by-pass system was able to restore the separator pressure drop to normal in the event that 30 percent of the cyclone tubes were blocked. P.D.

A92-35737
THE AERODYNAMIC ASSISTANT - A TOOL FOR V/STOL AIRCRAFT CONCEPTUAL DESIGN

D. J. PAISLEY (Boeing Co., Helicopters Div., Philadelphia, PA), J. R. BLYSTONE, G. R. WICHMANN, and G. W. SAUL (Boeing Computer Services, Philadelphia, PA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p. refs

The preliminary design of aircraft is a process that requires many iterations to develop a satisfactory solution given the constraints of the design requirements. As in any design function, creativity is a key element in the success of a design, but all too often the designer spends more time performing administrative chores than using engineering talents. As a result, the time required to develop a design using traditional methods precludes the examination of many alternatives, limiting the potential for achieving an optimal design. The design process has been facilitated by the emergence of better computing hardware, and existing software helps the designer, but does not take full advantage of advancing

technologies to optimize productivity. The objective of the Aerodynamic Assistant project is to provide a suitable framework for conceptual development of an aircraft design with provision for concurrent multi-disciplinary analysis of the most up-to-date configuration, using as much of the available computing technologies as possible. Author

A92-35738
THE USE OF INVERSE SIMULATION FOR CONCEPTUAL DESIGN
D. G. THOMSON and R. BRADLEY (Glasgow, University, Scotland) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

The calculation of the control inputs required to fly a predefined maneuver is known as inverse simulation. When the mathematical model used is generic, inverse simulation can be used to measure the effect on the performance of the helicopter due to parametric changes. The choice of which maneuvers are to be simulated is made easier by referring to the U.S. Aeronautical Design Standards for the handling qualities of military rotorcraft which defines a series of Mission Task Elements to be flown within specified performance limits. Mathematical representations of some of these maneuvers are developed in this paper, and the use of inverse simulation for design purposes is demonstrated by a series of simulations of a hypothetical helicopter configuration flying them. Author

A92-35744
EXPERIMENTING A NEW COMPOSITE ROTOR ON AN AEROSPATIALE DAUPHIN HELICOPTER
JEAN-LUC LEMAN and PHILIPPE LEGENDRE (Aerospatiale, Division Helicopteres, Marignane, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 11 p. refs

A comprehensive account is presented of the design features, manufacturing techniques, and performance test results associated with the Dauphin helicopter's new all-composite rotor. Attention is given to the carbon fiber-reinforced epoxy wound-filament mast structure. On the basis of a given powerplant, the new rotor is found to have a drag-area reduction of 15 percent, with consequent improvements in speed and/or fuel consumption, as well as reduced vibration. Handling-quality improvements are also noted. O.C.

A92-35750
EUROFAR AIRFRAME AERODYNAMIC DESIGN
THIERRY BILANGE (Aerospatiale, Division Helicopteres, Toulouse, France), PHILIPPE ROLLET (Aerospatiale, Division Helicopteres, Marignane, France), YVON VIGNERON (Aerospatiale, Division Helicopteres, Toulouse, France), and GIUSEPPE PAGNANO (Agusta S.p.A., Cascina Costa di Samatate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. refs

The paper outlines the aerodynamic airframe design performed during the EUROFAR preliminary feasibility phase. Attention is given to parametric studies giving a first baseline configuration and to efforts to refine the wing's preliminary design. Several other configurations were selected for wind tunnel tests and trade-off activities. Experimental results, along with computer codes for aerodynamics and flight mechanics prediction and configuration selection, allowed the baseline refinement to be carried out. General trade-offs, such as wing location or tail and engine configuration, were conducted, followed by wing profile improvement and optimization of the overall aircraft configuration. The adaptation of design methods and computation codes to the tilt-rotor aircraft is discussed. P.D.

A92-35751* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A PILOTED COMPARISON OF ELASTIC AND RIGID BLADE-ELEMENT ROTOR MODELS USING PARALLEL PROCESSING TECHNOLOGY
GARY HILL (NASA, Ames Research Center, Mountain View, CA), RONALD W. DU VAL, JOHN A. GREEN, and LOC C. HUYNH (Advanced Rotorcraft Technology, Inc., Mountain View, CA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 16 p. refs

A piloted comparison of rigid and aeroelastic blade-element rotor models was conducted at the Crew Station Research and Development Facility (CSRDF) at Ames Research Center. FLIGHTLAB, a new simulation development and analysis tool, was used to implement these models in real time using parallel processing technology. Pilot comments and quantitative analysis performed both on-line and off-line confirmed that elastic degrees of freedom significantly affect perceived handling qualities. Trim comparisons show improved correlation with flight test data when elastic modes are modeled. The results demonstrate the efficiency with which the mathematical modeling sophistication of existing simulation facilities can be upgraded using parallel processing, and the importance of these upgrades to simulation fidelity. Author

A92-35752
TAIL ROTOR AERODYNAMIC FEATURES RECORDED IN FLIGHT
A. D. S. ELLIN (Royal Aerospace Establishment, Bedford, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 21 p. refs
Copyright

Effects of main rotor-tail fin interactions are apparent in the instrumented Puma rotorcraft tail rotor blade trials reported; they are illustrated by frequency spectra and polar contour plots of tail rotor pressure coefficients. The removal of a segment of the main rotor tip loading peak by the influence from the tail rotor is included from previous main-rotor test results, and compared with a similar effect observed on the tail rotor. Attention is given to problems caused in the analysis of these types of data by variations in tail rotorblade chordwise velocity. O.C.

A92-35754
A SURVEY OF COMPOSITE STRUCTURE TECHNOLOGY AT THE AEROSPATIALE HELICOPTER DIVISION
G. BLACHERE, R. LAMBERTI, and J.-M. BERTHIER (Aerospatiale, Division Helicopteres, Marignane, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 16 p. refs

An overview and evaluation is presented for composite structures technologies applied to military and civilian helicopters, with a view to the lightning-protection, crashworthiness, survivability, stealth, and fire-resistance criteria that had to be accommodated by these materials. It has been established that composite fuselages are generally more expensive than metallic ones despite the automation of composite fabrication processes; this is largely due to the intrinsically high cost of materials, such as high-strength/modulus reinforcing fibers. O.C.

A92-35766
THE V-22 OSPREY - A SIGNIFICANT FLIGHT TEST CHALLENGE
PHILIP DUNFORD, KEN LUNN (Boeing Co., Helicopters Div., Philadelphia, PA), RON MAGNUSON, and ROGER MARR (Bell Helicopter Textron, Inc., Fort Worth, TX) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

The V-22 Osprey is a multiservice VSTOL aircraft that combines a novel tilt-rotor concept with mature, proven technology. This paper describes the test considerations, test methods, and extra testing required due to the V-22's unique multimode characteristics. Special consideration is given to the significant technical milestones and accomplishments achieved during the envelope expansion and configuration development period. Some of the problems that were encountered during flight testing are described along with their resolution. I.S.

A92-35767
ROTOR AEROMECHANICS RESEARCH WITH THE RAE RESEARCH LYNX - THE EXPERIMENTAL FACILITY AND TEST PROGRAMME
P. C. TARTTELIN (Royal Aerospace Establishment, Bedford, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 19 p. refs
Copyright

The instrumentation and flight test program for the RAE Bedford Lynx are described. The aircraft instrumentation includes an instrumented tail rotor, a helicopter air data system to enable low airspeed measurement, and a control input device to provide a means for injecting preprogrammed control inputs in a precise and repeatable manner. The test program is to include trims and dynamic response in steady and maneuvering flight to support aeromechanics model validation for performance, loads, and flying qualities. The data are gathered using an on-board data recording system, and a set of programs permits data handling and analysis. The lessons learned from experience with similar measurements on the RAE research Puma are reviewed as well. P.D.

A92-35771
LAH MAIN ROTOR MODEL TEST AT THE DNW
J. W. G. VAN NUNEN, C. HERMANS (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands), and H.-J. LANGER (DLR, Brunswick, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p. refs

Results are presented from a wind tunnel experiment executed in the German-Dutch Windtunnel on a dynamically and Mach scaled model of the A 129 LAH main rotor. Four different rotor configurations were examined, with the variations being either in the blade tip shape or in the twist distribution along the span of the blade. Results show that the dynamic characteristics of the various blade configurations agreed reasonably well, with exception of blade configurations that have swept back tips. These blades exhibited lower torsional frequencies than those by comparable blades with straight tips. The rotor torque measured on the model rotor correlated up to 130 kts with the torque determined during flight tests. I.S.

A92-35772* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BEARINGLESS ROTOR AEROMECHANICAL STABILITY MEASUREMENTS AND CORRELATIONS USING NONLINEAR AERODYNAMICS
JAMES M. WANG and INDERJIT CHOPRA (Maryland, University, College Park) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. refs
(Contract NAG2-409; DAAL03-88-C-0002)

The aeromechanical stability of a 1/8th Froude scaled bearingless rotor model was investigated experimentally in a wind tunnel. Both shaft-fixed and shaft-free conditions were examined to study the aeroelastic stability of a bearingless rotor without the incorporation of auxiliary dampers. This wind tunnel investigation generated a set of stability data for four different advance ratios, and a wide range of collective pitch settings. Theoretical analysis was performed using the newly developed University of Maryland Advanced Rotorcraft Code (UMARC). For analysis, the blade is modeled as an elastic beam undergoing flap bending, lag bending, elastic twist, and axial deformation. Blade response is calculated using a finite element method in time. Nonlinear aerodynamic effects are included by using a semiempirical stall modeling. The linearized periodic rotor perturbation equations in the nonrotating frame are solved for stability roots using Floquet transition matrix theory, as well as constant coefficient approximation. The predicted results are compared with the experimental data. Author

A92-35774
GENERAL MODEL OF ISOLATED HELICOPTER BLADE FOR STABILITY INVESTIGATION
JANUSZ NARKIEWICZ and WIESLAW LUCJANEK (Warsaw University of Technology, Poland) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

A model of a helicopter blade was developed to investigate the effect of the hub and blade arrangements on the rotor blade motion. In the analysis, the isolated rotor blade (which can be rigid or deformable) of a helicopter in steady flight is considered; the hub can be hingeless or have up to three hinges of arbitrary sequence, with stiffness and damping present in each hinge. The aerodynamic loading is calculated in the framework of strip theory using steady nonlinear airfoil characteristics with unsteady effects described by a dynamic inflow model. Equations of motion, derived from Hamiltonian principle, are included into the set of computer codes designed to perform comprehensive stability analysis of helicopter motion. I.S.

A92-35779
MODELING ROTOR DYNAMICS WITH ROTOR SPEED DEGREE OF FREEDOM FOR DRIVE TRAIN TORSIONAL STABILITY ANALYSIS
LINK C. JAW (Allied-Signal Aerospace Co., Garrett Engine Div., Phoenix, AZ) and ARTHUR E. BRYSON, JR. (Stanford University, CA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 13 p. Research supported by Allied-Signal Aerospace Co. refs

The paper analyzes the dynamics of an articulated rotor system in hover with a shaft/rotor speed degree-of-freedom (DOF), with the rotor speed DOF coming from the coupling between the rotor and the engine. It is shown that the effect of this coupling is to increase the natural frequency and damping ratio of the blade's lead-lag oscillations compared to a constant rotor speed model. The generic mass-spring-damper model was found inadequate. Consequently, two improvements of the generic spring-damper model are proposed which result in more accurate predictions of the resonance. I.S.

A92-35780
DESIGN AND MANUFACTURING OF TORSIONAL FLEXIBLE BLADE MODELS
F. DUPRIEZ, P. GEOFFROY, and B. PALUCH (ONERA, Institut de Mecanique des Fluides de Lille, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p. refs

This paper concerns manufacturing and design of instrumented blade models with specified torsional flexibility and straight removable tip, which will be tested in the ONERA Chalais wind-tunnel. The purposes are to take into account the torsional deformation of the blades in order to increase helicopter rotor performance, and to improve and fit the calculation codes relative to aeroelastic deformation and aerodynamic load during hover and forward flight. An iterative procedure is employed to determine the blade's internal distribution of composite material layers, and to obtain a value of tip end torsion angle close to +/- 3 deg during a rotation. Six material configurations are tested before a good agreement is found. To avoid strong couplings between modeshapes, this removable blade-tip joint is realized with two specific metallic inserts. The blades are instrumented with a particular strain gauge disposition, in order to measure their deflection during wind tunnel tests. Author

A92-35781
THEORETICAL AND EXPERIMENTAL STUDY OF A MODEL ROTOR
J.-J. COSTES, I. CAFARELLI, and N. TOURJANSKY (ONERA, Chatillon, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

In this paper, a finite element theory for a rotating beam is presented. The beam can have curvature in every direction of the 3D space as well as twist. The beam elasticity is represented by the 4 classical stiffness coefficients of extension, torsion, flap and lag. Though the development of the theory is not yet completed, it has already been applied to stability studies for a model rotor in hover. A comparison with experiments carried out in 1988 and

1989 is presented. The tests included variable coupling between the torsion and the second flap modes. The agreement between the theory and the experiments is satisfying. Author

A92-35929
FLIGHT TESTING A DIGITAL TERRAIN FOLLOWING SYSTEM
BRAD SMITH (USAF, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 1.3-1 to 1.3-10. refs
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A digital terrain-following (TF) system is developed with a digital terrain database and a radar altimeter, and the system is flight tested over a range of terrains. A precognitive evaluation of TF performance is developed with simulations of flights using digitized terrain, and the experimental approach involved a build-down in altitude and a build-up in terrain roughness. The 30 hours of digital TF tests include testing down to a 200-ft set clearance plane and up to 5 g, 600 knots ground speed, and 135 degrees of bank. The digital system is capable of maintaining the required height above the terrain and facilitates the crossing of dominant peaks at a 0-degree flight-path angle. The present system has significant advantages for aircraft combat scenarios including: (1) the absence of forward-looking radar that can be detected; (2) the optimization of flight paths beyond the line of sight; and (3) the capacity for aggressive maneuvering. C.C.S.

A92-35934
X-29 HIGH ANGLE OF ATTACK FLIGHT TEST PROCEDURES, RESULTS, AND LESSONS LEARNED
PAUL PELLICANO, JOSEPH KRUMENACKER (Grumman Aerospace Corp., Edwards AFB, CA), and DAVID VANHOY (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 2.4-1 to 2.4-24. refs
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A technical overview is presented of the testing of the X-29 aircraft with specific attention given to the build-up to a 66-degree angle of attack. The aircraft is described, and flight maneuvers are designed for flight-envelope clearance and aerodynamic analyses. An aerodynamic database is generated by means of a parameter-identification program, an off-line closed-loop simulation, and matching of the 'total aerodynamic coefficient'. An inertial navigation system is employed to obtain airspeed, angle of attack, and sideslip. The test results are given for directional stability, rudder and aileron effectiveness, roll damping, maximum nose-down pitching moment, and yaw asymmetries. The angle of attack for the X-29 is expanded to 66 degrees at 1 g, and the aircraft can stabilize in controlled flight up to 45 degrees angle of attack. The linear aerodynamics model is shown to be of value in the assessment of the aerodynamics at high angles of attack, and the procedures provide a useful methodology for testing at high angles of attack. C.C.S.

A92-35936* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PREDICTED AND MEASURED IN-FLIGHT WING DEFORMATIONS OF A FORWARD-SWEPT-WING AIRCRAFT
WILLIAM A. LOKOS (NASA, Flight Research Center, Edwards, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.1-1 to 3.1-20. refs
Copyright

An electrooptical flight-deflection measurement system (FDMS) is described in terms of its use in structural testing of the composite forward-swept wing of the X-29 aircraft. The wing deflected shapes measured using the present system are compared to the shapes predicted by NASTRAN and other codes as well as data from ground-test load measurements. The electrooptical FDMS is based on a control unit, two receivers, a target driver, and 12-16 IR LED targets. The FDMS determines the in-flight deflected wing shapes at a variety of altitudes at Mach 0.9, and the results are compared to the analytically predicted wing-twist distributions. The FDMS data describe the predicted increasing streamwise twist with increasing dynamic pressure and suggest that the streamwise twist is more prevalent at the inboard measurement station than at the wing tip. This hook shape is not represented in the predicted data, and suggestions are given for improving the modeling of the X-29 wing. C.C.S.

A92-35937
HANDLING AND PERFORMANCE CONSIDERATIONS WHEN CONDUCTING AIR-TO-AIR REFUELLING OF LARGE AIRCRAFT BY THE PROBE AND DROGUE SYSTEM
JOHN BRADLEY (Aeroplane and Armament Experimental Establishment, Boscombe Down, England) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.2-1 to 3.2-24.
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The flight environment required for the air-to-air refueling of large aircraft is examined within the context of the probe-and-drogue system. Attention is given to the longitudinal handling and lateral/directional handling required within the service envelope for this refueling. Trim changes are described in the receiver and the tanker that are required for typical handling situations, and phenomena such as engine surge and vibration are described which impinge on the refueling procedure. The receiver is required to increase power during air-to-air refueling so that it can penetrate the downwash field from the tanker and overcome the drag associated with making contact with the drogue. All the aircraft combinations described in the paper are able to refuel in the air, although some have limitations due to handling characteristics and/or stressing conditions. C.C.S.

A92-35938
HELICOPTER IN-FLIGHT FREQUENCY RESPONSE TEST TECHNIQUES
ANDREW J. LAPATI (Sikorsky Aircraft, Stratford, CT) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.3-1 to 3.3-10.
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An experimental and analytical investigation is conducted to define the structural and control dynamics of the CH-53E helicopter with and without external loads. Emphasis is placed on the flight-testing portion and the results which are studied to determine the dynamic response characteristics of all mission-loading configurations. A total of 95 transducers are used in addition to aircraft sensors related to the automatic flight-control system (AFCS), and measurements are selected based on predefined critical parameters. The frequency-response techniques employed to analyze the data include the discrete-frequency, sum-of-sinusoids, and the chirp technique. The present test is the first that requires large amounts of frequency-domain data so that the interactions between the AFCS and the airframe bending modes. The testing methods are applicable to ground testing and can be used to develop analytical frequency-response methodologies. C.C.S.

A92-35940
FOKKER 50 FLAMEOUTS IN ICING CONDITIONS
J. M. J. A. NICOLAES (Fokker Aircraft, Amsterdam, Netherlands) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.6-1 to 3.6-6.
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The accumulation of ice on the Fokker-50 intake assembly is investigated with observations to determine the deficiencies of simulated ice-testing in wind tunnels. A miniature video camera is installed on the intake assembly that does not obstruct the airflow and allows the in-flight monitoring of ice accumulation. It is shown that wind-tunnel tests do not sufficiently account for the propeller's influence on the flow behavior and that it is not possible to

understand the mechanism of ice accretion without the video monitoring. The intake behavior is found to be significantly affected under flight conditions that include hail and wet snow in combination with light-moderate icing conditions. The results are employed to modify the intake so that the icing condition is mitigated; the results demonstrate the efficacy of using video technology to study icing in a way that cannot be simulated in a wind tunnel. C.C.S.

A92-35944
RESEARCH FLIGHT TEST OF A SCALED UNMANNED AIR VEHICLE
RICHARD M. HOWARD, DANIEL F. LYONS, and JAMES C. TANNER (U.S. Naval Postgraduate School, Monterey, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 4.4-1 to 4.4-7. Research supported by U.S. Naval Postgraduate School. refs
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A study was initiated using a 1/2-scale Pioneer Unmanned Air Vehicle to predict the flight behavior of the full-scale aircraft. A drag polar was determined for comparison with a computer analysis and available full-scale data. Ground tests for power and thrust using a torque stand and a low-speed wind tunnel supported the flight tests for the determination of engine and propeller parameters. A panel method was used to predict the induced drag behavior of the tested air vehicle. Parasite drag was predicted by build-up methods. Though the scatter of data was large due to the recording methods applied, correlation of 1/2-scale vehicle data with full-scale numerical prediction was good. Comparison to full-scale flight data was poor, and the lack of correlation is discussed. Additional work was carried out to determine if wing drag could be reduced with an improved surface finish and a trailing edge modification. Author

A92-35945
X-29 HIGH ANGLE-OF-ATTACK FLIGHT TEST AIR DATA COMPARISONS OF AN INERTIAL NAVIGATION SYSTEM AND NOSEBOOM PROBE
DAVID M. RAJCZEWSKI (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 4.5-1 to 4.5-12. refs
Copyright
Data from the inertial navigation system (INS) are compared with those from a standard flight-test noseboom with a static source and a pitot probe on an aircraft operating at high angles of attack. The INS is equipped with wander-azimuth mechanization and operates at all altitudes, and the noseboom includes three angle-of-attack vanes and a beta vane. The technique for collecting INS data is delineated, and the INS upwash calibration is compared to the conventional upwash calibration. Sideslip is measured with either the INS, the noseboom vane, or a combination of the two, and the results show that the INS can be used to effectively compute the values of angle of attack, sideslip, true airspeed, and dynamic pressure. INS drift and wind variation with time require the incorporation of wind-speed data before data collection during a high-angle-of-attack run. C.C.S.

A92-35948
AV-8B V/STOL PERFORMANCE ANALYSIS
D. K. TIPPEY (McDonnell Aircraft Co., Saint Louis, MO) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 5.5-1 to 5.5-6.
Copyright
Performance analyses are conducted for the hover and vertical-landing maneuvers of the AV-8B V/STOL aircraft to examine this flight regime. Attention is given to the fundamental equations and variables that describe hover and vertical landing, and the results of the steady-state technique are compared to those that are corrected to account for the influence of acceleration. The required instrumentation and analysis techniques for vertical landing include an inertial navigation system (INS) and consideration for touchdown and bounce. The plot of bounce height vs sink rate is found to provide useful information for the analysis of vertical landings, since sink rate has the greatest influence on bounce height. The correction techniques for the hover and vertical-landings mode of the V/STOL aircraft can be used in conjunction with data from an INS to conduct accurate analyses of V/STOL performance. C.C.S.

A92-35952
DEALING WITH PILOT RESPONSE IN FAILURE CASE TESTING
JOHN R. WILLIAMS (Aeroplane and Armament Experimental Establishment, Boscombe Down, England) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 6.4-1 to 6.4-13.
Copyright
Two examples of failure-case testing are reviewed with specific attention given to the contribution of human factors including pilot response to accurate testing. The paper examines the case of engine failure during ground roll in a Lockheed C130 and the case of hydraulic failure in the yaw-control system of a battlefield helicopter. The C130 is tested to determine the ground minimum control speed, and pilot-intervention delay time is evaluated by examining the test data. The failure of tail-rotor hydraulic system in the helicopter is discussed in terms of pilot-intervention time and the factors influencing pilot action. Extensive statistical data from testing and flight situations are presented graphically. An assessment of the failure modes and pilot responses in each case is presented, and the failure mode in the helicopter case is characterized as unacceptable because it could lead to a high loss rate. C.C.S.

N92-22534*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE NASA AIRCRAFT ICING RESEARCH PROGRAM
ROBERT J. SHAW and JOHN J. REINMANN *In its* Aeropropulsion 1987 p 315-341 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 01/3
The objective of the NASA aircraft icing research program is to develop and make available to industry icing technology to support the needs and requirements for all-weather aircraft designs. Research is being done for both fixed wing and rotary wing applications. The NASA program emphasizes technology development in two areas, advanced ice protection concepts and icing simulation. Reviewed here are the computer code development/validation, icing wind tunnel testing, and icing flight testing efforts. Author

N92-22605 Virginia Polytechnic Inst. and State Univ., Blacksburg.
TIME-OPTIMAL REORIENTATION MANEUVERS OF AN AIRCRAFT Ph.D. Thesis
SPIRO BOCVAROV 1991 130 p
Avail: Univ. Microfilms Order No. DA9204627
The problem of time optimal fuselage reorientation maneuvering of a combat aircraft, with and without thrust vectoring capability, was analyzed. An accurate mathematical model for the reorientation maneuvers of interest was developed, to ensure practical value of the analysis. In particular, an effective method for smooth fitting of the aerodynamic data was devised. The Minimum Principle from optimal control theory was applied and the optimal control problems of interest cast into a form of numerical multipoint boundary value problems. These are extremely difficult to solve. To alleviate their treatment, a hybrid approach was adopted. Homotopy ideas were combined with comprehensive analyses of the structure of the dynamical equations and engineering insight into the mechanics of the reorientation motions. The approach successfully yielded a number of extremal solutions for a few typical reorientation maneuvers. The nature and essential characteristics of the extremal motions were understood, as well as their domains of existence.

A few parametric studies showed how aircraft design parameters should be tailored to allow for improved maneuverability.
Dissert. Abstr.

N92-22785# European Office of Aerospace Research and Development, FPO New York, NY.
REPORT ON AEROSPACE STRUCTURES AND STRUCTURAL MATERIALS R AND D IN EUROPE
J. G. R. HANSEN Oct. 1990 46 p
(PB92-123553; EOARD-LR-91-008) Avail: NTIS HC/MF A03 CSCL 01/3

The end-of-tour report summarizes 65 leading European R&D programs encountered by the author during his assignment as Chief, Structures and Structural Materials in the USAF EOARD (European Office of Aerospace Research and Development) from 1985 to 1990. There are two sections: (1) Aerospace Structural Materials; and (2) Aerospace Structures and Solid Mechanics. For each of the program, a summary of the capability is presented, contact information is provided for the principal investigator, other more detailed EOARD Liaison Reports (which can be ordered from EOARD) are referenced if they exist, and if there has been an R&D project funded by the USAF at the European organization, the name and address of the USAF project monitor is provided.
Author

N92-22864*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
WING FORCE AND SURFACE PRESSURE DATA FROM A HOVER TEST OF A 0.658-SCALE V-22 ROTOR AND WING
FORT F. FELKER, PATRICK R. SHINODA, RUTH M. HEFFERNAN, and HUGH F. SHEEHY Feb. 1990 221 p
(Contract RTOP 532-06-01)
(NASA-TM-102244; A-89267; NAS 1.15:102244) Avail: NTIS HC/MF A10 CSCL 01/3

A hover test of a 0.658-scale V-22 rotor and wing was conducted in the 40 x 80 foot wind tunnel at Ames Research Center. The principal objective of the test was to measure the surface pressures and total download on a large scale V-22 wing in hover. The test configuration consisted of a single rotor and semispan wing on independent balance systems. A large image plane was used to represent the aircraft plane of symmetry. Wing flap angles ranging from 45 to 90 degrees were examined. Data were acquired for both directions of the rotor rotation relative to the wing. Steady and unsteady wing surface pressures, total wing forces, and rotor performance data are presented for all of the configurations that were tested.
Author

N92-23227# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
INTEGRATED DESIGN ANALYSIS AND OPTIMISATION OF AIRCRAFT STRUCTURES
Feb. 1992 212 p The 72nd meeting was held in Bath, England, 29 Apr. - 3 May 1991
(AGARD-R-784; ISBN-92-835-0653-7) Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

At its 72nd meeting, the Structures and Materials Panel held a workshop to address the role of integrated design analysis and optimization of aircraft structures in order to review and evaluate modern computer codes, and the methodologies for their use. The workshop provided a very useful forum for the exchange of information which is reflected in the papers presented in this report. Among the topics covered are: aerodynamics, aeroelasticity, active control, composite materials, multidisciplinary design and optimization, fin design and optimization, and sensitivity analysis.

N92-23228*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SYSTEM APPROACH TO AIRCRAFT OPTIMIZATION
JAROSLAW SOBIESZCZANSKI-SOBIESKI *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 15 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01/3

Mutual couplings among the mathematical models of physical phenomenon and parts of a system such as an aircraft complicate the design process because each contemplated design change may have far reaching consequences throughout the system. This paper outlines techniques for computing these influences as system design derivatives useful in both judgmental and formal optimization purposes. The techniques facilitate decomposition of the design process into smaller, more manageable tasks and they form a methodology that can easily fit into existing engineering optimizations and incorporate their design tools.
Author

N92-23230*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF MULTIDISCIPLINARY OPTIMIZATION METHODS TO THE DESIGN OF A SUPERSONIC TRANSPORT
J.-F. M. BARTHELEMY, P. G. COEN, G. A. WRENN, M. F. RILEY, A. R. DOVI, and L. E. HALL (Unisys Corp., Hampton, VA.) *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 5 p Feb. 1992 Previously announced as N91-23135
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A new optimization based design method is discussed. This method is based on integrating existing disciplinary analysis and sensitivity analysis techniques by means of generalized sensitivity equations. A generic design system implementing this method is described. The system is being used to design the configuration and internal structure of a supersonic transport wing for optimum performance. This problem combines the disciplines of linear aerodynamics, structures, and performance. Initial results which include the disciplines of aerodynamics and structures in a conventional minimum weight design under static aeroelastic constraints are presented.
Author

N92-23231# General Dynamics Corp., Fort Worth, TX.
APPLICATION OF ANALYTICAL AND DESIGN TOOLS FOR FIGHTER WING AEROELASTIC TAILORING
JONATHAN D. BOHLMANN, MICHAEL H. LOVE, DANIEL K. BARKER, WILLIAM A. ROGERS, and BETH E. PAUL *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 14 p Feb. 1992
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Wing analysis and design studies have been performed for the Validation of Aeroelastic Tailoring (VAT) configuration. The VAT represents a series of static and dynamic wind tunnel tests, performed in the 1970's, to verify the beneficial use of aeroelastic tailoring for fighter aircraft wing design. The VAT provides a useful database for evaluation of various aeroelastic methodologies. Static analysis predictions for ELAPS, a Ritz structural analysis code, are compared to the VAT results, with excellent agreement. ASTROS, a new multidisciplinary finite element optimization code, is also used for static and dynamic analyses of the VAT. The results demonstrate several analysis capabilities of ASTROS. The composite wing skin of the VAT is also optimized by ASTROS for strength and displacement constraints simulating aeroelastic loads. ASTROS was able to design the composite skin to achieve a desired twist and camber deformation behavior. ASTROS is thus a viable tool for aeroelastic tailoring design.
Author

N92-23232# Saab-Scania, Linkoping (Sweden). Aircraft Div.
THE STRUCTURAL OPTIMIZATION SYSTEM OPTSYS: CURRENT STATUS AND APPLICATIONS
TORSTEN BRAMA *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 9 p Feb. 1992
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OPTSYS is a modular structural optimization system with well-defined interfaces to finite element (FE) programs and codes

for aeroelasticity. A mathematical programming approach is adopted where a sequence of convex approximations of the initial problem is solved, using the method of moving asymptotes (MMA). This approach makes it possible to take all design criteria into account simultaneously. Gradients are calculated semi-analytically. OPTSYS can treat design variables associated to the shape of the structure, the element cross section properties, or the material direction in the case of composite materials. Constraints can be defined on displacement, stress, eigenfrequency, local buckling, flutter, and aileron efficiency. Recent developments have concerned the constraints on dynamic response and acoustics. Other important gradients are: the integration of a preprocessor to define shape variables, the treatment of discrete variables, and the possibility to deal with substructured FE models. The current status of the system capabilities and methods will be discussed and illustrated with applications on aircraft and automotive structures. Author

N92-23233# British Aerospace Public Ltd. Co., Lancashire (England).
APPLICATION OF AN AUTOMATED MULTIDISCIPLINARY ANALYSIS AND OPTIMISATION SYSTEM TO THE DESIGN OF AIRCRAFT STRUCTURES
D. THOMPSON and J. C. AYRES *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 61 p Feb. 1992
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Prior to the development of the ECLIPSE system, structural optimization was performed by a combination of software and manual methods. These methods proved their worth by the reduction in costs and improvements in quality resulting from their use. The program used for optimization of structures subject to stiffness criteria became the focus for development of the aeroelastic constraints. This was later extended to incorporate strength constraints, fabrication constraints, and was coupled directly to the NASTRAN analysis system. This process of development continued with the result of the present general resizing, optimization, and post-processing system. This paper describes the application of the system to the optimization of three structures: tail plane, fin/rudder, and foreplane. The emphasis is on the use of the system to optimize for a flutter speed constraint in all three cases. However, in the case of the foreplane, the adaption of the system to include a detail stressing constraint is illustrated. A brief description of some of the developments proposed for the future is also given. Author

N92-23235# McDonnell Aircraft Co., Saint Louis, MO.
DESIGN OF A FIGHTER AIRCRAFT VERTICAL TAIL ENHANCED BUFFET ENVIRONMENT SURVIVABILITY
DALE M. PITT and ROBERT W. SCANLON *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 6 p Feb. 1992
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A method developed for multidisciplinary design of aircraft primary surfaces to include buffet fatigue life improvements is presented. The method is a multistep approach. First, measured buffet pressures are used as the source of excitation. These pressures excite the primary structural modes of the tail and result in high dynamic strains. Second, the Automated Structural Optimization System (ASTROS) multidisciplinary code is used to either raise or lower the primary modal frequencies. Third, a NASTRAN random analysis is used to determine the buffet dynamic strains. Fourth, a subsequent fatigue analysis is used to compute the change in fatigue life. The process was demonstrated on a generic vertical tail. Author

N92-23236# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Airplane Div.
FIRST APPROACH TO AN INTEGRATED FIN DESIGN
G. SCHNEIDER, J. KRAMMER, and H. R. E. M. HOERNLEIN *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 10 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The present paper is focused on findings and results of an integrated design optimization study for an aircraft fin. The basic flight mechanics design requirement for a vertical fin is to provide a specified control power inside the whole flight envelope with a minimum weight structure. A method of implicit function theorem has been applied on our MBB fin sample problem. The definition of state variables and independent variables will be discussed in detail. Three basic aerodynamic parameters have been chosen for the sensitivity analysis: taper ratio, aspect ratio, and surface area. This aerodynamic sensitivity analysis has been performed by the finite difference method. The necessary finite element models of the structure have been generated in the same way as the aerodynamic model for the finite difference method. The applied method based on implicit function theorem has proven its capability to provide a transparent method with clear defined discipline interfaces which are essential to monitor a complex system. Author

N92-23237# Alenia, Torino (Italy). Defence Aircraft Group.
A FIN OPTIMISATION STUDY
G. POLLANO *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 10 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

This paper details the ALENIA activities performed in order to optimize the design of a fin proposed by MBB in an AGARD sub-committee, using the in house optimization program SOS (Structural Optimization System). A series of different optimization studies using stress, efficiency, and flutter constraints was carried out. In addition comparisons between these results and optimizations having frequency separation and displacements as constraints were done. Author

N92-23239# Dassault Espace, Saint-Cloud (France).
STRUCTURAL OPTIMIZATION OF AIRCRAFT PRACTICE AND TRENDS
C. CORNUAULT, C. PETIAU, B. COIFFIER, and A. PARET *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 12 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

After a general presentation of the CATIA-ELFINI tool, developed by DASSAULT, where computer aided design (CAD), structural analysis, and optimization are fully embedded, we focus on a detailed description of the optimization algorithm. We show the special features of optimization with composite materials. We present: (1) the new organization of design resulting from use of optimization techniques; (2) the application of our optimization techniques on the case of the MBB fin; and (3) techniques neighboring optimization as model adjustment and computation with uncertain data. We conclude by presenting further developments. Author

N92-23822# Air Force Systems Command, Wright-Patterson AFB, OH. National Aero-Space Plane Joint Program Office.
DESIGN CHALLENGES FOR THE NATIONAL AERO-SPACE PLANE
FRANK D. BOENSCH *In* ESA, Spacecraft Structures and Mechanical Testing, Volume 1 p 293-297 Oct. 1991
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The National Aerospace Plane is a program conceived in 1986 by the U.S. Defense Advanced Research Projects Agency, to develop and demonstrate in flight, the technologies necessary for hypersonic flight including Single Stage To Orbit (SSTO) and cruise at sustained Mach numbers. In order to do this, a number of technologies, propulsion, structure aerodynamics, computational fluid dynamics, and materials must be matured to the point that hypersonic flight is practical. The progress made in the critical areas of materials and structures, highlighting advances in propulsion and computational fluid dynamics, made possible by

high materials such as titanium aluminides and carbon-carbon, is shown. An examination of the utility of hypersonic flight both in terms of an SSTO mission and the commercial potential for hypersonic flight is given. ESA

N92-23950# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
SPECIAL COURSE ON ENGINEERING METHODS IN AERODYNAMIC ANALYSIS AND DESIGN OF AIRCRAFT
Jan. 1992 248 p Special course held in Ankara, Turkey, 6-10 May 1991, in Rhode-Saint-Genese, Belgium, 13-17 May 1991, and in Madrid, Spain, 20-24 May 1991; sponsored in cooperation with the von Karman Inst. for Fluid Dynamics
(AGARD-R-783; ISBN-92-835-0652-9) Copyright Avail: NTIS HC/MF A11; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Lecture notes for the AGARD Fluid Dynamics Panel Special Course on 'Engineering Methods in Aerodynamic Analysis and Design of Aircraft' have been assembled in this report. Proven engineering methods used during conceptual and preliminary design and development of new aircraft concepts are presented. These methods focus on simple computational procedures for conceptual and preliminary design, low level analysis computer codes, and experimental techniques for aircraft performance predictions. The course was aimed at helping train young engineers to appreciate and work with simple engineering tools to enhance the art of cost effective preliminary design of new aircraft.

N92-23951# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
INTRODUCTION TO SPECIAL COURSE ON ENGINEERING METHODS IN AERODYNAMIC ANALYSIS AND DESIGN OF AIRCRAFT
P. W. SACHER *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 10 p Jan. 1992
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There are three major statements that characterize the findings of this special course. First, engineering work in aeronautical analysis and design is traditionally performed both through experiments and through numerical analysis. Second, an interdisciplinary approach is mandatory in conceptual and preliminary design work because although experiments will not be replaced by computational fluid dynamics (CFD), CFD may complement experiments by allowing quicker and more reliable selection of promising configurations. Third, engineering methods are indispensable because: high level CFD analysis is excluded in preliminary design; experimental work may be unavailable for configuration conception; and empirical low level flow code analysis and extrapolation from previous experience is the only logical consequence. H.A.

N92-23952# Dassault Espace, Saint-Cloud (France). Departement d'Aerodynamique Theorique.
COMPUTATIONAL PROCEDURES FOR PRELIMINARY DESIGN
P. PERRIER *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 10 p Jan. 1992
Copyright Avail: NTIS HC/MF A11; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Preliminary design of aircraft has evolved largely over the past ten years. The main origin of the evolution came from the rationalization and broadening of the preliminary emphasis on new project development. The project has to be evaluated more quickly and the capability of a project to meet its requirements must be satisfied. This paper deals specifically with low level computations for preliminary design, and covers such areas as: center of pressure evaluation; lift evaluation; drag evaluation; air-intake integration; afterbody integration; and interactions with non aerodynamic requirements. H.A.

N92-23953# Conceptual Research Corp., Sylmar, CA.
CONFIGURATION DEVELOPMENT
DANIEL P. RAYMER *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 20 p Jan. 1992
Copyright Avail: NTIS HC/MF A11; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Aircraft conceptual design is a complex, multidisciplinary process involving many aspects of engineering. Although this paper focuses on aerodynamic aspects of aircraft design, the overall configuration of the aircraft must both provide good aerodynamics and reflect a wide variety of other considerations. This paper will discuss the configuration development and its key role in aerodynamic design. Author

N92-23954# *Aircraft Research Association Ltd., Bedford* (England).
SURVEY OF EXPERIMENTAL TECHNIQUES FOR PERFORMANCE PREDICTION
A. B. HAINES *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 60 p Jan. 1992
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This paper reviews the present state of the art in experimental testing in large wind tunnels as a means of predicting aircraft performance. Desirable and attainable standards of accuracy are defined and the paper lists and discusses the factors that contribute to this accuracy. Topics covered include: balances and pressure scanners; quality of tunnel flow; correction of data for wall interference; extrapolation of scale model data to full scale aircraft Reynolds numbers; and propulsion interference effects. Author

N92-23955# National Aerospace Lab., Amsterdam (Netherlands).
PANEL METHODS FOR AERODYNAMIC ANALYSIS AND DESIGN
H. W. M. HOEIJMAKERS *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 47 p Jan. 1992
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An overview is presented of several aspects of panel methods used in the aerodynamic analysis and design of aircraft or aircraft components. Panel methods can provide the flow about complex configurations and are routinely used in the analysis of the aerodynamics of realistic aircraft shapes. However, panel methods are based on a mathematical model in which much of the fluid physics is ignored. The report discusses the capabilities and limitations of panel methods, the basic concepts of the panel method, choices that can be made in the basic implementation of the concepts, as well as possible types of boundary conditions that can be utilized to creatively model subsonic and supersonic flow. The discussion also includes aspects of the accuracy of the approximation, consistent formulations, aspects of low and high order panel methods, etc. Also discussed are the computational aspects of panel methods and possible extensions to nonlinear compressible flows, coupling with viscous flow methods, and applications to other flow problems. Author

N92-23957# Grumman Aerospace Corp., Bethpage, NY. Aircraft Systems Div.
AIRCRAFT DRAG ANALYSIS METHODS
CHARLES W. BOPPE *In* AGARD, Special Course on Engineering Methods in Aerodynamic Analysis and Design of Aircraft 50 p Jan. 1992
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A collection of aircraft drag analysis methods and drag reduction techniques has been prepared. Pressure, skin friction (viscous), wave (compressibility), lift induced (vortex), interference, throttle dependent, and trim drag source predictions are included. The need to establish a computational drag prediction experience base is emphasized and illustrated. Project type applications are described in which these drag prediction tools have been

implemented for drag reduction processes. The paper concludes by summarizing the role played by computerized drag prediction methods in aircraft design programs. Author

N92-24009 ESDU International Ltd., London (England).
NORMAL FORCE OF LOW ASPECT RATIO WING-BODY COMBINATIONS UP TO HIGH ANGLES OF ATTACK AT SUPERSONIC SPEEDS
Nov. 1991 15 p Supersedes ESDU-68022
(ESDU-91042; ESDU-68022; ISBN-0-85679-804-5; ISSN-0141-397X) Avail: ESDU

ESDU 91042 presents a method that applies to delta, cropped delta, or rectangular wings mounted on an axisymmetric body at mid-height. It applies to Mach numbers between 1.2 and 5 to configurations with thin, sharp-edged wings with aspect ratio between 0.2 and 4 at angles of attack up to 60 degrees. The method takes the isolated wing normal force (from ESDU 90013), factored to account for body interference on the wing and wing interferences on the body (using ESDU 91007) and to account for interference from the body vortices, and adds the body contribution (from ESDU 89014 or 90034). The vortex interference factor is provided graphically and depends on the point of separation of the vortices for which another graph provides data. The method applies for zero or near zero roll angle to both cruciform and monoplane wings. When predicted values were compared with experimental values extracted from the literature an accuracy of 10 percent was indicated. This is illustrated for results in the angles of attack range of 20 to 25 degrees, and the ranges of experimental parameters used are tabulated. A worked example illustrates the use of the method. ESDU

N92-24010 California Univ., Los Angeles.
ADAPTIVE ACTIVE FLUTTER SUPPRESSION OF WINGS IN SUBSONIC AND TRANSONIC FLIGHT REGIMES Ph.D. Thesis
CHAN-GI PAK 1991 227 p
Avail: Univ. Microfilms Order No. DA9207716

A digital adaptive controller is applied to the active flutter suppression problem of a wind under time varying flight conditions in subsonic and transonic flow. Linear quadratic controller gain at each time step is obtained using an iterative Riccati solver. The digital adaptive optimal controller is robust with respect to the unknown external loads. Flutter and divergence instabilities are simultaneously suppressed using a trailing edge control surface and displacement sensing. A new transonic unsteady aerodynamic approximation methodology is developed which enables one to carry out the rapid calculation required for transonic aeroservoelastic applications. This approximation is based on unsteady subsonic aerodynamics combined with a transonic correction procedure. Aeroservoelastic transient time response is obtained using Roger's approximation, state transition matrices and an iterative time marching algorithm. The aeroservoelastic system in the time domain is modeled using a deterministic ARMA model together with a parameter estimator. Transonic flutter boundaries of a wing structure are computed, in time domain, using an estimated aeroelastic system matrix and are in agreement with experimental data for the low transonic Mach number range. Dissert. Abstr.

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-33218#
DEVELOPMENT OF A MULTI-COMPUTER IN-FLIGHT DATA ACQUISITION AND ANALYSIS SYSTEM FOR GENERAL AVIATION AIRCRAFT
VAN G. CHANEY, KENNETH R. HALL, FRANK M. INGLES, JOHN K. OWENS, DAVID L. LAWRENCE, and TERRY L. TAYLOR (Mississippi State University, Mississippi State) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 17 p. refs
(AIAA PAPER 92-1037) Copyright

Parameter identification techniques require accurate measurements of pressure altitude, airspeed, rate of climb, engine RPM, shaft horsepower, and blade angle. A 690 Turbo Commander was equipped with a state-of-the-art data acquisition system, including precision Rosemount pressure transducers and other sensors in a wing mounted boom to minimize measurement errors. An AT-class personal computer equipped with Metrabyte 16 bit A/D cards was used to acquire the sensor data, and a Sun 386i workstation was installed to conduct the data analysis and to display the results. The computers are networked together for data transfer through an Ethernet card. The data channels are scanned at an average rate of 2.047 scans/second. Author

A92-33230#
C-130 GLASS COCKPIT SYSTEM DEVELOPMENT PROGRAM
W. D. DAWSON (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p.
(AIAA PAPER 92-1050) Copyright

The Military Airlift Command's Reliability and Maintainability Technology Insertion Program selected liquid-crystal display (LCD) technology as a candidate for replacement of conventional instruments in the C-130 cockpit in 1987. An Electronic Flight Instrument System (EFIS) was developed as an LCD display technology demonstrator. Attention is presently given to practical considerations for C-130 aircraft modifications facilitating EFIS incorporation. It is noted that LCD cockpit systems require careful attention to physical placement, viewing angles, and other human factors. O.C.

A92-33336#
ADVANCING AIRLIFT AVIONICS - C-17 AVIONICS SUITE
MIKE WATKINS and DOUG GARRETTE (McDonnell Douglas Corp., Long Beach, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 7 p.
(AIAA PAPER 92-1243) Copyright

The development of the avionic system for the U.S. Air Force/McDonnell Douglas C-17 airlifter represents the conclusion of a design process that began in the early 1970s with the YC-15 prototype program. Modern technological advances incorporated into the C-17 avionic systems employ digital electronics, color cathode ray tubes, head-up displays, liquid crystal displays and digital computers. The avionic system design provides for a two pilot crew operation. This was accomplished by integrating the functions performed by the navigator and the flight engineer into the avionics suite. Exercising the cockpit design, two pilots can effectively, routinely, and safely conduct all specified missions. The key to this, is a design that provides increased situational awareness for the pilots with a reduced need to concentrate on routine flying tasks. Author

A92-33337#
THE MISSION COMPUTER/ELECTRONIC DISPLAY SUBSYSTEM FOR THE UNITED STATES AIR FORCE C-17A TRANSPORT AIRCRAFT
ROY FARMER (Delco Electronics Corp., Goleta, CA) and ROBERT SEIBERT (Douglas Aircraft Co., Goleta, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p. Research sponsored by USAF. refs
(AIAA PAPER 92-1244) Copyright

The Mission Computer/Electronic Display Subsystem (MC/EDS) of the C-17A transport aircraft is described. The MC/EDS consists of 15 individual components, which encompass four multifunction display units installed in the primary cockpit display area, two multifunction display controllers, two mission/communications keyboards, and four mission/communications display units. Three Delco Magic V mission computers are installed in the electronic bay at the rear of the cockpit. Particular attention is given to the MC/EDS functions and avionics hardware description. O.G.

A92-34976
X-BAND SIDE-LOOKING AIRBORNE RADAR FOR REMOTE SENSING
PEKKA J. AHOLA, JORMA PALLONEN, and MARTTI HALLIKAINEN (Helsinki University of Technology, Espoo, Finland) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 607, 608.
Copyright

A side-looking airborne radar (SLAR) has been designed and constructed. The SLAR provides a microwave backscattering image of the target. The maximum measurement distance is 19 km. The spatial resolution of the radar is presently about 75 m by 75 m. The radar has been tested using a helicopter but it is possible to use the equipment in an airplane as well. The applications of the SLAR are mapping of sea ice, forests and oil spills. I.E.

A92-35276
MECHANICAL DESIGN OF AN AIRBORNE IMAGING MICROWAVE RADIOMETER
MARTTI KEMPPINEN and MARTTI HALLIKAINEN (Helsinki University of Technology, Espoo, Finland) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 4. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 2119-2123. refs
Copyright

The mechanics of an imaging 90-GHz radiometer to be mounted under a Bell JetRanger helicopter are considered. Different sampling techniques and scanning methods are discussed. Conical scan is chosen, and three different approaches are presented: parallel, pendulum, and rotating scans. A theory that relates the flight velocity to the angular velocity of the antenna beam to provide a good scan pattern is formulated for the pendulum scan. Results of each scan method are presented, compared, and the best one is chosen. The best performance is achieved by the parallel scan. Short delay is achieved by using a direct-drive servo and a lightweight sandwich RF box, which also provides good thermal insulation. No mirror is used. The beam is instead focused by a quasi-optical lens, which leads to a very compact construction. I.E.

A92-35454
HELMET-MOUNTED IMAGE INTENSIFICATION ANALYSIS
JULES Z. LEWYCKYJ (U.S. Navy, Naval Air Development Center, Warminster, PA) and JOSEPH C. WESTON (Veda, Inc., Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 188-191.
Copyright

A comprehensive list of prioritized night vision systems requirements for tactical aircraft systems of the future is presented. The night attack mission criteria was identified using functional analyses of performance requirements. These criteria including electrooptical performance, vision assessment, helmet systems, supportability, producibility, and escape safety were weighted based on their relative importance to the accomplishment of the night attack mission. O.G.

A92-35742
INNOVATION IN THE LASER WARNING SENSOR FIELD
F. LIBERATI (Agusta S.p.A., Rome, Italy) and A. BIANCHI (Agusta S.p.A., Tradate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 6 p.

The widespread use of such laser sources as those of range-finders, missile guiding target designators, and lidars, in prospective battlefield scenarios has prompted intensive development of laser warning sensors for helicopters and other aircraft. Attention is presently given to a novel laser detection system employing an arrangement of optical fibers. Design tradeoffs between beam-direction indicator accuracy and the amount of onboard hardware and software required are noted. O.C.

A92-35743
THE OBSTACLE AVOIDANCE RADAR - A SAFETY MEAN FOR LOW ALTITUDE FLIGHTS IN ADVERSE WEATHER CONDITIONS
HENRI QUEROL (Thomson-CSF, Division Radars et Contre-Mesures, Montrouge, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p.

ROMEO is a low-altitude night/adverse-weather flight collision-avoidance system for helicopters which employs mm-wave technology. The applications for ROMEO are envisioned to be primarily in emergency medical services operations and in nap-of-the-earth military operations. Attention has been given to the detection capability of the system in the case of power lines, and the devising of a suitable cockpit display/pilot-interface configuration that maximizes collision-warning effectiveness. O.C.

A92-35763
TEST ENGINEERING LANGUAGE FOR AVIONIC SYSTEMS
M. MAININI and G. P. MARIANI (Agusta S.p.A., Tradate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 9 p.

The paper describes a test engineering language (called Test Engineering Language for Avionic Systems, TELAS) developed for testing complex avionic systems, which was employed during the development and testing of the EH 101 and A 129 integrated avionic systems. The TELAS architecture is based on a data base that contains all the parameters definitions and their initialization values related to Mil 155 bus station, Arinc 429 bus station, and aircraft sensor emulators, which characterize all the information that the unit under test exchanges with emulated aircraft equipment/sensors. The paper presents the structure, the formal syntax, and examples of TELAS language, as well as the specific environment where TELAS is used for both the host computer and the hardware architecture of the rig. I.S.

A92-35764
INERTIAL REFERENCE UNITS WITH INTEGRATED AIR SPEED DETERMINATION FOR HELICOPTERS
WOLFGANG HASSENPFLUG (LITEF GmbH, Freiburg im Breisgau, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p.

The paper describes a family of strapdown inertial reference units (SDIRUs) with self-monitoring of system integrity and true airspeed determination, designed for use on helicopters. The fusion of true airspeed determination with the SDIRU eliminates the need of a separate air-data computer, saves weight and installation space, and reduces the cost of operation. The SDIRU family comprises a strapdown attitude and heading reference system, a Doppler velocity sensor, and a magnetic-sensor-augmented SDIRU which provides navigation capability. True airspeed (TAS) is provided by the LITEF Analytical Air Data System for Helicopters, which is able to provide TAS throughout the entire flight envelope independent of the standard air-mass sensor related equipment. I.S.

A92-35765
TRANSMISSION VIBRATION MONITORING - A SINGLE BOARD COMPUTER ARCHITECTURE
GABRIO MAGNI and FRANCO STRAZZULLO (Agusta S.p.A., Tradate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p.

The paper describes the architecture of a digital signal processor module capable of performing the acquisition and conversion of vibration signals coming from EH 101 helicopter transmission and of checking and processing the incoming data for obtaining shaft 'signature' parameters. Attention is also given to the requirements of transmission vibration monitoring and the methods used, the system implementation, the module performance and interfaces, and the software structure. This computer architecture has powerful capabilities in terms of processing and modularity and offers hardware reconfigurability provisions making it possible to modify

the architectural structure to accept other helicopter functions. I.S.

A92-35773
INSTRUMENTED BLADE EXPERIMENTS USING A LIGHT AUTOGIRO
ROBERT M. MCKILLIP, JR. and MICHAEL H. CHIH (Princeton University, NJ) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 9 p. refs

Results from a program to instrument the rotor blades of a light autogiro are described. The work was initiated to provide additional data on rotor dynamic response as well as investigate practical implementation issues on the use of blade-mounted instrumentation for rotor state feedback. A description of the aircraft and rotor electronics hardware design and installation is given, along with results to date from the initial flight test program for complete system check-out. Author

A92-35927
A DIGITAL DOPPLER RATE OF DESCENT INDICATOR (DRODI)
HARVEY WEISS and DOMINIC MANZOLILLO (Grumman Corp., Bethpage, NY) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 1.1-1 to 1.1-6.
Copyright

A digital velocimeter based on commercially available radar systems is presented that can be used to measure the rate of descent of an aircraft from final landing approach to touchdown. The Doppler Rate-of-Descent Indicator (DRODI) comprises an antenna/transceiver assembly with a microwave source, receiver, and horn antenna as well as a remote electronics unit which contains the microprocessor. The 12-bit TTL-compatible digital output in the unit uses four bits for status data and eight bits for data corresponding to a rate range of 2-30.6 ft/s. Testing is conducted for the unit at temperatures of -30 to +71 C and for random vibration levels in an aircraft. The DRODI unit can be employed with unregulated 28-vdc power, and testing of the unit demonstrates an accuracy of +/-0.3 ft/s as well as good sink-rate data. C.C.S.

A92-35932
STATE-OF-THE-ART AIRBORNE VIDEO RECORDING
CHRISTOPHER THACKER and JOHN E. NELSON (Photo-Sonics, Inc., Burbank, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 1.6-1 to 1.6-5.
Copyright

A high-resolution VHS airborne video-cassette recorder is described that can be employed for image capture in the flight-testing field. The airborne video recorder is based on the Super VHS format and is designed specifically for the severe environments relevant to MIL-STD-810D. The equipment has an extended bandwidth for recording high-resolution images with at least 400-line horizontal resolution. The testing of the unit is described with reference to recordings by airborne imaging sensors with high resolution such as over-the-shoulder cameras and displays. The video recorder can record digital data rates of up to 2.2 megabits/s and can therefore be used to record MIL-STD-1553 data-bus data. The present system is of interest to the testing and evaluation of aerospace vehicles and systems because of the potential applications of high-resolution color-image capture in severe environments. C.C.S.

A92-35941
THE SAS FLIGHT ANALYSIS AND AIRCRAFT MONITORING SYSTEM
MADS H. BRANDT (Scandinavian Airlines System, Copenhagen, Denmark) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.7-1 to 3.7-8.
Copyright

A flight-analysis and monitoring system is described in terms of experimental aims, flight-monitoring principles, and the format of the PC-based system. The SAS New Flight Analysis and Monitoring System includes 7 modules for operational supervision and 8 modules for technical supervision including a daily exceedance analysis, periodic trend analysis, and aircraft/cockpit animation. The EDP environment is a local-area network with automatic processing, and special analyses can be requested for all plot/list parameter profiles. The data from flight operational monitoring is routinely analyzed for operational routine events and operational exceedance events. The operational exceedance events are classified according to severity and type, and the data can be requested in tabular or animated displays. The automatic PC-based system is of value for the flight analysis of a range of aircraft to determine the operational states. C.C.S.

A92-35942
CALIBRATION OF AN AIRCRAFT CONTROL SURFACE USING A TRI-AXIAL ACCELEROMETER PACKAGE
JOSEPH G. TURNER (McDonnell Aircraft Co., Saint Louis, MO) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 4.1-1 to 4.1-5.
Copyright

A method for calibrating aircraft control surfaces is developed using a triaxial accelerometer package (TAP). Using accelerometers accurate to 0.1 mG, lab tests modeling stabilator, canard, and rudder control surfaces yield accuracies of +/- 0.01 to +/- 0.08 degrees depending on the angle between the hinge axis and the plane of gravity. Installation of the TAP for ground-test calibrations requires no special alignment with either the control surface or the aircraft. A complete system prototype is scheduled to be completed by the end of 1990. With an aircraft instrumentation-to-PC interface, the system is expected to read a larger number of data points as well as perform the calibration with the control surface moving. Author

A92-35949
LOW PROFILE MICROSENSOR FOR AERODYNAMIC PRESSURE MEASUREMENT
RONALD POFF (Endevco, San Juan Capistrano, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 5.6-1 to 5.6-8.
Copyright

A pressure transducer is presented and tested that can be used to measure pressure-induced loads on aerodynamic structures because of its low profile and consistent performance under extreme conditions. The transducer comprises a micromachined silicon sensor with a vacuum reference chamber, and ion implantation is used to make the doping level more linear. The compensation resistor has the same temperature coefficient as the sensor because zero compensation is put on the sensor, and a thin reflective coating is used to treat the exposed transducer surface. The present 'flat-pack' transducer can be mounted with adhesives, and a flat ribbon tape is used for connections to the instrumentation. The transducers are capable of withstanding severe environments and functioning effectively at temperatures of -65 to 250 F, shock to 10,000 g, vibration to 1000 g, and humidity to 95 percent. C.C.S.

A92-35950
FLIGHT TESTING OF THE BOEING 747-400 CENTRAL MAINTENANCE COMPUTER SYSTEM
ROGER K. NICHOLSON and KENNETH W. WHITFIELD (Boeing Commercial Airplane Group, Seattle, WA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 6.1-1 to 6.1-9. refs
Copyright

An integrated computer system for monitoring line-replaceable

units (LRUs) automatically and simultaneously in a number of aircraft systems is described and flight tested. The Central Maintenance Computer (CMC) for the 747-400 is described in terms of its general operation and the incorporation of flight-test instrumentation. Data is monitored with the Airborne Data Acquisition and Monitoring System, and the High-Speed Pulse-Code Modulation (HSPCM) system recorded parameters on the buses. A PC is used to collect the HSPCM data, and attention is given to the data reliability and CMC fault tolerance to comply with Federal Aviation Regulations. The flight testing of the CMC is used to verify the system interfaces in the flight-operating environment. The CMC is found to have no adverse effects on other aircraft systems during flight, and the CMC can be used to isolate faults at the LRU level and indicate the flight phase and leg of the fault occurrence. C.C.S.

A92-35953
DEVELOPMENT OF PITOT STATIC FLIGHTLINE TESTING
JOHN A. CURLEY (Druck, Inc., New Fairfield, CT) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 6.5-1 to 6.5-5.
Copyright

The development of air-data test systems (ADTSs) for the calibration of pitot static instrumentation is described with special attention given to flightline environments. The cart-type and hand-held ADTSs are discussed in terms of their applicability to ground and flight testing, and the dry pump systems and sensor technologies developed for the units are described. The systems utilize vibrating cylinder sensors, and the basic pressure controller is a closed-loop system driving two solenoid valves. The automatic start-up routine of the systems can be conducted with the hand-held version of the ADTS, and other functions include a leak test and calibrations of the engine-pressure ratio system. Both the hand terminal and the computer ADTSs can be programmed with respect to the operating limits of the aircraft system and instruments of the aircraft system being tested. C.C.S.

A92-36125
EVS COULD EXPAND ALL-WEATHER LANDING CAPABILITY OF AIRLINERS
NORRIS J. KRONE, JR. ICAO Journal (ISSN 0018-8778), vol. 47, no. 3, March 1992, p. 19-21.
Copyright

An evaluation of various prototype sensors and HUDs is being conducted to develop a certifiable enhanced vision system (EVS) that would greatly expand operations during low visibility periods. EVS offers the possibility for more economical operations at Category IIIA runways and provides the potential for a Category IIIA capability to the large number of runways that are presently certified for Category II and higher minima operations. Attention is given to the Cessna 402B EVS flight test aircraft whose major test components include a FLIR sensor, HUD, image processor, and supporting electronics and power converters. R.E.P.

N92-22395*# Computer Sciences Corp., Hampton, VA.
ADVANCED TRANSPORT OPERATING SYSTEM (ATOPS) COLOR DISPLAYS SOFTWARE DESCRIPTION: MICROVAX SYSTEM
CHRISTOPHER J. SLOMINSKI, VALERIE E. PLYLER, and RICHARD W. DICKSON Jan. 1992 266 p
(Contract NAS1-19038; RTOP 505-64-13-11)
(NASA-CR-189603; NAS 1.26:189603) Avail: NTIS HC/MF A12 CSCL 01/4

This document describes the software created for the Display MicroVAX computer used for the Advanced Transport Operating Systems (ATOPS) project on the Transport Systems Research Vehicle (TSRV). The software delivery of February 27, 1991, known as the 'baseline display system', is the one described in this document. Throughout this publication, module descriptions are presented in a standardized format which contains module purpose, calling sequence, detailed description, and global references. The global references section includes subroutines, functions, and common variables referenced by a particular module. The system described supports the Research Flight Deck (RFD) of the TSRV. The RFD contains eight Cathode Ray Tubes (CRTs) which depict a Primary Flight Display, Navigation Display, System Warning Display, Takeoff Performance Monitoring System Display, and Engine Display. Author

N92-22504*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A GRAPHICAL WEATHER SYSTEM DESIGN FOR THE NASA TRANSPORT SYSTEMS RESEARCH VEHICLE B-737
CHARLES H. SCANLON Feb. 1992 19 p Original contains color illustrations
(Contract RTOP 505-64-13-01)
(NASA-TM-104205; NAS 1.15:104205) Avail: NTIS HC/MF A03; 6 functional color pages CSCL 01/4

A graphical weather system was designed for testing in the NASA Transport Systems Research Vehicle B-737 airplane and simulator. The purpose of these tests was to measure the impact of graphical weather products on aircrew decision processes, weather situation awareness, reroute clearances, workload, and weather monitoring. The flight crew graphical weather interface is described along with integration of the weather system with the flight navigation system, and data link transmission methods for sending weather data to the airplane. Author

N92-22645*# Computer Sciences Corp., Hampton, VA.
ADVANCED TRANSPORT OPERATING SYSTEM (ATOPS) COLOR DISPLAYS SOFTWARE DESCRIPTION MICROPROCESSOR SYSTEM
CHRISTOPHER J. SLOMINSKI, VALERIE E. PLYLER, and RICHARD W. DICKSON Jan. 1992 291 p
(Contract NAS1-19038; RTOP 505-64-13-11)
(NASA-CR-189605; NAS 1.26:189605) Avail: NTIS HC/MF A13 CSCL 01/4

This document describes the software created for the Sperry Microprocessor Color Display System used for the Advanced Transport Operating Systems (ATOPS) project on the Transport Systems Research Vehicle (TSRV). The software delivery known as the 'baseline display system', is the one described in this document. Throughout this publication, module descriptions are presented in a standardized format which contains module purpose, calling sequence, detailed description, and global references. The global reference section includes procedures and common variables referenced by a particular module. The system described supports the Research Flight Deck (RFD) of the TSRV. The RFD contains eight cathode ray tubes (CRTs) which depict a Primary Flight Display, Navigation Display, System Warning Display, Takeoff Performance Monitoring System Display, and Engine Display.
Author

07

AIRCRAFT PROPULSION AND POWER

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

A92-34598*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF CASCADES USING A TWO DIMENSIONAL EULER AEROELASTIC SOLVER
T. S. R. REDDY, MILIND A. BAKHLE (Toledo, University, OH), DENNIS L. HUFF (NASA, Lewis Research Center, Cleveland, OH), and TIMOTHY W. SWAFFORD (Mississippi State University, Mississippi State) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p.

3139-3153. refs
(Contract NAG3-3139; NAG3-1137; NAG3-983)
(AIAA PAPER 92-2370)

A two-dimensional unsteady aerodynamic Euler solver based on a flux differencing scheme is being developed to analyze oscillating cascades. The cascades can have subsonic, transonic, or supersonic flow with either subsonic or supersonic axial velocity. The aerodynamic solver is coupled with a typical section structural model for each blade of the cascade. Flutter analysis methods both in time and frequency domains are then implemented into the resulting aeroelastic solver. Methods that reduce computational time for calculating the unsteady aerodynamic coefficients, namely the influence coefficient method and the pulse response method, are also implemented and validated. The present solver showed good correlation with published results for all the flow regimes. It is shown that grid coarsening improved the accuracy of the predictions. A representative flutter calculation showed that both the frequency domain and time domain methods are implemented correctly into the aeroelastic solver. Author

A92-35541
AN EXPERIMENTAL INVESTIGATION OF THE SWIRLING COMBUSTOR FOR INTEGRAL LIQUID FUEL RAMJET
XINYU QIU, BENQUAN GONG, and SHAOBO LIU (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 2, April 1992, p. 13-17. In Chinese. refs

Low-frequency combustion oscillation is examined in integral liquid-fuel ramjets which affects the normal operation of engine and fuel-energy release. Attention is given to the enhancement of combustion stability and the improvement of combustion process since the swirling chamber and flameholder was installed at combustor entrance. Ground-hotting test results show that the combinative configuration of swirling chamber and flameholder can effectively eliminate the low frequency combustion oscillation and increase the combustion efficiency. Author

A92-35551
EXPERIMENTAL INVESTIGATION ON BLADE LOSS TRANSIENT RESPONSE OF ROTOR WITH FLEXIBLE DAMPED SUPPORT
QIHAN LI, FUAN ZHAO, and SHIPING ZHANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 103-107. In Chinese. refs

A rotor system with flexible damped support has been investigated experimentally under conditions of simulated blade loss. Some results of the transient response dynamics are presented. Experiments under different sudden unbalances applied to the rotor system with various Squeeze Film Damper (SFD) film clearances were performed at different rotational speeds. The instability conditions characterized by limiting circle orbits for large amplitude at damper location can be determined, and some particular phenomena caused by nonlinearity of the rotor system such as lock up, bistable jump, and subharmonic etc. have been observed. The effectiveness and the capability of SFD for suppressing instability of the rotor system are analyzed. Author

A92-35560
A REAL-TIME RAIN-FLOW METHOD OF CYCLE COUNTING AND ITS PROGRAM DESIGN FOR AEROENGINE SERVICE LOADS
YONGXIN LI and HAI SUI (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 139-143. In Chinese. refs

The paper presents briefly a real-time rain-flow method of cycle counting and its program design for the service loads of aeroengines. The concept of real-time counting and its value to engineering application are also discussed. A detailed program flow chart is given which can be used in software programming of small size airborne data processing equipment. Author

A92-35561
EXPERIMENTAL RESEARCH ON BLADE CONTAINMENT
MENGXIAN GONG, LU S. WANG, and FENGLAN CAO (Gas Turbine Establishment, Jiangyou, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 144-146. In Chinese.

This paper describes blade containment tests for six sets of a single model blade on a vertical breaking-down tester with excess revolution. The experimental results indicate that a blade body fragment impacts the model aeroengine case time and again. The blade fragment against the case in the initial impact is smaller than in the later impacts, the case damage of the first impact is smaller than that of the final impact, and the impacts of the blade fragment against the case make the blade fragment crumple. In principle the experimental results of the blade fragment containment and noncontainment are consistent with the containment curve of single compressor blade in the Spey MK202 Stressing Standards (EGD-3) and are on the safe side. It is the preliminary conclusion that the containment curve of single compressor blade in EDG-3 can be used to predict the containment of a similar blade. Author

A92-35569
ENERGY ANALYSIS OF AEROENGINE AND ITS SIGNIFICANCE
RUHUI LI and XIAOMEI QIU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 169-172. In Chinese. refs

An energy analysis method of an aeroengine is presented and compared with the traditional energy analysis method. The significance of the energy analysis for the aeroengine engineering is considered. It is emphasized that the main part of the energy loss in the aeroengine comes out of the combustor. Therefore, to enhance the energy efficiency of the combustor is an essential measure to improve aeroengine performance. Author

A92-35570
STATISTICAL ANALYSIS AND PREDICTION OF AEROENGINE DETERIORATION
JIA LI and ZENGYUAN TAO (Air Force Engineering College, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 173-176. In Chinese.

An aeroengine deteriorates in the course of its service. Although its performance may be restored to some extent after overhaul, it goes down gradually in general. Based on the statistical information analysis of the test-bed performance decay of 500 engines after zero to three overhauls, a concept of an overall performance index is proposed to reflect the overall performance of the engine. According to this concept, a mathematical model of the engine deterioration is presented which is established by means of exponential smoothing theory. The prediction of the engine deterioration has been made which is quite consistent with practice. The final analysis shows that it is necessary and also feasible to adopt the method of statistical and synthetic analysis for the overall engine performance decay of both randomness and regularity with many parameters. Author

A92-35687*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A NUMERICAL CLASSICAL FLUTTER ANALYSIS OF ADVANCED PROPELLERS
R. SRIVASTAVA, T. S. R. REDDY (Toledo, University, OH), and O. MEHMED (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 365-375. refs
(Contract NAG3-3139; NAG3-1230)
(AIAA PAPER 92-2118)

A three-dimensional Euler solver is coupled with a three-dimensional structural dynamics model to investigate flutter of propfans. An implicit-explicit hybrid scheme is used to reduce computational time for the solution of Euler equations. The

aeroelastic equations are formulated in normal modes and are solved for flutter in frequency domain. The required generalized forces are obtained using a pulse response method. Computations show that the instability is dominated by the second mode frequency as was observed in experiment. Author

A92-35688#
AN INVESTIGATION OF CASCADE FLUTTER USING A TWO-DIMENSIONAL FULL-POTENTIAL SOLVER
MILIND A. BAKHLE, T. S. R. REDDY, and THEO G. KEITH, JR. (Toledo, University, OH) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 376-388. refs
(AIAA PAPER 92-2119) Copyright

The linear frequency domain unsteady aerodynamic coefficients for transonic cascade flows are calculated using a combination of two methods from a time-marching full-potential solver developed by Kao (1989). The first method, the influence coefficient method, allows coefficients for different interblade phase angles to be calculated simultaneously; the second method, the pulse response method, allows coefficients for several oscillation frequencies to be calculated from the same transient response. The combined method is used to calculate flutter in a cascade of NACA 64A010 airfoil. It was found that the results of calculations were different for different phase angles. Comparison of the present results with classical linear theory shows that the omission of transonic effects leads to a failure to capture the increase in flutter speed at higher Mach numbers. I.S.

A92-35911
TECHNICAL HISTORY OF AIRCRAFT ENGINES
KEIZO HATTA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 188-191. In Japanese.

The historical development of Japanese aircraft and spacecraft engines is presented. Research on short takeoff and landing (STOL) aircraft and H-I and H-II rockets is emphasized. Possible future trends in the development of aircraft engines are outlined. Y.P.Q.

A92-35912
RESEARCH ON AIRCRAFT ENGINES
TAKURO OKAZAKI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 192-194. In Japanese.

The development of Japanese aircraft engines is reviewed. The computer-aided fluid mechanical design for gas turbine engines is addressed. Aerodynamic noise and structural analysis are considered. Y.P.Q.

A92-35914
TRENDS OF RESEARCH ON CASCADE FLUTTER
HIDEO TANAKA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 201-208. In Japanese. refs

A numerical analysis of cascade flutter and its characteristics is presented. The effectiveness of three-dimensional cascade flutter is described. The computation of both steady and unsteady transonic flows in cascade flutter is examined. Y.P.Q.

A92-35915
COMBUSTION RESEARCH AND DESIGN TECHNOLOGY OF AIRCRAFT ENGINES
TAKASHI TAMARU Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 209-213. In Japanese. refs

Computational fluid technology is used for the combustor design of aircraft engines. The fuel vaporizer for a gas turbine engine is analyzed and Knight and Walker methods are used for the component pressure losses in combustion chambers. Y.P.Q.

A92-35917
AN AIRCRAFT CONTROLLER AND ITS DEVELOPMENT
HIDEKATSU KIKUCHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 220-224. In Japanese. refs

The characteristics of aircraft engine control is discussed. The hydromechanical control (HMC) and full authority digital electronic control (FADEC) systems are compared. Future trends in the area of engine control systems are discussed. Y.P.Q.

A92-35919
DEVELOPMENT TRENDS OF RECENT AIRCRAFT ENGINES
SOTOSHI YASHIMA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 229-234. In Japanese. refs

Development trends of commercial and military aircraft engines are presented. The outlet temperature of engine combustors is calculated, and engine propulsion and combustion nozzles are addressed. Y.P.Q.

A92-35921
PERSPECTIVE ON FUTURE AIRCRAFT ENGINES
SHOJIRO KAJI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 239-248. In Japanese. refs

The flight performance of double and single bypass engines is presented. The characteristics of the supersonic throughflow fan is analyzed. Scramjet engines and ram rockets are discussed. Y.P.Q.

A92-36126
THE ENGINE INSIDE
GUY NORRIS Flight International (ISSN 0015-3710), vol. 141, no. 4314, April 15, 1992, p. 23-27.
Copyright

The GTCP331-500B family of APUs constitutes the largest device of this type in existence; its development has been prompted by the performance requirements of such next-generation commercial aircraft as the B 777, which call for air-starts of such massive ultrahigh-bypass turbofan engines as the GE90. In addition to compressed air for engine starts, this APU will supply electrical and hydraulic power, fuel flow, and cabin air conditioning. The B 777 will mount the unit in its tailcone. Extensive advice was given by airline operators during design development; its choice for the B 777 was based on superior cost and weight performance, relative to competing APUs. O.C.

A92-36358
AEROELASTIC TAILORING ANALYSIS FOR ADVANCED TURBO PROPELLERS WITH COMPOSITE BLADES
TAKASHI YAMANE (MITI, Mechanical Engineering Laboratory, Tsukuba, Japan) (Japan-Soviet Union Joint Symposium on Computational Fluid Dynamics, 2nd, Tsukuba, Japan, Aug. 27-31, 1990) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 2, April 1992, p. 235-245. refs
Copyright

The development of unsteady aerodynamic analysis with computational fluid dynamics important for investigating the aeroelastic characteristics of rotors made of advanced composite materials. The purpose of the present analysis is to establish an aeroelastic model useful for the preliminary design of advanced turbo propellers. An unsteady aerodynamic model of high subsonic cascade airfoils, including sweep effects and finite span effects, is combined with a structural dynamic model for composite pretwisted propeller blades to produce an aeroelastic analysis tool. The p-k modal flutter analyses for the SR-3 propeller model (made of graphite/epoxy) were conducted. They revealed that suitable combinations of the fiber orientation can eliminate flutter without any weight penalties or strength penalties and that the flutter velocity is found to be sensitive to the interblade phase angle as well as the fiber orientation. These results indicate the effectiveness of aeroelastic tailoring for advanced turbo propellers and also the usefulness of the present analysis. Author

A92-36421
A METHOD FOR DETERMINING EQUIVALENT STRESSES IN AVIATION GAS TURBINE ENGINE BLADES [SPOSOB OPREDELENIIA EKVIVALENTNYKH NAPRIAZHENII V LOPATKAKH AVIATSIONNYKH GTD]
V. V. MALYGIN, D. G. FEDORCHENKO, and S. R. ZALAUTDINOV (NPO Trud, Samara, Russia) Problemy Prochnosti (ISSN 0556-171X), no. 2, 1992, p. 45-48. In Russian. refs
Copyright

A method is presented for estimating the damage that is caused by random dynamic stresses in the blades of aviation gas turbine engines. The method is based on the analytical/experimental determination of equivalent stresses and makes it possible to obtain sufficiently accurate damage estimates without a substantial increase in the time required for the analysis of dynamic strain measurements. An implementation of the method on a specialized hardware/software system for the analysis of dynamic strain data obtained in bench testing is presented. V.L.

N92-22098# Rolls-Royce Ltd., Derby (England).
IMPACT OF REGULATION CHANGES ON ENGINE DESIGN AND CERTIFICATION
C. G. CANT 1 Nov. 1990 16 p
(PNR-90789; ETN-92-90843) Copyright Avail: NTIS HC/MF A03

Some changes to the airworthiness regulations can have a major effect on the engine manufacturer. An example of such an effect was the enforced cessation of Civil Spey engine new production resulting from the introduction of the FAR Part 36 Stage 3 Noise rule. The resultant evolution of the Tay engine, initially conceived to power the Fokker F100 aircraft is traced and some of the design features and resulting engine certification test aspects are described. ESA

N92-22406# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
AIRCRAFT GAS TURBINE EMISSIONS: THEIR NATURE, TECHNOLOGY FOR REDUCTION, AND A POLLUTION COMPARISON WITH CHANNEL TUNNEL TRANSPORT M.S. Thesis
P. J. HEARD 1990 237 p Sponsored by Ministry of Defence Prepared in cooperation with Royal Air Force Coll., Cranwell, England
(ETN-92-91056) Copyright Avail: NTIS HC/MF A11

The techniques and technologies involved in reducing exhaust emission levels from aircraft gas turbine engines are examined and current pollution levels are compared with other modes of transport. The nature of gas turbine emissions and the available technology for reducing emission levels are discussed. A pollution comparison in traveling from London to Paris by air and via the Channel Tunnel is made. The first two routes compared were by air and by the through train from Waterloo to Paris (Gare du Nord Station); both of these routes offer journey times of approximately three hours and would therefore compete for a similar market. The entire rail network will be electrified between the two capitals, and hence the power station emissions produced in providing the energy to move the strains was included. With the exception of sulphur dioxide emissions (produced from power stations), the emissions per passenger in traveling by train are substantially lower than going by air. To complete the study, a third route was examined. This route is by petrol vehicle utilizing the Tunnel Shuttle. Comparisons of the emissions per passenger illustrated that travelling by car is the most damaging form of transport in terms of effect on the environment. ESA

N92-22492*# Akron Univ., OH.
A HIERARCHY FOR MODELING HIGH SPEED PROPULSION SYSTEMS
TOM T. HARTLEY and ALEX DEABREU *In its* Improved Large Perturbation Propulsion Models for Control System Design (1988-1989) and Large Perturbation Models of High Velocity Propulsion Systems (1989-1990) and Reduced Order Propulsion Models for Control System Design (1990-1991) p 1-20 Dec. 1991 Previously announced as N92-19934
(Contract NAG3-904)
Avail: NTIS HC/MF A05 CSCL 21/5

General research efforts on reduced order propulsion models for control systems design are overviewed. Methods for modeling high speed propulsion systems are discussed including internal flow propulsion systems that do not contain rotating machinery such as inlets, ramjets, and scramjets. The discussion is separated into four sections: (1) computational fluid dynamics model for the entire nonlinear system or high order nonlinear models; (2) high order linearized model derived from fundamental physics; (3) low order linear models obtained from other high order models; and (4) low order nonlinear models. Included are special considerations on any relevant control system designs. The methods discussed are for the quasi-one dimensional Euler equations of gasdynamic flow. The essential nonlinear features represented are large amplitude nonlinear waves, moving normal shocks, hammershocks, subsonic combustion via heat addition, temperature dependent gases, detonation, and thermal choking. H.A.

N92-22510*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AEROPROPULSION 1987
Washington Feb. 1990 498 p Conference held in Cleveland, OH, 17-19 Nov. 1987 Previously announced as N88-16697, N88-15785, N88-15790, N88-15794, N88-15800 and N88-15807
(Contract RTOP 505-62-3B)
(NASA-CP-3049; E-3798; NAS 1.55:3049) Avail: NTIS HC/MF A21 CSCL 21/5

Papers from the Aeropropulsion '87 Conference, held at the NASA Lewis Research Center (LeRC), are presented. Unclassified presentations by LeRC and NASA Headquarters senior management and many LeRC technical authors covered the philosophy and major directions of the LeRC aeropropulsion program, and presented a broad spectrum of recent research results in materials, structures, internal fluid mechanics, instrumentation and controls, and both subsonic and high-speed propulsion technology.

N92-22511*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IMPACT AND PROMISE OF NASA AEROPROPULSION TECHNOLOGY
NEAL T. SAUNDERS and DAVID N. BOWDITCH *In its* Aeropropulsion 1987 p 13-36 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

The aeropropulsion industry in the U.S. has established an enviable record of leading the world in aeropropulsion for commercial and military aircraft. NASA's aeropropulsion program (primarily conducted through the Lewis Research Center) has significantly contributed to that success through research and technology advances and technology demonstration. Some past NASA contributions to engines in current aircraft are reviewed, and technologies emerging from current research programs for the aircraft of the 1990's are described. Finally, current program thrusts toward improving propulsion systems in the 2000's for subsonic commercial aircraft and higher speed aircraft such as the High-Speed Civil Transport and the National Aerospace Plane are discussed. D.R.D.

N92-22518*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AEROPROPULSION STRUCTURES
LESTER D. NICHOLS *In its* Aeropropulsion 1987 p 105-111 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Aeropropulsion systems present unique problems to the structural engineer. The extremes in operating temperatures, rotational effects, and behaviors of advance material systems combine into complexities that require advances in many scientific disciplines involved in structural analysis and design procedures. This paper provides an overview of the complexities of

aeropropulsion structures and the theoretical, computational, and experimental research conducted to achieve the needed advances. D.R.D.

N92-22519*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DETERMINING STRUCTURAL PERFORMANCE
MICHAEL A. ERNST, ed., GERALD BROWN, ELISEO DIRUSSO, DAVID FLEMING, DAVID JANETZKE, ALBERT KASCAK, KRISHNA KAZA, ROBERT KIELB, LOUIS J. KIRALY, CHARLES LAWRENCE et al. *In its* Aeropropulsion 1987 p 113-128 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

An overview of the methods and concepts developed to enhance and predict structural dynamic characteristics of advanced aeropropulsion systems is presented. Aeroelasticity, vibration control, dynamic systems, and computational structural methods are four disciplines that make up the structural dynamic effort at LeRC. The aeroelasticity program develops analytical and experimental methods for minimizing flutter and forced vibration of aerospace propulsion systems. Both frequency domain and time domain methods were developed for applications on the turbofan, turbopump, and advanced turboprop. In order to improve life and performance, the vibration control program conceives, analyzes, develops, and demonstrates new methods for controlling vibrations in aerospace systems. Active and passive vibration control is accomplished with electromagnetic dampers, magnetic bearings, and piezoelectric crystals to control rotor vibrations. The dynamic systems program analyzes and verifies the dynamics of interacting systems, as well as develops concepts and methods for high-temperature dynamic seals. Work in this field involves the analysis and parametric identification of large, nonlinear, damped, stochastic systems. The computational structural methods program exploits modern computer science as an aid to the solutions of structural problems. Author

N92-22520*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LIFE PREDICTION TECHNOLOGIES FOR AERONAUTICAL PROPULSION SYSTEMS
MICHAEL A. MCGAW *In its* Aeropropulsion 1987 p 129-139 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Fatigue and fracture problems continue to occur in aeronautical gas turbine engines. Components whose useful life is limited by these failure modes include turbine hot-section blades, vanes, and disks. Safety considerations dictate that catastrophic failures be avoided, while economic considerations dictate that catastrophic failures be avoided, while economic considerations dictate that noncatastrophic failures occur as infrequently as possible. Therefore, the decision in design is making the tradeoff between engine performance and durability. LeRC has contributed to the aeropropulsion industry in the area of life prediction technology for over 30 years, developing creep and fatigue life prediction methodologies for hot-section materials. At the present time, emphasis is being placed on the development of methods capable of handling both thermal and mechanical fatigue under severe environments. Recent accomplishments include the development of more accurate creep-fatigue life prediction methods such as the total strain version of LeRC's strain-range partitioning (SRP) and the HOST-developed cyclic damage accumulation (CDA) model. Other examples include the development of a more accurate cumulative fatigue damage rule - the double damage curve approach (DDCA), which provides greatly improved accuracy in comparison with usual cumulative fatigue design rules. Other accomplishments in the area of high-temperature fatigue crack growth may also be mentioned. Finally, we are looking to the future and are beginning to do research on the advanced methods which will be required for development of advanced materials and propulsion systems over the next 10-20 years. Author

N92-22530*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DIRECTIONS IN PROPULSION CONTROL
CARL F. LORENZO *In its* Aeropropulsion 1987 p 251-260 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Discussed here is research at NASA Lewis in the area of propulsion controls as driven by trends in advanced aircraft. The objective of the Lewis program is to develop the technology for advanced reliable propulsion control systems and to integrate the propulsion control with the flight control for optimal full-system control. Author

N92-22531*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF THE SUBSONIC PROPULSION TECHNOLOGY SESSION
G. KEITH SIEVERS *In its* Aeropropulsion 1987 p 271-278 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

NASA is conducting aeronautical research over a broad range of Mach numbers. In addition to the generic and high speed propulsion research, the Lewis Research Center is continuing its substantial efforts towards propulsion technology for a broad range of subsonic flight applications. Reviewed here are some of the elements of that program, including small engine technology, rotorcraft, icing research, hot section technology, and the Advanced Turboprop Project. Author

N92-22532*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SMALL ENGINE TECHNOLOGY PROGRAMS
RICHARD W. NIEDZWIECKI *In its* Aeropropulsion 1987 p 279-302 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Described here is the small engine technology program being sponsored at the Lewis Research Center. Small gas turbine research is aimed at general aviation, commuter aircraft, rotorcraft, and cruise missile applications. The Rotary Engine program is aimed at supplying fuel flexible, fuel efficient technology to the general aviation industry, but also has applications to other missions. The Automotive Gas Turbine (AGT) and Heavy-Duty Diesel Transport Technology (HDTT) programs are sponsored by DOE. The Compound Cycle Engine program is sponsored by the Army. All of the programs are aimed towards highly efficient engine cycles, very efficient components, and the use of high temperature structural ceramics. This research tends to be generic in nature and has broad applications. The HDTT, rotary technology, and the compound cycle programs are all examining approaches to minimum heat rejection, or 'adiabatic' systems employing advanced materials. The AGT program is also directed towards ceramics application to gas turbine hot section components. Turbomachinery advances in the gas turbine programs will benefit advanced turbochargers and turbocompounders for the intermittent combustion systems, and the fundamental understandings and analytical codes developed in the research and technology programs will be directly applicable to the system projects. Author

N92-22533*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROTORCRAFT TRANSMISSIONS
JOHN J. COY *In its* Aeropropulsion 1987 p 303-313 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Highlighted here is that portion of the Lewis Research Center's helicopter propulsion systems program that deals with drive train technology and the related mechanical components. The major goals of the program are to increase life, reliability, and maintainability, to reduce weight, noise, and vibration, and to maintain the relatively high mechanical efficiency of the gear train. The current activity emphasizes noise reduction technology and analytical code development, followed by experimental verification.

Selected significant advances in technology for transmissions are reviewed, including advanced configurations and new analytical tools. Finally, the plan for transmission research in the future is presented. Author

N92-22535*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AIRCRAFT ENGINE HOT SECTION TECHNOLOGY: AN OVERVIEW OF THE HOST PROJECT
DANIEL E. SOKOLOWSKI and MARVIN H. HIRSCHBERG *In its* Aeropropulsion 1987 p 343-361 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

NASA sponsored the Turbine Engine Hot Section (HOST) project to address the need for improved durability in advanced aircraft engine combustors and turbines. Analytical and experimental activities aimed at more accurate prediction of the aerothermal environment, the thermomechanical loads, the material behavior and structural responses to loads, and life predictions for cyclic high temperature operation were conducted from 1980 to 1987. The project involved representatives from six engineering disciplines who are spread across three work disciplines - industry, academia, and NASA. The HOST project not only initiated and sponsored 70 major activities, but also was the keystone in joining the multiple disciplines and work sectors to focus on critical research needs. A broad overview of the project is given along with initial indications of the project's impact. Author

N92-22536*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF NASA PTA PROPFAN FLIGHT TEST PROGRAM
EDWIN J. GRABER *In its* Aeropropulsion 1987 p 363-382 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

The progress is covered of the NASA sponsored Propfan Test Assessment (PTA) flight test program. In PTA, a 9 ft. diameter propfan was installed on the left wing of a Gulfstream GII executive jet and is undergoing extensive flight testing to evaluate propfan structural integrity, near and far field noise, and cabin interior noise characteristics. This research testing includes variations in propeller tip speed and power loading, nacelle tilt angle, and aircraft Mach number and altitude. As a result, extensive parametric data will be obtained to verify and improve computer codes for predicting propfan aeroelastic, aerodynamic, and aeroacoustic characteristics. Over 600 measurements are being recorded for each of approx. 600 flight test conditions. Author

N92-22538*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA THRUSTS IN HIGH-SPEED AEROPROPULSION RESEARCH AND DEVELOPMENT: AN OVERVIEW
JOSEPH A. ZIEMIANSKI *In its* Aeropropulsion 1987 p 407-411 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

NASA is conducting aeronautical research over a broad range of Mach numbers. In addition to the advanced conventional takeoff or landing (CTOL) propulsion research described elsewhere, NASA Lewis has intensified its efforts towards propulsion technology for selected high speed flight applications. In a companion program, NASA Langley has also accomplished significant research in supersonic combustion ramjet (SCRAM) propulsion. An unclassified review is presented of the propulsion research results that are applicable for supersonic to hypersonic vehicles. This overview not only provides a preview of the more detailed presentations which follow, it also presents a viewpoint on future research directions by calling attention to the unique cycles, components, and facilities involved in this expanding area of work. Author

N92-22539*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUPERSONIC STOVL PROPULSION TECHNOLOGY PROGRAM: AN OVERVIEW
BERNARD J. BLAHA and PETER G. BATTERTON *In its* Aeropropulsion 1987 p 413-436 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

Planning activities are continuing between NASA, the DoD, and two foreign governments to develop the technology and to show the design capability by the mid-1990's for advanced, supersonic, short takeoff and vertical landing (STOVL) aircraft. Propulsion technology is the key to achieving viable STOVL aircraft, and NASA Lewis will play a lead role in the development of these required propulsion technologies. The initial research programs are focused on technologies common to two or more of the possible STOVL propulsion system concepts. An overview is presented of the NASA Lewis role in the overall program plan and recent results of the research program. The future research program will be focused on one or possibly two of the propulsion concepts seen as most likely to be successful in the post advanced tactical fighter time frame. Author

N92-22540*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROPULSION CHALLENGES AND OPPORTUNITIES FOR HIGH-SPEED TRANSPORT AIRCRAFT
WILLIAM C. STRACK *In its* Aeropropulsion 1987 p 437-452 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

The major challenges confronting the propulsion community for supersonic transport applications are identified. Both past progress and future opportunities are discussed in relation to perceived technology shortfalls for an economically successful SST that satisfies environmental constraint. A very large improvement in propulsion system efficiency is needed both at supersonic cruise and subsonic cruise conditions. Toward this end, several advanced engine concepts are being considered that promise up to 25 pct. better efficiency than the Concorde engine. The quest for high productivity through higher speed is also thwarted by the lack of a conventional, low priced fuel that is thermally stable at the higher temperatures associated with faster flight. Extending Jet A type fuel to higher temperatures and the adoption of liquid natural gas or methane are two possibilities requiring further study. Airport noise remains a tough challenge because previously researched concepts fall short of achieving FAR 36 Stage III noise levels. Innovative solutions may be necessary to reach acceptably low noise. Author

N92-22541*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUPERSONIC THROUGHFLOW FANS FOR HIGH-SPEED AIRCRAFT
CALVIN L. BALL and ROYCE D. MOORE *In its* Aeropropulsion 1987 p 453-468 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

A brief overview is provided of past supersonic throughflow fan activities; technology needs are discussed; the design is described of a supersonic throughflow fan stage, a facility inlet, and a downstream diffuser; and the results are presented from the analysis codes used in executing the design. Also presented is a unique engine concept intended to permit establishing supersonic throughflow within the fan on the runway and maintaining the supersonic throughflow condition within the fan throughout the flight envelope. Author

N92-22543*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC PROPULSION RESEARCH
G. BURTON NORTHAM *In* NASA. Lewis Research Center, Aeropropulsion 1987 p 487-506 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 21/5

The development of technology for the modular airframe integrated scramjet has been the focus of hypersonic propulsion research for several years. An part of this research, a variety of inlet concepts have been explored and characterized. The emphasis of the inlet program has been the development of the short (light weight), fixed geometry, side wall compression inlets

that operate efficiently over a wide Mach number range. As hypersonic combustion tunnels were developed, programs to study the parameters controlling fuel mixing and combustion with single and multiple strut models were conducted using direct connect test techniques. These various tests supported the design of subscale engine test hardware that integrated inlet and combustor technology and allowed the study of the effect of heat release on thrust and combustor/inlet interaction. A number of subscale engine tests have shown predicted performance levels at Mach 4 and 7 simulated flight conditions. A few of the highlights from this research program are summarized. Author

N92-22647*# Iowa State Univ. of Science and Technology, Ames. Engine Research Inst.
A TWO-STROKE DIESEL ENGINE SIMULATION PROGRAM Final Report
JON H. VANGERPEN Feb. 1990 25 p Sponsored by NASA. Lewis Research Center
(Contract DAAL03-86-D-0001; DA PROJ. 1L1-61102-AH-45; RTOP 505-62-OK)
(NASA-CR-185155; E-5121; NAS 1.26:185155; ERI-89179; AVSCOM-TR-88-C-024) Avail: NTIS HC/MF A03 CSCL 21/5

A computer program simulating a two stroke diesel engine is developed and documented. The program is suitable for simulating the diesel core of a high output combined-cycle diesel engine. The engine cylinder and the intake and exhaust ports are defined as independent thermodynamic systems and the mass and energy equations for these systems are developed. A single zone combustion model is used and perfect mixing during scavenging is assumed. The program input requirements and output results are discussed. A sample case is provided for an opposed piston, uniflow scavenged two stroke diesel engine. Author

N92-22863*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DESIGN AND PERFORMANCE OF CONTROLLED-DIFFUSION STATOR COMPARED WITH ORIGINAL DOUBLE-CIRCULAR-ARC STATOR
THOMAS F. GELDER, JAMES F. SCHMIDT, KENNETH L. SUDER, and MICHAEL D. HATHAWAY (Army Aviation Systems Command, Cleveland, OH.) Mar. 1989 80 p Presented at the 1987 Aerospace Technology Conference and Exposition, Long Beach, CA, 5-8 Oct. 1987; sponsored by SAE
(Contract DA PROJ. 1L1-61102-AH-45; RTOP 505-62-51)
(NASA-TP-2852; E-4195; NAS 1.60:2852; AVSCOM-TR-88-C-013; SAE-871783) Avail: NTIS HC/MF A05 CSCL 21/5

The performance of a fan stator blade row having Controlled Diffusion (CD) blade sections were compared with the performance of a fan stator blade row having Double Circular Arc (DCA) blade sections. A CD stator with the same chord length but half the blades of the DCA stator was designed and tested. The same fan rotor (tip speed, 429 m/sec; pressure ratio, 1.64) was used with each stator row. The design and analysis system for the CD stator is described. The overall stage and rotor performance with each stator are then compared along with selected stator blade element data. The CD stator efficiency drop (rotor minus stage efficiency overall) was about one percentage point higher than for the DCA stator at or near design speed of high losses in the hub region. Author

N92-23122 Stanford Univ., CA.
CONTROL OF A HELICOPTER ENGINE IN LOW ALTITUDE FLIGHT Ph.D. Thesis
LINK CHING JAW 1991 151 p
Avail: Univ. Microfilms Order No. DA9206794

Helicopters flying at low altitude must maneuver constantly to avoid terrain contours and obstacles above the ground, hence rapid responses to control commands are critical to the safety of the vehicle and its crew. To obtain these features, the engine control system must react quickly to change engine power. For most helicopters, the engine control bandwidth is lowered to avoid exciting rotor/engine system vibrational modes. This degrades engine control effectiveness to maintain a desired rotor speed during maneuvers. To increase the engine control bandwidth, accurate modeling of coupled rotor/engine torsional modes is essential. This research shows that the two way coupling between rotor and engine increases the frequency and damping of rotor collective lead lag modes, and it slows down the turbine speed lag mode. A simplified, fourth order model expressed in multiblade coordinates is derived to represent the coupled rotor/engine system. Even with increased fuel control bandwidth, the engine power can not be changed fast enough, because the allowable maximum fuel flow is limited to protect the engine. This shows that controlling free turbine inlet bleed flow is a feasible supplement to controlling fuel flow in affecting a rapid and large power change. The bleed flow control reduces speed variations and increases vehicle agility significantly. Dissert. Abstr.

N92-23254*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECTS OF CHEMICAL EQUILIBRIUM ON TURBINE ENGINE PERFORMANCE FOR VARIOUS FUELS AND COMBUSTOR TEMPERATURES
DONALD H. TRAN and CHRISTOPHER A. SNYDER Apr. 1992 22 p
(Contract RTOP 505-69-40)
(NASA-TM-105399; E-6795; NAS 1.15:105399) Avail: NTIS HC/MF A03 CSCL 21/5

A study was performed to quantify the differences in turbine engine performance with and without the chemical dissociation effects for various fuel types over a range of combustor temperatures. Both turbojet and turbofan engines were studied with hydrocarbon fuels and cryogenic, nonhydrocarbon fuels. Results of the study indicate that accuracy of engine performance decreases when nonhydrocarbon fuels are used, especially at high temperatures where chemical dissociation becomes more significant. For instance, the deviation in net thrust for liquid hydrogen fuel can become as high as 20 percent at 4160 R. This study reveals that computer central processing unit (CPU) time increases significantly when dissociation effects are included in the cycle analysis. Author

N92-23537*# 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 May 1992 11 p
(Contract RTOP 537-01-22)
(NASA-TM-105610; E-6948; NAS 1.15:105610) Avail: NTIS HC/MF A03 CSCL 21/5

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 5000 nautical mile range. The differences in turbine cooling assumptions were represented by varying the 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

N92-23671 Stanford Univ., CA.
COMPUTATIONS OF UNSTEADY MULTISTAGE TURBOMACHINERY FLOWS Ph.D. Thesis
KAREN LEANN GUNDY-BURLET 1991 142 p
Avail: Univ. Microfilms Order No. DA9206774

The fluid dynamic environment within multistage turbomachines

is extremely complex because of aerodynamic interactions between rotors and stators. Designers need to minimize the weight and size of turbomachines to improve overall efficiency of an airplane. However, this can cause large inviscid and viscous interactions between rotors and stators within an engine. A computational tool that can analyze these interactions can be useful in understanding these effects and will aid in the design of turbomachines that are light and compact as well as reliable and efficient. Two and three dimensional, unsteady, thin layer Euler/Navier-Stokes zonal codes were developed to analyze flows within multistage turbomachines (STAGE 2 and STAGE 3). The nonlinear equations are advanced in time using a third order accurate, implicit, upwind biased Roe algorithm. Body conforming 'O' grids are used to accurately resolve the viscous effects associated with each airfoil. These grids are overlayed on sheared cartesian grids which resolve the inviscid flow field between blades. The cartesian grids are allowed to slip past each other, simulating the relative motion between rotors and stators. The implementation of two and three dimensional zonal algorithms for multistage turbomachinery flows is discussed. Dissert. Abstr.

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AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A92-33245#
THE ATF YF-23 VEHICLE MANAGEMENT SYSTEM
AVTAR HAYRE, TOM DULL (Northrop Corp., Hawthorne, CA), and FRED MEYN (General Electric Co., Binghamton, NY) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 15 p.
(AIAA PAPER 92-1076) Copyright

The YF-23 fighter's Vehicle Management System (VMS) integrates flight control with aircraft utilities, avionics, and propulsion subsystems in order to obtain enhanced weapon-system performance and improved pilot-vehicle interface. Physical integration features of the VMS involve the sharing of sensing, processing, and communication resources. Functional integration allowed the implementation of subsystem control modes that benefited from the additional knowledge of the aircraft and its environment. The introduction of digital automatic control into subsystems facilitated the sharing of resources required for functional integration. O.C.

A92-33246#
FLIGHT MANAGEMENT SYSTEM INTEGRATION ON THE F-117A
S. R. COMBS, A. P. SANCHEZ-CHEW, and G. J. TAUKE (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p.
(AIAA PAPER 92-1077) Copyright

In order to reduce the pilot workload levels associated with F-117A navigation and sensor and weapons system operation, a flight management system (FMS) has been developed and tested. The FMS automatically flies the aircraft along a preplanned route; this stored mission plan can be modified by the pilot en route, via pilot-selectable modes. Additional modes and considerations encompass an autothrottle, a coupled glideslope mode, a pilot-activated automatic-recovery system, and both over- and under-speed protection. An account is given of the integration effort associated with the various engineering disciplines. O.C.

A92-33247#
SUIT STUDY - THE IMPACT OF VMS IN SUBSYSTEM INTEGRATION
BERNARD HILL (Northrop Corp., Aircraft Div., Hawthorne, CA) and ROLAND WATTS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 14 p. refs
(AIAA PAPER 92-1078) Copyright

One of the thrusts of the Wright Laboratory/FIVE-sponsored Subsystem Integration Technology (SUIT) study is to investigate the impact of emerging vehicle management system (VMS) concepts on subsystem integration. This paper summarizes the issues relating to VMS/subsystem integration as examined during the Northrop SUIT study. Projected future weapon system requirements are identified and their impact on VMS and subsystem design interpreted. Integrated VMS/subsystem control and management functions are proposed. A candidate system VMS architecture satisfying the aforementioned weapon system requirements and providing the identified control and management functions is proposed. This architecture is used, together with the environmental control system, as an illustrative subsystem example, to address the risks associated with the design, development, procurement, integration and testing of integrated VMS/subsystem concepts. The conclusion is that the development process requires an airframer to adopt the role of subsystem integrator, the consequences of which are discussed. Author

A92-33248#
F15E TERRAIN FOLLOWING SYSTEM DEVELOPMENT
K. L. JOHNSON (USAF, Aero-Systems Div., Wright-Patterson AFB, OH) and M. WENDL (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p.
(AIAA PAPER 92-1079)

The present discussion of the systems engineering design and qualification process undertaken for the F-15E's Flight Control System (FCS) and Terrain-Following (TF) capability integration gives attention to safety requirements, performance goals, redundancy-management features, and hydraulic actuator development. FCS software developments related to operational needs and to the incorporation of a LANTIRN navigation pod are noted. Detailed system flowcharts are presented. Reliability, maintainability, and accuracy have been effectively emphasized during the FCS-TF development process. O.C.

A92-33277#
HIGH-PERFORMANCE FIGHTER FLY-BY-WIRE FLIGHT CONTROL ACTUATION SYSTEM
K. W. VIETEN (Northrop Corp., Pico Rivera, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p.
(AIAA PAPER 92-1123) Copyright

The high control-surface actuation rates and large actuator excursions at low speeds required of the YF-23A have prompted the development of an actuation system employing conservation techniques for both hydraulic flow and electrical power conservation. Attention is given to the variable-area actuation concept, the two-stage direct valve design, tail-surface resonance controls, control surface actuation hardware design, loop-closure electronics, and fault-tolerant built-in-testing. The YF-23A has performed reliably and met all performance requirements. O.C.

A92-33278#
PILOT ACTIVATED AUTOMATIC RECOVERY SYSTEM ON THE F-117A
S. R. COMBS, K. G. GOUSMAN, and G. J. TAUKE (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p.
(AIAA PAPER 92-1126) Copyright

This paper describes the Pilot Activated Automatic Recovery System (PAARS) on the F-117A Stealth aircraft. This system provides an all attitude recovery capability to the aircraft should the pilot become disoriented due to sensor/display failures or due to distraction brought about by excessive pilot workload. System architecture (control laws and switching logic) is discussed and specifically related to the different means of recovery that occur as a result of vehicle means of recovery that occur as a result of vehicle flight condition at the time of PAARS activation. Autopilot/autothrottle command integration during the recovery,

safety considerations, and the estimation algorithm used to determine and display minimum altitude estimates during the recovery are also discussed. Operation of the system is shown for three different recovery conditions using nonlinear simulation data. Author

A92-34359#
THE EQUATIONS GOVERNING THE MOTION OF WING-AILERON STRUCTURAL SYSTEMS CONSTRUCTED FROM ADVANCED ANISOTROPIC COMPOSITE MATERIALS
G. KARPOUZIAN (U.S. Naval Academy, Annapolis, MD) and L. LIBRESCU (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 782-788. refs
(AIAA PAPER 92-2469)

A92-34470#
AIRCRAFT AEROSERVOELASTIC COMPENSATION USING CONSTRAINED OPTIMIZATION
PETER Y. CHENG and TIMOTHY J. HIRNER (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1909-1912. refs
(AIAA PAPER 92-2399) Copyright

Aeroservoelasticity introduces several high amplitude peaks into control-system frequency responses. An effort is presently made to eliminate the dependence on trial and error which has heretofore been associated with the design of aeroservoelastic compensation features for aircraft control systems, by employing a constrained optimization approach to design filters that minimize the phase lag. Stability margin and handling quality requirements are still satisfied, resulting in a compensation tool which yields significant savings in both time and manpower costs. O.C.

A92-34478# National Aeronautics and Space Administration, Washington, DC.
VIBRATION REDUCTION IN HELICOPTER ROTORS USING AN ACTIVE CONTROL SURFACE LOCATED ON THE BLADE
T. A. MILLOTT and P. P. FRIEDMANN (California, University, Los Angeles) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1975-1988. refs
(Contract NGT-50444; NAG2-477)
(AIAA PAPER 92-2451) Copyright

A feasibility study of vibration reduction in a four-bladed helicopter rotor using individual blade control (IBC), which is implemented by an individually controlled aerodynamic surface located on each blade, is presented. For this exploratory study, a simple offset-hinged spring restrained model of the blade is used with fully coupled flap-lag-torsional dynamics for each blade. Deterministic controllers based on local and global system models are implemented to reduce 4/rev hub loads using both an actively controlled aerodynamic surface on each blade as well as conventional IBC, where the complete blade undergoes cyclic pitch change. The effectiveness of the two approaches for simultaneous reduction of the 4/rev hub shears and hub moments is compared. Conventional IBC requires considerably more power to achieve approximately the same level of vibration reduction as that obtained by implementing IBC using an active control surface located on the outboard segment of the blade. The effect of blade torsional flexibility on the vibration reduction effectiveness of the actively controlled surface was also considered and it was found that this parameter has a very substantial influence. Author

A92-34479#
APPLICATION OF COMPOSITE ROTOR BLADE STABILITY ANALYSIS TO EXTENSION-TWIST COUPLED BLADES
MARK V. FULTON and DEWEY H. HODGES (Georgia Institute of Technology, Atlanta) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1989-1995. refs
(Contract DAAL03-89-K-0007)
(AIAA PAPER 92-2254) Copyright

A finite element based stability analysis is developed for a hingeless, composite, isolated rotor in hover. It includes a mechanism for the inclusion of a complete 6 x 6 stiffness matrix, as well as the effects of rotary inertia. No restrictions are made on the magnitudes of the displacements and rotations if the magnitudes of the strains remain small compared to unity. The equilibrium position is obtained by an iterative solution of the complete nonlinear equations. The dynamic equations are linearized about this position, yeilding and eigenproblem. The lift model is a two-dimensional, quasi-steady strip theory, with inflow taken from momentum theory. Initial results are given for the stability of extension-twist coupled rotor blades. Author

A92-34480*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROELASTIC RESPONSE AND BLADE LOADS OF A COMPOSITE ROTOR IN FORWARD FLIGHT
EDWARD C. SMITH and INDERJIT CHOPRA (Maryland, University, College Park) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1996-2014. refs
(Contract NAG1-1253; DAAL03-88-C-0002)
(AIAA PAPER 92-2566) Copyright

The aeroelastic response, blade and hub loads, and shaft-fixed aeroelastic stability is investigated for a helicopter with elastically tailored composite rotor blades. A new finite element based structural analysis including nonclassical effects such as transverse shear, torsion related warping and inplane elasticity is integrated with the University of Maryland Advanced Rotorcraft Code. The structural dynamics analysis is correlated against both experimental data and detailed finite element results. Correlation of rotating natural frequencies of coupled composite box-beams is generally within 5-10 percent. The analysis is applied to a soft-inplane hingeless rotor helicopter in free flight propulsive trim. For example, lag mode damping can be increased 300 percent over a range of thrust conditions and forward speeds. The influence of unsteady aerodynamics on the blade response and vibratory hub loads is also investigated. The magnitude and phase of the flap response is substantially altered by the unsteady aerodynamic effects. Vibratory hub loads increase up to 30 percent due to unsteady aerodynamic effects. Author

A92-34481#
AEROELASTIC RESPONSE OF HELICOPTERS WITH FLEXIBLE FUSELAGE MODELING
SENTHILVEL VELLAICHAMY and INDERJIT CHOPRA (Maryland, University, College Park) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2015-2026. refs
(Contract DAAL03-88-C-0002)
(AIAA PAPER 92-2567) Copyright

Aeroelastic response of a coupled rotor/body system is calculated using flexible fuselage modeling. The rotor and body dynamics are based on a finite element method in space and time. Each blade is assumed to be an elastic beam undergoing flap bending, lead-lag bending, elastic twist and axial deformation. Rotor loads are calculated using quasi-steady aerodynamics and body dynamic coupling. The main fuselage, wings and empennage are modeled with beam elements, with the Bell AH-1G helicopter airframe chosen as the baseline configuration. Coupled analysis is performed to predict the response of rotor and fuselage for

hover and forward flight. Vibration levels, predicted at nose, shaft position, fin and wing tip, grow substantially with forward speed, particularly at the nose and fin locations. The vibration levels at these locations are generally much higher than those at the wing tip and shaft locations. Author

A92-34482*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PARAMETRIC STUDIES FOR TILTROTOR AEROELASTIC STABILITY IN HIGH-SPEED FLIGHT
MARK W. NIXON (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2027-2037. refs
(AIAA PAPER 92-2568)

The influence of several system design parameters on tiltrotor aeroelastic stability is examined for the high-speed (axial) flight mode. Coupling of the rotor flapping modes with the wing elastic modes produces a whirl motion, typical of tiltrotors, that can become unstable at high speeds. The sensitivity of this instability with respect to rotor frequencies, wing stiffness, forward wing sweep, and rotor thrust level is examined. Some important new trends are identified regarding the role of blade lag dynamics and forward wing sweep in tiltrotor aeroelastic stability. The blade lag frequency may be tuned to improve tiltrotor stability, and forward wing sweep is destabilizing because of changes in rotor force components associated with the sweep. Author

A92-34547#
NEW COMPLEX POLE AND GUST RESPONSE APPROXIMATIONS FOR INTEGRATED AEROSERVOELASTIC SYNTHESIS
ELI LIVNE (Washington, University, Seattle) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2672-2681. refs
(AIAA PAPER 92-2377) Copyright

Past experience in wing synthesis reveals poor performance of commonly used aeroservoelastic approximations when control system design variables are added to the structural design variables in nonlinear programming/approximation concepts based multidisciplinary aeroservoelastic optimization. Here new approximations are presented for the complex poles of an aeroservoelastic system and its dynamic response to atmospheric gust excitation. These approximations are expected to improve convergence of the optimization process. Author

A92-34688
PDFIII - A FLIGHT CONTROL SYSTEM FOR EW UAV'S
DAVID B. HOGAN (International Aerospace Technologies, Inc., Huntsville, AL) IN: TABES 91 - Annual Technical and Business Exhibition and Symposium, 7th, Huntsville, AL, May 14, 15, 1991, Submitted Papers. Huntsville, AL, Huntsville Association of Technical Societies, 1991, p. 91-94.
(TABES PAPER 91-315) Copyright

An overview is presented of the status of unmanned air vehicles (UAVs) designed for electronic warfare, and a programmable digital filter (PDF) is introduced for stabilization autopilot. Vehicle-control methodologies are examined and shown to require a stabilization autopilot, and the problems associated with analog devices for stabilization autopilot are listed. The PDF is shown to be adaptable for varying flight dynamics and different vehicle configurations and therefore an effective flexible tool for an unmanned air platform. C.C.S.

A92-35651
AIAA DYNAMICS SPECIALISTS CONFERENCE, DALLAS, TX, APR. 16, 17, 1992, TECHNICAL PAPERS
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 612 p. For individual items see A92-35652 to A92-35707.
Copyright

This conference presents papers in the fields of spacecraft dynamics, the control of structures, the active flexible wing, flutter characteristics, and rotary-wing aeroelasticity. Also considered are control-structure interaction, unsteady aerodynamics, fixed-wing aeroelasticity, structural dynamics systems, and CSI-sensors and actuators. R.E.P.

A92-35652*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SUMMARY OF THE ACTIVE FLEXIBLE WING PROGRAM
BOYD PERRY, III, STANLEY R. COLE (NASA, Langley Research Center, Hampton, VA), and GERALD D. MILLER (Rockwell International Corp., Los Angeles, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1-10. refs
(AIAA PAPER 92-2080) Copyright

This paper presents a summary of the NASA/Rockwell Active Flexible Wing program. Major elements of the program are presented. Key program accomplishments included single- and multiple-mode flutter suppression, load alleviation and load control during rapid roll maneuvers, and multi-input/multi-ouput multiple-function active controls tests above the open-loop flutter boundary. Author

A92-35654*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FURTHER INVESTIGATIONS OF THE AEROELASTIC BEHAVIOR OF THE AFW WIND-TUNNEL MODEL USING TRANSONIC SMALL DISTURBANCE THEORY
WALTER A. SILVA and ROBERT M. BENNETT (NASA, Langley Research Center, Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 20-29. refs
(AIAA PAPER 92-2082) Copyright

The CAP-TSD (Computational Aeroelasticity Program - Transonic Small Disturbance) code, developed at the NASA Langley Research Center, is applied to the Active Flexible Wing wind-tunnel model for prediction of transonic aeroelastic behavior. A semi-span computational model is used for evaluation of symmetric motions, and a full-span model is used for evaluation of antisymmetric motions. Static aeroelastic solutions using CAP-TSD are computed. Dynamic (flutter) analyses then are performed as perturbations about the static aeroelastic deformations and presented as flutter boundaries in terms of Mach number and dynamic pressure. Flutter boundaries that take into account modal refinements, vorticity and entropy corrections, antisymmetric motions and sensitivity to the modeling of the wing tip ballast stores also are presented and compared with experimental flutter results. Author

A92-35655*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE MULTIPLE-FUNCTION MULTI-INPUT/MULTI-OUTPUT DIGITAL CONTROLLER SYSTEM FOR THE AFW WIND TUNNEL MODEL
SHERWOOD T. HOADLEY (NASA, Langley Research Center, Hampton, VA) and SANDRA M. MCGRAW (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 30-38. refs
(AIAA PAPER 92-2083) Copyright

A real-time multiple-function digital controller system was developed for the Active Flexible Wing (AFW) Program. The digital controller system (DCS) allowed simultaneous execution of two control laws: flutter suppression and either roll trim or a rolling maneuver load control. The DCS operated within, but independently of, a slower host operating system environment, at regulated

speeds up to 200 Hz. It also coordinated the acquisition, storage, and transfer of data for near real-time controller performance evaluation and both open- and closed-loop plant estimation. It synchronized the operation of four different processing units, allowing flexibility in the number, form, functionality, and order of control laws, and variability in selection of sensors and actuators employed. Most importantly, the DCS allowed for the successful demonstration of active flutter suppression to conditions approximately 26 percent (in dynamic pressure) above the open-loop boundary in cases when the model was fixed in roll and up to 23 percent when it was free to roll. Aggressive roll maneuvers with load control were achieved above the flutter boundary. Author

A92-35666*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLUTTER SUPPRESSION FOR THE ACTIVE FLEXIBLE WING - CONTROL SYSTEM DESIGN AND EXPERIMENTAL VALIDATION
M. R. WASZAK (NASA, Langley Research Center, Hampton, VA) and S. SRINATHKUMAR (National Aeronautical Laboratory, Bangalore, India) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 138-145. refs
(AIAA PAPER 92-2097) Copyright

The synthesis and experimental validation of a control law for an active flutter suppression system for the Active Flexible Wing wind-tunnel model is presented. The design was accomplished with traditional root locus and Nyquist methods using interactive computer graphics tools and with extensive use of simulation-based analysis. The design approach relied on a fundamental understanding of the flutter mechanism to formulate understanding of the flutter mechanism to formulate a simple control law structure. Experimentally, the flutter suppression controller succeeded in simultaneous suppression of two flutter modes, significantly increasing the flutter dynamic pressure despite errors in the design model. The flutter suppression controller was also successfully operated in combination with a rolling maneuver controller to perform flutter suppression during rapid rolling maneuvers.
Author

A92-35667*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIFUNCTION TESTS OF A FREQUENCY DOMAIN BASED FLUTTER SUPPRESSION SYSTEM
DAVID M. CHRISTHILF (Lockheed Engineering and Sciences Co., Hampton, VA) and WILLIAM M. ADAMS, JR. (NASA, Langley Research Center, Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 146-155. refs
(AIAA PAPER 92-2096) Copyright

This paper describes the process of analysis, design, digital implementation and subsonic testing of an active controls flutter suppression system for a full span, free-to-roll wind-tunnel model of an advanced fighter concept. The design technique employed a frequency domain representation of the plant and used optimization techniques to generate a robust multi-input/-multi-output controller. During testing in a fixed-in-roll configuration, simultaneous suppression of both symmetric and antisymmetric flutter was successfully demonstrated. For a free-to-roll configuration, symmetric flutter was suppressed to the limit of the tunnel test envelope. During aggressive rolling maneuvers above the open-loop flutter boundary, simultaneous flutter suppression and maneuver load control were demonstrated. Finally, the flutter suppression controller was reoptimized overnight during the test using combined experimental and analytical frequency domain data, resulting in improved stability robustness.
Author

A92-35668*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLUTTER SUPPRESSION DIGITAL CONTROL LAW DESIGN AND TESTING FOR THE AFW WIND TUNNEL MODEL
VIVEK MUKHOPADHYAY (NASA, Langley Research Center, Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 156-161. refs
(AIAA PAPER 92-2095) Copyright

Design of a control law for simultaneously suppressing the symmetric and antisymmetric flutter modes of a sting mounted fixed-in-roll aeroelastic wind tunnel model is described. The flutter suppression control law was designed using linear quadratic Gaussian theory, and involved control law order reduction, a gain root-locus study and use of previous experimental results. A 23 percent increase in the open-loop flutter dynamic pressure was demonstrated during the wind tunnel test. Rapid roll maneuvers at 11 percent above the symmetric flutter boundary were also performed when the model was in a free-to-roll configuration.
Author

A92-35669#
A FLUTTER SUPPRESSION SYSTEM USING STRAIN GAGES APPLIED TO ACTIVE FLEXIBLE WING TECHNOLOGY - DESIGN AND TEST
M. J. KLEPL (Rockwell International Corp., El Segundo, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 162-171. Research supported by Rockwell International Corp. refs
(AIAA PAPER 92-2098) Copyright

Flutter Suppression System control laws were designed for the Active Flexible Wing technology wind tunnel model. The sensor feedbacks were bending moments and torsion moments as a feasibility exploration instead of the universally used accelerometers. Both a symmetrical and an anti-symmetrical wing flutter modes were simultaneously stabilized by Direct Digital Design using the Nyquist Criterion. Further, a symmetrical flutter mode was stabilized while the model performed roll maneuvers. The control laws were successfully tested in the NASA Langley Transonic Dynamics Tunnel during March 1991. Details of the control law design and some of the test results are presented.
Author

A92-35670*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ROLLING MANEUVER LOAD ALLEVIATION USING ACTIVE CONTROLS
JESSICA A. WOODS-VEDELER (NASA, Langley Research Center, Hampton, VA) and ANTHONY S. POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 172-180. refs
(AIAA PAPER 92-2099) Copyright

Rolling Maneuver Load Alleviation (RMLA) has been demonstrated on the Active Flexible Wing (AFW) wind tunnel model in the NASA Langley Transonic Dynamics Tunnel. The design objective was to develop a systematic approach for developing active control laws to alleviate wing incremental loads during roll maneuvers. Using linear load models for the AFW wind-tunnel model which were based on experimental measurements, two RMLA control laws were developed based on a single-degree-of-freedom roll model. The RMLA control laws utilized actuation of outboard control surface pairs to counteract incremental loads generated during rolling maneuvers and actuation of the trailing edge inboard control surface pairs to maintain roll performance. To evaluate the RMLA control laws, roll maneuvers were performed in the wind tunnel at dynamic pressures of 150, 200, and 250 psf and Mach numbers of 0.33, .38 and .44, respectively. Loads obtained during these maneuvers were compared to baseline maneuver loads. For both RMLA controllers, the incremental torsion moments were reduced by up to 60 percent

at all dynamic pressures and performance times. Results for bending moment load reductions during roll maneuvers varied. In addition, in a multiple function test, RMLA and flutter suppression system control laws were operated simultaneously during roll maneuvers at dynamic pressures 11 percent above the open-loop flutter dynamic pressure. Author

A92-35671#
MANEUVER LOAD CONTROL USING OPTIMIZED FEEDFORWARD COMMANDS
DOUG MOORE (Rockwell International Corp., Los Angeles, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 181-187. refs
(AIAA PAPER 92-2100) Copyright

A maneuver load control system has been designed for the Active Flexible Wing wind-tunnel model using constrained minimization optimization. Objectives of the controller were to limit total wing loads while maintaining constant roll performance. The load control was performed as a feedforward control utilizing the optimization solutions as table lookups. The tables were a function of the commanded roll acceleration and the current roll rate and output surface deflections. Test results confirmed predicted behavior, with time-to-90 degrees meeting scaled MIL-SPEC roll requirements. The controller was also integrated with multiple flutter suppression controllers and successfully flow beyond the flutter boundary, maintaining roll and load control performance. Author

A92-35675#
ROBUSTNESS CHARACTERISTICS OF FAST-SAMPLING DIGITAL CONTROLLERS FOR ACTIVE FLUTTER SUPPRESSION
B. PORTER, T. MERZOUGUI (Salford, University, England), and Z. Q. GU (Nanjing Aeronautical Institute, People's Republic of China) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 224-229. refs
(AIAA PAPER 92-2104) Copyright

The robustness characteristics of fast-sampling digital controllers are established in the case of second-order partially irregular linear multivariable plants. It is shown that the plant-parameter variations tolerable by such digital controllers can be expressed very simply in terms of the step-response matrices of the nominal and actual plants. These general results are illustrated by examining the robustness characteristics of a fast-sampling digital controller for a typical fluttering wing. Author

A92-35676#
DESIGN OF ADAPTIVE FAST-SAMPLING DIGITAL CONTROLLERS FOR ACTIVE FLUTTER SUPPRESSION
B. PORTER, T. MERZOUGUI (Salford, University, England), and Z. Q. GU (Nanjing Aeronautical Institute, People's Republic of China) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 230-236. refs
(AIAA PAPER 92-2105) Copyright

It is shown that, by incorporating on-line recursive identifiers to provide up-dated step-response matrices, highly effective adaptive fast-sampling digital controllers can be readily designed for flutter suppression. The effectiveness of such adaptive digital controllers is illustrated by designing an adaptive fast-sampling digital controller for a typical fluttering wing which provides active flutter suppression at speeds of flight beyond the usual limits of robustness. Author

A92-35677*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FLUTTER SUPPRESSION VIA PIEZOELECTRIC ACTUATION
JENNIFER HEEG (NASA, Langley Research Center, Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 237-247. refs
(AIAA PAPER 92-2106) Copyright

The feasibility of using piezoelectric material actuators to suppress flutter was investigated analytically and experimentally. For this purpose, a two-degree of freedom wind-tunnel model was designed, analyzed, and tested. A digital control law was designed and implemented based on a discretized model. Experiments consisted of open- and closed-loop flutter tests. It is shown that analytical predictions agree well with experimental results. The open-loop flutter velocity prediction was 3.5 percent conservative, while the closed-loop prediction was 7.6 percent conservative. Results of the analysis showed that the flutter velocity would be increased by 15.7 percent with the control law, while 20 percent improvement was observed experimentally. I.S.

A92-35678*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ROTARY-WING AEROSERVOELASTIC PROBLEMS
PERETZ P. FRIEDMANN (California, University, Los Angeles) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 248-272. refs
(Contract NAG2-477)
(AIAA PAPER 92-2107) Copyright

The state-of-the-art in the field of alleviating rotary-wing aeroservoelastic problems (by using active controls that modify the pitch of a helicopter rotor blade so as to alleviate dynamic effects) is assessed, and the more promising developments are identified. Special attention is given to the active control of aeromechanical and aeroelastic problems, such as the active control of ground resonance, active control of air resonance, and active control of blade aeroelastic instabilities; individual blade control; active control of vibration reduction using a conventional swashplate; and coupled rotor/fuselage vibration reduction using open-loop active control. Some results are presented for each of these topics, illustrating the efficiency of the techniques which have been developed. I.S.

A92-35693#
A GENERAL GUST AND MANEUVER LOAD ANALYSIS METHOD TO ACCOUNT FOR THE EFFECTS OF ACTIVE CONTROL SATURATION AND NONLINEAR AERODYNAMICS
PATRICK J. GOGGIN (Douglas Aircraft Co., Long Beach, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 440-454. refs
(AIAA PAPER 92-2126) Copyright

A time-domain aeroservoelastic method for the calculation of loads and responses due to aircraft maneuvers and atmospheric turbulence that can take into account control surface saturation and aerodynamic nonlinearities is presented. Distributed aerodynamic force matrices are approximated instead of the generalized force matrices to allow the calculation of the integrated loads from the same approximations used for the equations of motion and also to facilitate the introduction of the nonlinear aerodynamic corrections. For the nonlinear aerodynamics, two different approaches are used: the quasi-steady replacement technique and the scaling technique. Results are shown for both the maneuver and gust load cases. Comparisons of spanwise wing bending moments are shown for various gust velocities. Time histories of the aileron deflection and aerodynamic weighting factors are shown for a 308-ft gradient distance. P.D.

A92-35732
FULL AUTHORITY ACTIVE CONTROL SYSTEM DESIGN FOR A HIGH PERFORMANCE HELICOPTER
D. WALKER and I. POSTLETHWAITE (Leicester, University, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. Research supported by Ministry of Defence Procurement Executive. refs

A continuing study into the application of H-infinity optimal control theory to the design of a low-speed full authority active control law for a generic high-performance single main rotor

helicopter. Two new designs are presented, each based on an eight state linearization of a nonlinear helicopter model provided by the Royal Aerospace Establishment, Bedford. Both designs have the same structure. An inner loop feeds rate and attitude signals directly back to respective activators, in a manner reminiscent of some autostabilization schemes in use. An outer loop then feeds back the controlled output measurements to a dynamic controller designed using H-infinity optimization. The use of the inner loop helps relieve the task of robust stabilization faced by the outer loop, by providing a simple and direct improvement to the unaugmented vehicle's stability. Author

A92-35747
ACHIEVEMENT OF ROTORCRAFT HANDLING QUALITIES SPECIFICATIONS VIA FEEDBACK CONTROL
WILLIAM L. GARRARD, EICHER LOW, and PETER A. BIDIAN (Minnesota, University, Minneapolis) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 11 p. refs
(Contract DAAL03-86-K-0056)

A methodology for the design of control laws for augmentation of helicopter handling qualities is presented. This procedure uses eigenstructure assignment techniques to design inner loop control laws which decouple roll, pitch and yaw rates and vertical velocity, provide appropriate bandwidths in all channels, and stabilize low frequency open loop instabilities. Various response types can be easily realized by simple single loop feedbacks and feedforwards wrapped around these inner loops. Both time and frequency responses show that the closed loop helicopter provides excellent nominal performance in terms of insensitivity to gusts, tracking of pilot commands and achievement of desired response type characteristics (handling qualities). Stability robustness was investigated by approximating unmodeled rotor dynamics, actuators, sensors, filters, sampling and computational delays, etc. by a single time delay. The effect of this uncertainty on the system was evaluated using unstructured singular value techniques. The effects of variations in aerodynamic stability and control coefficients was evaluated by the stochastic root locus. Author

A92-35748
MULTIVARIABLE METHODS FOR HELICOPTER FLIGHT CONTROL LAW DESIGN - A REVIEW
M. A. MANNESS, J. J. GRIBBLE, and D. J. MURRAY-SMITH (Glasgow, University, Scotland) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. Sponsorship: Ministry of Defence of England. refs
(Contract MOD-2048/53/RAE(B))

The design of flight control systems for actively controlled helicopters presents problems which are associated not only with the complex nature of the dynamics of the vehicle itself but also with the range of design objectives which must be satisfied. The techniques of multivariable control system design provide tools of potential value for helicopter flight control applications. The paper describes an approach which has been developed for the comparison of multivariable design methods using control law design criteria which can be related to handling quality requirements, robustness, noise rejection properties and insensitivity to atmospheric disturbances. The definition of the flight control task for these comparative investigations involves a reduced design problem with performance assessments based on linearized models. Author

A92-35749
COMMAND FOLLOWING CONTROL LAW DESIGN BY LINEAR QUADRATIC OPTIMISATION
J. J. GRIBBLE and D. J. MURRAY-SMITH (Glasgow, University, Scotland) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. Sponsorship: Ministry of Defence of England. refs
(Contract MOD-2048/53/RAE(B))

This paper presents a control law design for a linearized model of a Lynx-like helicopter in the 80 knots forward flight condition, with respect to an appropriate subset of the published handling qualities requirements. The synthesis method used was the Linear Quadratic Regulator (LQR) version of model following. The design is based principally on the rigid body quasi-steady state rotor model although a simplified representation of the actuator and blade flapping dynamics as pure delays is used to motivate the choice of the LQR input weighting matrix. The design assumes that all of the rigid body states can be measured. State estimation of actuator and rotor states is not used. The design is evaluated using a linear model which includes representations of the actuator and blade flapping dynamics. Author

A92-35756
PRELIMINARY EVALUATION OF NEW CONTROL LAWS ON THE EXPERIMENTAL FLY-BY-WIRE DAUPHIN HELICOPTER
P. DELESTRADE and J. M. MASSIMI (Aerospatiale, Division Helicopteres, Marignane, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 16 p.

The paper describes the methodology applied in preparing the control laws for the fly-by-wire system chosen for the Dauphin 6001 flying demonstrator. Particular attention is given to the system's architecture, the architecture of control laws, the results of qualitative assessment, and the quantitative analysis of handling qualities. Results of the first assessments demonstrated satisfactory performance of the contol laws studied. I.S.

A92-35757
EXPERIENCES WITH HIGH AUTHORITY HELICOPTER FLIGHT CONTROL
G. BOUWER, H. J. PAUSDER, and W. VON GRUENHAGEN (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

An example of the high-authority helicopter flight control is presented by describing results of experiments using the helicopter in-flight simulator termed Advanced Technologies Testing Helicopter System (ATTHES), which is a modified BO 105 helicopter equippped with a model following control system (MFCS). The effectiveness of the simulation tools is demonstrated by the analysis of strong impacts of actuator dynamics and nonlinearities on the flight dynamics which was obtained during flight tests in 1989. It is shown that the ATTHES realized on a BO 105 with a high-authority MFCS meets the requirements of low time delay, decoupling performance, off-nominal flight condition, and in-flight simulation capability. I.S.

A92-35762
ACTIVE CONTROL OF HELICOPTER GROUND AND AIR RESONANCE
G. REICHERT and U. ARNOLD (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

The phenomenon of air and ground resonance instabilities caused by coupling of rotor and body degrees of freedom is elucidated, and the different approaches to active air and ground resonance suppression are described. The influence of blade pitch control on the blade motion as well as of cyclic pitch input on the body motion is discussed. The different feedback structures are compared with respect to complexity and feasibility. The presented simulation results indicate that active control is an effective possibility for overcoming ground resonance instability. Air resonance stabilization must be considered in relation to the required handling qualities. Using the same controller for air resonance suppression as well as for stability and control augmentation may lead to unacceptable interferences. P.D.

A92-35768
EVALUATION OF A CONSTANT FEEDBACK GAIN FOR CLOSED LOOP HIGHER HARMONIC CONTROL
R. KUBE (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 8 p. refs

A controller with a constant feedback gain for a closed loop higher harmonic control (HHC) was developed using a special

controller design methodology based on minimization of a quality criterion. This design methodology leads to a fixed gain controller which remains stable within the whole flight envelope and which yields a vibration reduction similar to one achieved by an adaptive controller. The newly designed controller possesses a better transient behavior and is well suited for high-speed and high-agility helicopters. I.S.

A92-35769
GENERALIZED HIGHER HARMONIC CONTROL - TEN YEARS OF AEROSPATIALE EXPERIENCE
MICHEL POLYCHRONIADIS (Aerospatiale, Division Helicopteres, Marignane, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p. Research supported by Service Technique des Programmes Aeronautiques, DRET, and Direction Generale de l'Aviation Civile. refs

An overview of Aerospatiale's investigations in the field of rotor active control technology by higher harmonic blade pitch control is presented, with emphasis on vibration reduction, rotor noise reduction, and performance improvement by stall alleviation. In the case of vibration reduction, the successful development of a closed-loop system tested on the SA349 experimental Gazelle in 1985 is traced, as well as work performed since then: flight tests with blades equipped with pressure transducers and design studies on a production system for the future NH90 helicopter. The reduction of blade vortex interaction noise was demonstrated in flight on the SA349 helicopter with an open-loop higher harmonic control system. Attention is also given to the optimum rotor control concept, where an integrated system equipped with different sensors determines in real time the blade pitch control ideally adapted to the fight configuration. P.D.

A92-35770* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A STUDY OF COUPLED ROTOR-FUSELAGE VIBRATION WITH HIGHER HARMONIC CONTROL USING A SYMBOLIC COMPUTING FACILITY
I. PAPAVASSILIOU, C. VENKATESAN, and P. P. FRIEDMANN (California, University, Los Angeles) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 24 p. refs
(Contract NAG2-477; DAAL03-86-G-0109)

A fundamental study of vibration prediction and vibration reduction in helicopters using active controls was performed. The nonlinear equations of motion for a coupled rotor/flexible fuselage system have been derived using computer algebra on a special purpose symbolic computing facility. The details of the derivation using the MACSYMA program are described. The trim state and vibratory response of the helicopter are obtained in a single pass by applying the harmonic balance technique and simultaneously satisfying the trim and the vibratory response of the helicopter for all rotor and fuselage degrees of freedom. The influence of the fuselage flexibility on the vibratory response is studied. It is shown that the conventional single frequency higher harmonic control (HHC) capable of reducing either the hub loads or only the fuselage vibrations but not both simultaneously. It is demonstrated that for simultaneous reduction of hub shears and fuselage vibrations a new scheme called multiple higher harmonic control (MHHC) is required. The fundamental aspects of this scheme and its uniqueness are described in detail, providing new insight on vibration reduction in helicopters using HHC. Author

A92-35775
THE DEVELOPMENT AND TESTING OF AN ACTIVE CONTROL OF STRUCTURAL RESPONSE SYSTEM FOR THE EH101 HELICOPTER
ALAN E. STAPLE and DANIEL M. WELLS (Westland Helicopters, Ltd., Yeovil, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. refs

The development of an active control of structural response (ACSR) system for the EH 101 helicopter is discussed. The ACSR system installation on the EH 101 is described in detail, and the results of a comprehensive ground- and flight-test program are presented. Also presented are the results of a preliminary evaluation of the potential benefits and costs of the ACSR system for the EH 101. I.S.

A92-35776
IMPROVEMENT OF HELICOPTER ROBUSTNESS AND PERFORMANCE CONTROL LAW USING EIGENSTRUCTURE TECHNIQUES AND H-INFINITY SYNTHESIS
C. SAMBLANCAT, P. APKARIAN (ONERA, Centre d'Etudes et de Recherches de Toulouse, France), and R. J. PATTON (York, University, Heslington, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 8 p. refs

This paper deals with the design of a robust helicopter control law. A two-loop structured feedback is proposed. The first loop is static and computed using eigenstructure assignment. Its objective is to provide some decoupling between the different axes. The second loop is designed using H-infinity synthesis, and tends to zero as frequencies tend to infinity. The objective of the outer loop is to improve performance in terms of minimizing the error between the reference and output signals and some robustness against additive perturbations due to plant uncertainties. This procedure allows the compensator order to be reduced with respect to more classically derived H-infinity solutions. Author

A92-35777* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGH-ORDER STATE SPACE SIMULATION MODELS OF HELICOPTER FLIGHT MECHANICS
FREDERICK D. KIM, ROBERTO CELI (Maryland, University, College Park), and MARK B. TISCHLER (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. refs
(Contract NCA2-310)

This paper describes the formulation and validation of a high-order linearized mathematical model of helicopter flight mechanics, which includes rotor flap and lag degrees of freedom as well as inflow dynamics. The model is extracted numerically from an existing nonlinear, blade element, time simulation model. Extensive modifications in the formulation and solution process of the nonlinear model, required for a theoretically rigorous linearization, are described in detail. The validation results show that the linearized model successfully captures the coupled rotor-fuselage dynamics in the frequency band most critical for the design of advanced flight control systems. Additional results quantify the extent to which the order of the model can be reduced without loss of fidelity. Author

A92-35785
AN EVALUATION OF A SIMPLE PID CONTROLLER DESIGNED USING OPTIMAL CONTROL THEORY WHEN APPLIED TO HELICOPTER STABILISATION
J. FENTON, B. W. RAWNSLEY, K. J. POTTER, and S. J. ANDREWS (Smiths Industries Aerospace & Defence Systems, Ltd., Cheltenham, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 15 p. refs

The development of an all-digital automatic flight control system (AFCS) for the EH101 helicopter is described. The system comprises an autostabilizer and autopilot. The autostabilizer control laws were designed on a single-axis basis using classic root locus techniques to derive the proportional plus derivative gains used in the series actuator control loop and the integral gain used primarily in the parallel actuator trim system. A method is presented which uses optimal control theory to derive gain matrices for a multivariable PID controller which takes account of cross-coupling effects. No state estimation or additional sensors are required to implement the control law, which makes it potentially suitable for use in an AFCS. A comparison of the simulation results obtained using this method is made with those obtained from the current AFCS control laws. P.D.

A92-35786
EIGENSTRUCTURE ASSIGNMENT FOR HANDLING QUALITIES IN HELICOPTER FLIGHT CONTROL LAW DESIGN
G. HUGHES, M. A. MANNESS, and D. J. MURRAY-SMITH (Glasgow, University, Scotland) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. Sponsorship: Ministry of Defence of England. refs
(Contract MOD-2048/53/RAE(B))

The requirements of active control technology, together with increased operational demands, present a range of new problems for the designers of helicopter flight control laws. Multivariable control system design techniques, such as eigenstructure assignment, provide a potentially powerful set of tools for control law development which take account of the inherently multi-input multi-output nature of the helicopter. This paper examines the use of eigenstructure assignment for the design of control laws based on state variable feedback. The merits of this approach are examined through the use of an illustrative design example with particular emphasis being given to decoupling and robustness properties. Author

A92-35933
FLYING QUALITIES TESTING ON THE MODERN TECHNOLOGY AIRSHIP
JOHN A. TAYLOR (Veda, Inc., Lexington Park, MD) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 2.1-1 to 2.1-10.
Copyright

An overview is presented of the technical issues related to the flight testing of airships to examine their flying qualities. Attention is given to the expected airship mission scenarios, the requirements of airship airworthiness, and design considerations for rigid, semirigid, and nonrigid airships. The general test requirements of airship flying qualities are enumerated and include static and dynamic stability, flight control, trim requirements and effects, propulsion effects, hull flexibility modes, and gust response. Static stability should be demonstrated in pitch and yaw and in roll, and flight-control and trim are important for pitch and thrust-vector effects. The present review gives the general outline of considerations for the testing and evaluation of these airships, although other important factors should be considered such as structural load measurement and reliability. C.C.S.

A92-35939
LIMIT CYCLE OSCILLATION AND FLIGHT FLUTTER TESTING
WILLIAM J. NORTON (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 3.4-1 to 3.4-12. refs
Copyright

The problem of limit-cycle oscillation (LCO) is examined with specific references to the response in a number of aircraft, and a method is given for conducting flutter-clearance tests when LCO is present. The prediction of LCO is shown to be difficult, and the appearance of the phenomena is examined for the F-5, F-16, F-111, the F/A-18, and the F-15 STOL. The case studies demonstrate that LCO can be alleviated by changing the dynamics form a purely structural case or by adjusting the balance weight for control-surface-rotation LCO. In the case of store LCO the center of gravity of the store should be relocated, and control-system compensation such as feedback gain can be used to alleviate LCO related to the control system. A testing methodology is developed that involves real-time monitoring of structural responses to determine LCO unstable responses during flight and flight-flutter testing. C.C.S.

A92-35947
ESTIMATION OF FLYING QUALITIES USING A LEASTSQUARES LOWER-ORDER EQUIVALENT SYSTEMS TECHNIQUE
CLARKE O. MANNING (USAF, Wright-Patterson AFB, OH) and DANIEL GLEASON (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 5.4-1 to 5.4-13. refs
Copyright

Lower-order equivalent-systems (LOES) theory is employed to identify aircraft dynamics based on input/output data collected during flight to determine flying qualities. The test aircraft is analyzed in terms of its flying qualities during noncritical flight for the comparison of these typical qualities with flight dynamics during critical phases. The time-response LOES analysis is described, and the method is applied to the analysis of an NT-33A Variable-stability Aircraft. The LOES method is compared with the results of two pilot-rating methods, and the optimal ramp-input rise time is determined for the LOES time-response matching program. The least-squares LOES program is found to provide results that are consistent with those from the pilot-rating programs and that are correct for 92 percent of the configurations tested. The LOES technique is shown to be a good technique for applications requiring handling-qualities and flight-parameter identification. C.C.S.

N92-22157 Stanford Univ., CA.
HELICOPTER ACTIVE ROTOR CONTROL Ph.D. Thesis
JAMES WILLARD FULLER 1991 314 p
Avail: Univ. Microfilms Order No. DA9206767

A methodology for designing helicopter active rotor control algorithms was developed. A rotor can be regarded as an actuator whose outputs are the three components of thrust and whose inputs are collective, longitudinal cyclic, and lateral cyclic blade pitch. Active control can make the output response faster and more precise, eliminate cross-coupling, attenuate unwanted responses to gusts, and suppress vibration. The active control concept investigated here consists of sensors that measure the angles of rotation of the rotor flapping hinges of a fully articulated rotor, a computer that implements the control logic, and servo-actuators that move the swashplate to control blade pitch. The methodology for designing the control logic is described. Dissert. Abstr.

N92-22194*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
VARIABLE-CAMBER SYSTEMS INTEGRATION AND OPERATIONAL PERFORMANCE OF THE AFTI/F-111 MISSION ADAPTIVE WING
JOHN W. SMITH (PRC Systems Services Co., Edwards, CA.), WILTON P. LOCK, and GORDON A. PAYNE Apr. 1992 43 p
(Contract RTOP 533-02-00)
(NASA-TM-4370; H-1748; NAS 1.15:4370) Avail: NTIS HC/MF A03 CSCL 01/3

The advanced fighter technology integration, the AFTI/F-111 aircraft, is a preproduction F-111A testbed research airplane that was fitted with a smooth variable-camber mission adaptive wing. The camber was positioned and controlled by flexing the upper skins through rotary actuators and linkages driven by power drive units. The wing camber and control system are described. The measured servoactuator frequency responses are presented along with analytical predictions derived from the integrated characteristics of the control elements. A mission adaptive wing system chronology is used to illustrate and assess the reliability and dependability of the servoactuator system during 1524 hours of ground tests and 145 hours of flight testing. Author

N92-22529*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FIBER OPTICS FOR CONTROLS
GARY T. SENG *In its* Aeropropulsion 1987 p 243-249 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 01/3

The design, development, and testing of a fiber optic integrated propulsion/flight control system for an advanced supersonic dash aircraft (flies at supersonic speeds for short periods of time) is

the goal of the joint NASA/DOD Fiber Optic Control System Integration (FOCSI) program. Phase 1 provided a comparison of electronic and optical control systems, identified the status of current optical sensor technology, defined the aircraft sensor/actuator environment, proposed architectures for fully optical control systems, and provided schedules for development. Overall, it was determined that there are sufficient continued efforts to develop such a system. It was also determined that it is feasible to build a fiber optic control system for the development of a data base for this technology, but that further work is necessary in sensors, actuators, and components to develop an optimum design, fully fiber optic integrated control system compatible with advanced aircraft environments. Phase 2 is to design, construct, and ground test a fly by light control system. Its first task is to provide a detailed design of the electro-optic architecture. Author

N92-23229*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
SENSITIVITY ANALYSIS OF DYNAMIC AEROELASTIC RESPONSES
RAKESH K. KAPANIA *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 12 p Feb. 1992 (Contract NAS1-18471)
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01/3

This paper summarizes ongoing research on the sensitivity analysis of dynamic aeroelastic response of wings. Two approaches are being used to express the unsteady aerodynamic loads: (1) the frequency-domain approach, and (2) the state-space approach. The frequency-domain approach is demonstrated on a three-dimensional box wing and the state-space domain approach is demonstrated on a simple two-dimensional sectional model. Three different methods are used to find the sensitivities: (1) a purely finite difference approach, (2) a semi-analytical approach in which an analytical expression is used for calculating the sensitivity of an eigenvalue of the complex valued aeroelastic matrix, however, the derivatives of the components of the matrix are obtained using finite difference, and (3) a semi-analytic approach that differs from (2) in the sense that the sensitivity of the aerodynamic matrix is now obtained analytically. A good agreement is seen between the three sets of results. For the two-dimensional sectional model the results for the sensitivities of the flutter speed with respect to the various parameters are obtained. Author

N92-23234# Oklahoma Univ., Norman.
MULTIDISCIPLINARY OPTIMIZATION STUDIES USING ASTROS
ALFRED G. STRIZ and VIPPERLA B. VENKAYYA (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 29 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The influences of the structural and aerodynamic modeling on flutter analysis and multidisciplinary optimization of fully built-up finite element wing models in an aeroelastic environment are not yet well understood. Therefore, the dynamic aeroelastic and optimization capabilities in the Automated Structural Optimization System (ASTROS) were used to evaluate the flutter behavior and the behavior of structural optimization with flutter constraints of various representative fully built-up finite element wing models in subsonic and supersonic flow. ASTROS was here used as a tool to calculate flutter speeds and frequencies and to minimize the weight of these wing models in subsonic and supersonic flow under given flutter and frequency constraints to determine the effect that these modeling factors have. Author

N92-23238# British Aerospace Public Ltd. Co., Bristol (England). Airbus Div.
SIMULTANEOUS STRESS AND FLUTTER OPTIMIZATION FOR THE WING OF A TRANSPORT AIRCRAFT EQUIPPED WITH FOUR ENGINES
J. M. D. SNEE, H. ZIMMERMANN, D. SCHIERENBECK, and P. HEINZE (Deutsche Airbus G.m.b.H., Bremen, Germany, F.R.) *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 12 p Feb. 1992
Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The main objective of this work is to demonstrate the benefits of interdisciplinary optimization techniques to a modern aircraft design. The optimization is related to a four engine transport aircraft series equipped with a common wing. The series comprises of two aircraft differing in fuselage length by approximately 4 m but with the same maximum takeoff weight. Wing commonality in terms of optimization means that all the significant aeroelastic and static constraints are taken into account in order to achieve a weight optimized but also valid design proposal. In effect, this means that critical flutter situations of both aircraft types dependent on the fuel and load conditions as well as the dimensioning static load cases in combination with the stresses allowable must be introduced into a mathematical optimization model and the weight optimized solution must be sought with the aid of various optimization techniques. 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.

A92-34219
THE BERLIN OIL CHANNEL FOR DRAG REDUCTION RESEARCH
D. W. BECHERT, G. HOPPE, J. G. TH. VAN DER HOEVEN, and R. MAKRIS (DLR, Berlin, Federal Republic of Germany) Experiments in Fluids (ISSN 0723-4864), vol. 12, March 1992, p. 251-260. Research supported by DFG and DLR. refs
Copyright

An oil channel designed for drag reduction research is described. The channel is characterized by a varied thickness of the viscous sublayer (1-4 mm), surfaces with longitudinal ribs of fairly large dimensions, and lateral spacing of the ribs between 3 and 10 mm. Design innovations which contribute to the improvement of measurements include adjustable turbulators to maintain equilibrium turbulence in the channel, a bubble trap to avoid bubbles in the channel at high flow velocities, a simple method for the accurate calibration of manometers, and the elimination of the Coulomb friction in ball bearings. The channel has a cross section of 25 x 85 cm, is 11 m long, and is filled with about 4.5 metric tons of white paraffin oil. The kinematic viscosity of the oil is 1.2 x 10 exp -5 sq m/s, and the highest average velocity is 1.29 m/s. The Reynolds number range is between 5,000 and 26,800 for fully established turbulent flow. O.G.

A92-34596*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMIC CHARACTERISTICS OF A BENCHMARK MODELS PROGRAM SUPERCRITICAL WING
BRYAN E. DANSBERRY (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3122-3130. refs
(AIAA PAPER 92-2368) Copyright

The dynamic characteristics of the Benchmark Supercritical Wing are presented. The Benchmark Supercritical Wing is a rigid semi-span model with a rectangular planform and a supercritical airfoil shape. This model will be tested on a flexible mount system that provides a well defined, two-degree-of-freedom dynamic system. This paper defines the dynamic characteristics of the model/mount system as determined in a preliminary ground vibration test. A general description of the model, flexible mount system, and instrumentation are included as well as a summary of the data set which the testing of this model is intended to produce. Author

A92-35428
PARACHUTE CANOPY CONTROL SIMULATION - A SOLUTION FOR AIRCREW EMERGENCY TRAINING
JEFFREY R. HOGUE, WALTER A. JOHNSON, and R. W. ALLEN (Systems Technology, Inc., Hawthorne, CA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 8-13. refs
Copyright

A low-cost canopy control simulator is described which is aimed at providing flight training for smokejumper and military personnel who fly round and ramair parachutes on a routine operational mission basis. Flight simulators are used as standard and essential training methodology for all conventional aircraft due to their safety, availability, economy, and efficiency. They make it possible to learn good parachute handling techniques and suffer the consequences of poor techniques in complete safety. O.G.

A92-35443
TWO CREW STATIONS FOR DYNAMIC FLIGHT SIMULATION
CARL H. PIERCE (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 107-112. refs
Copyright

The Supine Crew Station (SCS) and the Reconfigurable Crew Station (RCS) for dynamic flight simulation (DFS) which are intended to provide adaptable fixtures for a wide variety of early development testing are discussed. The DFS is based on traditional flight simulation techniques in conjunction with the capabilities of a 50-foot arm length, controlled three-degrees-of- freedom centrifuge, resulting in flight simulation with high-fidelity sustained accelerations. The SCS is aimed at providing a dynamic test environment for crew systems based on use with a reclined seat position. The RCS makes it possible to conduct a wide variety of flight control, cockpit display, and man/seat interface studies in directly comparable configurations. The RCS design includes the two major seat mounting types and provisions for a wide variety of instruments and controls, which allows testing to vary from generic through high-fidelity crew stations. O.G.

A92-35653*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATION AND MODEL REDUCTION FOR THE AFW PROGRAM
CAREY BUTTRILL, BARTON BACON, JENNIFER HEEG, JACOB HOUCK (NASA, Langley Research Center, Hampton, VA), and DAVID WOOD (Unisys Government Systems, Inc., Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 11-19. refs
(AIAA PAPER 92-2081) Copyright

The simulation methodology used in the Active Flexible Wing wind-tunnel test program is described. An overview of the aeroservoelastic modeling used in building the required batch and hot-bench simulations is presented. Successful hot-bench implementation required that the full mathematical model be significantly reduced while assuring that accuracy be maintained for all combinations of 10 inputs and 56 outputs. The reduction was accomplished by using a method based on internally balanced realizations and focussing on the linear, aeroelastic portion of the full mathematical model. The error-bound properties of the internally balanced realization significantly contribute to its utility in the model reduction process. The reduction method and the results achieved are described. Author

A92-35656*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON-LINE ANALYSIS CAPABILITIES DEVELOPED TO SUPPORT THE AFW WIND-TUNNEL TESTS
CAROL D. WIESEMAN, SHERWOOD T. HOADLEY (NASA, Langley Research Center, Hampton, VA), and SANDRA M. MCGRAW (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 39-47. refs
(AIAA PAPER 92-2084) Copyright

A variety of on-line analysis tools were developed to support two Active Flexible Wing wind-tunnel tests. These tools were developed to verify control law execution, to satisfy analysis requirements of the control law designers, to provide measures of system stability in a real-time environment, and to provide project managers with a quantitative measure of controller performance. Description and purposes of capabilities which were developed are presented in this paper along with examples. Procedures for saving and transferring data for near real-time analysis, and descriptions of the corresponding data interface programs are also presented. The on-line analysis tools worked well before, during, and after the wind-tunnel tests and proved to be a vital and important part of the entire test effort. Author

A92-35692#
TRANSONIC WIND TUNNEL INVESTIGATION OF LIMIT CYCLE OSCILLATIONS ON FIGHTER TYPE WINGS - UPDATE
ATLEE M. CUNNINGHAM, JR. (General Dynamics Corp., Fort Worth, TX) and RUUD G. DEN BOER (National Aerospace Laboratory, Amsterdam, Netherlands) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 426-439. refs
(AIAA PAPER 92-2125) Copyright

Results of a wind tunnel investigation conducted to investigate the unsteady aerodynamic aspects of transonic limit cycle oscillations (LCO) on fighter-type aircraft wings are presented. Unsteady pressures and forces necessary for identifying the aerodynamic nature of transonic LCO which is currently encountered on many fighter configurations are obtained. The wing panel was oscillated in pitch at amplitudes and frequencies typical of LCO for flow conditions in which significant shock-induced separation is encountered. Unsteady pressure data were obtained for the wing panel in terms of both harmonic components and time-histories to highlight the nonlinearities. Unsteady forces and moments measured on the wing panel as well as on each wing store were also obtained to indicate the level of the contribution of each element to the overall unsteady wing loads for pitching motions. P.D.

N92-22096# Rolls-Royce Ltd., Bristol (England). Military Demonstrators.
RECENT DEVELOPMENTS AT THE SHOEBURYNESS (ENGLAND) STOVL TEST FACILITY
L. H. K. REED 1 Sep. 1990 10 p
(PNR-90806; ETN-92-90776) Copyright Avail: NTIS HC/MF A02

The last two years have seen a number of test programs performed that are directly targeted at the technology acquisition need for the next generation of STOVL (Short Take Off Vertical Landing) fighter aircraft. The facilities used comprise a dynamic test gantry with airframe and two augmented powerplants allowing operation in ground effect to be simulated at full scale over a wide range of jet energies and configurations. The areas of concern in the ground environment of a STOVL vehicle are described, together with how the current test programs are acquiring the knowledge to give confidence that the design solution will be satisfactory in service operation. ESA

N92-22195*# MCAT Inst., San Jose, CA.
STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNELS. PART 2: LIGHT SHEET AND VAPOR SCREEN Progress Report
GEORGE LEE Mar. 1992 34 p
(Contract NCC2-716)
(NASA-CR-190217; NAS 1.26:190217; MCAT-92-004) Avail: NTIS HC/MF A03 CSCL 14/2

Light sheet and vapor screen methods have been studied with particular emphasis on those systems that have been used in large transonic and supersonic wind tunnels. The various fluids and solids used as tracers or light scatters and the methods for tracing generation have been studied. Light sources from high intensity lamps and various lasers have been surveyed. Light sheet generation and projection methods were considered. Detectors and location of detectors were briefly studied. A vapor screen system and a technique for location injection of tracers for the NASA Ames 9 by 7 foot Supersonic Wind Tunnel were proposed. Author

N92-22237# Federal Aviation Administration, Atlantic City, NJ.
COMPARATIVE EVALUATION OF INTERNALLY AND EXTERNALLY LIGHTED TAXIWAY GUIDANCE SIGNS
ERIC S. KATZ Jan. 1992 10 p Original contains color illustrations
(DOT/FAA/CT-TN92/2) Avail: NTIS HC/MF A02

A comparative evaluation of two types of illuminated airport signs was conducted at the Federal Aviation Administration (FAA) Technical Center. The purpose of the evaluation was to determine if one sign illumination technique exhibited significantly better performance than the other technique. To obtain performance data applicable to signs presently in service, samples of both internally and externally illuminated signs were obtained and evaluated. Results of the evaluation indicate that the performance of the internally illuminated taxiway guidance signs can be expected to be significantly better than that of externally lighted signs, especially at greater viewing distances and under conditions of reduced visibility. Author

N92-22437*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF TECHNOLOGY DEVELOPED FOR FLIGHT SIMULATION AT NASA. LANGLEY RESEARCH CENTER
JEFF I. CLEVELAND, II *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 1 p 109-117 Dec. 1991
Avail: NTIS HC/MF A23 CSCL 14/2

In order to meet the stringent time-critical requirements for real-time man-in-the-loop flight simulation, computer processing operations including mathematical model computation and data input/output to the simulators must be deterministic and be completed in as short a time as possible. Personnel at NASA's Langley Research Center are currently developing the use of supercomputers for simulation mathematical model computation for real-time simulation. This, coupled with the use of an open systems software architecture, will advance the state-of-the-art in real-time flight simulation. Author

N92-22503# Federal Aviation Administration, Atlantic City, NJ.
MLS MATHEMATICAL MODELING STUDY OF PHILADELPHIA INTERNATIONAL AIRPORT RUNWAY 27L Technical Report, Mar. - Nov. 1991
LINDA PASQUALE Mar. 1992 23 p
(Contract FAA-T0603-B)
(DOT/FAA/CT-TN91/54; ACD-330) Avail: NTIS HC/MF A03

A mathematical modeling study of the proposed Microwave Landing System (MLS) for runway 27L at Philadelphia International Airport was performed at the request of the MLS Program Office. The study focused on the feasibility of three offset approaches designed to maintain acceptable separation distance from aircraft approaching runway 27R. Modeling was performed using these three approaches, two elevation sites, one azimuth site, and several potential multipath obstacles. Results of the modeling study indicate that the three offset approach procedures would be feasible in this environment. No problematic effects from the airport environment were predicted within the usable coverage volume of the MLS signal. Author

N92-22966# Federal Aviation Administration, Atlantic City, NJ.
AIRPORT SMART POWER LIGHTING SYSTEM
LARRY N. VANHOY Feb. 1992 13 p
(DOT/FAA/CT-TN91/12) Avail: NTIS HC/MF A03

The Swedish Airport Smart Power (ASP) System has been installed at the Federal Aviation Administration Technical Center, Atlantic City International Airport, (ACY) NJ. The purpose of this system is to provide control of individual lights on an airport from a remote location such as the Air Traffic Control Tower. A demonstration of the installed system's capabilities was conducted. Control of individual airport lights enhance the operation of systems such as hold-short bars, stopbars, wig-wag lights, taxiway guidance, lead-in lights, clearance bars, and control of lighted signs. Author

N92-23778# National Aerospace Lab., Tokyo (Japan). Aerodynamics Div.
DEVELOPMENT OF WALL PRESSURE MEASURING APPARATUS FOR AN EXISTING TRANSONIC WIND TUNNEL TEST SECTION
SEIZO SAKAKIBARA, HIDEO SAWADA, KOICHI SUZUKI, SEIGO NAKAMURA, and NOBUYUKI HOSOE Mar. 1987 29 p In JAPANESE; ENGLISH summary
(NAL-TM-565; ISSN-0452-2982; JTN-92-80309) Avail: NTIS HC/MF A03

An apparatus for measuring ventilated wall pressure distributions in the NAL 2 m x 2 m transonic wind tunnel was developed. Described in this paper is the necessity for transonic wind tunnel test section pressure distribution data. Secondly, the construction and function of each component of the apparatus, which were designed for the transonic wind tunnel without altering the existing wall configurations, are described. Finally, typical examples of pressure distribution data obtained with this apparatus are shown. The results of detailed analysis of this pressure distribution data will be separately reported. 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.

A92-33244#
GROUND TEST FACILITIES FOR AEROTHERMAL AND AERO-OPTICAL EVALUATION OF HYPERSONIC INTERCEPTORS
H. A. KOREJWO (SDIO, Washington, DC) and M. S. HOLDEN (Calspan-State University of New York Research Center, Buffalo) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 18 p.
(Contract F49620-91-C-0085)
(AIAA PAPER 92-1074)

An account is given of the essential requirements for duplication of the flowfield environment around a ground-based ballistic missile interception system's ground facility-tested endoatmospheric projectile. Attention is given to the duplication of flowfield velocity for simulation of both fluid-dynamic and real-gas effects, as well as to the design and projected performance of the projected Large Energy National Shock (LENS) wind tunnel facility. The LENS facility must ascertain the degree of optical distortion incurred as a result

of the passage of light through the projectile's cooled sensor window, since angular deviations must be less than 10 microradians. O.C.

A92-33287#
TRAJECTORY CONTROL FOR A LOW-LIFT MANEUVERABLE REENTRY VEHICLE
AXEL J. ROENNEKE and PHILLIP J. CORNWELL (Rose-Hulman Institute of Technology, Terre Haute, IN) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(AIAA PAPER 92-1146) Copyright

To operate laboratories in space, unmanned vehicles are necessary to carry experimental products to the ground. An example for such a concept is the European developed Space Mail capsule with a lift-to-drag ratio of about 0.5. This report presents a system model to describe the reentry flight of a maneuverable space capsule over a rotating planet and the development of a guidance and control concept using a reference trajectory. A technique to design a time-varying path controller is effectively applied to the Space Mail capsule. The controller design is based on linear state feedback of three states that are crucial for the problem: the errors in distance, speed, and flight path angle. The proposed controller can compensate for initial entry speed offsets of +/- 5 percent from the nominal entry speed. Author

A92-33602
KALMAN FILTER MECHANIZATION FOR INS AIRSTART
TUAN M. PHAM (McDonnell Douglas Helicopter Co., Mesa, AZ) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, Jan. 1992, p. 3-11. refs
Copyright

A strapdown mechanization and associated Kalman filter are developed to provide both ground align and airstart capabilities for inertial navigation systems (INSs) using Doppler velocity and position fixes, while not requiring an initial heading estimate. Position update during coarse mode is possible by defining sine and cosine of wander angle as filter states and modeling the position error in geographic frame while integrating velocity in the wander frame. INS Global Positioning System (GPS) differential position due to GPS antenna moment arm can aid heading convergence during hover turns in helicopter applications. Azimuth error state in the fine mode of the filter is defined as wander angle error to provide continuous estimation of navigational states, as well as inertial/aiding sensor errors, across the coarse-to-fine mode transition. Though motivated by a tactical helicopter application, the design can be applied to other vehicles. Advantages over conventional systems in addition to the airstart capability include robustness and versatility in handling many different operational conditions. I.E.

A92-33639
THE DIFFERENTIAL ALGEBRAIC APPROACH IN NONLINEAR DYNAMICAL FEEDBACK CONTROLLED LANDING MANEUVERS
HEBERTT SIRA-RAMIREZ (Universidad de Los Andes, Merida, Venezuela) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol. 37, April 1992, p. 518-524. Research supported by Universidad de Los Andes. refs
Copyright

A differential algebraic approach is proposed for the synthesis of a dynamical feedback controller regulating a spacecraft smooth descent toward the surface of a planet which exhibits nonnegligible atmospheric resistance. An exact linearization-based controller is synthesized using Fliess' generalized observability canonical form of the controller system. The smooth controlled trajectory is regulated by means of assumed amplitude modulated thrusting capabilities of the spacecraft. The robustness of the regulator is tested in the presence of significant unmodelled spatial changes in the coefficient of atmospheric resistance. A simulation example is provided. I.E.

A92-34893* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
HIGH ALTITUDE AIRBORNE REMOTE SENSING MISSION USING THE ADVANCED MICROWAVE PRECIPITATION RADIOMETER (AMPR)
J. GALLIANO, R. H. PLATT (Georgia Institute of Technology, Atlanta), ROY SPENCER, and ROBBIE HOOD (NASA, Marshall Space Flight Center, Huntsville, AL) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 195-198. refs
(Contract NAS8-37142)
Copyright

The advanced microwave precipitation radiometer (AMPR) is an airborne multichannel imaging radiometer used to better understand how the earth's climate structure works. Airborne data results from the October 1990 Florida thunderstorm mission in Jacksonville, FL, are described. AMPR data on atmospheric precipitation in mesoscale storms were retrieved at 10.7, 19.35, 37.1, and 85.5 GHz onboard the ER-2 aircraft at an altitude of 20 km. AMPR's three higher-frequency data channels were selected to operate at the same frequencies as the spaceborne special sensor microwave/imager (SSM/I) presently in orbit. AMPR uses two antennas to receive the four frequencies: the lowest frequency channel uses a 9.7-in aperture lens antennas, while the three higher-frequency channels share a separate 5.3-in aperture lens antenna. The radiometer's temperature resolution performance is summarized. I.E.

A92-35610
OUTLINE AND DISCUSSION OF THE COOLING LOOP OF THE HEATING CONTROL SYSTEM IN THE EXPOSED FACILITY OF THE JAPANESE EXPERIMENT MODULE (JEM)
KAZUHIKO KAMESAKI, M. TAKAI (NASDA, Tokyo, Japan), UICHI IMACHI, KATSUTO INOUE (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), and T. KATO IN: Space Station Conference, 7th, Tokyo, Japan, Apr. 16, 17, 1991, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1991, p. 15, 16. In Japanese.

A92-36127
THE DELTA CLIPPER DREAM
TIM FURNISS Flight International (ISSN 0015-3710), vol. 141, no. 4314, April 15, 1992, p. 30-32.
Copyright

A conceptual development status evaluation is presented for the SDIO's projected VTOL SSTOV, dubbed the 'Delta Clipper', which is envisioned as an alternative to the slowly developing NASP and the next-generation National Launch System. Delta Clipper program managers believe that the lightweight materials and structures entailed by the requisite empty/gross-weight ratio for an SSTOV are now available, precluding the airbreathing propulsion of such alternatives as HOTOL. The Delta Clipper could operate with a crew of two, or entirely unmanned. The 8-12 LH2/LOX engines employed are derived from the RL-10 engines of the Centaur launcher. O.C.

N92-22211*# Calspan-Buffalo Univ. Research Center, NY.
DEVELOPMENT OF AN INTEGRATED BEM APPROACH FOR HOT FLUID STRUCTURE INTERACTION: BEST-FSI: BOUNDARY ELEMENT SOLUTION TECHNIQUE FOR FLUID STRUCTURE INTERACTION Final Technical Report
G. F. DARGUSH, P. K. BANERJEE, and Y. SHI (State Univ. of New York at Buffalo, Amherst.) Mar. 1992 386 p
(Contract NAG3-712)
(NASA-CR-190190; NAS 1.26:190190) Avail: NTIS HC/MF A17 CSCL 21/8

As part of the continuing effort at NASA LeRC to improve both the durability and reliability of hot section Earth-to-orbit engine components, significant enhancements must be made in existing finite element and finite difference methods, and advanced techniques, such as the boundary element method (BEM), must

be explored. The BEM was chosen as the basic analysis tool because the critical variables (temperature, flux, displacement, and traction) can be very precisely determined with a boundary-based discretization scheme. Additionally, model preparation is considerably simplified compared to the more familiar domain-based methods. Furthermore, the hyperbolic character of high speed flow is captured through the use of an analytical fundamental solution, eliminating the dependence of the solution on the discretization pattern. The price that must be paid in order to realize these advantages is that any BEM formulation requires a considerable amount of analytical work, which is typically absent in the other numerical methods. All of the research accomplishments of a multi-year program aimed toward the development of a boundary element formulation for the study of hot fluid-structure interaction in Earth-to-orbit engine hot section components are detailed. Most of the effort was directed toward the examination of fluid flow, since BEM's for fluids are at a much less developed state. However, significant strides were made, not only in the analysis of thermoviscous fluids, but also in the solution of the fluid-structure interaction problem. K.S.

N92-22268# Technische Univ., Delft (Netherlands).
SYMPOSIUM ON HIGH SPEED AIRBREATHING PROPULSION: THE SOLID FUEL COMBUSTION CHAMBER AND BEYOND
P. A. O. G. KORTING (Prins Maurits Lab. TNO, Rijswijk, Netherlands) and H. WITTENBERG 1991 196 p Symposium held in Delft, Netherlands, 7 Jun. 1991 Sponsored in cooperation with Netherlands Technology Foundation, TNO Defence Research, Project Management Office for Research, and National Fund for the Use of Supercomputers Original contains color illustrations
(ETN-92-90685) Avail: NTIS HC/MF A09

The main topics of a cooperative research program on solid fuel combustion with emphasis on airbreathing aerospace propulsion are summarized. The intention is to expose the theoretical and experimental capabilities obtained during the research program. An introduction to the Solid Fuel Combustion Chamber Project (SFCCP) is given. The COPPEF (Computer Program for Parabolic and Elliptic Flow) SFCC performance prediction is described. Fuel pyrolysis in SFCCs is addressed. Experimental facilities for SFC are described. Theoretical and experimental results of the SFCCP are compared. Spin-offs of the SFCCP are described. Work on the Ramjet Technology Demonstration Program (RTDP) towards a European hypersonic space launch vehicle is reviewed. Research on high speed airbreathing propulsion in Europe is reported to broaden the scope to the multinational scene.
ESA

N92-22277# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).
HIGH SPEED AIRBREATHING PROPULSION IN EUROPE
Abstract Only
H. GRIEB *In* Technische Univ., Symposium on High Speed Airbreathing Propulsion: The Solid Fuel Combustion Chamber and Beyond p 183 1991
Avail: NTIS HC/MF A09

A comparative outline of the aspects favoring the two-stage horizontally launched space transport vehicle over multi-stage rockets and single-stage horizontally launched space transport vehicles is given. The significant key data for the Saenger space vehicle are discussed. The resulting technical requirements for the propulsion systems are explained with emphasis being placed on the propulsion system of the lower stage, since this represents the greatest technological challenge. Because of the high level of integration, the entire propulsion system, consisting of intake, actual engine and expansion ramp behind the engine, is covered. On this basis, the propulsion concepts taken into consideration for the lower stage up to this point are compared, in retrospect, with regard to their performance as well as the technical and technological problems. The key technologies involved which are presently being pursued are discussed. In this context, the requirements for a technology flight demonstrator, which will become indispensable for the further development of Saenger, and the associated problems are discussed. Based on the information available, apparent development trends and activities in the hypersonic propulsion field in the other European countries are commented on. ESA

N92-22598*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
AGREEMENTS/SUBAGREEMENTS APPLICABLE TO WALLOPS, 12 NOV. 1991
In NASA, Washington, Workshop on the Suborbital Science Sounding Rocket Program, Volume 1 22 p 1991
Avail: NTIS HC/MF A09 CSCL 14/2

The status of space science agreements are noted. A general overview of the Wallops Flight Facility (WFF) is given. The geography, history, and mission of the facility are briefly surveyed. Brief accounts are given of NASA earth science activities at the WFF, including atmospheric dynamics, atmospheric optics, ocean physics, microwave altimetry, ocean color research, wind-wave-current interaction, flight support activities, the Sounding Rocket Program, and the NASA Balloon Program. Also discussed are the WFF launch range, the research airport, aircraft airborne science, telemetry, data systems, communications, and command and control. Author

N92-22625*# Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.
TWO STAGE TO ORBIT DESIGN
Jun. 1991 92 p
(Contract NASW-4435)
(NASA-CR-189994; NAS 1.26:189994) Avail: NTIS HC/MF A05 CSCL 22/2

A preliminary design of a two-stage to orbit vehicle was conducted with the requirements to carry a 10,000 pound payload into a 300 mile low-earth orbit using an airbreathing first stage, and to take off and land unassisted on a 15,000 foot runway. The goal of the design analysis was to produce the most efficient vehicle in size and weight which could accomplish the mission requirements. Initial parametric analysis indicated that the weight of the orbiter and the transonic performance of the system were the two parameters that had the largest impact on the design. The resulting system uses a turbofan ramjet powered first stage to propel a scramjet and rocket powered orbiter to the stage point of Mach 6 to 6.5 at an altitude of 90,000 ft. Author

N92-23705# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA: SPACE
1 Apr. 1992 59 p Transl. into ENGLISH from various Russian articles
(JPRS-USP-92-002) Avail: NTIS HC/MF A04

A bibliography is given of Central Eurasian research in space sciences. Topics covered include solar sails, satellite motion prediction, magnetic storms, the Earth radiation belt, magnetic field vector measurement from a rotating spacecraft, the formation of planetary systems in the course of the evolution of close binary stars, and estimating the mass of Halley's Comet dust particles.
Author

N92-23820# National Space Development Agency, Ibaraki (Japan).
CONCEPTIONAL DESIGN TO HEAT-RESISTANT AIRFRAME OF HOPE
MASATAKA YAMAMOTO *In* ESA, Spacecraft Structures and Mechanical Testing, Volume 1 p 277-282 Oct. 1991
Copyright Avail: NTIS HC/MF A21

The HOPE (Japanese Spaceplane) airframe is recognized to meet with severe thermal and mechanical environment through the operation phases such as launch, reentry, and landing. The conceptional design model is studied using the results of research and development of heat resistance materials and of heat resistance structural design. The structural configuration of heat resistance is to fit the thermal protection panels out of the frame structure, in addition to mounting the onboard thermal insulation

material. Primary structural materials are carbon fiber reinforced polyimide (up to 300 C) and carbon-carbon (up to 1700 C); thermal protection materials are ceramic tile, titanium alloy panel, and carbon-carbon panel. ESA

N92-23821# Societe Europeenne de Propulsion, Saint-Medard-en-Jalles (France).
LARGE THIN COMPOSITE THERMOSTRUCTURAL PARTS
D. DESNOYER, A. LACOMBE, and J. M. ROUGES *In* ESA, Spacecraft Structures and Mechanical Testing, Volume 1 p 283-291 Oct. 1991
Copyright Avail: NTIS HC/MF A21

The new space transportation projects (Sanger, Hotol, STAR-H, STS 2000, NASP, and Hermes) have a challenge with their system mass performance. Due to the overall size of these systems, large surface high temperature parts are mandatory in order to increase the system reliability in decreasing the junction number (seals and fasteners) and to decrease the overall mass. To be mass efficient, these large parts should be thin. The rigidity is provided by integrated stiffeners. Depending on the reentry atmosphere, two main types of environment constraints should be considered: an oxidizing and nonoxidizing environment. For the oxidizing environment, an SiC matrix was selected and large parts were manufactured demonstrating the availability and validity of the technologies. Material tests performed under plasma arc jet showed the oxidizing resistance of the material. For the nonoxidizing environment (i.e. planetary reentry) carbon-carbon can be selected. A conic shaped panel with integrated stiffeners was studied and manufactured. The skin thickness is 0.5 mm with no delaminable preform. ESA

N92-23836# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
STRETCHED SKIN CONCEPT FOR THE ENTRY AERODYNAMIC DECELERATOR SYSTEM OF PLANETARY PROBES
C. BONNET, J. F. PUECH, and M. RIGAULT *In* ESA, Spacecraft Structures and Mechanical Testing, Volume 1 p 393-397 Oct. 1991
Copyright Avail: NTIS HC/MF A21

The joint NASA/ESA Cassini/Huygens mission is one of the forthcoming planetary exploration missions making use of a high drag decelerator. The requirements of this mission were used to support studies on new concepts for entry devices. Preliminary linear analysis performed on a very lightweight concept decelerator, based on ultra thin carbon-carbon skin showed that buckling is a driver during the entry phase. To avoid the consequence in stability of these stresses in the skin, the idea of using only a carbon fiber fabric without carbon impregnation was suggested. This was the first step towards the stretched skin concept. The second step was to design a proper structure to stretch the fabric. This concept, composed of a high temperature annular fabric, stretched into a rigid medium temperature armature and connected to the cold descent module structure, is described. A performance analysis is globally performed, and the predicted mass of the stretched skin concept is competitive. The technical feasibility is outlined. ESA

N92-23919*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NASA'S GPS TRACKING SYSTEM FOR ARISTOTELES
E. S. DAVIS, G. HAJJ, E. R. KURSINSKI, C. KYRIACOU, T. K. MEEHAN, WILLIAM G. MELBOURNE, R. E. NEILAN, L. E. YOUNG, and THOMAS P. YUNCK *In* ESA, The Solid-Earth Mission Aristoteles p 69-82 Dec. 1991 Sponsored by NASA, Washington
Avail: NTIS HC/MF A06; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 50 Dutch guilders

NASA 's Global Positioning System (GPS) tracking system for Artistoteles receivers and a GPS flight receiver aboard Aristoteles is described. It will include a global network of GPS ground receivers and a GPS flight receiver aboard Aristoteles. The flight receiver will operate autonomously; it will provide real time navigation solutions for Aristoteles and tracking data needed by ESOC for operational control of the satellite. The GPS flight and ground receivers will currently and continuously track all visible GPS satellites. These observations will yield high accuracy differential positions and velocities of Aristoteles in a terrestrial frame defined by the locations of the globally distributed ground work. The precise orbits and tracking data will be made available to science investigators as part of the geophysical data record. The characteristics of the GPS receivers, both flight and ground based, that NASA will be using to support Aristoteles are described. The operational aspects of the overall tracking system, including the data functions and the resulting data products are summarized. The expected performance of the tracking system is compared to Aristoteles requirements and the need to control key error sources such as multipath is identified. ESA

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A92-32564
APPLICATIONS OF COMPOSITE MATERIAL SYSTEMS TO AVIONIC SYSTEMS PACKAGING
ROBERT E. MORGAN (U.S. Navy, Naval Avionics Center, Indianapolis, IN) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-L-1 to 2-L-11.

The weight and life cycle cost reductions, and both reliability and performance enhancements, associated with novel composite packaging for avionics systems are being aggressively pursued by the Naval Avionics Center. Composites' contributions are under investigation in such applications as thermal-management systems, surface mounts, circuit module heat sinks, external stores, equipment racks and consoles, and electronic cable coverings. Development status characterizations are provided. O.C.

A92-32662
SAND EROSION BEHAVIOR OF GFRP
NOBUO HARAKI, KEN TSUDA (Tokyo Institute of Technology, Japan), and HIDEMITSU HOJO (Nihon University, Narashino, Japan) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 12-21. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 16-O-1 to 16-O-8. *refs*

Sand erosion tests were made with glass cloth/polyester composites and polyester resin by using the sand blasting type erosion tester in which the solid glass particle was accelerated by flowing air and impinged to the plate specimen. Impact velocity of particles was varied from 13 to 60 m/s and attack angle was varied from 20 to 90 deg. The change of weight loss with time at 90 deg of glass composites showed multierosion stages. In each stage, these composed two lines with different slopes. Lower slope was obtained in the period of matrix damage, and higher slope was of glass cloth. This behavior is different from that of homogeneous materials such as resins and metals. In volume erosion rate, at higher angle attack resin showed good resistance to erosion damage but at lower attack angle glass composites showed good resistance. The method to estimate the erosion rate of glass composite at 90 deg impact was proposed, and the calculated value agreed well with the experimental results.
Author

A92-33279#
DESIGN FOR CORROSION PREVENTION
J. A. MARCEAU and M. MOHAGHEGH (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 19 p. refs
(AIAA PAPER 92-1127) Copyright

The proprietary 'Design for Corrosion Prevention' document presently discussed establishes guidelines for the prevention of long-term corrosion problems that can be addressed by due attention to fluid drainage, materials/processes selection, faying surface sealing, and the use of corrosion-inhibiting finishes. It is stressed that structures must be designed to allow not only assembly-related access to all surfaces but regular maintenance inspection access as well. The problems addressed encompass stress corrosion cracking, exfolliation, pitting, crevice (electrolytic) corrosion, and galvanic corrosion. O.C.

A92-33918* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADDITION CURING THERMOSETS ENDCAPPED WITH 4-AMINO (2.2) PARACYCLOPHANE
JOHN F. WATERS (Case Western Reserve University, Cleveland, OH), JAMES K. SUTTER, MARY A. B. MEADOR, LARRY J. BALDWIN, and MICHAEL A. MEADOR (NASA, Lewis Research Center, Cleveland, OH) Journal of Polymer Science, Part A - Polymer Chemistry (ISSN 0887-624X), vol. 29, 1991, p. 1917-1924. refs
Copyright

A new family of addition curing polyimides were prepared that contained 4-amino (2.2)-paracyclophane as the endcap. An improved synthesis of the endcap 4-amino-(2.2) cyclophane was accomplished increasing the yield to 60 percent and simplifying the procedure. DSC and rheological analysis of endcapped polyimide oligomers confirmed that the onset for polymerization of the ethylene bridge was 250 C. C-13 CP/MAS NMR was used to determine the structural changes of the oligomers after thermal treatment. The cyclophane capped polyimides were successfully compression molded to form void free neat resin specimens. Tg's as high as 353 C were obtained by thermomechanical analysis for postcured samples. Preliminary thermal stability studies suggest that these resins have a high onset of decomposition ranging from 549 to 567 C. Author

A92-34474*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CERAMICS AND CERAMIC MATRIX COMPOSITES - AEROSPACE POTENTIAL AND STATUS
STANLEY R. LEVINE (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1942-1947. refs
(AIAA PAPER 92-2445) Copyright

Thermostructural ceramics and ceramic-matrix composites are attractive in numerous aerospace applications; the noncatastrophic fracture behavior and flaw-insensitivity of continuous fiber-reinforced CMCs renders them especially desirable. The present development status evaluation notes that, for most highly-loaded high-temperature applications, the requisite fiber-technology base is at present insufficient. In addition to materials processing techniques, the life prediction and NDE methods are immature and require a projection of 15-20 years for the maturity of CMC turbine rotors. More lightly loaded, moderate temperature aircraft engine applications are approaching maturity. O.C.

A92-35465
LASER ORDNANCE INITIATION SYSTEM
ROGER J. DALE (Hercules Allegany Ballistics Laboratory, Rocket Center, WV) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings. Yoncalla, OR, SAFE Association, 1992, p. 253-257.
Copyright

A miniature laser ordnance initiation system (LOIS) capable of withstanding the rigors of ammunition handling and storage is described. A piezoelectric crystal operated by the deceleration forces is used as a power supply to initiate the rocket motor after being fired from the gun. LOIS is considered to be a highly reliable and redundant system, it operates independently of any aircraft or seat power supply, and can be used for aircrew seat ejection systems. O.G.

A92-35475
WHY COMPOSITES WAIT IN THE WINGS
BILL SWEETMAN Interavia Aerospace Review (ISSN 0020-6512), vol. 47, April 1992, p. 48-53.
Copyright

An overview is presented of the development and current status of composites that could become the key aircraft manufacturing materials of the future, but to date, are still difficult and expensive to produce. An engineering revolution is in progress, based on the growing recognition that composite materials are quite unlike metals; not merely better than monolithic metals, composites are often necessary to go forward from where aerospace vehicles are today. Attention is given to various composite materials and the specific structures and parts under consideration for advanced flight vehicles in design and development. R.E.P.

A92-35916
RESEARCH AND DEVELOPMENT OF AIRCRAFT ENGINE MATERIALS
JUMPEI SHIOIRI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 459, 1992, p. 214-219. In Japanese. refs

The development of heat-resistant alloys for turbine blades is presented. The preparation of superalloys using the rapid solidification rate method is studied. The prealloyed powder metallurgy method is presented for turbine disk materials. Y.P.Q.

A92-36377
COMPOSITE MATERIALS FOR AEROSPACE APPLICATIONS
K. UPADHYA (GE Medical Systems, Milwaukee, WI) IN: Developments in ceramic and metal-matrix composites; Proceedings of the Symposium, TMS Annual Meeting, San Diego, CA, Mar. 1-5, 1992. Warrendale, PA, Minerals, Metals & Materials Society, 1991, p. 3-24. refs
Copyright

In the era of fast changing and demanding technology, the applications of composite materials will increase far beyond anybody's imagination. The outlook for the futuristic applications of composite in the exotic and demanding systems such as aircraft and Space Stations appears even more promising. This is true for every kind of composite including classic fiber glass as well as aramid, graphite, boron and other modern state-of-the-art materials. Expansion in the composite industry will continue as long as higher strength/lower weight will remain a prime design criterion. Many of the composite materials (C-C, reaction bonded Si3N4/SiC, Al2O3/ZrO2) may seem exotic and costly today, however, in due course with the advancement in the automation and mass production, these will become less costly and will find applications in our daily use of the parts and components. In this paper, however, an attempt has been made to describe and discuss the current and proposed applications of composites in the aircraft industry and space environment. Author

A92-36380
COMPOSITE STRENGTHENING OF NB-TI BASE ALLOYS
MARK G. BENZ, MELVIN R. JACKSON, and JOHN R. HUGHES (GE Corporate Research and Development Center, Schenectady, NY) IN: Developments in ceramic and metal-matrix composites; Proceedings of the Symposium, TMS Annual Meeting, San Diego, CA, Mar. 1-5, 1992. Warrendale, PA, Minerals, Metals & Materials Society, 1991, p. 49-64. refs
Copyright

Historically, niobium base alloys have been of interest because they have useful strength in the temperature regime where Ni

and Co base alloys begin to show incipient melting (1300 to 1350 C). Catastrophic oxidation and oxygen embrittlement, however, have severely limited the use of commercially available niobium base alloys for aircraft jet engine applications, although silicide coatings have been used with some success to provide protection. Recently, it has been shown that Nb-Ti-Cr-Al alloys have attractive oxidation and oxygen embrittlement resistance. However, these alloys have relatively low strength. The purpose of this study was to demonstrate that these alloys could be strengthened by the use of composite technology. Author

N92-22205 Case Western Reserve Univ., Cleveland, OH.
EVALUATION OF AN INNOVATIVE HIGH-TEMPERATURE CERAMIC WAFER SEAL FOR HYPERSONIC ENGINE APPLICATIONS Ph.D. Thesis
BRUCE MICHAEL STEINETZ 1991 198 p
Avail: Univ. Microfilms Order No. DA9202246

A high temperature seal test fixture was designed and fabricated to measure static seal leakage performance under engine simulated conditions. Ceramic wafer seal leakage rates are presented for engine simulated air pressure differentials up to 100 psi and temperatures up to 1350 F, sealing both flat and distorted wall conditions, where distortions can be as large as 0.15 in. in only an 18 in. span. Seal leakage rates are low, meeting an industry established tentative leakage limit for all combinations of temperature, pressure, and wall conditions considered. A seal leakage model developed from externally pressurized gas film bearing theory is also presented. Predicted leakage rates agree favorably with the measured data for nearly all combinations of temperature and pressure. Discrepancies noted at high temperature pressure and temperature are attributed to thermally induced, non-uniform changes in the size and shape of the leakage gap condition. Dissert. Abstr.

N92-22486*# Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
POLYMER INFILTRATION STUDIES Progress Report, 31 Dec. 1991 - 31 Mar. 1992
JOSEPH M. MARCHELLO Apr. 1992 82 p
(Contract NAG1-1067)
(NASA-CR-190204; NAS 1.26:190204) Avail: NTIS HC/MF A05 CSCL 11/3

Progress was made in several areas on the preparation of carbon fiber composites using advanced polymer resins. Polymer infiltration studies dealt with ways of preparing composite materials from advanced polymer resins and carbon fibers. This effort is comprised of an integrated approach to the process of composite part fabrication. The goal is to produce advanced composite materials for automated part fabrication using textile and robotics technology in the manufacture of subsonic and supersonic aircraft. The object is achieved through investigations at the NASA Langley Research Center and by stimulating technology transfer between contract researchers and the aircraft industry. Covered here are literature reviews, a status report on individual projects, current and planned research, publications, and scheduled technical presentations. Author

N92-22513*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH-TEMPERATURE POLYMER MATRIX COMPOSITES
MICHAEL A. MEADOR *In its* Aeropropulsion 1987 p 45-54 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 11/4

Polymers research at the NASA Lewis Research Center has produced high-temperature, easily processable resin systems, such as PMR-15. In addition, the Polymers Branch has investigated ways to improve the mechanical properties of polymers and the microcracking resistance of polymer matrix composites in response to industry need for new and improved aeropropulsion materials. Current and future research in the Polymers Branch is aimed at advancing the upper use temperature of polymer matrix composites to 700 F and beyond by developing new resins, by examining the use of fiber reinforcements other than graphite, and by developing coatings for polymer matrix composites to increase their oxidation resistance. D.R.D.

N92-22515*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF A NEW GENERATION OF HIGH-TEMPERATURE COMPOSITE MATERIALS
P. K. BRINDLEY *In its* Aeropropulsion 1987 p 65-78 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 11/4

Intermetallic matrix composites proposed to meet advanced aeropropulsion requirements are discussed. The powder metallurgy fabrication process currently being used to produce these intermetallic matrix composites will be presented, as will properties of one such composite, SiC/Ti3Al+Nb. In addition, the direction of future research will be outlined, including plans for enhanced fabrication of intermetallic composites by the arc-spray technique and fiber development by the floating-zone process. D.R.D.

N92-22517*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CERAMICS FOR ENGINES
JAMES D. KISER, STANLEY R. LEVINE, and JAMES A. DICARLO *In its* Aeropropulsion 1987 p 91-103 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 11/3

The NASA Lewis Research Center's Ceramic Technology Program is focused on aerospace propulsion and power needs. Thus, emphasis is on high-temperature ceramics and their structural and environmental durability and reliability. The program is interdisciplinary in nature with major emphasis on materials and processing, but with significant efforts in design methodology and life prediction. D.R.D.

N92-22637*# Lockheed Aeronautical Systems Co., Burbank, CA.
MANUFACTURING DEVELOPMENT OF PULTRUDED COMPOSITE PANELS Final Report
L. E. MEADE Apr. 1989 58 p
(Contract NAS1-15069; RTOP 505-63-01-06)
(NASA-CR-181780; NAS 1.26:181780) Avail: NTIS HC/MF A04 CSCL 11/4

The weight savings potential, of graphite-epoxy composites for secondary and medium primary aircraft structures, was demonstrated. One of the greatest challenges facing the aircraft industry is to reduce the acquisition costs for composite structures to a level below that of metal structures. The pultrusion process, wherein reinforcing fibers, after being passed through a resin bath are drawn through a die to form and cure the desired cross-section, is an automated low cost manufacturing process for composite structures. The Lockheed Aeronautical Systems Company (LASC) Composites Development Center designed, characterizated materials for, fabricated and tested a stiffened cover concept compatible with the continuous pultrusion process. The procedures used and the results obtained are presented. Author

N92-22678*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RTM: COST-EFFECTIVE PROCESSING OF COMPOSITE STRUCTURES
GREG HASKO (Lockheed Engineering and Sciences Co., Hampton, VA.) and H. BENSON DEXTER *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 2 p 12-21 Dec. 1991
Avail: NTIS HC/MF A22 CSCL 11/4

Resin transfer molding (RTM) is a promising method for cost effective fabrication of high strength, low weight composite structures from textile preforms. In this process, dry fibers are placed in a mold, resin is introduced either by vacuum infusion or pressure, and the part is cured. RTM has been used in many industries, including automotive, recreation, and aerospace. Each of the industries has different requirements of material strength, weight, reliability, environmental resistance, cost, and production

rate. These requirements drive the selection of fibers and resins, fiber volume fractions, fiber orientations, mold design, and processing equipment. Research is made into applying RTM to primary aircraft structures which require high strength and stiffness at low density. The material requirements are discussed of various industries, along with methods of orienting and distributing fibers, mold configurations, and processing parameters. Processing and material parameters such as resin viscosity, perform compaction and permeability, and tool design concepts are discussed. Experimental methods to measure preform compaction and permeability are presented. Author

N92-23223# Oak Ridge National Lab., TN.
EVALUATION OF THE ELEVATED-TEMPERATURE MECHANICAL RELIABILITY OF A HIPED SILICON NITRIDE
M. K. FERBER and M. G. JENKINS 1991 12 p Presented at the Automotive Technology Development Contractors' Coordination Meeting, Dearborn, MI, 22-25 Oct. 1991
(Contract DE-AC05-84OR-21400)
(DE92-007838; CONF-911050-4) Avail: NTIS HC/MF A03

The long-term mechanical reliability of a commercially-available hot isostatically pressed silicon nitride was evaluated by measuring the tensile creep and fatigue behavior at 1150, 1260, and 1370 C. The stress and temperature sensitivities of the secondary (or minimum) creep rates were used to estimate the stress exponent and activation energy associated with the dominant creep mechanism. The fatigue behavior was examined by allowing individual creep tests to continue until the specimen failed. The applicability of the four-point load geometry to the study of creep behavior was also evaluated by conducting a limited number of flexural creep tests. The tensile fatigue data revealed two distinct failure mechanisms. At 1150 C, failure was controlled by a slow crack growth mechanism. At 1260 and 1370 C, the accumulation of creep damage in the form of grain boundary cavities and cracks dominated the fatigue behavior. In this temperature regime, the fatigue life was controlled by the secondary (or minimum) creep in accordance with the Monkman-Grant relation. DOE

N92-24053*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VINYL CAPPED ADDITION POLYIMIDES Patent Application
RAYMOND D. VANNUCCI, inventor (to NASA), DIANE C. MALARIK, inventor (to NASA), and PETER DELVIGS, inventor (to NASA) 24 Dec. 1991 15 p
(NASA-CASE-LEW-15027-2; NAS 1.71:LEW-15027-2; US-PATENT-APPL-SN-824858) Avail: NTIS HC/MF A03 CSCL 11/3

Polyimide resins (PMR) are generally useful where high strength and temperature capabilities are required (at temperatures up to about 700 F). Polyimide resins are particularly useful in applications such as jet engine compressor components, for example, blades, vanes, air seals, air splitters, and engine casing parts. Aromatic vinyl capped addition polyimides are obtained by reacting a diamine, an ester of tetracarboxylic acid, and an aromatic vinyl compound. Low void materials with improved oxidative stability when exposed to 700 F air may be fabricated as fiber reinforced high molecular weight capped polyimide composites. The aromatic vinyl capped polyimides are provided with a more aromatic nature and are more thermally stable than highly aliphatic, norbornenyl-type end-capped polyimides employed in PMR resins. The substitution of aromatic vinyl end-caps for norbornenyl end-caps in addition polyimides results in polymers with improved oxidative stability. NASA

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ENGINEERING

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

A92-32555
DEVELOPMENT OF AN ADVANCED COMPOSITE MATERIAL ON VERTICAL STABILIZER OF F-X AIRCRAFT
SHAOJIAN WANG (Chengdu Aircraft Industrial Corp., People's Republic of China) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-C-1 to 2-C-11. refs

This paper presents the main contents of the development of an advanced composite vertical stabilizer for F-X aircraft. Design concept, strength analysis, static and dynamic aeroelastic analysis, fabrication technology, and molding die, ground and flight test, etc. are described. The paper also recites the design and test data which are useful in practical engineering. Author

A92-32556
DESIGN ANALYSIS OF THE T-800 INLET PARTICLE SEPARATOR/AIR OIL COOLER BLOWER
NARESH P. VAGHELA (Sundstrand Advanced Technology Group, Rockford, IL) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-D-1 to 2-D-9. refs

A92-32562
AN ANALYSIS OF IMPACT RESISTANCE OF COMPOSITE BLADES FOR AIRCRAFT ENGINES (ANALYSIS WITH TWO DIMENSIONAL AND THREE DIMENSIONAL FINITE ELEMENTS)
TOSHIO MIYACHI, HIDEHITO OKUMURA, and KUNIHIKO OHTAKE (National Aerospace Laboratory, Chofu, Japan) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 2-J-1 to 2-J-8. refs

The present impact-resistance feasibility FEM analysis for composite turbofan blades employs both plate elements and 3D elements, taking centrifugal loading effects into account. The impact response of six different fan-blade models was calculated. While the plate element models indicate a significant decrease of bending deformation by centrifugal force, torsional deformations and local deformations are not significantly reduced. It is found that the 3D-elements analysis for long, thin cantilever waves do not agree with experimental results. O.C.

A92-32578
APPROXIMATE CLOSED-FORM BUCKLING SOLUTIONS FOR THE OPTIMIZATION OF AIRCRAFT STRUCTURES
BO P. WANG and DANIEL P. COSTIN (Texas, University, Arlington) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 4-C-1 to 4-C-10. Research supported by Texas Higher Education Coordinating Board. refs

Approximate solutions to local panel buckling problems are presented which make it possible to incorporate buckling constraints in the design with a small computational penalty. For panels with only axial loads, a closed-form expression for the buckling load can be derived, and the sensitivities can also be

derived in closed form. When axial and shear loads are applied, a Fourier series can be used to describe the mode shape, and an eigenvalue problem solved to obtain the buckling load. Sensitivities can be found efficiently using the eigenvector associated with the critical buckling load. The constraints were tested using the ASTROS program for a simple wing structure. The addition of the buckling constraint increased the design weight by over 67 percent. Both the closed-form and the Fourier series buckling constraints were implemented with less than 30 percent increase in optimization CPU time. Author

A92-32636
MEASUREMENT OF BASIC MATERIAL AND PROCESSING PROPERTIES AFFECTING INJECTION-PULTRUSION TECHNOLOGY
JEROME P. FANUCCI, YOUNG R. KIM, STEPHEN C. NOLET, and CHRISTIAN KOPPERNAES (American Composite Technology, Inc., Boston, MA) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 12-21. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 13-C-1 to 13-C-10. refs

Analytical methods are presented for predicting the in-plane and transverse resin flow in random mat and 0/90 cloth in injection-pultrusion processing. It is found that permeability and compressibility are interrelated and depend mainly on the fiber volume fraction and fiber orientation. The analytical results are found to be in good agreement with experimental data. The characteristics and applications of a new type of pressure sensing device designed specifically for local pressure measurements in composite material processes are also described. V.L.

A92-32746* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NEW, UNUSUAL AND NONCLASSICAL BEHAVIOR OF THIN-WALLED COMPOSITE STRUCTURES
LAWRENCE W. REHFIELD, STEPHEN CHANG (California, University, Davis), and ALI R. ATILGAN (Georgia Institute of Technology, Atlanta) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 22-29. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 26-A-1 to 26-A-9. refs
(Contract NAS1-18754; DAAL03-89-K-0007)

Examples are discussed which illustrated several new, unusual, and nonclassical effects that are present in thin-walled composite structures. Some of the unusual deformation characteristics occur naturally, such as the apparent increased flexibility of thin-walled beam structures due to bending-transverse shear and extension-transverse shear elastic couplings. Others are created intentionally, such as the exaggerated Poisson expansion in the tailored wing covers that produces elastic chordwise camber deformations. Author

A92-32942* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PRESSURE OSCILLATION IN THE LEAKAGE ANNULUS BETWEEN A SHROUDED IMPELLER AND ITS HOUSING DUE TO IMPELLER-DISCHARGE-PRESSURE DISTURBANCES
D. W. CHILDS (Texas A & M University, College Station) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 114, March 1992, p. 61-67. refs
(Contract NAS8-37821)
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The perturbed flow in the leakage path between a shrouded-pump impeller and its housing is analyzed using experiences with the Space Shuttle Main Engine (SSME), high pressure fuel turbopump (HPFTP) wearing-ring seals. Analysis is based on a bulk-flow model which consists of the path-momentum, circumferential momentum, and continuity equations. The pressure oscillations in the leakage annulus are driven by a circumferential variation of the impeller discharge pressure. It is shown that the occurrence and nature of the pressure oscillations depend on the tangential-velocity ratio of the fluid entering the seal, the order of the Fourier coefficient, the closeness of the precessional frequency of the rotating pressure field to the first natural frequency of the fluid annulus, and the clearance of the wearing-ring seal. The results obtained may explain the internal melting observed on SSME HPFTP seal parts. O.G.

A92-32988
PROGRESS REPORT OF SCOT'S LASER ORDNANCE INITIATOR SYSTEM FOR CREW ESCAPE
JOHN A. COBBETT and MURPHY J. LANDRY (Scot, Inc., Downers Grove, IL) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 130-134. refs
Copyright

The components, configuration, and test results are described for a family of laser ordnance-initiation systems (LOISs) with reference to a LOIS canopy jettison. Three types of pyrolasers are used with fiberoptic lines, laser initiators and detonators, and an optical sequencer, and the system is tested under a range of environmental conditions. A mechanical LOIS pyrolaser is used as the primary component for canopy-jettison testing in an F-16 to demonstrate the feasibility of the systems. C.C.S.

A92-33185#
NAVIER-STOKES ANALYSIS OF HELICOPTER PLUME FLOWFIELD FOR INFRARED CALCULATIONS
FARI SAHELI (Boeing Defense and Space Group, Seattle, WA) and JULIE PITTS (U.S. Army, Laboratory Command, Adelphi, MD) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 6 p.
(AIAA PAPER 92-0983) Copyright

The flowfield of the exhaust plume of a helicopter in hover mode was simulated using VSAERO, a potential panel code, to obtain boundary condition and rotor downwash, and Full Navier-Stokes code to obtain plume-flow parameters (velocity, pressure, temperature, and species). A 3D interpolation code was developed to transform the computed data into a Cartesian grid for input to a 3D plume radiation code. Results of this analysis are presented in terms of contours of flow parameters in several 3D planes. Author

A92-33209*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PRELIMINARY DESIGN OF AN INTERMITTENT SMOKE FLOW VISUALIZATION SYSTEM
D. T. WARD, S. B. BRANDT (Texas A & M University, College Station), and J. H. MYATT (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(Contract NAG2-651)
(AIAA PAPER 92-1028)

A prototype intermittent smoke flow visualization system for studying the flowfield of an aircraft in flight has been constructed and demonstrated. It provides discrete pulses of dense white smoke suitable for video imaging to determine the unsteady vortex core trajectory of fluid elements in a high angle-of-attack flowfield. Two methods of pulsing the smoke were initially investigated: (1) periodically diverting the smoke between two exit ports and (2) completely blocking the smoke flow for short times. System dynamics have been modeled mathematically, data have been collected in a wind tunnel with blockage times up to 80 milliseconds, and the prototype is currently being flown on a general aviation airplane to collect three-dimensional video data. Three different plenum chamber sizes are available. Data collected so far are consistent and repeatable, though care must be taken to provide adequate contrast levels for accurate video resolution. Camera frame rates of at least 180 frames/second and wide angle lenses for the video cameras are needed to acquire meaningful vortex core velocities and accelerations for the general aviation test aircraft installation. Author

A92-33261#
DAMAGE TOLERANT STRUCTURAL DESIGN USING NEURAL NETWORKS
R. A. SWIFT and S. M. BATILL (Notre Dame, University, IN) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 10 p. Research supported by USAF. refs
(AIAA PAPER 92-1097) Copyright

A neural network application to the preliminary design of damage tolerant structures is presented. Neural networks are used to form approximate representations of the design space for candidate structures. The neural network representation is then used to determine trends and optimal values for the design variables of interest. Two distinctly different approaches, and examples, are considered. The first involves the configurational design of a helicopter tail-boom, where six possible damage conditions are considered. A fully-stressed design procedure is used to achieve minimum weight designs while satisfying all applicable stress constraints. Weight and natural frequency are considered as the objective function/constraints for the neural network analysis. The neural network was able to accurately represent trends and identify optimal configurations. In the second example, an undamaged baseline wing is designed for flutter and stress constraints under two aerodynamic loadings. One hundred and fifty possible damage states were analyzed for flutter and natural frequency characteristics. These results were used to train a neural network. The neural network was then used to predict flutter occurrence and the natural frequencies for all possible damage conditions. A comparison between the neural network and fifty damaged wings was performed; the neural network predicted structural behavior was in good agreement with detailed analysis. Author

A92-33282#
STRESS CONCENTRATION EFFECTS OF OBLIQUE HOLES IN ASPIRATED-COOLED TURBINE ENGINE LINERS
J. E. CENCULA and B. J. COYNE (GE Aircraft Engines, Cincinnati, OH) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p. refs
(AIAA PAPER 92-1130) Copyright

Innovative cooling concepts and new applications of these concepts are used to permit operation of turbopropulsion engines at higher temperatures and with less cooling air for greatest engine performance. These cooling concepts can cause detrimental structural effects due to stress concentrations or high thermal gradients that must be predictable to be incorporated into engine designs. This study analytically predicts the stress concentration effects of various patterns of small, closely-spaced cooling holes drilled through a thin plate and subjected to a biaxial stress field that represents a gas turbine engine application. These predictions are then verified by photoelastic analysis of the cooling hole patterns. Three hole patterns, a symmetrical diamond pattern and two unsymmetric patterns, are examined. The individual cooling holes are circular and drilled at a 30 degree inclination off the surface which produces an elliptical appearance on the surface. Graphical representations of the peak stress concentration factors for a range of stress fields are presented as a result of this study. Author

A92-33778
A STUDY OF THE PRECISION CHARACTERISTICS OF A GYROSCOPIC GRAVIMETER [ISSLEDOVANIE TOCHNOSTNYKH KHARAKTERISTIK GIROSKOPICHESKOGO GRAVIMETRA]
E. N. BEZVESIL'NAIA (Kievskii Politekhnicheskii Institut, Kiev, Ukraine) Mekhanika Giroskopicheskikh Sistem (ISSN 0203-3771), no. 10, 1991, p. 3-7. In Russian. refs
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A study is made of the effect of perturbation characteristics and design parameters on the systematic error of a gyroscopic gravimeter. It is shown that the accuracy of the gyroscopic gravimeter is superior to that of other types of gravimeters. Such gravimeters are recommended for use in aviation gravimetric systems. V.L.

A92-33847 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE EFFECTIVENESS OF CORIOLIS DAMPENING OF CONVECTION DURING AIRCRAFT HIGH-G ARCS
PETER A. CURRERI (NASA, Marshall Space Flight Center, Huntsville, AL) (Material processing in high gravity; Proceedings of the 1st International Workshop, Dubna, Russia, May 20-25, 1991. A92-33832 13-29) Journal of Crystal Growth (ISSN 0022-0248), vol. 119, no. 1-2, April 1992, p. 141-151. Research supported by NASA. refs
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Directional solidification data for metal samples in KC-135 parabolic maneuvers are examined to determine evidence for Coriolis dampening of convection. Microstructural and materials properties data are examined for iron carbon, immiscible, and superalloy systems. By comparison of low-g data and high-g data with those of one-g control samples, it is determined that there is no evidence that Coriolis dampening of convective flow is effective during the 1.8 g KC-135 high-g maneuvers. A first approximation model for the high-g arc is proposed. The model yields a centrifugal radius of 20,480 ft and an angular speed of 0.397 RPM. Comparison to centrifugal solidification experiments (for an equal acceleration) where Coriolis melt growth stabilization is significant indicates that the KC-135 high-g arc is less effective in dampening convection by a factor of 100. This large difference in Coriolis dampening of convection might be taken advantage of for experiments where separation of centrifugal acceeration and Coriolis acceleration is desirable. Author

A92-34289*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COUPLED ANALYSIS OF INDEPENDENTLY MODELED FINITE ELEMENT SUBDOMAINS
M. A. AMINPOUR (Analytical Services and Materials, Inc., Hampton, VA), J. B. RANSOM (NASA, Langley Research Center, Hampton, VA), and S. L. MCCLEARY (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 109-120. refs
(Contract NAS1-19000; NAS1-19317)
(AIAA PAPER 92-2235) Copyright

A new method for analyzing plate and shell structures with two or more independently modeled finite element subdomains is presented, assessed, and demonstrated. This method provides a means of coupling local and global models whose grid points do not coincide along their common interface. In general, the method provides a means of coupling structural components (e.g., wing and fuselage) which may have been modeled by different analysis. In both cases, the need for transition modeling, which is often tedious and complicated, is eliminated. The coupling is accomplished through an interface for which three formulations are considered and presented. These formulations are: collocation, least-squares, and hybrid variational. Several benchmark problems were analyzed and, based on the results, the hybrid variational formulation is identified as the preferred formulation in that it provides the most accurate solutions. Author

A92-34292#
COUPLED RAYLEIGH-RITZ/FINITE ELEMENT STRUCTURAL ANALYSIS USING PENALTY FUNCTION METHOD
PI-JEN KAO (Analytical Services and Materials, Inc., Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 135-141. refs
(AIAA PAPER 92-2238) Copyright

In order to employ the classical Rayleigh-Ritz and the popular finite element methods to model different structural regions so that each is used to its fullest advantage, a coupled Rayleigh-Ritz and finite element formulation using the penalty function method is presented. The formulation is based on a constrained variational

principle. Along the interface of two different regions, deformations obtained from the Rayleigh-Ritz method are set equal to deformations obtained from the finite element method. The potential energy of the Rayleigh-Ritz and finite element regions with these deformation constraints is used to derive a coupled stiffness matrix. This coupled stiffness matrix contains stiffness contributions from each region and an interface stiffness contribution from the constraints. The derivation is given for one dimensional coupling of a beam and two dimensional coupling of an equivalent plate with membrane finite elements to model a wing-like structure with box beam and leading/ trailing edges. Displacements and stresses using the coupled analysis are compared with those of using a single finite element analysis. Results indicate that using the coupled Rayleigh-Ritz and finite element analysis produces results with a level of accuracy approaching that of a finite element analysis, while providing enhanced modeling flexibility. Author

A92-34297*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A RAYLEIGH-RITZ DESIGN METHODOLOGY FOR CUTOUTS IN COMPOSITE STRUCTURES
STEVEN G. RUSSELL (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 181-189. refs
(Contract NAS1-18842)
(AIAA PAPER 92-2278)

A new design methodology is presented for cutouts in composite aircraft structure. The methodology is based on a Rayleigh-Ritz stress analysis procedure that accommodates circular and elliptical cutouts in composite panels under generalized in-plane loading conditions. Cutout padups and panel stiffener reinforcements are also included in this procedure. Panel strength calculations are performed by combining the stress analysis with a generalized version of the average stress failure criterion. Sizing procedures are given for design of padup and stiffener reinforcements in cutout panels, and an example problem is provided to illustrate typical results. Author

A92-34307*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN INDEPENDENT REFINEMENT AND INTEGRATION PROCEDURE IN MULTIREGION FINITE ELEMENT ANALYSIS
T. KRISHNAMURTHY and I. S. RAJU (Analytical Services and Materials, Inc., Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 302-312. refs
(Contract NAS1-19317)
(AIAA PAPER 92-2290) Copyright

An independent refinement and integration procedure is developed to couple together independently modeled (global and local) regions in a single analysis. The models can have different levels of refinement and along the interface between them the finite element nodes need not coincide with one another. In the local model all the nodes except the nodes at the interface are statically condensed and the reduced stiffness matrix is obtained. For this static condensation a modified frontal solution technique is employed. A spline interpolation function that satisfies the linear isotropic plate bending differential equation is used to relate the local model interface nodal displacements to the global model interface displacements. The proposed independent refinement and integration procedure is evaluated by applying it to two- and three-dimensional cases involving inplane and out-of-plane deformation. The procedure yielded very accurate results for all the examples studied. Author

A92-34320#
SYSTEM RELIABILITY AND RISK ASSESSMENT
T. A. CRUSE, Q. HUANG, S. MEHTA, and S. MAHADEVAN (Vanderbilt University, Nashville, TN) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 424-432. refs
(AIAA PAPER 92-2345) Copyright

A new methodology is reported for the prediction of the reliability of aerostructures subject to multiple failure modes, including progressive damage. Progressive damage is seen to reduce the reliability of the system through modification of the other system failure states. Correlated design variables are automatically accounted for in the system reliability calculations. New reliability bounds are reported which are unbiased to the specific events. The reliability bounds are based on neglecting the interaction of three simultaneous failure conditions. The new methodology is shown to have been automated and included in a structural reliability code NESSUS. A system risk assessment methodology is also reported that accounts for the cost of multiple types of failure modes, and includes the effect of inspection success on reducing the consequences of system failure. Application of the new technology is made to a simplified system model of an aeropropulsion rotor system. Author

A92-34332
AIAA/ASME/ASCE/AHS/ASC STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 33RD, DALLAS, TX, APR. 13-15, 1992, TECHNICAL PAPERS. PT. 2 - STRUCTURES II
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 605 p. For individual items see A92-34333 to A92-34388.
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Consideration is given to damage tolerance of composites, buckling of shells and cylinders, computational structural mechanics, buckling/postbuckling of plates and stiffened panels, adaptive structures, structural risk and reliability, analysis of composite structures, structural design and verification, finite element analysis of rotorcraft vibration, spacecraft dynamics, rotor aeroelasticity, and rotorcraft dynamics. Attention is also given to aeroelasticity, unsteady aerodynamics, eigen solution methods, design engineering, aerospace structural design optimization, modeling of material behavior, and ceramic matrix composites. O.G.

A92-34354#
TORSION AND TWISTING OF SYMMETRIC COMPOSITE LAMINATES
JOHN C. FISH (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 736-744. refs
(AIAA PAPER 92-2425) Copyright

A quasi-three-dimensional finite element analysis and classical lamination theory solutions are used to examine in-plane stresses due to twisting deformation in symmetric composite laminates. Two classical lamination theory solutions are derived which use different assumptions for the curvature-moment relationships. The finite element analysis results are found to be bounded by the two classical lamination theory solutions. This validates the finite element modeling approach and establishes closed-form solutions for approximating the in-plane effects of twisting deformation in symmetric composite laminates. In addition, a relationship between torsional twist rate and twisting derformation is derived and found to be valid, even for highly coupled laminates. Author

A92-34357*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLEXURE-TORSION BEHAVIOR OF SHEAT-DEFORMABLE BEAMS WITH APPLICATIONS TO AIRCRAFT WING SECTIONS
J. B. KOSMATKA (California, University, La Jolla) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical

Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 763-773. refs
(Contract NAG1-1151)
(AIAA PAPER 92-2467) Copyright

The flexure-torsion behavior of a tip-loaded cantilever beam with an arbitrary cross-section is studied using Saint-Venant's semi-inverse method along with a power series solution for the out-of-plane flexure and torsion warping functions. The power series coefficients are determined by solving a set of variationally derived linear algebraic equations. For complex cross-sections, the calculated coefficients represent a 'best-fit approximation' to the exact warping function. The resulting warping functions are used to determine the cross-section properties including: the torsion constant, shear deformation coefficients, shear correction factors, and the shear center location. A new linear relation is developed for locating the shear center using the Saint-Venant flexure and torsion solutions, where the twist rate is zero about the line of shear centers (not the centroidal axis). Numerical results are presented for a triangular cross-section and different NACA airfoils. Author

A92-34360*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL TAILORING/ANALYSIS FOR HYPERSONIC COMPONENTS - EXECUTIVE SYSTEM DEVELOPMENT
G. V. NARAYANAN, JANE R. KRAMER (Sverdrup Technology, Inc., Brook Park, OH), DALE A. HOPKINS, and CHRISTOS C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 789-797. refs
(Contract NAS3-25266)
(AIAA PAPER 92-2471)

No direct analytical or integrated numerical tool exists today for the optimal design of a generic class of built-up actively cooled composite structure for applications in hypersonic propulsion ducts. The need exists for a numerical tool to perform the comprehensive design/analysis of a panel on the inlet wall under hypersonic flight conditions. Such a tool requires relatively complex multi-disciplinary analysis. One such numerical tool controlled by an executive system has been developed and is named as STAHYC (Structural Tailoring/Analysis for HYpersonic Components). A detailed account of the executive system development of STAHYC along with the results of one example inlet panel design problem is given in this paper. Author

A92-34363*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COUPLED 2D-3D FINITE ELEMENT METHOD FOR ANALYSIS OF A SKIN PANEL WITH A DISCONTINUOUS STIFFENER
J. T. WANG, C. G. LOTTS, D. D. DAVIS, JR., and T. KRISHNAMURTHY (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 818-827. refs
(AIAA PAPER 92-2474) Copyright

This paper describes a computationally efficient analysis method which was used to predict detailed stress states in a typical composite compression panel with a discontinuous hat stiffener. A global-local approach was used. The global model incorporated both 2D shell and 3D brick elements connected by newly developed transition elements. Most of the panel was modeled with 2D elements, while 3D elements were employed to model the stiffener flange and the adjacent skin. Both linear and geometrically nonlinear analyses were performed on the global model. The effect of geometric nonlinearity induced by the eccentric load path due to the discontinuous hat stiffener was significant. The local model used a fine mesh of 3D brick elements to model the region at the end of the stiffener. Boundary conditions of the local 3D model were obtained by spline interpolation of the nodal displacements from the global analysis. Detailed in-plane and through-the-thickness stresses were calculated in the flange-skin interface near the end of the stiffener. Author

A92-34374#
ADAPTIVE RESPONSE CONTROL OF WING STRUCTURES CARRYING HEAVY TIP WEIGHTS
LIVIU LIBRESCU, CRAIG A. ROGERS, and OHSEOP SONG (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 925-930. refs
(AIAA PAPER 92-2527) Copyright

An integrated, distributed actuator design based on the converse piezoelectric effect and aimed at actively controlling the excessive deflections and large bending moments at the root section of a cantilevered thin-walled beam carrying a system of heavy concentrated masses, is presented. The numerical illustrations reveal the great capabilities of the adaptive technology to alleviate, without weight penalties, the undesirable effects mentioned above. Author

A92-34376# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REDUCED BASIS TECHNIQUE FOR EVALUATING THE SENSITIVITY COEFFICIENTS OF THE NONLINEAR TIRE RESPONSE
AHMED K. NOOR, JOHN A. TANNER, and JEANNE M. PETERS (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 946-964. refs
(Contract NAG1-1197; NCCW-0011)
(AIAA PAPER 92-2530) Copyright

An efficient reduced-basis technique is proposed for calculating the sensitivity of nonlinear tire response to variations in the design variables. The tire is modeled using a 2-D, moderate rotation, laminated anisotropic shell theory, including the effects of variation in material and geometric parameters. The vector of structural response and its first-order and second-order sensitivity coefficients are each expressed as a linear combination of a small number of basis vectors. The effectiveness of the basis vectors used in approximating the sensitivity coefficients is demonstrated by a numerical example involving the Space Shuttle nose-gear tire, which is subjected to uniform inflation pressure. L.M.

A92-34381*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMOVISCOPLASTIC ANALYSIS OF ENGINE COWL LEADING EDGE SUBJECTED TO OSCILLATING SHOCK-SHOCK INTERACTION
AJAY K. PANDEY (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1009-1017. refs
(Contract NAS1-19000)
(AIAA PAPER 92-2537) Copyright

A finite element thermoviscoplastic analysis method, which employs a unified constitutive model proposed by Bodner and Partom, is used to predict rate-dependent nonlinear structural behavior. The method is evaluated by predicting stress-strain behavior of a uniaxially loaded bar of nickel-based superalloy (B1900 + Hf) material. The method is used to predict the time-dependent thermoviscoplastic response of a B1900 + Hf leading edge subjected to oscillating shock-shock interaction loading. Viscoplastic analysis shows that the leading edge experiences significant plastic straining. The plastic region increases with cyclic loading in the high heat flux area. Author

A92-34382*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMOVISCOPLASTIC RESPONSE OF THIN PLATES SUBJECTED TO INTENSE LOCAL HEATING
TED G. BYROM, DAVID H. ALLEN (Texas A & M University, College Station), and EARL A. THORNTON (Virginia, University, Charlottesville) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1018-1026. refs
(Contract NAG1-1013)
(AIAA PAPER 92-2538) Copyright

A finite element method is employed to investigate the thermoviscoplastic response of a half-cylinder to intense localized transient heating. Thermoviscoplastic material behavior is characterized by the Bodner-Partom constitutive model. Structure geometry is modeled with a three-dimensional assembly of CST-DKT plate elements incorporating the large deflection von Karman assumptions. The paper compares the results of a dynamic analysis with a quasi-static analysis for the half-cylinder structure with a step-function transient temperature loading similar to that which may be encountered with shock wave interference on a hypersonic leading edge. Author

A92-34389
AIAA/ASME/ASCE/AHS/ASC STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 33RD, DALLAS, TX, APR. 13-15, 1992, TECHNICAL PAPERS. PT. 3 - STRUCTURAL DYNAMICS I
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 674 p. For individual items see A92-34390 to A92-34450.
Copyright

The present conference on structural dynamics encompasses finite-element analyses of rotorcraft vibration, spacecraft dynamics, dynamic analyses, rotor aeroelasticity, rotorcraft dynamics, damping, control analysis and experiments, and experimental dynamics and testing. Specific issues addressed include NASA/industry design-analysis methods for vibrations, controlling a large flexible structure to mimic a rigid one, the dynamic response of rapidly heated space structures, interval prediction in structural dynamic analysis, mode localization in computer disk drives, and a discrete transfer-matrix method for rotating beams. Also addressed are the dynamics of axially moving continua on an elastic foundation, stiffness and stress in a fluid-filled circular diaphragm, linear structure control by the modal force technique, directional filters for sensing 1D structural dynamics, and an adaptive multilevel substructuring method for efficient modeling of complex structures. C.C.S.

A92-34403#
DYNAMIC RESPONSE TO TIME-DEPENDENT EXCITATIONS OF CANTILEVERED AIRCRAFT WING STRUCTURES MODELLED AS THIN-WALLED BEAMS
O. SONG and L. LIBRESCU (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1258-1263. refs
(AIAA PAPER 92-2213) Copyright

A model of thin-walled beams is developed that includes nonclassical effects such as transverse shear to describe the response of cantilevered aircraft wings to time-dependent external excitations. An extension of the Laplace transform technique is employed to derive the frequency-response functions of beams in which only transverse bending is considered. The response quantities are determined in terms of a convolution integral which suggests that the determination of the response to arbitrary time-independent excitations is based on the frequency-response functions. The solution is applied to the case of a cantilevered box-beam constructed of a single layer of transversely isotropic material, and the first three eigenfrequencies are developed. The results demonstrate that the present method is useful for the description of cantilevered aircraft wings undergoing time-dependent excitations. C.C.S.

A92-34410#
EXPERIMENTAL AND THEORETICAL STUDY FOR NONLINEAR AEROELASTIC BEHAVIOR OF A FLEXIBLE ROTOR BLADE
D. M. TANG and E. H. DOWELL (Duke University, Durham, NC) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992; p. 1324-1339. refs
(Contract DAAL03-87-K-0023)
(AIAA PAPER 92-2253) Copyright

Flutter instability and forced responses are determined analytically and experimentally as they relate to a nonrotating flexible rotor blade with a structural nonlinearity. The full ONERA nonlinear aerodynamic model is employed to analyze a nonlinear blade structure with either an unstalled aerodynamic model or a large effective mean angle of attack. The analytical findings are compared to the results of low-speed wind-tunnel testing of a blade section to study flutter and forced response. The effects of the geometrical nonlinearity are significant when the angle of attack is large or when stall occurs. Bounded oscillation can result from a freeplay structural nonlinearity, and a significant chordwise response can result from base excitation in the pitch-angle direction. The correlation between the experimental and analytical work demonstrate that the present findings are of value to the understanding of nonlinear aeroelastic behavior in a flexural-flexural-torsional hingeless rotor blade. C.C.S.

A92-34451
AIAA/ASME/ASCE/AHS/ASC STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 33RD, DALLAS, TX, APR. 13-15, 1992, TECHNICAL PAPERS. PT. 4 - STRUCTURAL DYNAMICS II
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 701 p. For individual items see A92-34452 to A92-34521.
Copyright

The present conference discusses composites damage tolerance, shell and cylinder buckling, computational structural mechanics, adaptive structures, structural risk and reliability, the analysis of composite structures, the thermal analysis of structures, the finite-element analysis of rotorcraft vibration, spacecraft dynamics, and rotor aeroelasticity. Also discussed are rotorcraft dynamics, structural damping, control analyses and control experiments, dynamic methods, experimental dynamics and testing, composite structural dynamics and damage, aeroelasticity, future directions in flight mechanics and structures, rotorcraft aeroelasticity, dynamics applications, unsteady aerodynamics, eigensolution methods, nonlinear dynamics, sensitivity analysis and topology optimization, shape optimization, modeling of material behavior, and ceramic-matrix composites. O.C.

A92-34452#
RESPONSE OF PLATE-LIKE STRUCTURES TO CORRELATED RANDOM PRESSURE FLUCTUATIONS
GIORA MAYMON (Rafael Armament Development Authority, Haifa, Israel) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1741-1746. refs
(AIAA PAPER 92-2378) Copyright

The response of platelike structures to correlated random pressure fluctuations, originated from boundary layer turbulence, are calculated and compared to the traditional design procedure in which uncorrelated pressure fluctuations are used. A Crocker-type model is assumed for the boundary layer. By comparing joint acceptances, it is shown that the traditional

procedure yields conservative results for the power spectral density of the response. Thus, the use of correlated pressure fluctuations will yield less conservative designs. Author

A92-34465*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYTICAL SHAPE SENSITIVITIES AND APPROXIMATIONS OF MODAL RESPONSE OF GENERALLY LAMINATED TAPERED SKEW PLATES
SARVESH SINGHVI and RAKESH K. KAPANIA (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1858-1869. refs
(Contract NAS1-18471)
(AIAA PAPER 92-2391) Copyright

In the present determination of the derivatives of natural frequencies and mode shapes of a generally laminated tapered skew plate, with respect to various shape parameters, springs are used to simulate the essential boundary conditions. The independent shape parameters are plate surface area, aspect ratio, taper ratio, and sweep angle. Eigenvalues and eigenvectors are approximated over the range of the variable using linear, exponential, and pseudoexponential approximation schemes, and are compared with reanalysis-obtained values. Numerical results are presented for symmetrically and unsymmetrically laminated plates. O.C.

A92-34467# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TIME SIMULATION OF FLUTTER WITH LARGE STIFFNESS CHANGES
M. KARPEL (Technion - Israel Institute of Technology, Haifa) and C. D. WIESEMAN (NASA, Langley Research Center, Hampton, VA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1878-1886. refs
(Contract NAGW-1708; NAS1-18605)
(AIAA PAPER 92-2394) Copyright

Time simulation of flutter, involving large local structural changes, is formulated with a state-space model that is based on a relatively small number of generalized coordinates. Free-free vibration modes are first calculated for a nominal finite-element model with relatively large fictitious masses located at the area of structural changes. A low-frequency subset of these modes is then transformed into a set of structural modal coordinates with which the entire simulation is performed. These generalized coordinates and the associated oscillatory aerodynamic force coefficient matrices are used to construct an efficient time-domain, state-space model for basic aeroelastic case. The time simulation can then be performed by simply changing the mass, stiffness and damping coupling terms when structural changes occur. It is shown that the size of the aeroelastic model required for time simulation with large structural changes at a few a priori known locations is similar to that required for direct analysis of a single structural case. The method is applied to the simulation of an aeroelastic wind-tunnel model. The diverging oscillations are followed by the activation of a tip-ballast decoupling mechanism that stabilizes the system but may cause significant transient overshoots. Author

A92-34472*# National Aeronautics and Space Administration, Washington, DC.
OVERVIEW AND MAJOR CHARACTERISTICS OF FUTURE AERONAUTICAL AND SPACE SYSTEMS
SAMUEL L. VENNERI (NASA, Space Research Div., Washington, DC) and AHMED K. NOOR (Virginia, University, Charlottesville) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1924-1934. refs
(AIAA PAPER 92-2441)

A systematic projection is made of prospective materials and structural systems' performance requirements in light of emerging applications. The applications encompass high-speed/long-range rotorcraft, advanced subsonic commercial aircraft, high speed (supersonic) commercial transports, hypersonic aircraft and missiles, extremely high-altitude cruise aircraft and missiles, and aerospace craft and launch vehicles. A tabulation is presented of the materials/structures/dynamics requirements associated with future aerospace systems, as well as the further development needs foreseen in each such case. O.C.

A92-34473*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL STRUCTURES TECHNOLOGY
AHMED K. NOOR (NASA, Langley Research Center, Hampton; Virginia, University, Charlottesville) IN: AIAA/ASME/ASCE/AHS/ASC Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1935-1940. refs
(AIAA PAPER 92-2442)

Computational structures technology (CST), which has emerged from FEM developments, is a fusion of materials modeling, structural and dynamic analysis and synthesis methods, on the one hand, and numerical analysis and approximation theory, on the other. In addition to computational materials modeling, CST encompasses computational methods for predicting the response, performance, failure, and service life of structures and their components, as well as automated methods for structural synthesis and optimization. O.C.

A92-34475#
AEROELASTICITY - ADVANCES AND FUTURE DIRECTIONS
TERRENCE A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 4. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1948-1951.
(AIAA PAPER 92-2446) Copyright

An evaluation is made of advancements in aeroelastic analysis methods. While methods expected to be available in the near term are directed toward aeroelastic interaction in helicopter rotors and turbomachinery, more ambitious undertakings in aeroelasticity involve the actively controlled structure-associated problems of aeroservoelasticity. The exploitation of nonlinear effects, which is expected to result in the development of novel materials, entails the development of the mathematics of nonlinearity. O.C.

A92-34522
AIAA/ASME/ASCE/AHS/ASC STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 33RD, DALLAS, TX, APR. 13-15, 1992, TECHNICAL PAPERS. PT. 5 - DESIGN ENGINEERING/DESIGN OPTIMIZATION, MATERIALS, WORK-IN-PROGRESS
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, 859 p. For individual items see A92-34523 to A92-34605.
Copyright

The conference focuses on recent advances in disciplines related to the analysis and design of aerospace structures. Topics discussed include damage tolerance of composites, computational structural mechanics, buckling/postbuckling of plates and stiffened panels, adaptive structures, spacecraft dynamics, and aeroelasticity. Other topics include unsteady aerodynamics, aerospace structural design optimization, modeling of material behavior, and ceramic matrix composites. V.L.

A92-34524#
A UNIFIED NUMERICAL APPROACH FOR THE ANALYSIS OF ROTATING DISKS INCLUDING TURBINE ROTORS
SUSANA C. STERNER (Carnegie Mellon University, Pittsburgh,

PA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2416-2423. Research supported by ARCO Chemical Co. and Lily Endowment, Inc. refs
(Contract NSF MSM-90-57055)
(AIAA PAPER 92-2303) Copyright

A numerical procedure for the analysis of the stresses due to rotation produced in disks of a general, arbitrary configuration is presented in this paper. The governing equilibrium equations and constitutive equations for the rotating disk element are written in terms of the radial stress. A numerical simulation is performed based on repeated applications of a truncated Taylor's expansion to advance along the radius of the deformed disk. Both initial value problems and two point boundary value problems with a corresponding iterative root finding method are treated. Examples for various disk geometries, including disks of constant thickness, linearly tapered thickness, and hyperbolic variation of thickness are provided. Particular consideration is given to the industrial example of turbine rotors carrying buckets. The simple procedure developed in this study may serve as an effective tool for performing preliminary design calculations for complex rotating components. Author

A92-34525*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
STUDY OF WELD OFFSET IN LONGITUDINALLY WELDED SSME HPFTP INLET
J. B. MIN, K. S. SPANYER (NASA, Marshall Space Flight Center, Huntsville, AL), and R. M. BRUNAIR (Sverdrup Technology, Inc., Huntsville, AL) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2424-2430. refs
(AIAA PAPER 92-2305) Copyright

Welded joints are an essential part of rocket engine structures such as the Space Shuttle Main Engine (SSME) turbopumps. Defects produced in the welding process can be detrimental to weld performance. Recently, review of the SSME high pressure fuel turbopump (HPFTP) titanium inlet X-rays revealed several weld discrepancies such as penetrameter density issues, film processing discrepancies, weld width discrepancies, porosity, lack of fusion, and weld offsets. Currently, the sensitivity of welded structures to defects is of concern. From a fatigue standpoint, weld offset may have a serious effect since local yielding, in general, aggravates cyclic stress effects. Therefore, the weld offset issue is considered in this report. Using the FEM and beamlike plate approximations, parametric studies were conducted to determine the influence of weld offsets and a variation of weld widths in longitudinally welded cylindrical structures with equal wall thicknesses on both sides of the joint. Following the study, some conclusions are derived for the weld offsets. Author

A92-34548#
SHAPE OPTIMIZATION OF THREE-DIMENSIONAL STRUCTURES WITH ADAPTIVE MESHING
V. N. PARTHASARATHY and SRINIVAS KODIYALAM (GE Solid Mechanics Laboratory, Schenectady, NY) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2682-2688. refs
(AIAA PAPER 92-2434) 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 focused 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

A92-34591#
SPACE SHUTTLE SHELL STRUCTURE WAFFLE PANEL OPTIMIZATION
DAH N. YIN and MARK E. RAUSCHER (Rockwell International Corp., Space Systems Div., Downey, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3063-3071. refs
(AIAA PAPER 92-2359) Copyright

The waffle panel's weight, as an objective function, must be minimized, subject to side constraints and nonlinear implicit behavior constraints. The number of weight optimization parameters is reduced by evaluating each parameter's sensitivity and developing relationships among the parameters. Once the nonlinear weight optimization problem has been simplified, the waffle is optimized by using the sequential quadratic programming method. The waffle panel optimization methodology considers the maximum strength-to-weight ratio, multiple sets of loads, frame and subsystem attachment capability, minimum machining, and manufacturing costs. Author

A92-34603*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
COMBINED COMPRESSIVE AND SHEAR BUCKLING ANALYSIS OF HYPERSONIC AIRCRAFT SANDWICH PANELS
WILLIAM L. KO and RAYMOND H. JACKSON (NASA, Flight Research Center, Edwards, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3198-3225. Previously announced in STAR as N91-25422. refs
(AIAA PAPER 92-2487) Copyright

The combined-load (compression and shear) buckling equations were established for orthotropic sandwich panels by using the Rayleigh-Ritz method to minimize the panel total potential energy. The resulting combined-load buckling equations were used to generate buckling interaction curves for super-plastically-formed/diffusion-bonded titanium truss-core sandwich panels and titanium honeycomb-core sandwich panels having the same specific weight. The relative combined-load buckling strengths of these two types of sandwich panels are compared with consideration of their sandwich orientations. For square and nearly square panels of both types, the combined load always induces symmetric buckling. As the panel aspect ratios increase, antisymmetric buckling will show up when the loading is shear-dominated combined loading. The square panel (either type) has the highest combined buckling strength, but the combined load buckling strength drops sharply as the panel aspect ratio increases. For square panels, the truss-core sandwich panel has higher compression-dominated load buckling strength. However, for shear dominated loading, the square honeycomb-core sandwich panel has higher shear-dominated combined load buckling strength. Author

A92-34759
A METHOD FOR THE CONSTRUCTION OF SAFE S-N CURVES
T. J. SWEETING (Surrey, University, Guildford, England) Fatigue and Fracture of Engineering Materials and Structures (ISSN 8756-758X), vol. 15, April 1992, p. 391-398. Research sponsored by Ministry of Defence of England. refs
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The fatigue life behavior of airframe components under

spectrum loading differs markedly in the moderately high and low loading severity regimes. Statistical analysis of fatigue test and strength data leads to suitable safe S-N curves for each of these regions and the problem is how to construct a single S-N curve which blends these two curves together. A method of constructing such a curve is described here. This method has been incorporated into recent guidelines for compliance with design and airworthiness requirements. Author

A92-34825
LARGE EDDY SIMULATION OF UNSTEADY TURBULENT WAKE OF A CIRCULAR CYLINDER USING THE FINITE ELEMENT METHOD
CHISACHI KATO and MASAHIRO IKEGAWA (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Ibaraki, Japan) IN: Advances in numerical simulation of turbulent flows; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 49-56. refs
Copyright

A novel streamline FEM formulation is used by the present large-eddy simulation of a circular cylinder's turbulent wake at a subcritical Reynolds number, in order to obtain time-accurate solutions of the governing equations. The wake's transition to turbulence is modeled by a damping of the subgrid-scale eddy viscosity in a region near the cylinder surface. The results obtained exhibit a three-dimensionality in the region behind the cylinder, as a result of which the calculated fluctuating-lift coefficient is about one-fourth that of 2D calculations. The drag coefficient, Strouhal number, and fluctuating lift coefficient obtained are in substantial agreement with experimental results. O.C.

A92-35055
ESTIMATION OF THE P-3/SAR L-, C- AND X-BAND ANTENNA DIRECTIVITY IN RANGE DIRECTION BASED ON CORNER REFLECTOR MEASUREMENTS WITHIN THE ABSOLUTE SAR CALIBRATION
DIETER J. CICHON (Karlsruhe, Universitaet, Federal Republic of Germany), ERIC S. KASISCHKE, and DAN R. SHEEN (Michigan, Environmental Research Institute, Ann Arbor) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 993-996. refs
Copyright

The antenna directivity, the most significant error source of absolute radiometric calibration of airborne SAR (synthetic aperture radar) systems, is investigated. The results of corner reflector measurements with the P-3/SAR system for a like-polarized radar channel at X- C- and L-band are presented. The variation of the antenna directivities due to mounting the antennas on the airframe are strongly dependent on the frequency-polarization combination. An improved approximation in an estimate of the actual antenna directivity is obtained with the described reflector array measurement. This leads to a more accurate estimation of the radar cross section of the illuminated area. I.E.

A92-35142
POCONO MOUNTAIN SAR DATA ANALYSIS FOR TESTING SLANT RANGE TO GROUND RANGE CONVERSION
JEANNETTE EVANS-MORGIS, PETER CHO, ANDREW R. OCHADLICK, JR., and STEPHEN KRASZNAY (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1413-1415. refs
Copyright

As part of an inhouse independent research effort, synthetic aperture radar (SAR) data sets from the Pocono region were collected by the US Naval Air Development Center (NADC) and processed by the NADC SAR Facility. The area studied was centered below an octagonal flight path and thereby imaged from various look directions. Prominent features in the images used in the geometric analysis included lakes, roads, and power lines. These terrain features are used to study the dependence of the slant range to ground range conversion on aspect angle. The accuracy of the registration between these images after geometric correction is examined. I.E.

A92-35479
A HIGH RESOLUTION MULTISPECTRAL VIDEO SYSTEM
J. H. EVERITT, D. E. ESCOBAR, and J. NORIEGA (USDA, Agricultural Research Service, Weslaco, TX) Geocarto International (ISSN 1010-6049), vol. 6, no. 4, Dec. 1991, p. 45-51. refs
Copyright

The general design and operation of a high-resolution multispectral video system (HRMVS) are described, and test results are reported. The system incorporates three black-and-white visible/near-IR light sensitive CCD cameras equipped with band-pass filters and provides two kinds of synchronized video images: color-infrared composite imagery and its three-band black-and-white image components. Examples of the imagery are presented to demonstrate the utility of the system as a remote sensing tool for natural resource assessment. V.L.

A92-35546
THE NUMERICAL METHOD FOR CALCULATING THE FLOW FIELD, TEMPERATURE FIELD AND RADIATION FLUXFIELD IN THE PIPE
DEZHANG LIU and DONGMEI ZHAO (Nanjing Aeronautical Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 2, April 1992, p. 46-53. In Chinese. refs

The flow field, temperature field and radiation flux field formed by mixing the coaxial parallel cold air with hot gas in the pipe, caused by ejection of aeroengine exhaust gas into surrounding air, numerically calculated in this paper. It is based on physical principles instead of pure mathematical deduction, in order to analyze and explain the calculation results and to make the calculation results approach the experimental results properly. The flow field, temperature field and infrared radiation flux field have been studied by changing the ejection coefficient with numerical method. The results of numerical calculation are in good agreement with the data of experiment. Author

A92-35554
ANALYSIS OF TENON AND MORTISE CONTACT PROBLEMS BY BOUNDARY ELEMENT METHODS
WEIDONG WEN and DEPING GAO (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 117-120. In Chinese. refs

The boundary element equations of 2D elastic contact problems are established by the incremental principle and some concrete approaches to the solution of the contact procedure are considered. The contact stresses of the dove tail and the pine tree joints of the disk/blade assembly are numerically analyzed. From the comparison of the numerical results of BEM with those of FEM and photoelasticity experiments it is concluded that the results of BEM are satisfactory. In contrast with FEM, the BEM not only simplifies data preparation but also gives the results of the same accuracy level with fewer discrete elements and saves computer time tremendously. Author

A92-35555
A COMPOUND FATIGUE INVESTIGATION OF PLATE SPECIMEN UNDER LOW-CYCLE LOAD SUPERPOSED ON HIGH CYCLE LOAD
FENGJING XU, JINGXU NIE, and CHANGZHAN ZHAO (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 121-124. In Chinese. refs

According to real operating conditions of turbine-engine blades in service, a series of combination tests of various load matching

and frequency matching for plate specimens was carried out on a compound fatigue testing rig which can simulate operating loads on blades. From the test results and theoretical analyses, some characteristics and the regularities of this compound fatigue are obtained. A new method of life prediction for this compound fatigue is presented. The calculated results of this method are in good agreement with experiments. Author

A92-35556
RESEARCH ON DAMAGE TOLERANCE OF COMPRESSOR BLADE
GUANGHUA ZHENG, JUANHONG YU, and GUICHANG HOU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 125-128. In Chinese. refs

This paper describes the damage tolerance analysis of a compressor blade by fracture mechanics. An FEM finite element method with 20- node solid elements is used for the stress calculation. A displacement method is provided to determine the SIFs versus crack length a of the blade. Based on the material toughness, additional extension, and deviation of natural frequency of the cracked blade, the failure criterion of the compressor blade is discussed and the critical crack length is determined. By the use of Pris formula and in consideration of the influence of high cycles on low cycle fatigue crack propagation, the damage tolerance life of the blade is obtained. As an example, a calculation of a certain compressor blade is given. In order to investigate the relation of natural frequency versus crack length, the vibration of compressor blades has been tested. The presented method can be used for the strength evaluation of a turbojet engine. Author

A92-35564
LIFE PREDICTION OF LOCAL STRESS-STRAIN METHOD
XANGSHENG LIU (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 153-155. In Chinese. refs

The local stress-strain method is applied to LCF life prediction. The method and procedure for determining reliability life and flight life are provided. The influence of the variable-amplitude cycle loading on the lives and effects of the fluctuation of material fatigue constants on the lives are considered. In addition the present method is compared with the EGD-3 method. Author

A92-35567
A METHOD FOR MEASURING HIGH-SUBSONIC TWO-DIMENSIONAL PERIODIC FLOW FIELD USING A SINGLE-HOLE HIGH-RESPONSE CYLINDRICAL PRESSURE PROBE
YUCHUN LI and HAOKANG JIANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 164-166. In Chinese. refs

This paper presents in detail a method for measuring a high-subsonic 2D periodic flow field with a single-hole cylindrical pressure probe with high-frequency response. The method normalizes the probe calibration curves at different Mach number and simplifies the compressibility correction. The probe is set at nine azimuthal angles while measuring the flow. Sampled and averaged data are used to determine flow angles by least square fitting. Mach number and stagnation pressure are then obtained from solving a set of nonlinear equations. The method has been successfully applied to measuring the rotor exit flow in a multistage compressor with high accuracy. Author

A92-35572
A CIRCUMFERENTIAL NON-UNIFORM EFFECT MODEL FOR MULTISTAGE AXIAL-FLOW COMPRESSOR THROUGHFLOW
SHIMING LI and MAOZHANG CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 181-185. In Chinese. refs

The effects of momentum and energy transportation caused by circumferential nonuniformities of the flow in a multistage axial compressor are studied. A model has been developed to represent the circumferential nonuniform stresses and heat flux. A preliminary comparison between experimental results and the model demonstrates that this model is feasible. The momentum transport effects of circumferential nonuniformities are not distinct, but the energy transport effects of the nonuniformities are quite strong and have the same order of magnitude as the turbulent diffusion. The relative importances of the turbulent diffusion and the nonuniformities depend on compressor configuration, loadings, and spanwise positions in the compressor. Compared with the effects of their mean stream counterparts, the circumferential nonuniform stresses can be sometimes neglected, according to the compressor loadings, configuration, and the calculation tolerances. Author

A92-35573
VIBRATION OF GEAR SYSTEM WITH WEB STRUCTURE
ZONGDE FANG, DAWEI HE, and YUNWEN SHEN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 2, April 1992, p. 186-189. In Chinese. refs

The web structure has been widely used in design of aviation gears and its structure vibration has attracted much attention. But the function of a web as a torsion spring in the dynamic behavior or a gear system needs thorough investigation. In this paper, a typical gear transmission is used as an example, its dynamic model has been built up to analyze the vibration mode of the system. The dynamic responses of this system at various speeds have been obtained with Fourier method by considering the transmission error of the pair of gears as excitation. Further, the influences of web flexibility and attached damping on the dynamic responses have been studied, the dynamic loads on the teeth when the web thickness is changed, and the damping, both attached and unattached, have been calculated. Some useful conclusions have been drawn which show that the combination of flexible web and attached damping can lower the vibration level and decrease the dynamic loads. Author

A92-35672#
DEVELOPMENT AND ANALYSIS OF FLIGHT FLUTTER PREDICTION METHODS
S. J. PRICE (McGill University, Montreal, Canada) and B. H. K. LEE (National Research Council of Canada, Institute for Aerospace Research, Ottawa) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 188-200. Research supported by DND, National Research Council of Canada, NSERC, et al. refs
(AIAA PAPER 92-2101) Copyright

New techniques are developed and existing methods are evaluated to aid in the interpretation of flight test data for flutter testing of aircraft. For a binary flutter the 'flutter margin method' is a good way of extrapolating from subcritical flight test data to estimate the flutter speed. The flutter margin varies in an approximately linear manner with dynamic pressure and, generally, the best estimates of flutter speed are obtained with a linear extrapolation. Good estimates of the flutter speed can be obtained from data at speeds as low as 50 percent of the flutter speed. R.E.P.

A92-35673*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NEW TIME-DOMAIN TECHNIQUE FOR FLUTTER BOUNDARY IDENTIFICATION
CHAN-GI PAK and PERETZ P. FRIEDMANN (California, University, Los Angeles) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 201-214. refs
(Contract NCC2-374)
(AIAA PAPER 92-2102) Copyright

A new methodology for flutter boundary identification in the time domain is presented. This technique is based on a single-input single-output deterministic ARMA model and an on-line parameter

estimation procedure. It is capable of simultaneous identification of the aeroelastic modal parameters as well as the static offset term which represents the static deformation or state of the aeroelastic system. The capabilities of the method are illustrated by applying it to several examples, such as: damped free oscillations, a two degree of freedom NACA 64A010 airfoil in transonic flight, and a cantilevered rectangular wing in subsonic flow. Numerical implementations of the new methodology developed in this study demonstrates that it is a cost effective time-domain technique for flutter boundary identification. Author

A92-35674# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
DIGITAL TIME SERIES ANALYSIS FOR FLUTTER TEST DATA
S. M. BATILL, D. M. CAREY (Notre Dame, University, IN), and M. W. KEHOE (NASA, Flight Research Center, Edwards, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 215-223. refs
(Contract NCA2-548)
(AIAA PAPER 92-2103) Copyright

An application of digital time series analysis to flutter test data processing was conducted. A numerical investigation was used to evaluate the method, as well as its sensitivity to noise and parameter variations. These parameters included those involved with data acquisition, as well as system response characteristics. This digital time series method was then used to predict flutter speed from subcritical response wind tunnel tests. Flutter speeds predicted from forced response, subcritical wind tunnel tests were compared to the experimental flutter speeds. Author

A92-35691*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A NEW METHOD FOR TRANSONIC STATIC AEROELASTICITY PROBLEMS
FORT F. FELKER (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 415-425. refs
(AIAA PAPER 92-2123) Copyright

A new method has been developed to calculate the steady flow and structural deformations for fluid/structure interaction problems. The discretized fluid dynamic and structural equations are regarded as a single set of coupled, nonlinear, algebraic equations. The equilibrium solution is directly obtained using Newton's method. The governing equations used for the fluid flow are the two-dimensional Navier-Stokes equations, and a finite-element model is used to represent the structure. This paper describes the analytical method and presents sample calculations demonstrating the technique. The results show rapid convergence and good agreement with experimental data. Author

A92-35695*# National Aeronautics and Space Administration, Washington, DC.
TEMPERATURE AND INITIAL CURVATURE EFFECTS IN LOW-DENSITY PANEL FLUTTER
HUGO B. RESENDE (Stanford University, CA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 467-477. Research supported by Embraer - Empresa Brasileira de Aeronautica, S.A. and Conselho Nacional de Desenvolvimento Cientifico e Tecnologico of Brazil. refs
(Contract NGL-05-020-243)
(AIAA PAPER 92-2128) Copyright

The panel flutter phenomenon is studied assuming free-molecule flow. This kind of analysis is relevant in the case of hypersonic flight vehicles traveling at high altitudes, especially in the leeward portion of the vehicle. In these conditions the aerodynamic shear can be expected to be considerably larger than the pressure at a given point, so that the effects of such a loading are incorporated into the structural model. Both the pressure and shear loadings are functions of the panel temperature, which can lead to great variations on the location of the stability boundaries for parametric studies. Different locations can, however, be 'collapsed' onto one another by using as ordinate an appropriately normalized dynamic pressure parameter. This procedure works better for higher values of the panel temperature for a fixed undisturbed flow temperature. Finally, the behavior of the system is studied when the panel has some initial curvature. This leads to the conclusion that it may be unrealistic to try to distinguish between a parabolic or sinusoidal initial shape.
Author

A92-35696*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FINITE ELEMENT NONLINEAR PANEL FLUTTER WITH ARBITRARY TEMPERATURES IN SUPERSONIC FLOW
DAVID Y. XUE and CHUH MEI (Old Dominion University, Norfolk, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 478-491. refs
(Contract NAS1-18584)
(AIAA PAPER 92-2129)

A finite element frequency domain method for predicting nonlinear flutter response of panels with temperature effects is presented. By using the principle of virtual work, the element nonlinear stiffness formulation for a panel under a combined thermal and aerodynamic loads is derived on the bases of von Karman's large deflection plate theory, the first-order piston theory aerodynamics and the quasi-steady thermal stress theory. The system equations of motion can be mathematically separated into two sets of equations and then solved in sequence. The first set of equations yields the panel thermal-aerodynamic equilibrium and the second set of equations of motion leads to the flutter limit-cycle oscillations. Stability and flutter boundaries can also be obtained from the two sets of system equations. Finite element large amplitude limit-cycle flutter results at different uniform temperatures are obtained for a simply supported square panel and are compared with existing Galerkin/time integration and other finite element solutions. Effects of nonuniform temperature distributions, panel length-to-width ratios, and boundary conditions on flutter responses of rectangular and triangular panels are presented. Author

A92-35697*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LARGE-AMPLITUDE FINITE ELEMENT FLUTTER ANALYSIS OF COMPOSITE PANELS IN HYPERSONIC FLOW
CARL E. GRAY, JR. (NASA, Langley Research Center, Hampton, VA) and CHUH MEI (Old Dominion University, Norfolk, VA) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 492-512. refs
(AIAA PAPER 92-2130) Copyright

Consideration is given to a finite-element approach for determining the nonlinear flutter characteristics of 3D thin laminated composite panels using the full third-order-piston transverse-loading aerodynamic theory. The unsteady hypersonic aerodynamic theory and the von Karman large-deflection-plate theory are used to formulate the aeroelasticity problem. Nonlinear flutter analyses are performed to assess the influence of the higher-order aerodynamic theory on the structure's limit-cycle amplitude and the dynamic pressure of the flow velocity. A solution procedure is presented to solve the nonlinear panel flutter and large-amplitude free-vibration finite-element equations. Nonlinear flutter analyses are performed for different boundary support-conditions and for various system parameters. Linear finite-element flutter for isotropic and composite panels and large-amplitude isotropic panel flutter results are compared with existing classical solutions. The large-amplitude panel flutter results using the full third-order piston aerodynamic theory are presented to assess the influence of the nonlinear aerodynamic theory. P.D.

A92-35699#
NONLINEAR FLUTTER OF ORTHOTROPIC COMPOSITE PANEL UNDER AERODYNAMIC HEATING
JEHAD F. ABBAS, R. A. IBRAHIM, and RONALD F. GIBSON

(Wayne State University, Detroit, MI) IN: AIAA Dynamics Specialists Conference, Dallas, TX, Apr. 16, 17, 1992, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 524-535. refs
(AIAA PAPER 92-2132) Copyright

The problem of nonlinear aerothermoelasticity of isotropic and specially orthotropic panels in supersonic air flow is examined. Reissner functional is used with Hamilton's principle to derive the governing equations of motion, the constitutive relations, and the natural boundary conditions. Work done by aerodynamic forces is represented by using the 'piston' theory for two-dimensional lifting surfaces. The aerodynamic heating effect is estimated based on the adiabatic wall temperature due to the high speed airstream. Galerkin's method is then applied to generate a set of coupled ordinary nonlinear differential equations. Linear flutter analysis for heated and unheated panels is carried out for the six mode equations which are aerodynamically coupled. Nonlinear dynamic deflection due to the six modes is estimated for different aerodynamic pressure levels. Poincare sections of the first return are estimated for three different types of material and it is shown that isotropic and 90-deg orthotropic panels experience chaos while 0-deg orthotropic panels exhibit regular limit cycles under all possible temperature levels. The 90-deg orthotropic panels are found to exhibit flutter at lower aerodynamic pressure than the one for isotropic or 0-deg orthotropic panels. The degree of chaotic response characteristics is further examined in terms of statistical response parameters such as power spectra and probability density functions. Author

A92-35729
THE USE OF STODOLA MODES IN ROTOR-BLADE AEROELASTIC STUDIES
A. SIMPSON (Royal Aerospace Establishment, Flight Dynamics Div., Bedford, England) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 20 p. refs

A single step of Stodola's method is used to derive Stodola modes for a nonrotating nonuniform blade from the uncoupled lead-lag, flap, and torsion eigenfunctions of a corresponding uniform blade. Stodola modes, orthogonalized by the Rayleigh-Ritz method, are employed in the various stages of an aeroelastic formulation for a rotor (in hover) comprising semirigid blades. It is shown that the basic nonrotational Stodola modes may be used to formulate the Lagrangian equations of the motion of a 'rotational basis system', the eigenvalues of which exhibit excellent convergence properties. The fully coupled eigenfunctions of the rotational basis system are applied as normal modes in the aeroelastic formulation. Hover trim states and aeroelastic eigenvalues are studied with respect to the number of retained normal modes. P.D.

A92-35745
A FREQUENCY DOMAIN THEORY FOR STRUCTURAL IDENTIFICATION
JOSHUA H. GORDIS (Rensselaer Polytechnic Institute, Troy, NY) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 29 p. Research supported by U.S. Army. refs

The present theory, which allows a FEM to be corrected in such a way that frequency-response predictions will exactly match corresponding test data at all frequencies of interest, is based on frequency domain structural synthesis (FDSS). FDSS is a structural-modification and substructure-coupling methodology that furnishes an analytic bridge between the FEM frequency-response model of a linear structural dynamic system and its experimentally-derived counterpart. The theory demonstrates that an exact solution for the corrective structural matrices is directly available from spatially complete frequency-response data. The theory can provide precise information as to the location of modeling errors due to the discretization of a continuous structure. O.C.

A92-35746
CRASHWORTHINESS OF TRUNCATED COMPOSITE CONES UNDER SIDE LOADS
DAVID C. FLEMING and ANTHONY J. VIZZINI (Maryland, University, College Park) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. Research sponsored by U.S. Army. refs

Truncated cones of varying degrees of taper were manufactured from unidirectional AS4/3501-6 graphite/epoxy preimpregnated tape and were loaded in compression. Different amounts of side loads were introduced by orienting the loading axis away from the central axis of the cone. The cones were crushed under quasi-static conditions, and their energy absorption was measured. For small amounts of taper, the energy absorbency decreases with increasing amounts of side load. There is also an increasing tendency toward toppling. As the amount of taper is increased, the energy absorbency properties are better maintained through the range of side loads applied. Furthermore, the tendency for toppling is reduced. Thus, optimization of a crashworthy structure with constant cross section specimens characterized solely by uniaxial tests can result in poor performance during a crash event. However, optimization using tapered cross sections results in a structure capable of absorbing energy during a uniaxial crushing event as well as an event with substantial amounts of side loads. Author

A92-35847
THERMAL STRUCTURES AND MATERIALS FOR HIGH-SPEED FLIGHT; COLLECTION OF PAPERS OF THE 1ST THERMAL STRUCTURES CONFERENCE, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, NOV. 13-15, 1990
EARL A. THORNTON, ED. (Virginia, University, Charlottesville) Washington, DC, American Institute of Aeronautics and Astronautics, Inc. (Progress in Astronautics and Aeronautics. Vol. 140), 1992, 557 p. For individual items see A92-35848 to A92-35850.
(ISBN 1-56347-017-9) Copyright

The present conference discusses aerobrake-maneuver vehicle aerothermodynamics, aerothermal issues in the structural design of high speed vehicles, laser surface-alloying of superlight metals with ceramic surfaces, high-temperature Al alloys for supersonic and hypersonic vehicles, advanced metallics for high temperature airframes, novel materials for engine applications, and the development status of computational methods for high temperature structural design. Also discussed are a transient thermal-structural analysis using adaptive unstructured remeshing and mesh movement, the FEM thermoviscoplastic analysis of aerospace structures, hot-structures testing techniques, a thermal-structural analysis of a carbon-carbon/refractory metal heat pipe-cooled leading edge, dynamic effects in thermoviscoplastic structures, microlevel thermal effects in metal-matrix composites (MMCs), thermomechanical effects in the plasma spray manufacture of MMC monotapes, and intelligent HIP processing. Most of the presentations at this conference were abstracted previously (see A91-16027 to A91-16047). O.C.

A92-35977
FORCED-INJECTION QUENCHING OF A HOT-TUBE UNDER MICROGRAVITY
M. KAWAJI, C. J. WESTBYE (Toronto, University, Canada), and B. N. ANTAR (Tennessee, University, Tullahoma) IN: Forum on Microgravity Flows - 1991; ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991, Proceedings. New York, American Society of Mechanical Engineers, 1991, p. 1-3. refs
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The two-phase flow and boiling heat transfer characteristics have been investigated for quenching of a hot tube under microgravity. A 14 mm I.D., 1.2 m long quartz tube was initially heated to 300-400 C and then injected with liquid freon (R-113). The two-phase flow patterns were photographed and the temperature responses of the tube wall at various axial locations recorded on board NASA's KC-135 airplane. Long, continuous filaments of liquid and large droplets were seen to flow mostly in the middle of the tube, being unable to rewet the tube wall because of the thick vapor film existing between the liquid and the hot wall. Heat transfer was in either film boiling or forced convection to vapor, and the heat transfer rates were seen to be much lower

than those in 1-g under the similar operating conditions. The results indicate that quenching may be significantly delayed under microgravity due to the inefficient precursory cooling prior to quench. Author

A92-36007* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
STUDIES ON LAMINAR BOUNDARY-LAYER RECEPTIVITY TO FREESTREAM TURBULENCE NEAR A LEADING EDGE
JAMES M. KENDALL (JPL, Pasadena, CA) IN: Boundary layer stability and transition to turbulence; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 23-30. refs
Copyright

An experimental study of the generation of Tollmien-Schlichting waves and wave packets in a flat-plate boundary-layer by weak freestream turbulence has been conducted with the intent of clarifying receptivity mechanisms. Emphasis was placed upon the properties of such waves at stations as far forward as the minimum critical Reynolds number. It was found that alteration of the flow about the leading edge, due either to an asymmetry associated with lift, or due to a change of the fineness ratio of the leading edge, altered the T-S wave amplitude at early stations. The subsequent growth of the waves proceeded faster than expected according to certain stability theory results. Speculation regarding receptivity mechanisms is made. Author

A92-36032
A REFINED ANALYTICAL METHOD FOR DESIGNING HIGH PRESSURE RATIO CENTRIFUGAL IMPELLERS
SARIM N. J. AL-ZUBAIDY (United Arab Emirates University, Al Ain) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 35-43. refs
Copyright

A procedure is described for generating the detailed geometry of impellers capable of delivering one kg of air per second at a total-to-total pressure ratio of six to one. A computer package is used to draw the isometric view of the sample design. The set of constraints imposed on the sample design insure an easily manufactured impeller whose general configuration falls within the category of existing designs which provide acceptable performance. C.D.

A92-36037
OUTFLOW BOUNDARY CONDITIONS FOR EULER ANALYSIS OF FLOW IN TURBINE SCROLL
M. FURUKAWA, K. FUKUI, K. HARA, and M. INOUE (Kyushu University, Fukuoka, Japan) IN: Numerical simulations in turbomachinery; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 81-87. refs
Copyright

Three schemes for outflow boundary conditions are applied to the Euler analysis of 2D flow in the vaneless turbine scroll in order to clarify what conditions should be specified at the scroll exit where the flow cannot be assumed to be uniform. In scheme A, the upstream-running Riemann invariant is specified and the entropy, tangential velocity, and downstream running Riemann invariant are extrapolated at the outflow boundary. In scheme B the static pressure is specified and the density and momentum fluxes in the x and y directions are extrapolated at the outflow boundary. In scheme C, the same scheme as B is performed at the first step and the circumferential split governing equations obtained by the time split approximation are integrated at the second step. Scheme A is found to be more suitable for the outflow boundary treatment of the turbine scroll than the others. Scheme A also exhibits a better convergence than the others. C.D.

A92-36156
PERFORMANCE OF ALUMINUM HONEYCOMB PANELS WITH STRUCTURAL DEFECTS AND CORE ANOMALIES. II - SPECIMEN DESCRIPTION AND TEST RESULTS
J. M. BURKES, M. A. GRIFFIN, and C. H. PARR (Southwest Research Institute, San Antonio, TX) SAMPE Journal (ISSN 0091-1062), vol. 28, no. 3, May-June 1992, p. 35-42.
(Contract F41608-87-D-A237)
Copyright

A test program has been conducted for a wide variety of structural defects and core anomalies in Al alloy honeycomb core structures. A total of 16 defect categories are evaluated in the framework of existing procurement specifications; for each category, test results from panels containing defects exceeding current acceptance criteria are compared with baseline panels having acceptable characteristics, thereby ascertaining the tolerance and/or sensitivity of a given structure to a typical defect. Attention is given to specimens and testing for four defect categories which were found to degrade structure performance by more than 30 percent: core-edge member gaps, foam adhesive voids at edge members, mismatched nodes in corrugated cores, and incomplete edge seals. O.C.

A92-36194
MOTION OF A SPHERE IN A GAS - NUMERICAL SOLUTION OF THE LINEARIZED BOLTZMANN EQUATION
S. K. LOYALKA (Missouri-Columbia, University, Columbia) Physics of Fluids A (ISSN 0899-8213), vol. 4, no. 5, May 1992, p. 1049-1056. Research supported by EPA. refs
Copyright

The motion of a spheric particle in a gas is accurately described on the basis of the linearized Boltzmann equation. The equation is solved for the drag and the torque problems using the rigid sphere intermolecular interaction and diffuse reflection of molecules at the sphere's surface. Detailed numerical results are presented for the drag and the torque as well as the molecular distribution and other macroscopic quantities for all values of R and general molecular force and gas-surface interaction laws. The work provides the basis for solving a number of problems in aerosol sciences. For instance, it can be directly adapted in thermophoresis, diffusiophoresis, and photophoresis. I.S.

A92-36351
ACTIVE CONTROL OF THE HYDRAULIC FORCES OF A BODY BY A SPLITTER PLATE
NORIO ARAI and MASATOMO KOMATSU (Tokyo Noko University, Koganei, Japan) (Japan-Soviet Union Joint Symposium on Computational Fluid Dynamics, 2nd, Tsukuba, Japan, Aug. 27-31, 1990) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 2, April 1992, p. 145-150. refs
Copyright

The present article investigates numerically the structure of the wake behind a square-section cylinder mounted with a splitter plate. The two-dimensional Navier-Stokes equation is solved numerically. The interaction between the transverse flow (behind the body) and the splitter has considerable influence on the rearrangement of the vortex street. With the splitter plate suitably located, the peak of the lift coefficient is reduced to 40 percent of the isolated body case. Also, the frequency of the variation of the lift coefficient becomes smaller. It is found that there is an optimal location for the splitter plate. Author

N92-22099# Rolls-Royce Ltd., Derby (England).
THE PROBLEM OF STATIC PRESSURE MEASUREMENT IN TURBOMACHINERY ANNULI USING TRAVERSABLE INSTRUMENTATION
P. D. SMOUT 1 Nov. 1990 18 p
(PNR-90791; ETN-92-90844) Copyright Avail: NTIS HC/MF A03

Traverse probes are used in a component rig and engine testing to measure a range of aerodynamic quantities. Of these quantities, static pressure is the least accurately indicated towards the wall of introduction. Three particularly problematic areas in the

measurement of static pressure using specifically the wedge type traverse probe are explained, the discussion drawing on the findings of several researches in addition to 'in house' experience. In view of the importance of an accurate knowledge of the static pressure field in determining turbomachine performance and efficiency levels, an experimental and theoretical study was planned. With the ultimate goal of understanding the root causes of the static pressure measurement problem, details of this study are presented, a study which it is hoped will lead to an elimination of this fundamental problem, either through reviewed calibration procedures, or through new probe designs. ESA

N92-22132 State Univ. of New York, Stony Brook.
PRINCIPLES AND COMPUTER SIMULATIONS OF INTERCOOLED-TURBOCHARGED GAS GENERATOR/EXPANDER ENGINE Ph.D. Thesis
YUAN-LIANG JENG 1991 183 p
Avail: Univ. Microfilms Order No. DA9205246

An internal combustion engine is proposed that is based on a patent of Dr. L. S. Wang. This engine utilizes a two-stage adiabatic compression with intercooling to reduce exhaust energy loss, and a reciprocating piston-gasifier to raise the cycle peak temperature. Combustion occurs within piston-gasifier to generate high temperature and pressure gases with no brake net work output. The discharge gas expands in turbocharging turbine to drive the two compressors. Further expansion is performed in the power turbine to produce the engine power output. To study the feasibility of the proposed engine, piston-gasifier is designed and computer code was developed to simulate the engine operations. Processes in various system components are described by several submodels which are integrated in the computer code to predict the engine performance. The piston-gasifier model treats manifolds and cylinders as open systems and combustion is described as a one-zone heat release process. Processes including heat transfer and friction are described in sufficient detail to determine the mass and energy transfers in each manifold and master cylinder. The power turbine is described by the modified Stodola Ellipse while other machineries are described by scaled performance maps. Intercoolers are modeled by a combination of analytical solutions and empirical correlations. The predicted quasi-steady performance characteristics of piston-gasifier are studied. And a reference operating point is chosen to select turbomachineries and to design intercoolers. The system performance is obtained by matching the operations of all components. Covering a wide range of operations, the results of engine simulations show that excellent part load performance is obtained by the reduction of exhaust energy loss. Still liable to refinements, discussions are made, pointing out future directions of further improvement.
Dissert. Abstr.

N92-22209# Cambridge Univ. (England). Dept. of Engineering.
SEPARATION OF RELAMINARISED BOUNDARY LAYERS
RUNE BRANDT and M. GASTER Oct. 1991 104 p
(CUED/A-AERO/TR-16; ISBN-0309-7293; RAE-2029/236) Avail: NTIS HC/MF A06

A series of experiments have been performed using a new experimental rig. This rig is capable of producing accelerations and decelerations of a boundary layer on a flat plate. The boundary layer developed initially in a zero pressure gradient was subjected to pressure gradients similar to those observed on leading edges of wings at high angles of attack. The data obtained will be useful for validating methods for predicting such flows. Among the tests performed are: varying the initial momentum-thickness Reynolds number; skin friction measurements; velocity and turbulence intensity profiles; and flow separation and reattachment. H.A.

N92-22228*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
NUMERICAL SIMULATION OF TRANSIENT HYPERVELOCITY FLOW IN AN EXPANSION TUBE Final Report
P. A. JACOBS Mar. 1992 49 p Submitted for publication
(Contract NAS1-18605; RTOP 505-90-52-01)
(NASA-CR-189615; NAS 1.26:189615; ICASE-92-10) Avail: NTIS HC/MF A03 CSCL 20/4

Several numerical simulations of the transient flow of helium in an expansion tube are presented in an effort to identify some of the basic mechanisms which cause the noisy test flows seen in experiments. The calculations were performed with an axisymmetric Navier-Stokes code based on a finite volume formulation and upwinding techniques. Although laminar flow and ideal bursting of the diaphragms was assumed, the simulations showed some of the important features seen in experiments. In particular, the discontinuity in tube diameter of the primary diaphragm station introduced a transverse perturbation to the expanding driver gas and this perturbation was seen to propagate into the test gas under some flow conditions. The disturbances seen in the test flow can be characterized as either small amplitude, low frequency noise possibly introduced during shock compression or large amplitude, high frequency noise associated with the passage of the reflected head of the unsteady expansion.
Author

N92-22239*# Pratt and Whitney Aircraft, East Hartford, CT. Commercial Engine Business.
HIGH TEMPERATURE STRAIN GAGE TECHNOLOGY FOR HYPERSONIC AIRCRAFT DEVELOPMENT APPLICATIONS
W. L. ANDERSON and H. P. GRANT Feb. 1992 54 p
(Contract NAS3-25410)
(NASA-CR-189101; NAS 1.26:189101; PWA-6141) Avail: NTIS HC/MF A04 CSCL 14/2

An experimental evaluation of Pd 13 percent Cr and of BCL-3 alloy wire strain gages was conducted on IN100 and Cu 0.15 percent Zr alloy substrates. Testing included apparent strain, drift, gage factor, and creep. Maximum test temperature was 1144 K (1600 F). The PdCr gages incorporated Pt temperature compensation elements. The PdCr gages were found to have good resistance stability below 866 K (1100 F). The BCL 3 gages were found to have good resistance stability above 800 K (981 F), but high drift around 700 K (800 F). Author

N92-22296# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: ENGINEERING AND EQUIPMENT
2 Jan. 1992 29 p Transl. into ENGLISH from various Russian articles
(JPRS-UEQ-92-001) Avail: NTIS HC/MF A03

A bibliography is given of U.S.S.R. research in engineering and equipment. Topics covered include nuclear energy; non-nuclear energy; turbines; engines propulsion systems; the mechanics of gases, liquids, and solids; and industrial planning, technology, and productivity. Author

N92-22298# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA: ENGINEERING AND EQUIPMENT
31 Jan. 1992 33 p Transl. into ENGLISH from various Russian articles
(JPRS-UEQ-92-002) Avail: NTIS HC/MF A03

A bibliography is given of U.S.S.R. research in engineering and equipment. Topics covered include aviation, space technology, optics, high energy devices, nuclear energy, electric power transmission lines, and industrial technology, planning, and productivity. Author

N92-22315 Wisconsin Univ., Madison.
DYNAMIC SIMULATION OF A SOLID FUELLED GAS TURBINE SYSTEM Ph.D. Thesis
CARL ALEXANDER PALMER 1991 438 p
Avail: Univ. Microfilms Order No. DA9124683

A computer model for a novel directly fired combustor-gas turbine system using woodchips has been developed. In this downdraft combustor, the fuel burning rate is determined by pressure, temperature, air flow, and fuel moisture; not by the fuel feed rate. This thesis integrates the characteristics of compressor, gas producer, and power turbine sections from an actual turbine

with the combustor characteristics in order to understand steady state and dynamic system operation, and to develop a control system. The model qualitatively reproduces experimental data. Active control is needed for moving from one steady state point to another. For changing loads, the bypass valve and house air valves should move simultaneously so that the combustion conditions remain fairly constant, which would keep the system from 'drifting'. The house air valve setting controls the combustion conditions. To change load, active control with the vent valve is used for moving the system from one steady state bypass point to another, using carbon dioxide as the controlled variable. The control should take into account the thermal lag by not being too fast, yet must be fast enough to catch drift. An external motor can start the system using a preheated bed. Dissert. Abstr.

N92-22397# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: ENGINEERING AND EQUIPMENT
6 Sep. 1991 26 p Transl. into ENGLISH of various Russian articles
(JPRS-UEQ-91-010) Avail: NTIS HC/MF A03

A bibliography is given of U.S.S.R. research in engineering and equipment. Topics covered include optics; high energy devices; nuclear and non-nuclear energy; the mechanics of gases, liquids, and solids; and industrial technology, planning, and productivity. Author

N92-22426*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
WELDING TECHNOLOGY TRANSFER TASK/LASER BASED WELD JOINT TRACKING SYSTEM FOR COMPRESSOR GIRTH WELDS
ALAN LOONEY *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 1 p 24-31 Dec. 1991
Avail: NTIS HC/MF A23 CSCL 13/8

Sensors to control and monitor welding operations are currently being developed at Marshall Space Flight Center. The laser based weld bead profiler/torch rotation sensor was modified to provide a weld joint tracking system for compressor girth welds. The tracking system features a precision laser based vision sensor, automated two-axis machine motion, and an industrial PC controller. The system benefits are elimination of weld repairs caused by joint tracking errors which reduces manufacturing costs and increases production output, simplification of tooling, and free costly manufacturing floor space. Author

N92-22451*# Wright Lab., Wright-Patterson AFB, OH.
THE AIR FORCE MANUFACTURING TECHNOLOGY (MANTECH): TECHNOLOGY TRANSFER METHODOLOGY AS EXEMPLIFIED BY THE RADAR TRANSMIT/RECEIVE MODULE PROGRAM
TRACY HOUPT and MARGARET RIDGELY *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 1 p 243-246 Dec. 1991
Avail: NTIS HC/MF A23 CSCL 09/3

The Air Force Manufacturing Technology program is involved with the improvement of radar transmit/receive modules for use in active phased array radars for advanced fighter aircraft. Improvements in all areas of manufacture and test of these modules resulting in order of magnitude improvements in the cost of and the rate of production are addressed, as well as the ongoing transfer of this technology to the Navy. Author

N92-22491*# Akron Univ., OH. Dept. of Electrical Engineering.
IMPROVED LARGE PERTURBATION PROPULSION MODELS FOR CONTROL SYSTEM DESIGN (1988-1989) AND LARGE PERTURBATION MODELS OF HIGH VELOCITY PROPULSION SYSTEMS (1989-1990) AND REDUCED ORDER PROPULSION MODELS FOR CONTROL SYSTEM DESIGN (1990-1991) Final Report
TOM T. HARTLEY and J. ALEX DEABREU-GARCIA Dec. 1991 84 p
(Contract NAG3-904)
(NASA-CR-190148; NAS 1.26:190148) Avail: NTIS HC/MF A05 CSCL 20/4

Methods for modeling high speed propulsion systems will be discussed. Included in this category are internal flow propulsion systems without rotating machinery, such as inlets, ramjets, and scramjets. Among the modeling topics discussed are modeling of linear isentropic flow, heat exchange, gasdynamics, lumped parameter systems, and infinite dimensional systems. Furthermore, a generalized overview of modeling high speed propulsion systems is presented in this collection of papers.

N92-22495*# Akron Univ., OH. Dept. of Electrical Engineering.
MODELING OF LINEAR ISENTROPIC FLOW SYSTEMS
ATHAN D. SARANTOPOULOS and TOM T. HARTLEY *In its* Improved Large Perturbation Propulsion Models for Control System Design (1988-1989) and Large Perturbation Models of High Velocity Propulsion Systems (1989-1990) and Reduced Order Propulsion Models for Control System Design (1990-1991) 4 p Dec. 1991
(Contract NAG3-904)
Avail: NTIS HC/MF A05 CSCL 20/4

A modeling approach for linear isentropic flow systems based on the quasi-one-dimensional Euler equations of non-viscous, compressible flow are presented. Such systems are representative of certain high speed propulsion systems. Accurate models useful in control system studies are developed. A supersonic inlet is considered, and the resulting set of partial differential equations with boundary conditions is solved for a linear transfer matrix using Laplace transforms. Author

N92-22514*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CREEP AND FATIGUE RESEARCH EFFORTS ON ADVANCED MATERIALS
JOHN GAYDA *In its* Aeropropulsion 1987 p 55-63 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 20/11

Two of the more important materials problems encountered in turbine blades of aircraft engines are creep and fatigue. To withstand these high-temperature phenomena, modern engines utilize single-crystal, nickel-base superalloys as the material of choice in critical applications. This paper will present recent research activities at NASA's Lewis Research Center on single-crystal blading material, related to creep and fatique. The goal of these research efforts is to improve the understanding of microstructure-property relationships and thereby guide material development. D.R.D.

N92-22523*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INLETS, DUCTS, AND NOZZLES
JOHN M. ABBOTT, BERNHARD H. ANDERSON, and EDWARD J. RICE *In its* Aeropropulsion 1987 p 157-174 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 20/4

The internal fluid mechanics research program in inlets, ducts, and nozzles consists of a balanced effort between the development of computational tools (both parabolized Navier-Stokes and full Navier-Stokes) and the conduct of experimental research. The experiments are designed to better understand the fluid flow physics, to develop new or improved flow models, and to provide benchmark quality data sets for validation of the computational methods. The inlet, duct, and nozzle research program is described according to three major classifications of flow phenomena: (1) highly 3-D flow fields; (2) shock-boundary-layer interactions; and (3) shear layer control. Specific examples of current and future elements of the research program are described for each of these phenomenon. In particular, the highly 3-D flow field phenomenon is highlighted by describing the computational and experimental research program in transition ducts having a round-to-rectangular area variation. In the case of shock-boundary-layer interactions, the specific details of research for normal shock-boundary-layer interactions are described. For shear layer control, research in vortex generators and the use of aerodynamic excitation for enhancement of the jet mixing process are described. Author

N92-22526*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESEARCH SENSORS
DAVID R. ENGLUND *In its* Aeropropulsion 1987 p 217-224 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 14/2

The LeRC program in research sensors is directed at development of sensors and sensing techniques for research applications on turbine engines and propulsion systems. In general, the sensors are used either to measure to response of an engine component to the imposed environment. Locations of concern are generally within the gas path and, for the most part, are within the hot section of the engine. Since these sensors are used for research testing as opposed to operational use, a sensor lifetime of the order of 50 hr is considered sufficient. The following discussion presents a sample of this work, describing programs to develop a dynamic gas temperature measuring system, total heat flux sensors, a variety of thin-film sensors, and high-temperature strain measuring systems. Author

N92-22527*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OPTICAL MEASUREMENT SYSTEMS
DANIEL J. LESCO *In its* Aeropropulsion 1987 p 225-232 Feb. 1990
Avail: NTIS HC/MF A21 CSCL 14/2

Some of the areas of research conducted at the LeRC on optical measurement techniques for propulsion systems research are described. Most of the optical techniques used to measure gas parameters depend on very inefficient light scattering principles and, therefore, require the high light intensities provided by lasers. Significant advances in laser technology, together with the availability of sensitive photodetection systems, provide much of the impetus for research in optical diagnostics techniques. The goal of the research is to enhance the capabilities of nonintrusive research instrumentation to meet the special needs of aeropropulsion research. Optical techniques are being used to validate analytical codes and to verify the performance of aeropropulsion components and systems. Author

N92-22562# Communications Research Centre, Ottawa (Ontario).
A TMS320-BASED MODEM FOR THE AERONAUTICAL-SATELLITE CORE DATA SERVICE
MICHAEL L. MOHER and JOHN H. LODGE *In* Telesat Canada, The Future is Now! p 116-120 1989
Avail: Secretariat Office, P.O. Box 7190, Ottawa, ON K1L 8E3 Canada

The International Civil Aviation Organization (ICAO) Future Air Navigation Systems (FANS) committee, the Airlines Electronics Engineering Committee (AEEC), and Inmarsat have been developing standards for an aeronautical satellite communications service. These standards encompass a satellite communications system architecture to provide comprehensive aeronautical communications services. Incorporated into the architecture is a core service capability, providing only low rate data communications, which all service providers and all aircraft earth terminals are required to support. In this paper an implementation of the physical layer of this standard for the low data rate core service is described. This is a completely digital modem (up to a low intermediate frequency). The implementation uses a single TMS320C25 chip for the transmit baseband functions of scrambling, encoding, interleaving, block formatting and modulation. The receiver baseband unit uses a dual processor configuration to implement the functions of demodulation, synchronization, de-interleaving, decoding and de-scrambling. The hardware requirements, the software structure and the algorithms of this implementation are described. Author (CISTI)

N92-22572# Department of Communications, Ottawa (Ontario). Mobile Satellite Terminal Development Group.
DESIGN CONSIDERATIONS FOR GENERAL AVIATION MOBILE SATELLITE TERMINALS
JOHN T. SYDOR *In* Telesat Canada, The Future is Now! p 190-194 1989
Avail: Secretariat Office, P.O. Box 7190, Ottawa, ON K1L 8E3 Canada

Satellite mobile voice communications terminals for general aviation jets, helicopters, and propeller driven aircraft must be designed in a manner that will reduce the size, weight, and installation complexity of the terminal. Discrete radio frequency (RF) hardware components used to carry out signal transmission, reception, amplification, and filtering must be integrated through the use of microminiature microwave integrated circuitry (MMIC) or eliminated altogether. Terminal functions such as antenna beam forming and steering, Doppler shift elimination, automatic frequency correction, and the generation of high stability frequency references, will be achieved using relatively simple hardware in conjunction with adaptive controllers. Digital signal processing (DSP) microprocessors will be used for all terminal signal processing functions with the integration of control, modulation, and coding software. Ultimately the terminal will become two distinct physical layers. One being composed of a highly integrated RF front end that interfaces with a second layer providing DSP. Such terminals will be designed to minimize the effect on the aircraft's airframe, reduce installation time, and conform with all aviation certification requirements. Author (CISTI)

N92-22573# Transport Canada Aviation, Ottawa (Ontario).
AERONAUTICAL MOBILE SATELLITE SERVICE: AN OVERVIEW
JACK RIGLEY *In* Telesat Canada, The Future is Now! p 195-198 1989
Avail: Secretariat Office, P.O. Box 7190, Ottawa, ON K1L 8E3 Canada

Successful flight trials of Aeronautical Mobile Satellite Services (AMSS) were first carried out in the 1960's but it is only in the past few years that plans to implement such a system have achieved any degree of certainty. System architecture has been agreed upon by users, service providers, and manufacturers. Detailed avionic characteristics have been approved and the International Civil Aviation Organization is currently preparing AMSS standards which will ensure the safety and regularity of international air traffic. In this paper, a review is provided of the history of AMSS, especially of Canadian participation, and a description of the technical and operational features of the system are given. The system will use the 1545-1555 and 1646.5-1656.5 MHz bands for satellite to aircraft and aircraft to satellite communication. Different categories of communication including air traffic control, aeronautical operational control, aeronautical administrative communications, and aeronautical passenger communication, will be assigned different priorities. A set of radio frequency (RF) channels have been defined to accommodate all foreseen traffic types. Standards for the avionics required for large passenger planes have been developed by the Airlines Electronic Engineering Committee. Author (CISTI)

N92-22577# Department of Communications, Ottawa (Ontario).
EVALUATING THE USE OF SATELLITE COMMUNICATIONS IN THE GOVERNMENT OF CANADA
HOWARD L. MACUMBER and OSWALD HOCH *In* Telesat Canada, The Future is Now! p 269-273 1989
Avail: Secretariat Office, P.O. Box 7190, Ottawa, ON K1L 8E3 Canada

The Canadian Government Telecommunications Agency (GTA) has recently introduced the Government Satellite Network (GSN) for data, voice, and image communications. Three major field trials of this network have been undertaken, two involving time division multiple access (TDMA) and the third involving a single channel per carrier (SCPC) system. It was found that telecommunication delays experienced with single hop satellite communications had minimal effect but double hop systems seriously interfered with voice communications. The quality of transmitted facsimile images were equal or superior to those transmitted over terrestrial lines. Data transmission quality varied from excellent to unacceptable under moderate line loading. The SCPC system was used in trials

involving the Canadian Coast Guard and the Air Administration. In an Air Administrative application, users were unable to differentiate between transmission over satellite and terrestrial channels. A demonstration has been established to enable government departments to evaluate satellite communications applications, and to verify essential aspects of system functionality and performance. Author (CISTI)

N92-22641# European Space Agency, Paris (France).
INVESTIGATION OF THE DYNAMIC BEHAVIOUR AND THE FREQUENCY RESPONSE OF THE GG 1342 LASER GYRO
HELMUT NIEDERSTRASSER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Nov. 1991 100 p Transl. into ENGLISH of Untersuchung des Dynamischen Verhaltens und Vermessung der Uebertragungsfunktion des Laserkreisels GG 1342 (Brunswick, Fed. Republic of Germany, DLR), Jan. 1990 95 p Original language document was announced as N91-12070
(ESA-TT-1236; DLR-FB-90-22; ETN-92-91206) Avail: NTIS HC/MF A05

The dynamic behavior of a laser gyro under conditions of angular vibrations and constant rates of rotation is investigated on a single axis turntable. It is demonstrated that a laser gyro for inertial navigation also meets flight control requirements. The gyro behavior is represented by power density spectra of its measured rate of rotation and by its transfer function. A measuring system consisting of inductosyn, tachometer, and linear accelerometer serves as hybrid rotational speed reference. The characteristics of the gyro rate measurements, for example the measurement noise and the other reaction motion, are discussed. ESA

N92-22649*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A PARALLEL-VECTOR ALGORITHM FOR RAPID STRUCTURAL ANALYSIS ON HIGH-PERFORMANCE COMPUTERS
OLAF O. STORAASLI, DUC T. NGUYEN, and TARUN K. AGARWAL (Old Dominion Univ., Norfolk, VA.) Apr. 1990 20 p Presented at the AIAA/ASME/ASCE/AHS 31st Structures, Structural Dynamics and Materials Conference, Long Beach, CA, 2-4 Apr. 1990 Previously announced in IAA as A90-29293
(Contract NAG1-858; RTOP 505-63-01-10)
(NASA-TM-102614; NAS 1.15:102614; AIAA-90-1149) Avail: NTIS HC/MF A03 CSCL 20/11

A fast, accurate Choleski method for the solution of symmetric systems of linear equations is presented. This direct method is based on a variable-band storage scheme and takes advantage of column heights to reduce the number of operations in the Choleski factorization. The method employs parallel computation in the outermost DO-loop and vector computation via the loop unrolling technique in the innermost DO-loop. The method avoids computations with zeros outside the column heights, and as an option, zeros inside the band. The close relationship between Choleski and Gauss elimination methods is examined. The minor changes required to convert the Choleski code to a Gauss code to solve non-positive-definite symmetric systems of equations are identified. The results for two large scale structural analyses performed on supercomputers, demonstrate the accuracy and speed of the method. Author

N92-22662*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
METHODOLOGY FOR SENSITIVITY ANALYSIS, APPROXIMATE ANALYSIS, AND DESIGN OPTIMIZATION IN CFD FOR MULTIDISCIPLINARY APPLICATIONS Progress Report, 15 Apr. 1991 - 14 Apr. 1992
ARTHUR C. TAYLOR, III and GENE W. HOU Apr. 1992 70 p
(Contract NAG1-1265)
(NASA-CR-190201; NAS 1.26:190201) Avail: NTIS HC/MF A04 CSCL 20/4

Fundamental equations of aerodynamic sensitivity analysis and approximate analysis for the two dimensional thin layer Navier-Stokes equations are reviewed, and special boundary condition considerations necessary to apply these equations to isolated lifting airfoils on 'C' and 'O' meshes are discussed in detail. An efficient strategy which is based on the finite element method and an elastic membrane representation of the computational domain is successfully tested, which circumvents the costly 'brute force' method of obtaining grid sensitivity derivatives, and is also useful in mesh regeneration. The issue of turbulence modeling is addressed in a preliminary study. Aerodynamic shape sensitivity derivatives are efficiently calculated, and their accuracy is validated on two viscous test problems, including: (1) internal flow through a double throat nozzle, and (2) external flow over a NACA 4-digit airfoil. An automated aerodynamic design optimization strategy is outlined which includes the use of a design optimization program, an aerodynamic flow analysis code, an aerodynamic sensitivity and approximate analysis code, and a mesh regeneration and grid sensitivity analysis code. Application of the optimization methodology to the two test problems in each case resulted in a new design having a significantly improved performance in the aerodynamic response of interest. Author

N92-22688*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FORCE LIMITED VIBRATION TESTING
TERRY D. SCHARTON *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 2 p 105-115 Dec. 1991
Avail: NTIS HC/MF A22 CSCL 20/11

A new method of conducting lab vibration tests of spacecraft equipment was developed to more closely simulate the vibration environment experienced when the spacecraft is launched on a rocket. The improved tests are tailored to identify equipment design and workmanship problems without inducing artificial failures that would not have occurred at launch. These new, less destructive types of vibration tests are essential to JPL's protoflight test approach in which lab testing is conducted using the flight equipment, often one of a kind, to save time and money. In conventional vibration tests, only the input vibratory motion is specified; the feedback, or reaction force, between the test item and the vibration machine is ignored. Most test failures occur when the test item goes into resonance, and the reaction force becomes very large. It has long been recognized that the large reaction force is a test artifact which does not occur with the lightweight, flexible mounting structures characteristic of spacecraft and space vehicles. In new vibration tests, both the motion and the force provided to the test item by the vibration machine are controlled, so that the vibration ride experienced by the test item is as in flight. Author

N92-22692*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INFLATABLE TRAVERSING PROBE SEAL
PAUL A. TRIMARCHI *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 2 p 140-145 Dec. 1991
Avail: NTIS HC/MF A22 CSCL 13/11

An inflatable seal acts as a pressure-tight zipper to provide traversing capability for instrumentation rakes and probes. A specially designed probe segment with a teardrop cross-section in the vicinity of the inflatable seal minimizes leakage at the interface. The probe is able to travel through a lengthwise slot in a pressure vessel or wind tunnel section, while still maintaining pressure integrity. The design uses two commercially available inflatable seals, opposing each other, to cover the probe slot in a wind tunnel wall. Proof-of-concept tests were conducted at vessel pressures up to 30 psig, with seals inflated to 50 psig, showing no measurable leakage along the seal's length or around the probe teardrop cross-section. This seal concept can replace the existing technology of sliding face plate/O-ring systems in applications where lengthwise space is limited. Author

N92-22720*# Naval Postgraduate School, Monterey, CA. Dept. of Physics.
THERMOACOUSTIC REFRIGERATION

STEVEN L. GARRETT and THOMAS J. HOFLER *In* NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 2 p 397-406 Dec. 1991 Sponsored in part by ONR and Office of Naval Technology
Avail: NTIS HC/MF A22 CSCL 13/2

A new refrigerator which uses resonant high amplitude sound in inert gases to pump heat is described and demonstrated. The phasing of the thermoacoustic cycle is provided by thermal conduction. This 'natural' phasing allows the entire refrigerator to operate with only one moving part (the loudspeaker diaphragm). The thermoacoustic refrigerator has no sliding seals, requires no lubrication, uses only low-tolerance machine parts, and contains no expensive components. Because the compressor moving mass is typically small and the oscillation frequency is high, the small amount of vibration is very easily isolated. This low vibration and lack of sliding seals makes thermoacoustic refrigeration an excellent candidate for food refrigeration and commercial/residential air conditioning applications. The design, fabrication, and performance of the first practical, autonomous thermoacoustic refrigerator, which will be flown on the Space Shuttle (STS-42), are described, and designs for terrestrial applications are presented. Author

N92-23154*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARISON OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL DROPLET TRAJECTORY CALCULATIONS IN THE VICINITY OF FINITE WINGS
STANLEY R. MOHLER, JR. (Sverdrup Technology, Inc., Brook Park, OH.) and COLIN S. BIDWELL 1992 34 p Presented at the 30th Aerospace Sciences Meeting, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA Previously announced in IAA as A92-28215
(Contract RTOP 505-68-10)
(NASA-TM-105617; E-6806; NAS 1.15:105617; AIAA-92-0645)
Avail: NTIS HC/MF A03 CSCL 20/4

Computational predictions of ice accretion on flying aircraft most commonly rely on modeling in two dimensions (2D). These 2D methods treat an aircraft geometry either as wing-like with infinite span, or as an axisymmetric body. Recently, fully three dimensional (3D) methods have been introduced that model an aircrafts true 3D shape. Because 3D methods are more computationally expensive than 2D methods, 2D methods continue to be widely used. However, a 3D method allows us to investigate whether it is valid to continue applying 2D methods to a finite wing. The extent of disagreement between LEWICE, a 2D method, and LEWICE3D, a 3D method, in calculating local collection efficiencies at the leading edge of finite wings is investigated in this paper. Author

N92-23251# Technische Univ., Twente (Netherlands). Faculty of Applied Mathematics.
IMPROVED SHOCK-CAPTURING OF JAMESON'S SCHEME FOR THE EULER EQUATIONS
J. W. VANDERBURG, J. G. M. KUERTEN, and P. J. ZANDBERGEN Sep. 1991 29 p
(PB92-148758; MEMO-997) Avail: NTIS HC/MF A03 CSCL 20/4

It is known that Jameson's scheme is a pseudo-second-order accurate scheme for solving discrete conservation laws. The scheme contains a nonlinear artificial dissipative flux which is designed to capture shocks. It is shown that the shock-capturing of Jameson's scheme for the Euler equations can be improved by replacing the Lax-Friedrichs' type of dissipative flux with Roe's dissipative flux. The replacement is at a moderate expense of the calculation time. GRA

N92-23267*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COUPLED MULTI-DISCIPLINARY SIMULATION OF COMPOSITE ENGINE STRUCTURES IN PROPULSION ENVIRONMENT
CHRISTOS C. CHAMIS and SURENDRA N. SINGHAL (Sverdrup Technology, Inc., Brook Park, OH.) 1992 24 p Proposed for presentation at the International Gas Turbine and Aeroengine Congress and Exposition, Cologne, Fed. Republic of Germany, 1-4 Jun. 1991
(Contract NAS3-25266; RTOP 505-63-53)
(NASA-TM-105575; E-6901; NAS 1.15:105575) Avail: NTIS HC/MF A03 CSCL 20/11

A computational simulation procedure is described for the coupled response of multi-layered multi-material composite engine structural components which are subjected to simultaneous multi-disciplinary thermal, structural, vibration, and acoustic loadings including the effect of hostile environments. The simulation is based on a three dimensional finite element analysis technique in conjunction with structural mechanics codes and with acoustic analysis methods. The composite material behavior is assessed at the various composite scales, i.e., the laminate/ply/constituents (fiber/matrix), via a nonlinear material characterization model. Sample cases exhibiting nonlinear geometrical, material, loading, and environmental behavior of aircraft engine fan blades, are presented. Results for deformed shape, vibration frequency, mode shapes, and acoustic noise emitted from the fan blade, are discussed for their coupled effect in hot and humid environments. Results such as acoustic noise for coupled composite-mechanics/heat transfer/structural/vibration/acoustic analyses demonstrate the effectiveness of coupled multi-disciplinary computational simulation and the various advantages of composite materials compared to metals. Author

N92-23352*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF A NEW FLUX SPLITTING SCHEME
MENG-SING LIOU and CHRISTOPHER J. STEFFEN, JR. *In its* Center for Modeling of Turbulence and Transition (CMOTT). Research Briefs: 1990 p 144-145 Oct. 1991 Previously announced in IAA as A91-40793
Avail: NTIS HC/MF A08 CSCL 20/4

The use of a new splitting scheme, the advection upstream splitting method, for model aerodynamic problems where Van Leer and Roe schemes had failed previously is discussed. The present scheme is based on splitting in which the convective and pressure terms are separated and treated differently depending on the underlying physical conditions. The present method is found to be both simple and accurate. Author

N92-23435*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH TEMPERATURE DYNAMIC ENGINE SEAL TECHNOLOGY DEVELOPMENT
BRUCE M. STEINETZ, CHRISTOPHER DELLACORTE, MICHAEL MACHINCHICK, RAJAKKANNU MUTHARASAN, GUANG-WU DU, FRANK KO, PAUL J. SIROCKY, and JEFFREY H. MILLER (Sverdrup Technology, Inc., Brook Park, OH.) 1992 24 p Presented at the National Aerospace Plane Mid-Term Technology Review, Monterey, CA, 20-24 Apr. 1992
(Contract RTOP 763-22-41)
(NASA-TM-105641; E-6945; NAS 1.15:105641) Avail: NTIS HC/MF A03 CSCL 13/9

Combined cycle ramjet/scramjet engines being designed for advanced hypersonic vehicles, including the National Aerospace Plane (NASP), require innovative high temperature dynamic seals to seal the sliding interfaces of the articulated engine panels. New seals are required that will operate hot (1200 to 2000 F), seal pressures ranging from 0 to 100 psi, remain flexible to accommodate significant sidewall distortions, and resist abrasion over the engine's operational life. This report reviews the recent high temperature durability screening assessments of a new braided rope seal concept, braided of emerging high temperature materials, that shows promise of meeting many of the seal demands of hypersonic engines. The paper presents durability data for: (1) the fundamental seal building blocks, a range of candidate ceramic fiber tows; and for (2) braided rope seal subelements scrubbed under engine simulated sliding, temperature, and preload conditions. Seal material/architecture attributes and limitations are

identified through the investigations performed. The paper summarizes the current seal technology development status and presents areas in which future work will be performed. Author

N92-23496# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Electromechanics.
ANALYSIS OF A 37 KW CAGE-INDUCTION MOTOR
A. ARKKIO 1991 69 p
(PB92-142116; ISBN-951-22-0757-5) Avail: NTIS HC/MF A04
CSCL 09/1

An analysis was made of a 37 kW cage induction motor. The operating characteristics of the motor fed by a PWM frequency convertor are studied. Special attention is given to the additional losses caused by the convertor supply and suggestions are made on how to reduce these losses. The calculation of the motor is based on a time stepping, finite element analysis of the electromagnetic field. The field is assumed to be two dimensional. The time dependence of the field and the motion of the rotor are modeled by the Crank-Nicholson method. The nonsinusoidal voltage supplied by the frequency convertor is imposed on the formulation through the circuit equations of the winding. A new rotor specially designed for convertor drives was constructed for the 37 kW motor using the ideas obtained from the analysis. The characteristics measured for the motor equipped with the original rotor are compared with those measured for the new rotor. The new rotor has lower losses and thus produces a smaller temperature rise especially at the low frequency region of operation. Author

N92-23560*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A TWO-DIMENSIONAL EULER SOLUTION FOR AN UNBLADED JET ENGINE CONFIGURATION
MARK E. M. STEWART Apr. 1992 10 p Presented at the Third Canadian Symposium on Aerodynamics, Toronto (Ontario), 20-21 Nov. 1991; sponsored by the Canadian Aeronautics and Space Inst.
(Contract NASA ORDER C-99066-G)
(NASA-TM-105329; ICOMP-91-22; E-6691; NAS 1.15:105329)
Avail: NTIS HC/MF A02 CSCL 20/4

A two dimensional, nonaxisymmetric Euler solution in a geometry representative of a jet engine configuration without blades is presented. The domain, including internal and external flow, is covered with a multiblock grid. In order to construct this grid, a domain decomposition technique is used to subdivide the domain, and smooth grids are dimensioned and placed in each block. The Euler solution is verified by examining five theoretical properties. The result demonstrates techniques for performing numerical solutions in complex geometries and provides a foundation for complete engine throughflow calculations. Author

N92-23997 Virginia Polytechnic Inst. and State Univ., Blacksburg.
NUMERICAL SIMULATIONS OF WAKES, BLADE-VORTEX INTERACTION, FLUTTER, AND FLUTTER SUPPRESSION BY FEEDBACK CONTROL Ph.D. Thesis
BONIAN DONG 1991 191 p
Avail: Univ. Microfilms Order No. DA9204637

A general aerodynamic model for 2-D inviscid flows was developed. This model was used to simulate wakes and blade-vortex interaction. It was also coupled with dynamics and feedback controls to simulate flutter and flutter suppression. The flow was assumed to be attached and incompressible. The model was based on a vorticity panel method coupled with vortex dynamics. The model was used to simulate some actual experiments: wakes generated by oscillating airfoils and blade-vortex interactions in which one airfoil was placed in or near the wake generated by another oscillating airfoil upstream. Flutter was studied by means of numerical simulations. In an incompressible flow, an airfoil was mounted on an elastic support. The airfoil can pitch (rotate) and plunge (translate vertically). The coupled aerodynamic model accurately predicts the critical flutter speed of the freestream, the speed at which the motion of the airfoil grows spontaneously. A feedback control was coupled with aerodynamics to suppress the flutter motion of the airfoil. A flap was added at the trailing edge of the airfoil as a control surface, and its deflection (rotation) about the hinge point was commanded by a feedback control law. Dissert. Abstr.

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A92-34878
COMPARISON OF AIRCRAFT SYNTHETIC APERTURE RADAR AND BUOY SPECTRA DURING NORCSEX '88
C. L. RUFENACH, R. A. SHUCHMAN (Michigan, Environmental Research Institute, Ann Arbor), and J. A. JOHANNESSEN (Nansen Environmental and Remote Sensing Center, Bergen, Norway) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 129-132. refs
(Contract N00014-81-C-0692)
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Aircraft synthetic-aperture-radar (SAR) measurements from seven flight paths at two different altitudes were acquired over a trimodal ocean wave system off the coast of Norway on March 11, 1988. The seven flight paths, in conjunction with the three wave systems, resulted in a nearly uniform distribution of azimuth peak directions varying from 0 to 83 deg and R/V varying from 28 to 100. The SAR derived and buoy peak wavelength and direction comparison show some scatter and bias. The scatter is thought to be primarily due to the statistical uncertainty in the spectral estimates, the wavenumber resolution, and differences in the temporal and spatial averaging. Scanning distortion, in addition to other SAR motions effects, can result in significant bias in the image wave systems. I.E.

A92-34908
DEVELOPMENT OF A 3-D REMOTE SENSING RADAR
JUHA KOIVULA and MARTTI HALLIKAINEN (Helsinki University of Technology, Espoo, Finland) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 263, 264. refs
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Development of an imaging multipolarization airborne radar is discussed. The goal of the project is to combine some of the properties of the three main remote-sensing radar types (polarimeter, altimeter, synthetic-aperture radar) in a single sensor. A 3-D radar provides three-dimensional images of the target simultaneously at several polarization combinations. The basis for the study was the development of an eight-channel helicopter-borne scatterometer called HUTSCAT, completed in 1990. The radar was designed especially for remote sensing of forests; it measure the backscattering profile of trees with a range (height) resolution of 1 m from a narrow swath under the helicopter. The HUT signal simulator system is described. The main application of an airborne 3-D imaging radar in Finland would be mapping of forest canopies. I.E.

A92-35028* National Aeronautics and Space Administration, Washington, DC.
RELATING THE MICROWAVE RADAR CROSS SECTION TO THE SEA SURFACE STRESS - PHYSICS AND ALGORITHMS
DAVID E. WEISSMAN (Hofstra University, Hempstead, NY), WILLIAM J. PLANT (Woods Hole Oceanographic Institution, MA),

ROBERT A. BROWN (Washington, University, Seattle), KENNETH L. DAVIDSON (U.S. Naval Postgraduate School, Monterey, CA), and WILLIAM J. SHAW (Battelle Pacific Northwest Laboratories, Richland, WA) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 867-871. Research supported by NASA, U.S. Navy, and NSF. refs
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The FASINEX (Frontal Air-Sea Interaction Experiment) provided a unique data set with coincident airborne measurements of the ocean surface radar cross section (at Ku-band) and surface windstress. It is being analyzed to create new algorithms and to better understand the air-sea variables that can have a strong influence on the RCS (radar cross section). Several studies of portions of data from the FASINEX indicate that the RCS is more dependent on the surface stress than on the wind speed. Radar data have been acquired by the JPL and NRL groups. The data span 12 different flight days. Stress measurements can be inferred from ship-board instruments and from aircraft closely following the scatterometers. I.E.

A92-35109
INTERACTIVE GRAPHICS METHOD FOR REMOVAL OF HELICOPTER MOTIONS FROM LASER PROFILE DATA
HARDY B. GRANBERG (Sherbrooke, Universite, Canada) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1243-1246. Research supported by Finnish Institute of Marine Research. refs
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The analysis of laser profiles obtained from a helicopter during the Bothnian Experiment in Preparation for ERS-1 (BEPERS-88) and the Finnish Antarctic Expedition (FINNARP 1989) prompt the development of an interactive graphics technique for removal of the effects of the movements of the remote-sensing platform. The technique is similar in concept to that used by Lowry and Brochu (1978), but in addition to finding the aircraft trajectory the present technique also interactively determines cutoff limits for wild data points. The profile-analysis routines are implemented on a portable computer equipped with an HP-BASIC language processor. I.E.

A92-35132* *National Aeronautics and Space Administration.* Goddard Space Flight Center, Greenbelt, MD.
THE APPLICATION OF HIGH SPECTRAL AND SPATIAL RESOLUTION IMAGING SPECTROMETERS FOR LOCATING DOWNED AIRCRAFT
JAMES A. GATLIN, ELIZABETH M. MIDDLETON, JAMES R. IRONS, and JON W. ROBINSON (NASA, Goddard Space Flight Center; STX, Inc., Greenbelt, MD) IN: IGARSS '91; Proceedings of the 11th Annual International Geoscience and Remote Sensing Symposium, Espoo, Finland, June 3-6, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1363-1366. refs
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The utility of high-resolution imaging spectrometer data is examined as an aid in locating downed aircraft by using a unique spectral signature while not requiring the extremely high spatial resolution needed to identify an aircraft by shape. Ground spectral measurements of several airplane wings, overflight spectral measurements of aircraft scenes, and the rationale for the chosen spectral signature are presented. It is concluded that imaging spectrometers which can detect and spatially locate a narrow-band spectral signature filling only a few pixels appear to have a utility for search and rescue aircraft or satellite systems as a aid in locating small downed aircraft. This spectral feature would have to be added to the surface coatings applied to aircraft. Proposed for use as such a spectral signature is a significant negative reflectance slope, in the 520 to 580 nm interval. I.E.

N92-22770*# Johnson Controls, Inc., Milwaukee, WI.
NICKEL HYDROGEN COMMON PRESSURE VESSEL BATTERY DEVELOPMENT
KENNETH R. JONES and JEFFREY P. ZAGRODNIK *In* NASA. Marshall Space Flight Center, The 1991 NASA Aerospace Battery Workshop p 667-673 Feb. 1992
Avail: NTIS HC/MF A99 CSCL 10/2

Our present design for a common pressure vessel (CPV) battery, a nickel hydrogen battery system to combine all of the cells into a common pressure vessel, uses an open disk which allows the cell to be set into a shallow cavity; subsequent cells are stacked on each other with the total number based on the battery voltage required. This approach not only eliminates the assembly error threat, but also more readily assures equal contact pressure to the heat fin between each cell, which further assures balanced heat transfer. These heat fin dishes with their appropriate cell stacks are held together with tie bars which in turn are connected to the pressure vessel weld rings at each end of the tube.
Author

N92-22971# Midwest Research Inst., Golden, CO.
SERI ADVANCED WIND TURBINE BLADES
J. TANGLER, B. SMITH, and D. JAGER Feb. 1992 6 p Presented at the World Congress of the International Solar Energy Society, Denver, CO, 19-23 Aug. 1991
(Contract DE-AC02-83CH-10093)
(DE92-001216; NREL/TP-257-4492; CONF-910802-3) Avail: NTIS HC/MF A02

The primary goal of the Solar Energy Research Institute's (SERI) advanced wind turbine blades is to convert the kinetic energy in the wind into mechanical energy in an inexpensive and efficient manner. To accomplish this goal, advanced wind turbine blades have been developed by SERI that utilize unique airfoil technology. Performance characteristics of the advanced blades were verified through atmospheric testing on fixed-pitch, stall-regulated horizontal-axis wind turbines (HAWTs). Of the various wind turbine configurations, the stall-regulated HAWT dominates the market because of its simplicity and low cost. Results of the atmospheric tests show that the SERI advanced blades produce 10 percent to 30 percent more energy than conventional blades. DOE

N92-23119# Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
MEASURED AND PREDICTED ROTOR PERFORMANCE FOR THE SERI ADVANCED WIND TURBINE BLADES
J. TANGLER, B. SMITH, N. KELLEY, and D. JAGER Feb. 1992 7 p Presented at the Windpower '91: 21st American Wind Energy Association (AWEA) Conference, Palm Springs, CA, 24-27 Sep. 1991
(Contract DE-AC02-83CH-10093)
(DE92-001215; NREL/TP-257-4594; CONF-9109112-9) Avail: NTIS HC/MF A02

Measured and predicted rotor performance for the Solar Energy Research Institute (SERI) advanced wind turbine blades were compared to assess the accuracy of predictions and to identify the sources of error affecting both predictions and measurements. An awareness of these sources of error contributes to improved prediction and measurement methods that will ultimately benefit future rotor design efforts. Propeller/vane anemometers were found to underestimate the wind speed in turbulent environments such as the San Gorgonio Pass wind farm area. Using sonic or cup anemometers, good agreement was achieved between predicted and measured power output for wind speeds up to 8 m/sec. At higher wind speeds an optimistic predicted power output and the occurrence of peak power at wind speeds lower than measurements resulted from the omission of turbulence and yaw error. In addition, accurate two-dimensional (2-D) airfoil data prior to stall and a post stall airfoil data synthesization method that reflects three-dimensional (3-D) effects were found to be essential for accurate performance prediction. DOE

N92-23383# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
RECOMMENDED SYSTEM CONCEPT [VORGESCHLAGENES SYSTEMKONZEPT]
C. BOESSWETTER *In its* Euromar-Seastars: A Definition Study on Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 4 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

It is shown that microwave sensors are mainly used for the detection and measurement of surface effects, and that only a multispectral measurement system with several independent sensor principles is able to give a unique interpretation of the phenomena. Such a system is not currently available, either in Germany or in Europe. It should include modular instrumentation on different carrier aircraft, possibilities of integration of sensor systems from the European Euromar countries by standardization, optoelectronic and microwave sensors, and distribution of multisensor data in all interested institutions of Euromar countries. ESA

N92-23387# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
THE IMAGING SPECTROMETER [ABBILDENDES SPEKTROMETER]
B. KUNKEL *In its* Euromar-Seastars: A Definition Study of Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 46 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

EURIS (Euromar Imaging Spectrometer) is a modified derivative of the ROSIS (Reflective Optics Systems Imaging Spectrometer) airborne version. It is a fully electronic scanning instrument, in both spatial and spectral dimensions, which operates with all reflective objective and spectrometer optics, and allows for a wide spectral range coverage. The main applications are described: biomass determination through chlorophyll absorption and fluorescence measurements; discrimination of algae species; and turbidity and sediment transport determination. The main system parameters are summarized. ESA

N92-23391# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
THE IMAGING RADAR SYSTEM [ABBILDENDE RADAR-SYSTEME]
A. P. WOLFRAMM *In its* Euromar-Seastars: A Definition Study on Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 24 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

It is shown that radar instruments can be used under almost all weather conditions, as compared with optical sensors. Synthetic Aperture Radar (SAR), Side Looking Airborne Radar (SLAR), and Forward Looking Airborne Radar (FLAR) are described. Their missions are presented. Two main operational radar modes are identified. Their specific parameters are given. ESA

N92-23393# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
QUICK-LOOK SYSTEM [QUICK-LOOK SYSTEM]
P. HICKS *In its* Euromar-Seastars: A Definition Study on Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 16 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

The requirements of the quick look system on board the measuring aircraft are described. Recommendations for the implementation of such a system are given. The functions of the quick look system are presented: sensor checking, sensor mode, control of the flight path, and first collection of measuring results. ESA

N92-23402# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
PRECONSIDERATIONS ON AIRCRAFT INTEGRATION [VORUEBERLEGUNGEN ZUR FLUGZEUG-INTEGRATION]
H. FINKENZELLER *In* MBB, Euromar-Seastars: A Definition Study on Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 4 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

Preconsiderations were envisaged in the integration of the various sensors and subsystems in the aircraft belonging to the German air and space institution. These preconsiderations could not be carried out because of lack of cooperation in the definition phase. The assembly configuration for the DO 228 LM aircraft is shown as an example. ESA

N92-23403# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
SENSOR COMPATIBILITY/OPTIMAL SENSOR COMBINATIONS [SENSOR-VERTRAEGLICHKEIT/OPTIMALE SENSOR-KOMBINATIONEN]
C. BOESSWETTER *In its* Euromar-Seastars: A Definition Study on Modular Multisensor Instrumentation for Airborne Remote Sensing of the Sea 2 p May 1991 In GERMAN
Avail: NTIS HC/MF A19

It is shown that the sensors considered scan extraordinary wide bandwidth. They cover practically the whole electromagnetic spectrum which is significant for the examination of ocean situation. Sensor compatibility is examined using examples such as the reaction of pilot radiotelephony on simultaneously operating radar or microwave radiometer system. The influence of sensors on the propagation path can be neglected. The most important restrictions result from the limited payload capacity and power consumption of all aircraft carriers considered. ESA

N92-23441# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Space Technology.
DEVELOPMENT OF A HELICOPTER-BORNE 8-CHANNEL RANGING SCATTEROMETER
J. HYYPPAE and M. HALLIKAINEN Jul. 1991 29 p (PB92-141977; ISBN-951-22-0733-8; REPT-4) Avail: NTIS HC/MF A03 CSCL 14/2

A helicopter-borne dual-frequency FM-CW scatterometer (Helsinki University of Technology Scatterometer (HUTSCAT)) is described. The HUTSCAT can measure the backscattering properties of a target with a range resolution of 65 cm. This is accomplished by performing the Fast Fourier Transform (FFT) to the received time-domain signal. The measurement is made simultaneously at eight channels. The scatterometer measures the radar return spectrum for eight channels in 16.6 ms which corresponds to an along-track distance of 0.33 m for the helicopter speed of 20 m/s. GRA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A92-32542
THE INITIAL DEVELOPMENT OF AN EXPERT SYSTEM FOR DESIGNING COMPOSITE MATERIAL WING STRUCTURES
J. L. CHEN (National Cheng Kung University, Tainan, Republic of China), W.-C. HWANG (Chung Shan Institute of Science and Technology, Lungtan, Republic of China), and S.-H. SUN (National Cheng Kung University, Tainan, Republic of China) IN: Composites; Proceedings of the 8th International Conference on Composite Materials (ICCM/8), Honolulu, HI, July 15-19, 1991. Section 1-11. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 1-G-1 to 1-G-10. refs

This paper describes an initial implementation of an expert system for designing composite material wing structures. Currently, this expert system contains two subsystems for composite material

selection and preliminary configuration arrangement of wing structures. The overall architecture of this system and the structure of the knowledge base, knowledge representation, and inference engine used in this system are presented. The present capabilities of this expert system are demonstrated with example. Author

A92-33191#
POTENTIAL ROLE OF NEURAL NETWORKS AND FUZZY LOGIC IN FLIGHT CONTROL DESIGN AND DEVELOPMENT
MARC STEINBERG (U.S. Navy, Naval Air Warfare Center, Warminster, PA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(AIAA PAPER 92-0999)

Neural network and fuzzy logic technology has the potential to substantially alter future flight control systems. In its most conservative use, this technology may yield powerful flight control law design tools. In more extensive uses, this technology may simplify or improve lengthy expensive development phases, such as control system tuning in flight testing and flight control software development. Neural network and fuzzy logic technology may augment conventional flight control systems or provide completely new capabilities, such as on-line learning. This paper identifies some of the possible uses of this technology, and describes how these uses might affect the flight control system design and development process for manned fixed wing aircraft. Much of this is based on and illustrated by results from an ongoing Navy program to assess the suitability of neural networks and fuzzy logic for application to advanced flight control systems. Author

A92-33300#
CONCEPTS FOR A FUTURE AIRCRAFT DESIGN ENVIRONMENT
EUGENE E. BOUCHARD (Lockheed Advanced Development Co., Burbank, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 15 p. refs
(AIAA PAPER 92-1188) Copyright

One of the means to the efficient exploration of aerospace 'design space' is the use of extremely flexible tools for parametric design, which may be regarded as the task of making those decisions which furnish values for quantities needed to create a specific object from an overall concept for that type of object. The Engineer's Scratch Pad (ESP) is a software system for the implementation of just such a parametric-design strategy which specifies the calculations to be performed via some combination of equations and data-flow diagrams. ESP has been successfully applied in recent years to vehicle conceptual design, environmental control system design, heat-exchanger design, and production-process analyses. O.C.

A92-33301#
INTEGRATION OF ARTIFICIAL INTELLIGENCE AND NUMERICAL OPTIMIZATION TECHNIQUES FOR THE DESIGN OF COMPLEX AEROSPACE SYSTEMS
SIU S. TONG, DAVID POWELL (GE Corporate Research and Development Center, Schenectady, NY), and SANJAY GOEL (GE Consulting Services, Albany, NY) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. Research supported by General Electric Co. refs
(AIAA PAPER 92-1189) Copyright

A new software system called Engineous combines artificial intelligence and numerical methods for the design and optimization of complex aerospace systems. Engineous combines the advanced computational techniques of genetic algorithms, expert systems, and object-oriented programming with the conventional methods of numerical optimization and simulated annealing to create a design optimization environment that can be applied to computational models in various disciplines. Engineous has produced designs with higher predicted performance gains that current manual design processes - on average a 10-to-1 reduction of turnaround time - and has yielded new insights into product design. It has been applied to the aerodynamic preliminary design of an aircraft engine turbine, concurrent aerodynamic and mechanical preliminary design of an aircraft engine turbine blade and disk, a space superconductor generator, a satellite power converter, and a nuclear-powered satellite reactor and shield. Author

A92-33302# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN INTERACTIVE SYSTEM FOR AIRCRAFT DESIGN AND OPTIMIZATION
ILAN M. KROO (Stanford University, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 13 p. Research supported by NASA. refs
(AIAA PAPER 92-1190) Copyright

A system for aircraft design utilizing a unique analysis architecture, graphical interface, and suite of numerical optimization methods is described in this paper. The non-procedural architecture provides extensibility and efficiency not possible with conventional programming techniques. The interface for analysis and optimization, developed for use with this method, is described and its application to example problems is discussed. Author

A92-33303#
DESIGN SHEET - AN ENVIRONMENT FOR FACILITATING FLEXIBLE TRADE STUDIES DURING CONCEPTUAL DESIGN
M. J. BUCKLEY, K. W. FERTIG, and D. E. SMITH (Rockwell International Palo Alto Laboratory, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 14 p. refs
(AIAA PAPER 92-1191) Copyright

This paper summarizes the capabilities of Design Sheet, a software program that facilitates trade studies during conceptual design. Design Sheet permits the designer to build a model for use in conceptual design by entering a set of algebraic equations in a very flexible form. The designer can then use Design Sheet to easily change the set of independent variables in the algebraic model, and to rapidly perform trade studies, optimization, and sensitivity analyses. The basic mathematics and algorithms used in Design Sheet are outlined. The functionality of Design Sheet is illustrated first with a simple example, and then with a more complex example involving initial aircraft sizing. For realistic conceptual design problems, it is argued that Design Sheet provides the capability to perform trade studies with significantly increased flexibility and efficiency. Author

A92-33304*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONSTRAINT-BASED COMPONENT-MODELING FOR KNOWLEDGE-BASED DESIGN
MARK A. KOLB (GE Corporate Research and Development Center, Schenectady, NY) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p. Research sponsored by GE Aircraft Engines. refs
(Contract NAG2-478)
(AIAA PAPER 92-1192) Copyright

The paper describes the application of various advanced programming techniques derived from artificial intelligence research to the development of flexible design tools for conceptual design. Special attention is given to two techniques which appear to be readily applicable to such design tools: the constraint propagation technique and the object-oriented programming. The implementation of these techniques in a prototype computer tool, Rubber Airplane, is described. I.S.

A92-33306#
INTEGRATION OF SUPPORTABILITY ELEMENTS INTO THE CONCEPTUAL DESIGN PROCESS
STEVEN J. D'URSO, HOMER W. FANNIN, JR., and JAMES MACE (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 9 p.
(AIAA PAPER 92-1194) Copyright

This paper describes McDonnell Aircraft Company's approach to the integration of supportability into the advanced conceptual design process. Methods used to determine required level of supportability, evaluations to assess designs, and typical candidate design descriptors affecting supportability are delineated.

Application of these approaches to the Multirole Fighter studies in MCAIR's New Aircraft Products Division, as a pilot program is described. Author

A92-33345# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ACSYNT - A STANDARDS-BASED SYSTEM FOR PARAMETRIC, COMPUTER AIDED CONCEPTUAL DESIGN OF AIRCRAFT
S. JAYARAM (Virginia Polytechnic Institute and State University, Blacksburg), A. MYKLEBUST, and P. GELHAUSEN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 14 p. refs
(Contract NAG4-261)
(AIAA PAPER 92-1268) Copyright

A group of eight US aerospace companies together with several NASA and NAVY centers, led by NASA Ames Systems Analysis Branch, and Virginia Tech's CAD Laboratory agreed, through the assistance of Americal Technology Initiative, in 1990 to form the ACSYNT (Aircraft Synthesis) Institute. The Institute is supported by a Joint Sponsored Research Agreement to continue the research and development in computer aided conceptual design of aircraft initiated by NASA Ames Research Center and Virginia Tech's CAD Laboratory. The result of this collaboration, a feature-based, parametric computer aided aircraft conceptual design code called ACSYNT, is described. The code is based on analysis routines begun at NASA Ames in the early 1970's. ACSYNT's CAD system is based entirely on the ISO standard Programmer's Hierarchical Interactive Graphics System and is graphics-device independent. The code includes a highly interactive graphical user interface, automatically generated Hermite and B-Spline surface models, and shaded image displays. Numerous features to enhance aircraft conceptual design are described. Author

A92-33603
NEVER MAKE THE SAME MISTAKE TWICE - USING CONFIGURATION CONTROL AND ERROR ANALYSIS TO IMPROVE SOFTWARE QUALITY
JAMES M. HAUGH (IBM Corp., Federal Sector Div., Houston, TX) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, Jan. 1992, p. 12-16.
Copyright

To provide a controlled environment, changes to the Space Shuttle primary avionics system software have been grouped into operational increments (OIs) that identify a predefined set of changes and discrepancy corrections (a baseline) for that OI. Two early processes implemented were an automated configuration management database and a prologue in all the code modules. This allows a causal analysis program that permits each problem to be analyzed to determine the change authorization that caused the code modification that results in the problem. This causal analysis provides the information that is used for process improvement and to measure effectiveness. I.E.

A92-33607* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN FOR VALIDATION
SALLY C. JOHNSON and RICKY W. BUTLER (NASA, Langley Research Center, Hampton, VA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, Jan. 1992, p. 38-43. refs
Copyright

An approach is outlined for the development of ultrareliable avionics for civil air transports using a design-for-validation philosophy that includes rigorous application of formal methods. The basic concept of the methodology is introduced, and the role of formal methods is explored. The impact of the design-for-validation philosophy on the system design process is then demonstrated by two simple examples. More details about the design-for-validation methodology are then given. I.E.

A92-33754
SYNTHESIS OF OPTIMAL DIGITAL SYSTEMS FOR THE STABILIZATION OF STOCHASTICALLY PERTURBED UNSTABLE DYNAMIC SYSTEMS [SINTEZ OPTIMAL'NYKH TSIFROVYKH SISTEM STABILIZATSII STOKHASTICHESKI VOZMUSHCHENNYKH NEUSTOICHIVYKH DINAMICHESKIKH OB'EKTOV]
V. V. BELAN, M. I. RYZHKOV, and A. A. TUNIK (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukraine) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 89, 1991, p. 10-15. In Russian. refs
Copyright

The problem of the stabilization of a scalar unstable stochastically perturbed stationary linear plant is considered. The controller is synthesized for a discrete model in the frequency domain by the Wiener-Hopf method. As an example, attention is given to the synthesis of an optimal discrete system of helicopter stabilization with respect to the pitch angle, whose transfer function has an oscillatory instability. L.M.

A92-34542#
STRUCTURAL OPTIMIZATION AT AEROSPATIALE AIRCRAFT
CH. BES and J. LOCATELLI (Aerospatiale, Toulouse, France) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2619-2624. refs
(AIAA PAPER 92-2371) Copyright

The principal features of the first generation of structural optimization software developed at Aerospatiale Aircraft are briefly reviewed. In particular, attention is given to the design optimization model, optimization algorithms, an aircraft sizing and optimization procedure, and global and local identification techniques. Some new features and improvements that are expected to be incorporated into the second generation optimization software tools are outlined. V.L.

A92-34554#
IMPROVED COORDINATION IN NON-HIERARCHIC SYSTEM OPTIMIZATION
J. E. RENAUD and G. A. GABRIELE (Rensselaer Polytechnic Institute, Troy, NY) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 2730-2739. refs
(AIAA PAPER 92-2497) Copyright

An improved coordination procedure for the optimization of nonhierarchic systems by decomposition into reduced subspaces is presented. A subspace coordination procedure based on sequential global approximation is extended to include second-order information. This second-order global approximation is formed using information obtained during subspace optimizations. The use of second-order information in the coordination procedure results in improved convergence for nonhierarchic system optimization as compared to studies using a first-order coordination procedure. The same objective function and cumulative constraints are imposed at each subspace. Nonlocal functions are approximated at the subspaces using global sensitivities. The method optimizes subspace problems concurrently allowing for parallel processing. Following each sequence of concurrent subspace optimizations a second-order approximation of the global problem is formed using design data accumulated during the subspace optimizations. The solution of the global approximation problem is used as the starting point for subsequent subspace optimizations in an iterative solution procedure. Author

A92-34604#
AN EXPERT SYSTEM TO AID REAL WORLD FINITE ELEMENT ANALYSIS
N. I. MUNIR and J. N. KUDVA (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX,

Apr. 13-15, 1992, Technical Papers. Pt. 5. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 3226-3232. refs
(AIAA PAPER 92-2488) Copyright

FEVES, an expert system for aiding structural analysis and design using FEM is described. Using FEVES can reduce time, cast, and errors associated with developing structural finite element models by novice as well as experienced users. FEVES provides consistency in modeling, flags common modeling errors, and provides expertise on a timely basis. Using the airframe classification option together with FEVE allows the user to gain quick understanding of a large model in terms of airframe subcomponents. The main advantages of using FEVES are the automation of the tedious and error-prone task of classifying subcomponents in a large NASTRAN model and the automation of the error checking process, leading to consistent modeling practices by users. C.D.

A92-35739
AN APPLICATION OF DISTRIBUTED ENVIRONMENT IN FLIGHT SIMULATION
D. CANETTA, S. CERIANI, and D. EUFRI (Agusta S.p.A., Tradate, Italy) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 9 p. refs

A distributed-microprocessor 'transputer' computing environment is presently used to implement a flight simulator that is less expensive than those based on more conventional hardware. The computation modules used encompass: view-transform, clipping, perspective-transform, scan conversion, shading, and Z-buffer. Attention is given to the blade-element theory model proposed for faithful reproduction of rotor dynamics during simulations. O.C.

A92-35943
C.A.T.C.H. - COMPUTER AIDED TEST CONDUCTOR HANDBOOK: A METHOD FOR REDUCING COST, TIME AND EFFORT IN AN AIRCRAFT TEST AND CERTIFICATION PROGRAM
EDWARD M. DE REYES (Douglas Aircraft Co., Long Beach, CA) IN: Society of Flight Test Engineers, Annual Symposium, 21st, Garden Grove, CA, Aug. 6-10, 1990, Proceedings. Lancaster, CA, Society of Flight Test Engineers, 1990, p. 4.3-1 to 4.3-12.
Copyright

A92-36417
NONPARAMETRIC METHODS OF REGRESSION ANALYSIS IN PROBLEMS RELATED TO THE PROCESSING OF AERODYNAMIC BALANCE CALIBRATION TESTS [NEPARAMETRICHESKIE METODY REGRESSIONNOGO ANALIZA V ZADACHAKH OBRABOTKI KALIBROVOCHNYKH ISPYTANII AERODINAMICHESKIKH VESOV]
V. A. VASENIN and A. A. MAKAROV Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), no. 1, Jan.-Feb. 1992, p. 58-64. In Russian. refs
Copyright

The application of nonparametric methods of linear regression analysis to the processing of calibration test results for the measurement circuit of automatic control systems using aerodynamic scales as the primary measurement device is discussed. A nonparametric method for estimating the inclination angle in the problem of simple linear regression is proposed. The advantages of the method over the traditional approach are discussed, and the efficiency of the method is demonstrated by an example. V.L.

N92-22216# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
THREE-DIMENSIONAL MULTIGRID ALGORITHM FOR THE EULER AND THE THIN-LAYER NAVIER-STOKES EQUATIONS
T. SIIKONEN 30 Mar. 1991 33 p
(PB92-134329; SER-A-91-A12; ISBN-951-22-0602-3) Avail: NTIS HC/MF A03 CSCL 09/2

The 3-D thin-layer Navier-Stokes equations are solved in a finite-volume form. The scheme is cell-centered and the fluxes on the cell boundary are calculated applying the flux-vector splitting method of Van Leer or the flux-differnce splitting of Roe. The equations are solved by an LU-factored implicit time integration method with multigrid acceleration of convergence. The method is applied for calculating inviscid and viscous flows around the ONERA M6 wing. Turbulent viscosity is evaluated by an algebraic model. The simulations are compared with the results obtained elsewhere as well as with experimental data. These comparisons demonstrate the accuracy and efficiency of the method. GRA

N92-22320*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FORMAL DESIGN AND VERIFICATION OF A RELIABLE COMPUTING PLATFORM FOR REAL-TIME CONTROL. PHASE 2: RESULTS
RICKY W. BUTLER and BEN L. DIVITO (Vigyan Research Associates, Inc., Hampton, VA.) Jan. 1992 161 p
(Contract RTOP 505-64-10-05)
(NASA-TM-104196; NAS 1.15:104196) Avail: NTIS HC/MF A08 CSCL 09/2

The design and formal verification of the Reliable Computing Platform (RCP), a fault tolerant computing system for digital flight control applications is presented. The RCP uses N-Multiply Redundant (NMR) style redundancy to mask faults and internal majority voting to flush the effects of transient faults. The system is formally specified and verified using the Ehdm verification system. A major goal of this work is to provide the system with significant capability to withstand the effects of High Intensity Radiated Fields (HIRF). Author

N92-22493*# Akron Univ., OH. Dept. of Electrical Engineering
APPROXIMATE TRUNCATED BALANCED REALIZATIONS FOR INFINITE DIMENSIONAL SYSTEMS
TOM T. HARTLEY and J. ALEX DEABREU-GARCIA *In its* Improved Large Perturbation Propulsion Models for Control System Design (1988-1989) and Large Perturbation Models of High Velocity Propulsion Systems (1989-1990) and Reduced Order Propulsion Models for Control System Design (1990-1991) 14 p Dec. 1991
(Contract NAG3-904)
Avail: NTIS HC/MF A05 CSCL 12/1

This paper presents an approximate method for obtaining truncated balance realizations of systems represented by non-rational transfer functions, that is infinite dimensional systems. It is based on the approximation to the Hankel operator. Author

N92-22643*# Boeing Advanced Systems Co., Seattle, WA.
DESIGN OF AN INTEGRATED AIRFRAME/PROPULSION CONTROL SYSTEM ARCHITECTURE
GERALD C. COHEN, C. WILLIAM LEE, and MICHAEL J. STRICKLAND Mar. 1990 556 p
(Contract NAS1-18099; RTOP 505-66-71-02)
(NASA-CR-182004; NAS 1.26:182004) Avail: NTIS HC/MF A24 CSCL 12/2

The design of an integrated airframe/propulsion control system architecture is described. The design is based on a prevalidation methodology that used both reliability and performance tools. An account is given of the motivation for the final design and problems associated with both reliability and performance modeling. The appendices contain a listing of the code for both the reliability and performance model used in the design. Author

N92-22644*# Boeing Advanced Systems Co., Seattle, WA.
DESIGN OF AN INTEGRATED AIRFRAME/PROPULSION CONTROL SYSTEM ARCHITECTURE Final Report
GERALD C. COHEN, C. WILLIAM LEE, MICHAEL J. STRICKLAND, and THOMAS C. TORKELSON Mar. 1990 253 p Prepared for Draper (Charles Stark) Lab., Inc., Cambridge, MA
(Contract NAS1-18099; RTOP 505-66-71-02)
(NASA-CR-182007; NAS 1.26:182007) Avail: NTIS HC/MF A12 CSCL 12/2

The design of an integrated airframe/propulsion control system architecture is described. The design is based on a prevalidation

methodology that uses both reliability and performance. A detailed account is given for the testing associated with a subset of the architecture and concludes with general observations of applying the methodology to the architecture. Author

N92-22673 Politecnico di Milano (Italy). Dipartimento di Elettronica.
STATE AND TIME GRANULARITY IN SYSTEM DESCRIPTION: AN EXAMPLE
FABIO A. SCHREIBER Sep. 1991 11 p
(REPT-91-040; ETN-92-91177) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

By a simple, but realistic example, which can be extended to other application domains such as nuclear power plants or the game of chess, it is shown that the description tools for complex systems must be adapted to the desired level of granularity, and that the different levels can be formally related to each other. In an Air Traffic Control (ATC) radar system, a change in the state value at the lower level, i.e., airplane position, results in an event which, in turn, possibly triggers a state change at the upper level, i.e., the learning of the radar snapshot. This shows that not only the duality between events and state change can be fruitful for modeling complex systems, but also that the concept of state evaluation is consistent with such a model. A figure synthetically shows the main steps to the description transformation. ESA

N92-23881# Israel Aircraft Industries Ltd., Ben-Gurion Airport.
FROM IGES TO STEP
JEAN-PIERRE STROWEIS *In* CASA RI/SME, Proceedings of the International Conference on CAD/CAM and AMT. Volume 1: General Sessions 6 p 14 Dec. 1989
(REPT-3.1.6) Avail: NTIS HC/MF A10

This paper describes some of the new concepts of the STEP (Standard for Exchange of Product Model Data), an ongoing international effort to define a high-level neutral data interface between different CAD/CAM systems. The evolution of computer-generated data transfer is placed into the CAD/CAM historical perspective. STEP notions on geometry, presentation, topology, form features, and tolerances are presented. Comparison with the IGES (Initial Graphics Exchange Specification) is drawn. ISA

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PHYSICS

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

A92-32980
ACTIVE NOISE REDUCTION
CAROLYN R. GEYER (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings. Newhall, CA, SAFE Association, 1991, p. 43-46.
Copyright

Active noise reduction (ANR) techniques are described with reference to their application to crewmembers during aircraft operation to enhance productivity and safety. ANR concepts and theory are explained, and the development of protective ANR systems for direct implementation are described. Sound attenuation testing was conducted to study the feasibility of aircraft-powered ANR systems, and the positive results spurred their development for compatibility with flight helmets. The Helmets Limited ANR system uses a bypass mode at times of limited available power and complements the use of passive sound attenuation. Subjective testing results show that the device is effective, and a planned program of intensive evaluation is discussed. The aircraft that require an ANR system are listed, and key areas of implementation include battery power and the combination of ANR circuitry and helmet oxygen masks. It is suggested that ANR techniques can positively impact the efficiency and performance of crewmembers in high-noise-level aircraft. C.C.S.

A92-33770
POWER SPECTRUM OF RING MODES OF PRESSURE FLUCTUATIONS AT THE SURFACE OF A CYLINDER IN AXIAL FLOW [SPEKTR MOSHCHNOSTI KOL'TSEVYKH MOD PUL'SATSII DAVLENIIA NA POVERKHNOSTI PRODOL'NO OBTEKAEMOGO TSILINDRA]
V. I. ZARKHIN, D. G. ROBIKOV, and V. M. TKACHENKO (Tsentral'nyi NII imeni A. N. Krylova, St. Petersburg, Russia) Akusticheskii Zhurnal (ISSN 0320-7919), vol. 38, Jan.-Feb. 1992, p. 46-51. In Russian. refs
Copyright

Results of turbulent surface pressure fluctuations are presented for an extended rigid cylinder in axial flow at small angles of attack (from -8 to 8 deg). The measurements have been made using point and circular pressure transducers. Quantitative relations between spectral components of the ring modes and a regular power spectrum are obtained, as are data on the effect of the angle of attack. V.L.

A92-33771
AN EXPERIMENTAL STUDY OF THE NOISE OF FLOW PAST A WING AT LOW VELOCITIES [EKSPERIMENTAL'NOE ISSLEDOVANIE SHUMA OBTEKANIIA KRYLA PRI MALYKH SKOROSTIAKH POTOKA]
A. G. MUNIN, A. G. PROZOROV, and A. V. TOPOROV (Tsentral'nyi Aerogidrodinamicheskii Institut, Zhukovski, Russia) Akusticheskii Zhurnal (ISSN 0320-7919), vol. 38, Jan.-Feb. 1992, p. 108-113. In Russian. refs
Copyright

The effect of the incoming flow velocity and turbulence on the spectrum and radiation pattern of wing noise is investigated experimentally. It is found that the incoming flow spectrum has only a slight effect on the continuous component of the wing noise spectrum. Various methods of modifying the tonal noise components and their characteristics are discussed. V.L.

A92-33790
DYNAMIC SYNTHESIS OF MECHANICAL SYSTEMS WITH A FINITE NUMBER OF DEGREES OF FREEDOM [DINAMICHESKII SINTEZ MEKHANICHESKIKH SISTEM S KONECHNYM CHISLOM STEPENEI SVOBODY]
O. N. KOVBASKO and IU. V. RADYSH (Kievskii Politekhnicheskii Institut, Kiev, Ukraine) Mekhanika Giroskopicheskikh Sistem (ISSN 0203-3771), no. 10, 1991, p. 105-109. In Russian. refs
Copyright

A procedure for the synthesis of a dynamic model of a complex mechanical system consisting of simple subsystems is proposed which is based on the formalism of differential forms. An algorithm is developed for the dynamic synthesis of a complex mechanical system in the case of a linear model of the simple subsystems and linear equations of coupling between the subsystems. The algorithm, which has been implemented in FORTRAN, has been used in the synthesis of a large elastic-suspension flight vehicle structure. V.L.

A92-35741* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ACOUSTIC RESULTS OF THE BOEING MODEL 360 WHIRL TOWER TEST
MICHAEL E. WATTS and DAVID JORDAN (NASA, Ames Research Center, Moffett Field, CA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 12 p. refs

An evaluation is presented for whirl tower test results of the Model 360 helicopter's advanced, high-performance four-bladed composite rotor system intended to facilitate over-200-knot flight. During these performance measurements, acoustic data were acquired by seven microphones. A comparison of whirl-tower tests with theory indicate that theoretical prediction accuracies vary with

both microphone position and the inclusion of ground reflection. Prediction errors varied from 0 to 40 percent of the measured signal-to-peak amplitude. O.C.

A92-35778* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ROTOR BLADE-VORTEX INTERACTION NOISE REDUCTION AND VIBRATION USING HIGHER HARMONIC CONTROL
THOMAS F. BROOKS and EARL R. BOOTH, JR. (NASA, Langley Research Center, Hampton, VA) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. refs

The use of higher harmonic control (HHC) of blade pitch to reduce blade-vortex interaction (BVI) noise is examined by means of a rotor acoustic test. A dynamically scaled, four-bladed, articulated rotor model was tested in a heavy gas (Freon-12) medium. Acoustic and vibration measurements were made for a large range of matched flight conditions where prescribed (open loop) HHC pitch schedules were superimposed on the normal (baseline) collective and cyclic trim pitch. A novel sound power measurement technique was developed to take advantage of the reverberance in the hard walled tunnel. Quantitative sound power results are presented for a 4/rev (4P) collective pitch HHC. By comparing the results using 4P HHC to corresponding baseline (no HHC) conditions, significant midfrequency noise reductions of 5-6 dB are found for low-speed descent conditions where BVI is most intense. For other flight conditions, noise is found to increase with the use of HHC. LF loading noise, as well as fixed and rotating frame vibration levels, show increased levels. P.D.

A92-35782
SOME AERODYNAMIC MECHANISMS OF IMPULSIVE NOISE DURING BLADE-VORTEX-INTERACTION
J. BALLMANN and C. S. KOCAAYDIN (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 14 p. Research supported by DFG. refs

A computational study of the two-dimensional blade-vortex-interaction was done in comparison to the recent experimental results, which were obtained by wind tunnel and shock tube experiments. The free stream Mach number was varied from the low subsonic to the high transonic regime. Other parameters of interest were the strength, the core radius and the path of vortex, the angle of attack and the thickness of airfoil. Two major aerodynamic mechanisms which can generate strong acoustic waves were identified in the nearfield. According to the experiments, a critical Mach number related to a transient supersonic pocket on the windward side of the airfoil could be a dominant parameter for the aeroacoustics of helicopters in operation. Author

A92-36006* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BOUNDARY-LAYER RECEPTIVITY OF SOUND WITH ROUGHNESS
WILLIAM S. SARIC, JON A. HOOS, and RONALD H. RADEZTSKY (Arizona State University, Tempe) IN: Boundary layer stability and transition to turbulence; Proceedings of the Symposium, ASME and JSME Joint Fluids Engineering Conference, 1st, Portland, OR, June 23-27, 1991. New York, American Society of Mechanical Engineers, 1991, p. 17-22. refs
(Contract AF-AFOSR-90-0234; NCC2-659)
Copyright

An experimental study of receptivity was carried out using an acoustical disturbance in the freestream. The receptivity was enhanced by using a uniform two-dimensional roughness strip (tape). The roughness strip generated the local adjustment in the flow needed to couple the long-wavelength sound wave with the short-wavelength T-S wave. The method proved to be highly sensitive, with slight changes in the forcing frequency or in the height of the 2D roughness element having a strong effect on the amplitude of the observed T-S wave. V.L.

A92-36416
THE PROBLEM OF BODY MOTION IN A MEDIUM WITH RESISTANCE [K ZADACHE O DVIZHENII TELA V SREDE S SOPROTIVLENIEM]
M. V. SHAMOLIN Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), no. 1, Jan.-Feb. 1992, p. 52-58. In Russian. refs
Copyright

A model version of the interaction of a body with a resistant medium is analyzed in qualitative terms. For plane parallel motion, the case of the constant velocity of the center of mass is considered in detail. The existence of nonisolated periodic solutions, absence of limiting cycles, and transcendental integrability are proved. The necessary and sufficient conditions are presented for the expression of the integral in terms of elementary functions. V.L.

N92-22137 Washington Univ., Seattle.
THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE THERMODYNAMICS OF THE THERMALLY CHOKED RAM ACCELERATOR Ph.D. Thesis
CARL KNOWLEN 1991 138 p
Avail: Univ. Microfilms Order No. DA9131665

A Hugoniot analysis of the quasi-one-dimensional ram accelerator propulsive modes is presented which relates the thermodynamic properties of the stationary propellant gas to the end state conditions that exist after projectile passage. The quasi-steady theoretical approach determines the differences between the inlet and outlet properties of a supersonic propellant gas that enters a control volume with a specified mass and momentum flux, and then leaves the control volume with the same mass flux, a new chemical composition, and a different momentum flux. Regions of potentially accessible thermodynamic end states were identified, which indicates that there are no fundamental reasons why a properly shaped projectile cannot operate at or above the Chapman-Jouguet (C-J) detonation velocity. The velocity and acceleration histories predicted by the Hugoniot analysis for the thermally choked ram accelerator cycle are shown to correlate well with experiments. Theoretical prediction for the pressure at the thermal chocking point match the tube wall pressure data, collected from behind the combustion zone at the projectile base, up to the C-J velocity of the propellant mixture. Good agreement between theory and experiments strongly supports the assumption that projectiles are accelerated with a thermally choked propulsive cycle while they are operating in the subdetonative velocity regime. Dissert. Abstr.

N92-22241# Southampton Univ. (England). Audiology and Human Effects Group.
RISK TO HEARING FROM OVERFLIGHT NOISE OF MILITARY AIRCRAFT
B. W. LAWTON and D. W. ROBINSON May 1991 56 p
Sponsored by Ministry of Defence
(ISVR-TR-194; ETN-92-91197) Avail: NTIS HC/MF A04

The maximum level of aircraft noise to which the ear can be exposed without significant permanent noise induced hearing loss was investigated. A systematic database search is described. This search failed to reveal any published reports of permanent hearing threshold shift due to aircraft noise. However, some evidence exists that a small amount of temporary threshold shift may be induced by noise at levels in the region of 125 dB(A), which would nevertheless be without permanent effect. By characterizing overflight noise by its total exposure value (taking into account overflight duration), comparisons are made with existing damage risk criteria. Predictions of permanent threshold shift, using established relationships, suggest that there is no credible risk to hearing even for long term repeated exposures on the basis of several events per day at 125 dB(A). The nature of the relationship between noise exposure and permanent threshold shift, as it relates to the most susceptible fraction of an exposed population, inhibits the specification of a unique level which would guarantee total freedom from noise induced hearing loss in every individual. However, there appears to be a practical margin of safety in the case of aircraft noise producing a maximum level of 125 dB(A)

during the overflight. The conclusion rests upon experimental evidence of the course of noise level versus time, typical of military aircraft overflights. Taking the margin of safety into account, recommendations are made which, while suggesting that the existing criterion value be maintained, offer guidance on its interpretation and practical implementation. ESA

N92-23295*# Royal Aircraft Establishment, Farnborough (England). Space Dept.
SURFACE ACTIVATION OF CONCORDE BY BE-7
P. R. TRUSCOTT, C. S. DYER, and J. C. FLATMAN *In* NASA. Langley Research Center, LDEF: 69 Months in Space. First Post-Retrieval Symposium, Part 1 p 249-254 Jan. 1992
Avail: NTIS HC/MF A99; 8 functional color pages CSCL 20/8

Activation analysis of two airframe components from the Concorde aircraft has identified the presence of Be-7, a nuclide found by other investigators that was deposited on the forward edge of the Long Duration Exposure Facility (LDEF) structure. The results of the Concorde analysis indicate that this phenomenon is very much a surface effect, and that the areal densities of the Be-7 are comparable to those found for LDEF. The collection of Be-7 by the aircraft must be greater than in the case of LDEF (since duration for which Concorde is accumulating the nuclide is shorter) and is of the order of 1.2 to 41 nuclei/sq cm(-)s(exp -1) depending upon assumptions made regarding the altitude at which collection becomes appreciable, and the efficiency of the process which removes the radionuclide. D.R.D.

N92-23588# National Aerospace Lab., Amsterdam (Netherlands).
EVALUATION OF THE APPLICABILITY OF HELMHOLTZ RESONATORS FOR LOW FREQUENCY ACOUSTIC LINERS
J. M. M. VANDERWAL 19 Sep. 1988 39 p
(PB92-138544; NLR-TR-88148-U) Avail: NTIS HC/MF A03 CSCL 20/1

A literature study was performed on the acoustic behavior of those Helmholtz resonator type liners which are most promising for low frequency sound absorption in aero-engine applications. The equations for the acoustic impedance of various types of Helmholtz resonators were analyzed as well as the conditions for the validity of these equations. An experimental program is defined for a further analysis of various types of resonators. GRA

N92-23726 Pennsylvania State Univ., University Park.
EXPERIMENTAL STUDY OF THE MECHANISM OF SOUND GENERATION BY ROTATING STALL IN CENTRIFUGAL TURBOMACHINES Ph.D. Thesis
LUC MONGEAU 1991 258 p
Avail: Univ. Microfilms Order No. DA9127385

Experiments were conducted in order to investigate the aerodynamic sound generating mechanisms in centrifugal turbomachines. A facility consisting of a centrifugal water pump impeller with a variable discharge configuration and an inlet duct was designed and built for the experiments. Air is used as the fluid medium. The inlet duct provides a controlled, quiet inflow to the impeller. Measurements of the acoustic noise radiated in the pump surroundings were made in parallel with fluid dynamic measurements in order to establish correlations. The most significant conclusion reached is that a form of rotating stall dominates the voice signature in various configurations with no outlet diffuser or casing. The sequence of experiments that led to this finding is analyzed and presented in detail. Dissert. Abstr.

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A92-33221#
TYING IT ALL TOGETHER - THE NASA/USRA UNIVERSITY ADVANCED DESIGN PROGRAM
VICKI S. JOHNSON (Universities Space Research Association, Houston, TX) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 12 p. refs
(AIAA PAPER 92-1040) Copyright

A review is presented of the NASA/USRA University Advanced Design Program (ADP). The ADP is a unique program that seeks to evolve engineering design and design education by bringing together faculty and students from U.S. engineering schools with engineers from NASA centers through the integration of current and future NASA aeronautics and space engineering curriculum. Observations concerning the issues and challenges of design education based on experience with the ADP are discussed, and ideas are offered on how the ADP might make additional contributions to design education. R.E.P.

A92-33256*# National Aeronautics and Space Administration, Washington, DC.
SYSTEM DESIGN FROM MISSION DEFINITION TO FLIGHT VALIDATION
S. M. BATILL (Notre Dame, University, IN) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 11 p. Research supported by NASA and Universities Space Research Association. refs
(AIAA PAPER 92-1091) Copyright

Considerations related to the engineering systems design process and an approach taken to introduce undergraduate students to that process are presented. The paper includes details on a particular capstone design course. This course is a team oriented aircraft design project which requires the students to participate in many phases of the system design process, from mission definition to validation of their design through flight testing. To accomplish this in a single course requires special types of flight vehicles. Relatively small-scale, remotely piloted vehicles have provided the class of aircraft considered in this course. Author

A92-33257#
THE USE OF LARGE TEAMS IN CONCEPTUAL AIRCRAFT DESIGN
RAY WHITFORD (Royal Military College of Science, Shrivenham, England) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992. 7 p. refs
(AIAA PAPER 92-1092) Copyright

The paper addresses the objectives, organization, and management of large group design projects. In this context 'large' implies teams of up to 15 students working on a single conceptual design over a period of eight months. The paper emphasizes the team-building and collaboration necessary to achieve joint and individual success. It also shows the benefits of a competitive (i.e., team vs team) environment. Details of how the teams are formed, reference to design activities, and recent projects are given. Continuous monitoring of progress via weekly, formally conducted meetings and regular presentations to senior UK aerospace, airline industry, and Royal Air Force personnel leads an air of project office realism. Author

A92-33269#
MULTIDISCIPLINARY DESIGN ENVIRONMENT DEVELOPMENT FOR AIR VEHICLE ENGINEERING
J. A. VOLK (Northrop Corp., Flight Loads and Dynamics Technology Div., Pico Rivera, CA) AIAA, Aerospace Design Conference,

Irvine, CA, Feb. 3-6, 1992. 8 p. Research supported by Northrop Corp.
(AIAA PAPER 92-1113) Copyright

An account is given of a proprietary effort to develop and implement a highly integrated engineering analytic-systems environment, using the USAF's recently concluded ATF competition as a pilot program. The initial goal chosen for this engineering environment, designated the Rapid Multidisciplinary Computational Method, or 'RAMCOMP', was the significant reduction of design-cycle time for the ATF. Attention is given to the illustrative application of RAMCOMP to fighter maneuver-loads analysis, which entails strongly interdisciplinary interactions among design team members. O.C.

A92-33428
PERSPECTIVES ON THE COOPERATIVE AIR TRAFFIC MANAGEMENT CONCEPT - FAR EAST/PACIFIC POINT OF VIEW
JOHN MOONEY (Airways Corporation of New Zealand, Ltd., Wellington) IN: Radio Technical Commission for Aeronautics, Technical Symposium, Washington, DC, Nov. 18-20, !991, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1991, p. 49-62.
Copyright

New Zealand experience in air traffic control that is a part of the aviation infrastructure is reviewed, and perspectives for the future cooperative air traffic management are discussed. It is suggested that the improvements in the world's aviation infrastructure will be through the airline industry's ability and determination to demand from the providers of the infrastructure the same commercial disciplines under which they operate themselves. Consultation is considered to be an integral part of the commercial relationship between the airways corporations and their customers. To provide cost-effective quality services it is necessary to recognize the basic rules of commerce in air traffic management services. O.G.

A92-33463
THE LAW IN AUSTRALIA RELATING TO NEGLIGENCE OF AIRCREW AND ENGINEERS
TONY PYNE (Department of Aviation, Canberra, Australia) IN: Australian aeronautics, 1989-90. Mascot, Australia, Royal Aeronautical Society in Australia, 1991, p. 53-59. refs

The law of negligence in Australian air-transport law is examined in terms of aircrews and engineers with reference to tort claims related to negligent advice and products liability. The final responsibility for the safe operation of an aircraft lies with the commander, and products liability for engineers resides in both the manufacture and design of a product for the foreseeable high-safety requirements of the aviation context. It is shown that aircrew and engineers are subjected to high professional standards due to the potential consequences of their work. C.C.S.

A92-34692
ANALYSIS, DEVELOPMENT, AND INTEGRATION OF THE MECHANICAL COMPONENTS OF A VEHICLE POWERED BY PHOTO-VOLTAIC CELLS
SUSHIL H. BHAVNANI (Auburn University, AL) IN: TABES 91 - Annual Technical and Business Exhibition and Symposium, 7th, Huntsville, AL, May 14, 15, 1991, Submitted Papers. Huntsville, AL, Huntsville Association of Technical Societies, 1991, p. 194-201. refs
(TABES PAPER 91-503) Copyright

The mechanical subsystems of an aerodynamic solar-electric vehicle are discussed in terms of their requirements and incorporation into the final vehicle design. Specific attention is given to the lightweight Al frame, the independent double-A-arm suspension, the four-speed tranmission, and the aerodynamic body configuration of the vehicle powered by photovoltaic cells. The optimal strategy development for the vehicle is defined in terms of solar insolation, the orientation of the photovoltaic cells, the state of charge of the battery, and the level of allowable battery depletion. The integrated components are shown to perform as per design specifications for a 1600-mile road test and structural, mechanical, and electrical tests. The composite-material body, the frame, and the structural components are found to be adequate, and battery management is identified as an area requiring optimization. C.C.S.

A92-34770
FACING THE CRISIS IN AIRCRAFT DESIGN EDUCATION
JAN ROSKAM (Kansas, University, Lawrence) Aerospace America (ISSN 0740-722X), vol. 30, April 1992, p. 24-27.
Copyright

A review of aircraft design education indicates that educational programs in this field should devote more time and course content to aircraft design and to the vehicle integration aspects of the subject. Students need more exposure to how basic technologies such as aerodynamic, structure and materials, performance, propulsion, stability, control, and aircraft systems are integrated into an airworthy, reliable aircraft. Since most engineers in industry take part in designing and developing a military or commercial viable product, design education should be an important component of their education. R.E.P.

A92-34771
DESIGNING A BETTER ENGINEER
LELAND M. NICOLAI (Lockheed Corp., Calabasas, CA) Aerospace America (ISSN 0740-722X), vol. 30, April 1992, p. 30-33, 46.
Copyright

An overview is presented of some of the undergraduate engineering study approaches used in universities today and suggestions are offered to keep the U.S. competitive and stop turning out graduates who make great scientists but mediocre engineers. Consideration is given to the need of the aerospace undergraduate to: have a solid grasp of the fundamentals in mathematics, basic sciences, and engineering sciences; understand and experience the design process; understand and be able to apply the drawing, sketching, and descriptive geometry tools of design; have working knowledge of kinematics, statistics, CAD/CAM, and material and processes/manufacturing. R.E.P.

N92-23928# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Unternehmensbereich Energie- und Industrietechnik.
SYMPOSIUM ON MARKETING FOR TECHNOLOGICAL PRODUCTS [SYMPOSIUM MARKETING FUER TECHNNOLOGIEPRODUKTE]
1990 84 p In GERMAN Symposium held in Munich, Fed. Republic of Germany, 27 Mar. 1990
(MBB-UE-0014-90-PUB; ETN-92-91074) Avail: NTIS HC/MF A05

Subjects covered were: market directed thinking in a technological operation, marketing qualification as a requirement for operational success, marketing as a necessary condition for the successful development and commercialization of technological products, and requirements for the training profile of the engineer and definition of his role.

ESA

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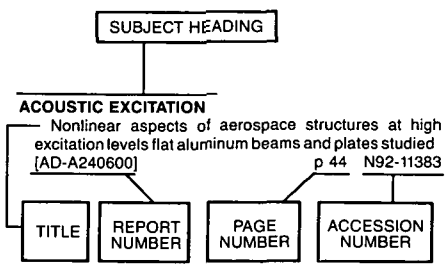

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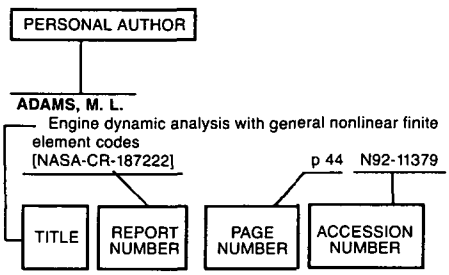

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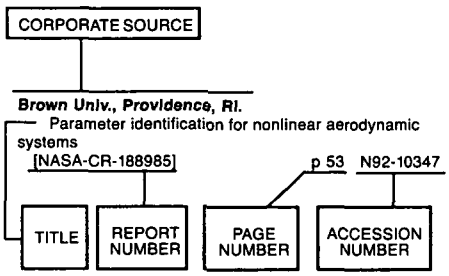

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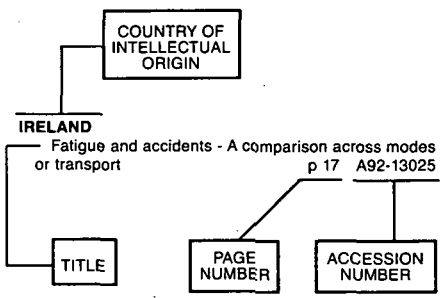

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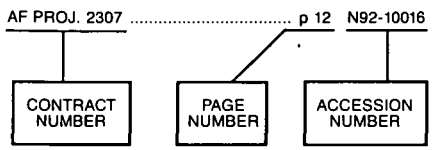

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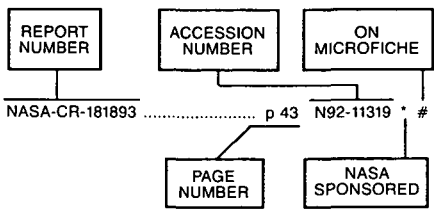

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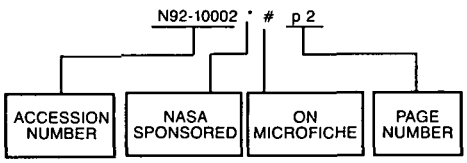

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