NASA SP-7037 (303)
April 1994

P-89

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1994

This publication was prepared by the NASA Center for AeroSpace Information,
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INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 211 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N94-22702 — N94-24784
Open Literature (A-10000 Series)	None in this issue

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 1994 will be published in early 1995.

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

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TABLE OF CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → **N94-10675*#** National Aeronautics and Space Administration. ← CORPORATE SOURCE
Langley Research Center, Hampton, VA.

TITLE → **STATIC INTERNAL PERFORMANCE OF A SINGLE EXPANSION RAMP NOZZLE WITH MULTIAXIS THRUST VECTORING CAPABILITY**

AUTHORS → FRANCIS J. CAPONE and ALBERTO W. SCHIRMER (George Washington Univ., Hampton, VA.) Washington Jul. 1993 ← PUBLICATION DATE
272 p

CONTRACT NUMBER → (Contract RTOP 505-62-30-01)

REPORT NUMBERS → (NASA-TM-4450; L-17163; NAS 1.15:4450) Avail: CASI HC A12/ ← AVAILABILITY AND PRICE CODE
MF A03

An investigation was conducted at static conditions in order to determine the internal performance characteristics of a multiaxis thrust vectoring single expansion ramp nozzle. Yaw vectoring was achieved by deflecting yaw flaps in the nozzle sidewall into the nozzle exhaust flow. In order to eliminate any physical interference between the variable angle yaw flap deflected into the exhaust flow and the nozzle upper ramp and lower flap which were deflected for pitch vectoring, the downstream corners of both the nozzle ramp and lower flap were cut off to allow for up to 30 deg of yaw vectoring. The effects of nozzle upper ramp and lower flap cutout, yaw flap hinge line location and hinge inclination angle, sidewall containment, geometric pitch vector angle, and geometric yaw vector angle were studied. This investigation was conducted in the static-test facility of the Langley 16-foot Transonic Tunnel at nozzle pressure ratios up to 8.0. Author (revised)

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

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ACCESSION NUMBER → **A94-10806*** National Aeronautics and Space Administration. ← CORPORATE SOURCE
Langley Research Center, Hampton, VA.

TITLE → **FLIGHT CONTROL APPLICATION OF NEW STABILITY ROBUSTNESS BOUNDS FOR LINEAR UNCERTAIN SYSTEMS**

AUTHOR → RAMA K. YEDAVALLI (Ohio State Univ., Columbus) Journal of ← AUTHOR'S AFFILIATION AND JOURNAL TITLE
Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 6

PUBLICATION DATE → Nov.-Dec. 1993 p. 1032-1037. refs

CONTRACT NUMBER → (Contract NAG1-1164)

This paper addresses the issue of obtaining bounds on the real parameter perturbations of a linear state-space model for robust stability. Based on Kronecker algebra, new, easily computable sufficient bounds are derived that are much less conservative than the existing bounds since the technique is meant for only real parameter perturbations (in contrast to specializing complex variation case to real parameter case). The proposed theory is illustrated with application to several flight control examples.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 303)

April 1994

01

AERONAUTICS (GENERAL)

N94-23553*# Sverdrup Technology, Inc., Brook Park, OH.
UNSTEADY JET FLOW COMPUTATION TOWARDS NOISE PREDICTION Final Report
WOO-YUNG SOH Jan. 1994 17 p Presented at the 32nd Aerospace Sciences Meeting, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract NAS3-25266; RTOP 537-02-22)
(NASA-CR-194449; E-8329; NAS 1.26:194449; AIAA PAPER 94-0138) Avail: CASI HC A03/MF A01

An attempt has been made to combine a wave solution method and an unsteady flow computation to produce an integrated aeroacoustic code to predict far-field jet noise. An axisymmetric subsonic jet is considered for this purpose. A fourth order space accurate Pade compact scheme is used for the unsteady Navier-Stokes solution. A Kirchhoff surface integral for the wave equation is employed through the use of an imaginary surface which is a circular cylinder enclosing the jet at a distance. Information such as pressure and its time and normal derivatives is provided on the surface. The sound prediction is performed side by side with the jet flow computation. Retarded time is also taken into consideration since the cylinder body is not acoustically compact. The far-field sound pressure has the directivity and spectra show that low frequency peaks shift toward higher frequency region as the observation angle increases from the jet flow axis. Author

N94-24100*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROLES, USES, AND BENEFITS OF GENERAL AVIATION AIRCRAFT IN AEROSPACE ENGINEERING EDUCATION
DENNIS P. ODONOGHUE (Sverdrup Technology, Inc., Brook Park, OH.) and ROBERT C. MCKNIGHT Jan. 1994 15 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract NAS3-25266)
(NASA-TM-106463; E-8326; NAS 1.15:106463; AIAA PAPER 94-0852) Avail: CASI HC A03/MF A01

Many colleges and universities throughout the United States offer outstanding programs in aerospace engineering. In addition to the fundamentals of aerodynamics, propulsion, flight dynamics, and air vehicle design, many of the best programs have in the past provided students the opportunity to design and fly airborne experiments on board various types of aircraft. Sadly, however, the number of institutions offering such 'airborne laboratories' has dwindled in recent years. As a result, opportunities for students to apply their classroom knowledge, analytical skills, and engineering judgement to the development and management of flight experiments on an actual aircraft are indeed rare. One major reason for the elimination of flight programs by some institutions, particularly the smaller colleges, is the prohibitive cost of operating and maintaining an aircraft as a flying laboratory. The purpose of this paper is to discuss simple, low-cost, relevant flight experiments that can be performed using readily available general aviation aircraft. This paper examines flight experiments that have been successfully conducted on board the NASA Lewis Research Center's T-34B aircraft, as part of the NASA/AIAA/University Flight Experiment Program for Students (NAUFEPS) and discusses how similar experiments could be inexpensively performed on other general aviation aircraft. Author (revised)

N94-24241 Israel Society of Aeronautics and Astronautics, Tel Aviv.
THE 33RD ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS
ALEXANDER BURCAT (Technion - Israel Inst. of Tech., Haifa.) *25 Feb. 1993 523 p Conference held in Tel-Aviv, Israel, February* 24-25, 1993 Convened by Israel Society of Aeronautics and Astronautics, Tel-Aviv; Technion - Israel Institute of Technology, Haifa; Tel-Aviv University, Ramat Aviv, Israel; Ben-Gurion University of the Negev, Beersheva, Israel; RAFAEL - Armament Development Auth
(ITN-94-85227) Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Subjects covered by the 48 papers include: aircraft design and development technology; satellite and spacecraft design and testing; unmanned aerial vehicle technology; shock and blast studies; propellant, combustion and engine performance; space systems, spacecraft and satellites; space and aircraft structures, structural materials and damage control; aircraft control and spacecraft control; particle combustion; fracture mechanics and fatigue; structural dynamics; and spray combustion. ISA

02

AERODYNAMICS

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

N94-22894*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF UPPER SURFACE BLOWING ON DYNAMIC STALL Semiannual Report, Jun. - Dec. 1993
JIN TSO 15 Dec. 1993 5 p
(Contract NCA2-811)
(NASA-CR-194863; NAS 1.26:194863) Avail: CASI HC A01/MF A01

An experimental investigation of the effect of upper surface blowing on dynamic stall was conducted. Progress made during the period from Jun. to Dec. 1993 is summarized. Topics covered include VR-7 wing model, pulse valve, and wing/load cell junction. CASI

N94-23116 Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
COMPUTATIONAL STUDY OF GA(W)-1: AIRFOIL NEAR STALL

J. HOFFREN 1993 26 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB93-226249; SER-B-93-41) Avail: CASI HC A03

The testing of a new time-accurate thin-layer Navier-Stokes solver is continued with attempts to simulate the stall of the GA(W)-1 airfoil. Subsonic high Reynolds number flow at 7.0 - 19.5 degrees angle of attack is studied utilizing two different grids. Near the lower end of the angle of attack range, the results are reasonably good, but serious problems emerge as the stall proceeds. Unsteady solutions are obtained, although the time-averaged results agree poorly with measurements. The algebraic turbulence model applied is apparently inadequate for these types of time-dependent cases. The behavior of the solutions is also found to depend critically on the spatial resolution and the modeling of transition. The temporal accuracy may be an additional factor affecting the results. Since the calculations are very costly, it is not considered worthwhile to continue the effort with an improved resolution until a better, more physically sound turbulence model is available. NTIS

N94-23149# Institut Franco-Allemand de Recherches, Saint-Louis (France).
A NEW EXPERIMENTAL APPARATUS FOR THE STUDY OF THE UNSTEADY FLOWFIELD OVER AN AIRFOIL IN PITCHING AND HEAVING MOTIONS USING LASER DOPPLER ANEMOMETRY
P. WERNERT, G. KOERBER, and F. WIETRICH 2 Oct. 1992 14 p Presented at the European Forum on Wind Tunnels and Wind Tunnel Test Techniques, Southampton, England, 14-17 Sep. 1992 See also A94-10438
(Contract DRET-86-156)
(ISL-CO-229/92; ETN-94-95126) Avail: CASI HC A03/MF A01

An experimental setup used for the study of the flowfield over an airfoil undergoing arbitrary pitching or heaving motions is described. This setup is basically composed of two parts: a novel driving mechanism, based on an automatic apparatus, two speed drives, two brushless motors and a support system, which allows the airfoil to be put into a wide range of periodic or transient motions and a classical two dimensional laser Doppler anemometry system which provides streamwise and transversal components of the velocity. Data acquisition, data reduction and synchronization problems are discussed. Results concerning dynamic stall features observed in the near wake of a pitching airfoil at a Reynolds number of 287,000 are given. ESA

N94-23161# Institut Franco-Allemand de Recherches, Saint-Louis (France).
LDA MEASUREMENTS OF THE UNSTEADY NEAR WAKE BEHIND AN AIRFOIL UNDERGOING TRANSIENT AND PERIODIC PITCHING MOTIONS
P. WERNERT, G. KOERBER, and F. WIETRICH 30 Jun. 1992 10 p Presented at the 6th International Symposium on Applications of Laser Techniques in Fluid Mechanics, Lisbon, Portugal, 20-23 Jul. 1992
(Contract DRET-86-156)
(ISL-CO-215/92; ETN-94-95124) Avail: CASI HC A02/MF A01

Results of two dimensional Laser Doppler Anemometry (LDA) measurements performed in the near wake of an airfoil undergoing stepwise motions and saw tooth periodic motions with incidence variations from -1 to 25 deg revealing dynamic stall features are presented. The driving mechanism used is based on an automatic apparatus which allows the airfoil to be put into a wide range of periodic or transient pitching and/or heaving motions. Time dependent velocity traces for the two components, streamwise velocity profiles, evolution of the semi-wake thickness, and vector velocity field are discussed. These results, obtained at a Reynolds number of 287,000, are compared to those corresponding to steady flow. ESA

N94-23299*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN OVERVIEW OF A MODEL ROTOR ICING TEST IN THE NASA LEWIS ICING RESEARCH TUNNEL
RANDALL K. BRITTON (Sverdrup Technology, Inc., Brook Park, OH.), THOMAS H. BOND, and ROBERT J. FLEMMING (Sikorsky Aircraft, Stratford, CT.) Jan. 1994 24 p Presented at the 32nd Aerospace Sciences Meeting, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract NAS3-25266; RTOP 505-68-11)
(NASA-TM-106471; E-8340; NAS 1.15:106471; AIAA PAPER 94-0716) Avail: CASI HC A03/MF A01

During two entries in late 1989, a heavily instrumented sub-scale model of a helicopter main rotor was tested in the NASA LeRC Icing Research Tunnel (IRT). The results of this series of tunnel tests were published previously. After studying the results from the 1989 test and comparing them to predictions, it became clear that certain test conditions still needed investigation. Therefore, a re-entry of the Sikorsky Aircraft Powered Force Model (PFM) in the IRT was instituted in order to expand upon the current rotor craft sub-scale model experimental database. The major areas of interest included expansion of the test matrix to include a larger number of points in the FAA AC 29-2 icing envelope, inclusion of a number of high power rotor performance points, close examination of warm temperature operations, operation of the model in constant lift mode, and testing for conditions for icing test points in the full scale helicopter database. The expanded database will allow further and more detailed examination and comparison with analytical models. Participants in the test were NASA LeRC, the U.S. Army Vehicle Propulsion Directorate based at LeRC, and Sikorsky Aircraft. The model rotor was exposed to a range of icing conditions (temperature, liquid water content, median droplet diameter) and was operated over ranges of shaft angle, rotor tip speed, advance ratio, and rotor lift. The data taken included blade strain gage and balance data, as well as still photography, video, ice profile tracings, and ice molds. A discussion of the details of the test is given herein. Also, a brief examination of a subset of the data taken is also given. Author (revised)

N94-23465*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MEASUREMENTS AND MODELING OF FLOW STRUCTURE IN THE WAKE OF A LOW PROFILE WISHBONE VORTEX GENERATOR
B. J. WENDT and W. R. HINGST Jan. 1994 11 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract RTOP 505-62-52)
(NASA-TM-106468; E-8334; NAS 1.15:106468; AIAA PAPER 94-0620) Avail: CASI HC A03/MF A01

The results of an experimental examination of the vortex structures shed from a low profile 'wishbone' generator are presented. The vortex generator height relative to the turbulent boundary layer was varied by testing two differently sized models. Measurements of the mean three-dimensional velocity field were conducted in cross-stream planes downstream of the vortex generators. In all cases, a counter-rotating vortex pair was observed. Individual vortices were characterized by three descriptors derived from the velocity data; circulation, peak vorticity, and cross-stream location of peak vorticity. Measurements in the cross plane at two axial locations behind the smaller wishbone characterize the downstream development of the vortex pairs. A single region of stream wise velocity deficit is shared by both vortex cores. This is in contrast to conventional generators, where each core coincides with a region of velocity deficit. The measured cross-stream velocities for each case are compared to an Oseen model with matching descriptors. The best comparison occurs with the data from the larger wishbone. Author (revised)

N94-23511*# Sverdrup Technology, Inc., Brook Park, OH.
SIMPLIFIED, INVERSE, EJECTOR DESIGN TOOL
LAWRENCE J. DECHANT Dec. 1993 37 p
(Contract NAS3-25266; RTOP 505-69-50)
(NASA-CR-194438; E-8289; NAS 1.26:194438) Avail: CASI HC A03/MF A01

A simple lumped parameter based inverse design tool has been

developed which provides flow path geometry and entrainment estimates subject to operational, acoustic, and design constraints. These constraints are manifested through specification of primary mass flow rate or ejector thrust, fully-mixed exit velocity, and static pressure matching. Fundamentally, integral forms of the conservation equations coupled with the specified design constraints are combined to yield an easily invertible linear system in terms of the flow path cross-sectional areas. Entrainment is computed by back substitution. Initial comparison with experimental and analogous one-dimensional methods show good agreement. Thus, this simple inverse design code provides an analytically based, preliminary design tool with direct application to High Speed Civil Transport (HSCT) design studies. Author (revised)

N94-23512*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LEADING-EDGE VOTEX-SYSTEM DETAILS OBTAINED ON F-106B AIRCRAFT USING A ROTATING VAPOR SCREEN AND SURFACE TECHNIQUES

JOHN E. LAMAR, JAY BRANDON, KATHRYN STACY, THOMAS D. JOHNSON, JR. (Lockheed Engineering and Sciences Co., Hampton, VA.), KURT SEVERANCE, and BROOKS A. CHILDERS Nov. 1993 159 p Original contains color illustrations

(Contract RTOP 505-59-30-03)

(NASA-TP-3374; L-17150; NAS 1.60:3374) Avail: CASI HC A08/MF A02; 47 functional color pages

A flight research program to study the flow structure and separated-flow origins over an F-106B aircraft wing is described. The flight parameters presented include Mach numbers from 0.26 to 0.81, angles of attack from 8.5 deg to 22.5 deg, Reynolds numbers from 22.6 x 10(exp 6) to 57.3 x 10(exp 6) and load factors from 0.9 to 3.9 times the acceleration due to gravity. Techniques for vapor screens, image enhancement, photogrammetry, and computer graphics are integrated to analyze vortex-flow systems. Emphasis is placed on the development and application of the techniques. The spatial location of vortex cores and their tracks over the wing are derived from the analysis. Multiple vortices are observed and are likely attributed to small surface distortions in the wing leading-edge region. A major thrust is to correlate locations of reattachment lines obtained from the off-surface (vapor-screen) observations with those obtained from on-surface oil-flow patterns and pressure-port data. Applying vapor-screen image data to approximate reattachment lines is experimental, but depending on the angle of attack, the agreement with oil-flow results is generally good. Although surface pressure-port data are limited, the vapor-screen data indicate reattachment point occurrences consistent with the available data. Author (revised)

N94-23522*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CHARACTERISTICS OF SURFACE ROUGHNESS ASSOCIATED WITH LEADING EDGE ICE ACCRETION

JAIWON SHIN Jan. 1994 18 p Presented at the AIAA 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA

(Contract RTOP 505-68-10)

(NASA-TM-106459; E-8320; NAS 1.15:106459; AIAA PAPER 94-0799) Avail: CASI HC A03/MF A01

Detailed size measurements of surface roughness associated with leading edge ice accretions are presented to provide information on characteristics of roughness and trends of roughness development with various icing parameters. Data was obtained from icing tests conducted in the Icing Research Tunnel (IRT) at NASA Lewis Research Center (LeRC) using a NACA 0012 airfoil. Measurements include diameters, heights, and spacing of roughness elements along with chordwise icing limits. Results confirm the existence of smooth and rough ice zones and that the boundary between the two zones (surface roughness transition region) moves upstream towards stagnation region with time. The height of roughness grows as the air temperature and the liquid water content increase, however, the airspeed has little effect on the roughness height. Results also show that the roughness in the surface roughness transition region grows during a very early stage of accretion but reaches a critical height and then remains fairly constant. Results also indicate that a uniformly distributed roughness model is only valid at a very initial stage of the ice accretion process. Author (revised)

N94-23557*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LINAIR: A MULTI-ELEMENT DISCRETE VORTEX WEISSINGER AERODYNAMIC PREDICTION METHOD

DONALD A. DURSTON Oct. 1993 76 p Original contains color illustrations

(Contract RTOP 505-59-20)

(NASA-TM-108786; A-93111; NAS 1.15:108786) Avail: CASI HC A05/MF A01; 1 functional color page

LinAir is a vortex lattice aerodynamic prediction method similar to Weissinger's extended lifting-line theory, except that the circulation around a wing is represented by discrete horseshoe vortices, not a continuous distribution of vorticity. The program calculates subsonic longitudinal and lateral/directional aerodynamic forces and moments for arbitrary aircraft geometries. It was originally written by Dr. Ilan Kroo of Stanford University, and subsequently modified by the author to simplify modeling of complex configurations. The Polhamus leading-edge suction analogy was added by the author to extend the range of applicability of LinAir to low aspect ratio (i.e., fighter-type) configurations. A brief discussion of the theory of LinAir is presented, and details on how to run the program are given along with some comparisons with experimental data to validate the code. Example input and output files are given in the appendices to aid in understanding the program and its use. This version of LinAir runs in the VAX/VMS, Cray UNICOS, and Silicon Graphics Iris workstation environments at the time of this writing. Author (revised)

N94-23592*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EFFECT OF DELTA TABS ON MIXING AND AXIS SWITCHING IN JETS FROM ASYMMETRIC NOZZLES

K. B. M. Q. ZAMAN Jan. 1994 20 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA

(Contract RTOP 537-02-22)

(NASA-TM-106450; E-8308; NAS 1.15:106450; AIAA PAPER 94-0186) Avail: CASI HC A03/MF A01

The effect of delta tabs on mixing and the phenomenon of axis switching in free air jets from various asymmetric nozzles was studied experimentally. Flow visualization and Pitot probe surveys were carried out with a set of small nozzles (D = 1.47 cm) at a jet Mach number, Mj = 1.63. Hot wire measurements for streamwise vorticity were carried out with larger nozzles (D = 6.35 cm) at Mj = 0.31. Jet mixing with the asymmetric nozzles, as indicated by the mass fluxes downstream, was found to be higher than that produced by a circular nozzle. The circular nozzle with four delta tabs, however, produced fluxes much higher than that produced by a asymmetric nozzles themselves or by most of the tab configurations tried with them. Even higher fluxes could be obtained with only a few cases, e.g., with 3:1 rectangular nozzle with two large delta tabs placed on the narrow edges. In this case, the jet 'fanned out' at a large angle after going through one axis switch. The axis switching could be either stopped or augmented with suitable choice of the tab configurations. Two mechanisms are identified governing the phenomenon. One, as described in Ref. 12 and referred to here as the omega(sub Theta)-induced dynamics, is due to differential induced velocities of different segments of a rolled up azimuthal vortical structure. The other is the omega(sub x)-induced dynamics due to the induced velocities of streamwise vortex pairs in the flow. While the former dynamics are responsible for rapid axis switching in periodically forced jets, the effect of the tabs is governed mainly by the latter. It is inferred that both dynamics are active in a natural asymmetric jet issuing from a nozzle having an upstream contraction. The tendency for axis switching caused by the omega(sub Theta)-induced dynamics is resisted by the omega(sub x)-induced

dynamics, leading to a delayed or no switch over in that case. In jets from orifices and in screeching jets, the omega(sub Theta)-induced dynamics dominate causing a faster switch over.
Author

N94-23625*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
DEVELOPMENT OF A CODE FOR WALL CONTOUR DESIGN IN THE TRANSONIC REGION OF AXISYMMETRIC AND SQUARE NOZZLES Status Report, 1 Sep. 1992 - 1 Jan. 1994
TIMOTHY ALCENIUS and STEVEN P. SCHNEIDER 1 Jan. 1994 46 p
(Contract NAG1-1133)
(NASA-CR-194857; NAS 1.26:194857) Avail: CASI HC A03/MF A01

Nozzle design codes developed earlier under NAG1-1133 were modified and used in order to design a supersonic wind tunnel nozzle with square cross sections. As part of the design process, a computer code was written to implement the Hopkins and Hill perturbation solution for the flow in the transonic region of axisymmetric nozzles. This technique is used to design the bleed slot of quiet-flow nozzles. This new design code is documented in this report. Author

N94-23656*# Colorado Univ., Boulder. Dept. of Aerospace and Engineering Sciences.
SUPERSONIC MINIMUM LENGTH NOZZLE DESIGN FOR DENSE GASES
ANDREW C. ALDO and BRIAN M. ARGROW *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 329-341 Nov. 1993
Avail: CASI HC A03/MF A04; 5 functional color pages

Recently, dense gases have been investigated for many engineering applications such as for turbomachinery and wind tunnels. Supersonic nozzle design for these gases is complicated by their nonclassical behavior in the transonic flow regime. In this paper a method of characteristics (MOC) is developed for two-dimensional (planar) and, primarily, axisymmetric flow of a van der Waals gas. Using a straight aortic line assumption, a centered expansion is used to generate an inviscid wall contour of minimum length. The van der Waals results are compared to previous perfect gas results to show the real gas effects on the flow properties and inviscid wall contours. Author

N94-23661*# Maine Univ., Orono. Div. of Mathematics.
AN ANALYTIC STUDY OF A TWO-PHASE LAMINAR AIRFOIL IN SIMULATED HEAVY RAIN
YU-KAO HSU *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 413-427 Nov. 1993 Sponsored by NASA. Langley Research Center
Avail: CASI HC A03/MF A04; 5 functional color pages

A mathematical model for a two-phase flow laminar airfoil in simulated heavy rain has been established. The set of non-linear partial differential equations has been converted into a set of finite difference equations; appropriate initial and boundary conditions are provided. The numerical results are compared with the experimental measurements. They show good agreement in quality. Author

N94-23975*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPRESSIBILITY EFFECTS ON DYNAMIC STALL OF AIRFOILS UNDERGOING RAPID TRANSIENT PITCHING MOTION Final Report, 1 Oct. 1989 - 30 Sep. 1992
M. S. CHANDRASEKHARA (Naval Postgraduate School, Monterey, CA.) and M. F. PLATZER (Naval Postgraduate School, Monterey, CA.) Nov. 1992 28 p Sponsored in part by Naval Air Systems Command
(Contract AF-AFOSR-0012-90; AF-AFOSR-0007-91; AF-AFOSR-0004-92; AF PROJ. 2307)
(NASA-TM-109681; NAS 1.15:109681) Avail: CASI HC A03/MF A01

The research was carried out in the Compressible Dynamic Stall Facility, CDSF, at the Fluid Mechanics Laboratory (FML) of NASA Ames Research Center. The facility can produce realistic nondimensional pitch rates experienced by fighter aircraft, which on model scale could be as high as 3600/sec. Nonintrusive optical techniques were used for the measurements. The highlight of the effort was the development of a new real time interferometry method known as Point Diffraction Interferometry - PDI, for use in unsteady separated flows. This can yield instantaneous flow density information (and hence pressure distributions in isentropic flows) over the airfoil. A key finding is that the dynamic stall vortex forms just as the airfoil leading edge separation bubble opens-up. A major result is the observation and quantification of multiple shocks over the airfoil near the leading edge. A quantitative analysis of the PDI images shows that pitching airfoils produce larger suction peaks than steady airfoils at the same Mach number prior to stall. The peak suction level reached just before stall develops is the same at all unsteady rates and decreases with increase in Mach number. The suction is lost once the dynamic stall vortex or vortical structure begins to convect. Based on the knowledge gained from this preliminary analysis of the data, efforts to control dynamic stall were initiated. The focus of this work was to arrive at a dynamically changing leading edge shape that produces only 'acceptable' airfoil pressure distributions over a large angle of attack range. Author

N94-24052*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace Engineering.
ISSAC, JASON CHERIAN SES IN TRANSONIC FLOW
JASON CHERION ISSAC and RAKESH K. KAPANIA 1993 80 p
(Contract NAG1-1411)
(NASA-CR-194837; NAS 1.26:194837; VPI-AOE-210) Avail: CASI HC A05/MF A01

Flutter analysis of a two degree of freedom airfoil in compressible flow is performed using a state-space representation of the unsteady aerodynamic behavior. Indicial response functions are used to represent the normal force and moment response of the airfoil. The structural equations of motion of the airfoil with bending and torsional degrees of freedom are coupled to the unsteady air loads and the aeroelastic system so modelled is solved as an eigenvalue problem to determine the stability. The aeroelastic equations are also directly integrated with respect to time and the time-domain results compared with the results from the eigenanalysis. A good agreement is obtained. The derivatives of the flutter speed obtained from the eigenanalysis are calculated with respect to the mass and stiffness parameters by both analytical and finite-difference methods for various transonic Mach numbers. The experience gained from the two degree of freedom model is applied to study the sensitivity of the flutter response of a wing with respect to various shape parameters. The parameters being considered are as follows: (1) aspect ratio; (2) surface area of the wing; (3) taper ratio; and (4) sweep. The wing deflections are represented by Chebyshev polynomials. The compressible aerodynamic state-space model used for the airfoil section is extended to represent the unsteady aerodynamic forces on a generally laminated tapered skewed wing. The aeroelastic equations are solved as an eigenvalue problem to determine the flutter speed of the wing. The derivatives of the flutter speed with respect to the shape parameters are calculated by both analytical and finite difference methods. Author (revised)

N94-24084*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EVALUATION OF TURBULENCE MODELS IN THE PARC CODE FOR TRANSONIC DIFFUSER FLOWS
N. J. GEORGIADIS, J. E. DRUMMOND (Akron Univ., OH.), and B. P. LEONARD (Akron Univ., OH.) Jan. 1994 13 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract RTOP 537-02-23)
(NASA-TM-106391; E-8216; NAS 1.15:106391; AIAA PAPER 94-0582) Avail: CASI HC A03/MF A01

Flows through a transonic diffuser were investigated with the

PARC code using five turbulence models to determine the effects of turbulence model selection on flow prediction. Three of the turbulence models were algebraic models: Thomas (the standard algebraic turbulence model in PARC), Baldwin-Lomax, and Modified Mixing Length-Thomas (MMLT). The other two models were the low Reynolds number k-epsilon models of Chien and Speziale. Three diffuser flows, referred to as the no-shock, weak-shock, and strong-shock cases, were calculated with each model to conduct the evaluation. Pressure distributions, velocity profiles, locations of shocks, and maximum Mach numbers in the duct were the flow quantities compared. Overall, the Chien k-epsilon model was the most accurate of the five models when considering results obtained for all three cases. However, the MMLT model provided solutions as accurate as the Chien model for the no-shock and the weak-shock cases, at a substantially lower computational cost (measured in CPU time required to obtain converged solutions). The strong shock flow, which included a region of shock-induced flow separation, was only predicted well by the two k-epsilon models. Author (revised)

N94-24103*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
LIFT AUGMENTATION ON A DELTA WING VIA LEADING EDGE FENCES AND THE GURNEY FLAP M.S. Thesis
MARK D. BUCHHOLZ Dec. 1992 71 p
(Contract NCC2-730)
(NASA-CR-194793; NAS 1.26:194793) Avail: CASI HC A04/MF A01

Wind tunnel tests were conducted on two devices for the purpose of lift augmentation on a 60 deg delta wing at low speed. Lift, drag, pitching moment, and surface pressures were measured. Detailed flow visualization was also obtained. Both the leading edge fence and the Gurney flap are shown to increase lift. The fences and flap shift the lift curve as much as 5 deg and 10 deg, respectively. The fences aid in trapping vortices on the upper surface, thereby increasing suction. The Gurney flap improves circulation at the trailing edge. The individual influences of both devices are roughly additive, creating high lift gain. However, the lower lift to drag ratio and the precipitation of vortex burst caused by the fences, and the nose down pitching moment created by the flap are also significant factors. Author

N94-24142*# Stanford Univ., CA. Center for Turbulence Research.
TOWARD MODELING WINGTIP VORTICES
O. ZEMAN *In its* Annual Research Briefs, 1993 p 31-40 Dec. 1993
Avail: CASI HC A02/MF A04

Wingtip vortices are generated by lifting airfoils; their salient features are compactness and relatively slow rate of decay. The principal motivation for studying the far field evolution of wingtip vortices is the need to understand and predict the extent of the vortex influence during aircraft take-off or landing. On submarines a wingtip vortex ingested into a propeller can be a source of undesirable noise. The main objectives of this research are (1) to establish theoretical understanding of the principal mechanisms that govern the later (diffusive) stages of a turbulent vortex, (2) to develop a turbulence closure model representing the basic physical mechanisms that control the vortex diffusive stage, and further (3) to investigate coupling between the near and far field evolutions; in other words, to study the effect of initial conditions on the vortex lifetime and the ultimate state. Author (revised)

N94-24143*# Stanford Univ., CA. Center for Turbulence Research.
NEW CONCEPTS FOR REYNOLDS STRESS TRANSPORT EQUATION MODELING OF INHOMOGENEOUS FLOWS
J. BLAIR PEROT and PARVIZ MOIN *In its* Annual Research Briefs, 1993 p 41-65 Dec. 1993
Avail: CASI HC A03/MF A04

The ability to model turbulence near solid walls and other types of boundaries is important in predicting complex engineering flows. Most turbulence modeling has concentrated either on flows which are nearly homogeneous or isotropic, or on turbulent boundary layers. Boundary layer models usually rely very heavily on the presence of mean shear and the production of turbulence due to that mean shear. Most other turbulence models are based on the assumption of quasi-homogeneity. However, there are many situations of engineering interest which do not involve large shear rates and which are not quasi-homogeneous or isotropic. Shear-free turbulent boundary layers are the prototypical example of such flows, with practical situations being separation and reattachment, bluff body flow, high free-stream turbulence, and free surface flows. Although these situations are not as common as the variants of the flat plate turbulent boundary layer, they tend to be critical factors in complex engineering situations. The models developed are intended to extend classical quasi-homogeneous models into regions of large inhomogeneity. These models do not rely on the presence of mean shear or production, but are still applicable when those additional effects are included. Although the focus is on shear-free boundary layers as tests for these models, results for standard shearing boundary layers are also shown.
Author (revised)

N94-24145*# Texas A&M Univ., College Station.
COMPUTATION OF TURBULENT FLOWS OVER BACKWARD AND FORWARD-FACING STEPS USING A NEAR-WALL REYNOLDS STRESS MODEL
SUNG HO KO *In* Stanford Univ., Annual Research Briefs, 1993 p 75-90 Dec. 1993
Avail: CASI HC A03/MF A04

Separation and reattachment of turbulent shear layers is observed in many important engineering applications, yet it is poorly understood. This has motivated many studies on understanding and predicting the processes of separation and reattachment of turbulent shear layers. Both of the situations in which separation is induced by adverse pressure gradient, or by discontinuities of geometry, have attracted attention of turbulence model developers. Formulation of turbulence closure models to describe the essential features of separated turbulent flows accurately is still a formidable task. Computations of separated flows associated with sharp-edged bluff bodies are described. For the past two decades, the backward-facing step flow, the simplest separated flow, has been a popular test case for turbulence models. Detailed studies on the performance of many turbulence models, including two equation turbulence models and Reynolds stress models, for flows over steps can be found in the papers by Thangam & Speziale and Lasher & Taulbee). These studies indicate that almost all the existing turbulence models fail to accurately predict many important features of back step flow such as reattachment length, recovery rate of the redeveloping boundary layers downstream of the reattachment point, streamlines near the reattachment point, and the skin friction coefficient. The main objectives are to calculate flows over backward and forward-facing steps using the NRSM and to make use of the newest DNS data for detailed comparison. This will give insights for possible improvements of the turbulence model. Author (revised)

N94-24150*# Stanford Univ., CA. Center for Turbulence Research.
TOWARD LARGE EDDY SIMULATION OF TURBULENT FLOW OVER AN AIRFOIL
HAECHEON CHOI *In its* Annual Research Briefs, 1993 p 145-149 Dec. 1993
Avail: CASI HC A01/MF A04

The flow field over an airfoil contains several distinct flow characteristics, e.g. laminar, transitional, turbulent boundary layer flow, flow separation, unstable free shear layers, and a wake. This diversity of flow regimes taxes the presently available Reynolds averaged turbulence models. Such models are generally tuned to predict a particular flow regime, and adjustments are necessary for the prediction of a different flow regime. Similar difficulties are likely to emerge when the large eddy simulation technique is applied with the widely used Smagorinsky model. This model has not been successful in correctly representing different turbulent flow fields with a single universal constant and has an incorrect near-wall

behavior. Germano et al. (1991) and Ghosal, Lund & Moin have developed a new subgrid-scale model, the dynamic model, which is very promising in alleviating many of the persistent inadequacies of the Smagorinsky model: the model coefficient is computed dynamically as the calculation progresses rather than input a priori. The model has been remarkably successful in prediction of several turbulent and transitional flows. We plan to simulate turbulent flow over a '2D' airfoil using the large eddy simulation technique. Our primary objective is to assess the performance of the newly developed dynamic subgrid-scale model for computation of complex flows about aircraft components and to compare the results with those obtained using the Reynolds average approach and experiments. The present computation represents the first application of large eddy simulation to a flow of aeronautical interest and a key demonstration of the capabilities of the large eddy simulation technique. Derived from text

N94-24164*# Stanford Univ., CA.
DIRECT SIMULATION OF ISOTHERMAL-WALL SUPERSONIC CHANNEL FLOW
GARY N. COLEMAN *In its* Annual Research Briefs, 1993 p 313-328 Dec. 1993
Avail: CASI HC A03/MF A04

The motivation for this work is the fact that in turbulent flows where compressibility effects are important, they are often poorly understood. A few examples of such flows are those associated with astrophysical phenomena and those found in combustion chambers, supersonic diffusers and nozzles, and over high-speed airfoils. For this project, we are primarily interested in compressibility effects near solid surfaces. Our main objective is an improved understanding of the fundamentals of compressible wall-bounded turbulence, which can in turn be used to cast light upon modeling concepts such as the Morkovin hypothesis and the Van Driest transformation. To this end, we have performed a direct numerical simulation (DNS) study of supersonic turbulent flow in a plane channel with constant-temperature walls. All of the relevant spatial and temporal scales are resolved so that no sub grid scale or turbulence model is necessary. The channel geometry was chosen so that finite Mach number effects can be isolated by comparing the present results to well established incompressible channel data. Here the fluid is assumed to be an ideal gas with constant specific heats, constant Prandtl number, and power-law temperature-dependent viscosity. Isothermal-wall boundary conditions are imposed so that a statistically stationary state may be obtained. The flow is driven by a uniform (in space) body force (rather than a mean pressure gradient) to preserve stream wise homogeneity, with the body force defined so that the total mass flux is constant. Derived from text

N94-24178 Montreal Univ. (Quebec). Dept. de Genie Mecanique.
THREE DIMENSIONAL STUDY OF AN AIRPLANE WING AND ITS WAKE IN THE SUBSONIC REGIME M.S. Thesis [ETUDE 3D D'UNE AILE D'AVION ET DE SON SILLAGE EN REGIME SUBSONIQUE]
FRANCIS NORMANDIN Aug. 1990 133 p In FRENCH
(ISBN-0-315-58963-9; CTN-94-60875) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A numerical method and a computer code were developed for the analysis of three dimensional (3D) airplane wing configurations in the subsonic regime. Comparisons with analytical solutions, experimental data, and commercial computer code validates the results. The overall approach is based on resolution of the Laplace equation. As is the case in any classical panel method, the linearity of the equation to be resolved allows limiting the problem to a surface integral. This linearity serves as a criterion of simplicity and will allow establishment of foundations for future developments in the 3D domain. The method is based directly on the full potential, which permits easy interpretation of the results. Using bi-linear doublet distributions only on triangular surface elements facilitates discretization of the configuration to be analyzed while limiting abrupt variations of the solution at the panel edges. To take into account the vorticity effects related to the lift developed on the wing, a wake relaxation is included which introduces a coupling approach into the calculation, since the shape of the wake is unknown at the start. A two dimensional semi-stationary development method is used to generate the wake behind the wing by convecting Treftz plans. Once the wake geometry is obtained, a new potential calculation is performed. Author (CISTI)

N94-24182 Pioneer Aerospace Corp., Melbourne, FL.
RADIALLY CONSTRUCTED CRUCIFORM PARACHUTE Patent
JAMES D. REUTER, inventor (to Pioneer Aerospace Corp.) 12 Oct. 1993 18 p
(CA-PATENT-1323021; INT-PATENT-CLASS-B64D-017/02; CTN-94-60932) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A radially constructed cruciform parachute is discussed. The parachute is adapted to support a load below it. The parachute itself includes a canopy having a hemispherically shaped member defining an apex in the uppermost portion. The canopy also defines a lower canopy edge that is generally circular around its lowermost portion. A plurality of panel members are each positioned extending vertically from a position adjacent the apex to the lower canopy edge. The panel members are attached with respect to one another along their vertically extending edges to form the hemispheric member of the canopy. Each panel includes upper and lower sections, and a plurality of the individual panels have lower panel sections which define open sections to form gores for facilitating stability of the overall parachute. These open sections extend from the lower canopy edge upwardly to the immediate edge of the upper panel and are defined laterally by the vertical edges of the adjacent panel sections. Each open section is positioned diametrically opposite another open section about the hemispheric member of the canopy to provide increased stability while inflating and after inflation. A plurality of support lines secured to the lower canopy edge extend downward to support the load. A preferred configuration of the parachute has 16 solid panels and eight panels with an open section. Author (CISTI)

N94-24285 Aero-Design and Development Ltd., Rehovoth (Israel).
AERODYNAMIC MODELS FOR PERFORMANCE CALCULATIONS OF MODERN TECHNOLOGY PROPELLERS
I. WEISSBERG, G. ENGEL, and A. ROSEN (Technion - Israel Inst. of Tech., Haifa.) *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 458-468 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Three numerical models for predicting the aerodynamic performance of Modern Technology Propellers (MTP) are described. The models include a Blade-Element/Momentum model, a Lifting Line model, and a VLM (Vortex Lattice Method) model. These three models are simple and characterized by numerical efficiency. The first two models use two dimensional tabulated airfoil data to account for the compressibility, viscosity, and nonlinear airfoil characteristics. The models also include corrections for various effects such as tip effect, sweep, and induced tangential velocity. The results of the three models are compared with experimental results for two MTP designs, one with straight blades and the other with swept ones. The results are explained and discussed. ISA

N94-24295*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
REDUCTION OF STRUCTURAL LOADS USING MANEUVER LOAD CONTROL ON THE ADVANCED FIGHTER TECHNOLOGY INTEGRATION (AFTI)/F-111 MISSION ADAPTIVE WING
STEPHEN V. THORNTON Washington Sep. 1993 31 p

(Contract RTOP 505-63-50)
(NASA-TM-4526; H-1940; NAS 1.15:4526) Avail: CASI HC A03/MF A01

A transonic fighter-bomber aircraft, having a swept supercritical wing with smooth variable-camber flaps was fitted with a maneuver load control (MLC) system that implements a technique to reduce the inboard bending moments in the wing by shifting the spanwise load distribution inboard as load factor increases. The technique modifies the spanwise camber distribution by automatically commanding flap position as a function of flap position, true airspeed, Mach number, dynamic pressure, normal acceleration, and wing sweep position. Flight test structural loads data were obtained for loads in both the wing box and the wing root. Data from uniformly deflected flaps were compared with data from flaps in the MLC configuration where the outboard segment of three flap segments was deflected downward less than the two inboard segments. The changes in the shear loads in the forward wing spar and at the roots of the stabilators also are presented. The camber control system automatically reconfigures the flaps through varied flight conditions. Configurations having both moderate and full trailing-edge flap deflection were tested. Flight test data were collected at Mach numbers of 0.6, 0.7, 0.8, and 0.9 and dynamic pressures of 300, 450, 600, and 800 lb/sq ft. The Reynolds numbers for these flight conditions ranged from 26 x 10(exp 6) to 54 x 10(exp 6) at the mean aerodynamic chord. Load factor increases of up to 1.0 g achieved with no increase in wing root bending moment with the MLC flap configuration.

Author (revised)

N94-24311*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EXPERIMENTAL INVESTIGATION OF A MACH 3.0 HIGH-SPEED CIVIL TRANSPORT AT SUPERSONIC SPEEDS

GLORIA HERNANDEZ, PETER F. COVELL, and MARVIN E. MCGRAW, JR. (Lockheed Engineering and Sciences Co., Hampton, VA.) Nov. 1993 94 p Microfiche as supplement
(Contract RTOP 505-59-20-01)
(NASA-TP-3365; L-17171; NAS 1.60:3365) Avail: CASI HC A05/MF A01

An experimental study was conducted to determine the aerodynamic characteristics of a proposed high speed civil transport. This configuration was designed to cruise at Mach 3.0 and sized to carry 250 passengers for 6500 n.mi. The configuration consists of a highly blended wing body and features a blunt parabolic nose planform, a highly swept inboard wing panel, a moderately swept outboard wing panel, and a curved wingtip. Wind tunnel tests were conducted in the Langley Unitary Plan Wind Tunnel on a 0.0098-scale model. Force, moment, and pressure data were obtained for Mach numbers ranging from 1.6 to 3.6 and at angles of attack ranging from -4 to 10 deg. Extensive flow visualization studies (vapor screen and oil flow) were obtained in the experimental program. Both linear and advanced computational fluid dynamics (CFD) theoretical comparisons are shown to assess the ability to predict forces, moments, and pressures on configurations of this type. In addition, an extrapolation of the wind tunnel data, based on empirical principles, to full-scale conditions is compared with the theoretical aerodynamic predictions. Author (revised)

N94-24335*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ETHYLENE TRACE-GAS TECHNIQUES FOR HIGH-SPEED FLOWS

DAVID O. DAVIS and BRUCE A. REICHERT Feb. 1994 12 p Presented at the 32nd Aerospace Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract RTOP 505-62-52)
(NASA-TM-106491; AIAA PAPER 94-0733; E-8478; NAS 1.15:106491) Avail: CASI HC A03/MF A01

Three applications of the ethylene trace-gas technique to high-speed flows are described: flow-field tracking, air-to-air mixing, and bleed mass-flow measurement. The technique involves injecting a non-reacting gas (ethylene) into the flow field and measuring the concentration distribution in a downstream plane. From the distributions, information about flow development, mixing, and mass-flow rates can be dtermined. The trace-gas apparatus and special considerations for use in high-speed flow are discussed. A description of each application, including uncertainty estimates is followed by a demonstrative example. Author

N94-24464*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPERIMENTAL CAVITY PRESSURE MEASUREMENTS AT SUBSONIC AND TRANSONIC SPEEDS. STATIC-PRESSURE RESULTS

E. B. PLENTOVICH, ROBERT L. STALLINGS, JR. (Lockheed Engineering and Sciences Co., Hampton, VA.), and M. B. TRACY Dec. 1993 76 p
(Contract RTOP 505-68-70-08)
(NASA-TP-3358; L-17157; NAS 1.60:3358) Avail: CASI HC A05/MF A01

An experimental investigation was conducted to determine cavity flow-characteristics at subsonic and transonic speeds. A rectangular box cavity was tested in the Langley 8-Foot Transonic Pressure Tunnel at Mach numbers from 0.20 to 0.95 at a unit Reynolds number of approximately 3 x 10(exp 6) per foot. The boundary layer approaching the cavity was turbulent. Cavities were tested over a range of length-to-depth ratios (l/h) of 1 to 17.5 for cavity width-to-depth ratios of 1, 4, 8, and 16. Fluctuating- and static-pressure data in the cavity were obtained; however, only static-pressure data is analyzed. The boundaries between the flow regimes based on cavity length-to-depth ratio were determined. The change to transitional flow from open flow occurs at l/h at approximately 6-8 however, the change from transitional- to closed-cavity flow occurred over a wide range of l/h and was dependent on Mach number and cavity configuration. The change from closed to open flow as found to occur gradually. The effect of changing cavity dimensions showed that if the vlaue of l/h was kept fixed but the cavity width was decreased or cavity height was increased, the cavity pressure distribution tended more toward a more closed flow distribution. Author (revised)

N94-24576*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STRUCTURAL DYNAMICS DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FY 1993 AND PLANS FOR FY 1994

ELEANOR C. WYNNE Jan. 1994 84 p
(Contract RTOP 505-63-50-13)
(NASA-TM-109036; NAS 1.15:109036) Avail: CASI HC A05/MF A01

The purpose is to present the Structural Dynamics Division's research accomplishments for F.Y. 1993 and research plans for F.Y. 1994. The work under each Branch (technical area) is described in terms of highlights of accomplishments during the past year and highlights of plans for the current year as they relate to 5-year plans for each technical area. This information will be useful in program coordination with other government organizations and industry in areas of mutual interest.

Author (revised)

N94-24586*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC CHARACTERISTICS AND PRESSURE DISTRIBUTIONS FOR AN EXECUTIVE-JET BASELINE AIRFOIL SECTION

DENNIS O. ALLISON and RAYMOND E. MINECK Dec. 1993 103 p
(Contract RTOP 505-59-10-30)
(NASA-TM-4529; L-17228; NAS 1.15:4529) Avail: CASI HC A06/MF A02

A wind tunnel test of an executive-jet baseline airfoil model was conducted in the adaptive-wall test section of the NASA Langley 0.3-Meter Transonic Cryogenic Tunnel. The primary goal of the test was to measure airfoil aerodynamic characteristics over a wide range of flow conditions that encompass two design points.

The two design Mach numbers were 0.654 and 0.735 with corresponding Reynolds numbers of 4.5 x 10(exp 6) and 8.9 x 10(exp 6) based on chord, respectively, and normal-force coefficients of 0.98 and 0.51, respectively. The tests were conducted over a Mach number range from 0.250 to 0.780 and a chord Reynolds number range from 3 x 10(exp 6) to 18 x 10(exp 6). The angle of attack was varied from -2 deg to a maximum below 10 deg with one exception in which the maximum was 14 deg for a Mach number of 0.250 at a chord Reynolds number of 4.5 x 10(exp 6). Boundary-layer transition was fixed at 5 percent of chord on both the upper and lower surfaces of the model for most of the test. The adaptive-wall test section had flexible top and bottom walls and rigid sidewalls. Wall interference was minimized by the movement of the adaptive walls, and the airfoil aerodynamic characteristics were corrected for any residual top and bottom wall interference. Author (revised)

N94-24606*# United Technologies Research Center, East Hartford, CT.

AN ANALYSIS FOR HIGH REYNOLDS NUMBER INVISCID/VISCID INTERACTIONS IN CASCADES Final Report

MARK BARNETT, JOSEPH M. VERDON, and TIMOTHY C. AYER Washington May 1993 50 p

(Contract NAS3-25425; RTOP 584-03-11)

(NASA-CR-4519; E-7851; NAS 1.26:4519) Avail: CASI HC A03/MF A01

An efficient steady analysis for predicting strong inviscid/viscid interaction phenomena such as viscous-layer separation, shock/boundary-layer interaction, and trailing-edge/near-wake interaction in turbomachinery blade passages is needed as part of a comprehensive analytical blade design prediction system. Such an analysis is described. It uses an inviscid/viscid interaction approach, in which the flow in the outer inviscid region is assumed to be potential, and that in the inner or viscous-layer region is governed by Prandtl's equations. The inviscid solution is determined using an implicit, least-squares, finite-difference approximation, the viscous-layer solution using an inverse, finite-difference, space-marching method which is applied along the blade surfaces and wake streamlines. The inviscid and viscid solutions are coupled using a semi-inverse global iteration procedure, which permits the prediction of boundary-layer separation and other strong-interaction phenomena. Results are presented for three cascades, with a range of inlet flow conditions considered for one of them, including conditions leading to large-scale flow separations. Comparisons with Navier-Stokes solutions and experimental data are also given. Author (revised)

N94-24773# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.

NONLINEAR EQUATIONS OF MOTION FOR A PANEL SUBJECT TO EXTERNAL LOADS Interim Report, Jan. 1992 - Oct. 1993

MARK A. HOPKINS Nov. 1993 45 p

(Contract AF PROJ. 2401)

(AD-A273142; WL-TM-93-308) Avail: CASI HC A03/MF A01

The equations of motion of a constant thickness, rectangular panel subject to external static loads and unsteady supersonic aerodynamic forces is derived. Both isotropic and orthotropic panels are examined. The static loads come from in-plane forces, a temperature differential, and a pressure differential. The equations allow for slight initial curvature due to manufacturing imperfections. The equations are derived using a nonlinear strain-displacement relationship which permits both linear and nonlinear panel response studies. First order piston theory predicts the unsteady aerodynamic forces due to the supersonic flow over the upper surface. DTIC

03

AIR TRANSPORTATION AND SAFETY

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

N94-23288*# Boeing Commercial Airplane Co., Seattle, WA. Avionics/Flight Systems.

AIRPORT SURFACE OPERATIONS REQUIREMENTS ANALYSIS Final Report

JOHN L. GROCE, GREG J. VONBOKERN, and RICK L. WRAY Aug. 1993 101 p

(Contract NAS1-18027; RTOP 505-64-13-01)

(NASA-CR-191508; NAS 1.26:191508) Avail: CASI HC A06/MF A02

This report documents the results of the Airport Surface Operations Requirements Analysis (ASORA) study. This study was conducted in response to task 24 of NASA Contract NAS1-18027. This study is part of NASA LaRC's Low Visibility Surface Operations program, which is designed to eliminate the constraints on all-weather arrival/departure operations due to the airport/aircraft ground system. The goal of this program is to provide the capability for safe and efficient aircraft operations on the airport surface during low visibility conditions down to zero. The ASORA study objectives were to (1) develop requirements for operation on the airport surface in visibilities down to zero; (2) survey and evaluate likely technologies; (3) develop candidate concepts to meet the requirements; and (4) select the most suitable concept based on cost/benefit factors. Author

N94-23523*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CLOSE-UP ANALYSIS OF INFLIGHT ICE ACCRETION

ANDREW L. REEHORST, THOMAS P. RATVASKY, and JAMES SIMS (Cortez 3 Services Corp., Brook Park, OH.) Jan. 1994 12 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA

(Contract NAS3-24816; RTOP 505-68-10)

(NASA-TM-106457; E-8318; NAS 1.15:106457; AIAA PAPER 94-0804) Avail: CASI HC A03/MF A01

The objective of this effort was to validate in flight, data that has been gathered in the NASA Lewis Research Center's Icing Research Tunnel (IRT) over the past several years. All data was acquired in flight on the NASA Lewis Research Center's Twin Otter Icing Research Aircraft. A faired 3.5 in. diameter metal-clad cylinder exposed to the natural icing environment was observed by a close-up video camera. The grazing angle video footage was recorded to S-VHS video tape and after the icing encounter, the resultant ice shape was documented by 35 mm photography and pencil tracings. The feather growth area was of primary interest; however, all regions of the ice accretion, from the stagnation line to the aft edge of run back were observed and recorded. After analysis of the recorded data several interesting points became evident: (1) the measured flight feather growth rate is consistent with IRT values, (2) the feather growth rate appears to be influenced by droplet size, (3) the feathers were straighter in the lower, spottier LWC of flight in comparison to those observed in the IRT, (4) feather shedding and ice sublimation may be significant to the final ice shape, and (5) the snow encountered on these flights appeared to have little influence on ice growth. Author (revised)

N94-23579# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: INADVERTENT IN-FLIGHT SLAT DEPLOYMENT, CHINA EASTERN AIRLINES FLIGHT 583, MCDONNELL DOUGLAS MD-11, B-2171, 950 NAUTICAL MILES SOUTH OF SHEMYA, ALASKA, 6 APRIL 1993

27 Oct. 1993 73 p

(PB93-910408; NTSB/AAR-93/07) Avail: CASI HC A04/MF A01

This report explains the inadvertent deployment of the MD-11

airplane's leading edge wing slats while the airplane was in cruise flight, about 950 nautical miles south of Shemya, Alaska, on April 6, 1993. Safety issues in the report focused on the inadequate design of the flap/slat actuation handle, the inadvertent extension of the leading edge wing slats, the longitudinal stability of the airplane during the pitch upset, the pilot-induced oscillations that can occur during recovery, the premature deterioration of the seat cushion fire-blocking material, and the inability of the material to provide the required seat cushion fire protection on transport-category airplanes. Safety recommendations on these issues were made to the Federal Aviation Administration. Author

N94-23810 National Inst. of Standards and Technology, Gaithersburg, MD. Building and Fire Research Lab.
DISPERSION OF FIRE SUPPRESSION AGENTS DISCHARGED FROM HIGH PRESSURE VESSELS: ESTABLISHING INITIAL/BOUNDARY CONDITIONS FOR THE FLOW OUTSIDE THE VESSEL
L. Y. COOPER Sep. 1993 38 p Sponsored by Department of the Air Force, Wright-Patterson AFB, OH Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-103660; NISTIR-5219) Avail: Issuing Activity (National Technical Information Service (NTIS))

The dispersion and extinguishment effectiveness of Halon and Halon-alternative fire extinguishment agents discharged from N2-pressurized vessels was studied. In the systems under consideration, as the agent exists from the vessel, thermodynamic and fluid-dynamic instabilities lead to flashing and break-up of the agent into a two-phase droplet/gaseous jet mixture. This occurs in a transition region relatively close to the vessel exit orifice/nozzle. Downstream of this region the two-phase agent jet then mixes with the ambient air environment and is dispersed in the protected space. A mathematical model was developed previously to simulate the time-dependent discharge of the agent from the pressure vessel. Using the output of this model and thermodynamic and fluid-dynamic considerations of the phenomena in the transition section, the present work develops a method for determining a set of initial/boundary conditions at an initial section of the jet, downstream of the transition region. These initial/boundary conditions are in a form that can be used to formulate and solve the problem of the development and dispersal of the ensuing mixed air/two-phase-agent jet. Example applications of the developed methodology are presented. These are for agent discharge from a half-liter cylindrical discharge vessel with a circular discharge nozzle/orifice of diameter 0.019m. Simulations involve discharge of the vessel when it is half-filled with either Freon 22 or Halon 1301 and then pressurized with N2 to 41.37 x 10(exp 5)Pa (600psi). NTIS

N94-24047*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RIME-, MIXED- AND GLAZE-ICE EVALUATIONS OF THREE SCALING LAWS
DAVID N. ANDERSON Jan. 1994 15 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-106461; E-8323; NAS 1.15:106461; AIAA PAPER 94-0718) Avail: CASI HC A03/MF A01

This report presents the results of tests at NASA Lewis to evaluate three icing scaling relationships or 'laws' for an unheated model. The laws were LWC x time = constant, one proposed by a Swedish-Russian group and one used at ONERA in France. Icing tests were performed in the NASA Lewis Icing Research Tunnel (IRT) with cylinders ranging from 2.5- to 15.2-cm diameter. Reference conditions were chosen to provide rime, mixed and glaze ice. Scaled conditions were tested for several scenarios of size and velocity scaling, and the resulting ice shapes compared. For rime-ice conditions, all three of the scaling laws provided scaled ice shapes which closely matched reference ice shapes. For mixed ice and for glaze ice none of the scaling laws produced consistently good simulation of the reference ice shapes. Explanations for the observed results are proposed, and scaling issues requiring further study are identified. Author

N94-24062# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: IN-FLIGHT ENGINE SEPARATION. JAPAN AIRLINES, INC., FLIGHT 46E, BOEING 747-121, N473EV, ANCHORAGE, ALASKA, 31 MARCH 1993
13 Oct. 1993 109 p
(PB93-410407; NTSB/AAR-93/06) Avail: CASI HC A06/MF A02

This report explains the in-flight separation of the No. 2 engine and engine pylon from a B-747-121 airplane shortly after its takeoff from Anchorage International Airport, Anchorage, Alaska, on March 31, 1993. The safety issues discussed in the report focused on the inspection of B-747 engine pylons, meteorological hazards to aircraft, the lateral load-carrying capability of engine pylon structures, and aircraft departure routes at Anchorage International Airport during turbulent weather conditions. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration and the National Weather Service. Author

N94-24091# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AIRCRAFT FLIGHT SAFETY: A BIBLIOGRAPHY [LA SECURITE EN VOL: UNE BIBLIOGRAPHIE]
Dec. 1993 53 p
(AGARD-R-805; ISBN-92-835-0730-4) Copyright Avail: CASI HC A04/MF A01

A bibliography of publications held by NASA on aspects of aircraft flight safety is provided. The abstracts are listed by the following topics: human errors, injury reduction, engines, structures and materials, aircraft aging, fire, adverse weather, aircraft maintenance, future safety requirements, and miscellaneous items. The bibliography was compiled originally as a contribution to a conference on aircraft flight safety, sponsored jointly by AGARD and the Russian International Integration Association, which was held in Russia in August/September 1993. Author (revised)

N94-24718 Naval Postgraduate School, Monterey, CA.
A NUMERICAL STUDY OF AIRPLANES FLYING IN PROXIMITY M.S. Thesis
DAVID B. PORTER Sep. 1993 140 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A273373) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

During an emergency such as an unsafe landing gear indication, a second aircraft is often used to perform an airborne visual inspection of the landing gear. The chase airplane may be quite dissimilar in size and wing loading and consequently experience unexpected aerodynamic forces and moments caused by the other airplane. A numerical study of the inherent danger involved with the aerodynamic interaction of aircraft flying in proximity was made using the low-order panel code PMARC (Panel Method Ames Research Center). PMARC validation was made by comparing wind tunnel and analytically derived stability data for T-34 and F-14 models with PMARC results. A T-34 was then placed at various distances underneath an F-14 to determine changes in lift and pitching moments on the T-34. Color illustrations of pressure coefficients were used to highlight the changes in aerodynamic forces and moments as vertical separation between the two aircraft was decreased. PMARC showed that 4.5 degrees of elevator trim change was required as a T-34 approached to within its semispan of an F-14. DTIC

N94-24750# *Office of Technology Assessment, Washington, DC.*
AIRCRAFT EVACUATION TESTING: RESEARCH AND TECHNOLOGY ISSUES
Sep. 1993 65 p
(PB94-107620) Avail: CASI HC A04/MF A01

The report explains and analyzes the current state of testing procedures used to certify aircraft in terms of emergency evacuation capability. A number of issues regarding the requirement for certification based on people evacuating an actual aircraft are reviewed, as are possible alternatives or supplements to the procedure. Technologies that might be considered for making survival times greater in a real emergency are identified. NTIS

N94-24781# Naval Postgraduate School, Monterey, CA.
INFORMATION SYSTEMS STRATEGY IN AIR TRANSPORT M.S. Thesis
DESMOND P. MCGLADE Sep. 1993 135 p
(AD-A273125) Avail: CASI HC A07/MF A02

Seeking to improve the role of Information Technology (IT) and business practices in the Department of Defense, organizations were sought to serve as a model to aid in the improvement process. Southwest Airlines, a major U.S. carrier based in Dallas, Texas was chosen because of its record of profitability and its unique use of information technology. This case study describes Southwest's mission, goals, organization, business decisions, attitude, growth and information technology. The primary focus is the fact that Southwest does not participate in a major carrier's reservation system. Lessons learned for a military officer in terms of Information Technology are to avoid redundancy, improve functionality, avoid expensive enhancements that do not contribute to our requirements, and don't discount old technologies. DTIC

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

N94-24120 National Defence Headquarters, Ottawa (Ontario). Directorate of Research and Development Communications and Space.
AN OVERVIEW OF A GENERIC MULTI-SENSOR INTEGRATED NAVIGATION SYSTEM DESIGN
D. F. LIANG Jun. 1993 22 p
(CTN-94-60916) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

The application of Kalman filtering technology to the design and development of a multi-sensor generic integrated navigation system (GINS) for aircraft is described. The primary system component is the integrated sensor unit which consists of all the selected navigation sensors. These sensors can be classified into two main categories: dead reckoning (DR) and radio navigation systems. To take advantage of the short-term stability of the DR system and the long-term stability of the radio navigation system, optimal estimation theory can be applied in the form of a Kalman filter (KF) to combine all the available measurements and provide a statistically optimal estimate of aircraft position and other parameters. To achieve the desired performance, the GINS processor must perform signal conditioning and sensor compensation functions and must contain efficient KF integration algorithms, error control, and performance monitoring routines. The system development approach is described, as well as system error modelling, and KF design. CISTI

N94-24127# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
ANALYSIS AND SURVEILLANCE PERFORMANCE AT CHICAGO O'HARE AIRPORT Project Report
SYLVIA I. ALTMAN, DOUGLAS W. BURGESS, RICHARD G. POTTS, RONALD G. SANDHOLM, and M. LOREN WOOD 28 Jan. 1994 95 p
(Contract DTFA-01-93-Z-02018; F19628-90-C-0002)
(DOT/FAA/RD-92/29; ATC-193) Avail: CASI HC A05/MF A01

The results of RF measurements of the 1030 and 1090 MHz environment in the Chicago terminal area conducted by Lincoln Laboratory in October 1991 are described. The measurements were made at the request of the FAA in response to reports by controllers in Chicago that TCAS interrogations are affecting the surveillance performance of the Chicago Secondary Surveillance Radar (SSR). The Airborne Measurements Facility (AM), developed at Lincoln Laboratory, was used to gather TCAS and SSR interrogation and reply data in the vicinity of O'Hare Airport during periods of active TCAS operation. Simultaneously, local aircraft track data were collected using the Automated Radar Terminal System (ARTS) data recording facility. Analysis of both the AMF data and the ARTS data show that TCAS interrogations do not cause a significant degradation in SSR surveillance performance and that the average Chicago ARTS track performance in the presence of TCAS-equipped aircraft is comparable to earlier measurements of track performance in Chicago as well as at a number of other high-density terminal areas. Specific regions within the Chicago surveillance area were observed to contain concentrations of poor ARTS track performance, and analysis of the data has shown the cause to be differential vertical lobing associated with the SSR antenna and faulty Mode S transponders on certain air carrier aircraft. Both of these problems were subsequently corrected. Author (revised)

N94-24176 New Brunswick Univ., Fredericton. Dept. of Surveying Engineering.
AN INVESTIGATION INTO ACCELERATION DETERMINATION FOR AIRBORNE GRAVIMETRY USING THE GLOBAL POSITIONING SYSTEM M.S. Thesis
DERRICK R. PEYTON Jun. 1990 155 p
(ISBN-0-315-59470-5; CTN-94-60873) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305 Ottawa, Ontario, K2P 2G8, Canada HC/MF

The determination of acceleration using the NAVSTAR Global Positioning System (GPS) is investigated for airborne gravimetric applications. The position and velocity requirements for airborne gravimetry were met using GPS observing and processing techniques. However, the separation of the aircraft acceleration from the observed gravity still remains to be resolved to the 1-2 milligal accuracy requirements. As a means to move toward achieving such accuracy, a model is developed in which the accelerations are obtained by utilizing the second time derivative of the GPS carrier phase. Carrier phase data were collected from pairs of GPS receivers located at fixed points. Spectral analysis techniques for determining acquired acceleration accuracy were applied to computed accelerations from these data sets. Low-pass filters were applied to the acceleration data to separate the high frequency receiver measurement noise from the low frequency acceleration data. The implications and handling of GPS data contaminated by selective availability are addressed. Results show that for carrier phase observations over a fixed baseline of under 100 m, differential techniques can give accelerations which meet the 1-2 milligal accuracy requirements. Author (CISTI)

N94-24472# Civil Aeromedical Inst., Oklahoma City, OK.
AN EXAMINATION OF THE OPERATIONAL ERROR DATABASE FOR AIR ROUTE TRAFFIC CONTROL CENTERS Final Report
MARK D. RODGERS, ed. Dec. 1993 29 p
(DOT/FAA/AM-93/22) Avail: CASI HC A03/MF A01

Monitoring the frequency and determining the causes of operational errors - defined as the loss of prescribed separation between aircraft - is one approach to assessing the operational safety of the air traffic control system. The Federal Aviation Administration (FAA) refers to the loss of separation standards between aircraft as an operational error (OE). The extent to which separation is lost determines the severity of the error. The first study examined the relationships between error occurrence, controller workload (number of aircraft and traffic complexity), and causal factors involved. The FAA's Final Operational Error/Deviation Reports for ARTCC facilities during calendar years 1985-88 comprised the data base. A majority of the errors occurred

under conditions of below average (25 percent) or average (39 percent) complexity. Complexity and number of aircraft were highly correlated. However, there was a significant difference across facilities in average workload during an event. Improved guidelines for quality assurance personnel are needed to insure a more standardized determination and reporting of workload dimensions. Results suggest that the frequency of some of the causal factors varied in response to changes in number of aircraft worked and traffic complexity. The second study analyzed the workload and causal factors related to the severity of OE's at ARTCC's during 1988-91. Neither the number of aircraft being worked nor air traffic complexity were significantly associated with severity. In general, the causal factors that resulted in greater severity likely involved reduced situation awareness by the controller. The relationship of aircraft profiles and flight levels with OE severity is examined. Facility level differences are reviewed regarding controller workload and awareness of the developing error. More in depth information is needed to determine precisely the manner in which alterations in workload influence the nature of the error process. Both studies point to the need for increasing the level of objectivity in the operational error investigation process. Author (revised)

N94-24474 Synetics Corp., Wakefield, MA.
WORLDWIDE VESSEL LOCATING AND TRACKING SYSTEM, VOLUME 1 Final Report, Oct. 1991 - Dec. 1992
KEVIN J. ODONNELL and DAVID A. AMOS Dec. 1992 135 p Prepared in cooperation with Maritime Administration, Washington, DC Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DTMA91-91-C-10038)
(PB93-193217; MA-RD-840-93000-VOL-1) Avail: Issuing Activity (National Technical Information Service (NTIS))

The report contains an assessment of the possible design and implementation of an automated worldwide Vessel Locating and Tracking System (VESLOTS). During the Technology Assessment task, viable systems were identified for each technology class (i.e., navigation, communication, and display/interface) and each of three geographic operating regions (i.e., worldwide, coastal U.S./Great Lakes, and inland waterway). During the User Requirements analysis task, potential VESLOTS operators and users were surveyed to amass a set of operational requirements for a VESLOTS implementation based on five criteria: message data content, navigation system, communication system, display/interface, and land link. NTIS

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N94-23146# Institut Franco-Allemand de Recherches, Saint-Louis (France).
COMPUTATION OF THE LOADS ON THE AH-1/OLS MODEL ROTOR IN FORWARD FLIGHT AND COMPARISON WITH WIND TUNNEL TESTS
M. SCHAFFAR and J. HAERTIG 2 Oct. 1992 16 p Presented at the 18th European Rotorcraft Forum, Avignon, France, 15-18 Sep. 1992
(ISL-CO-230/92; ETN-94-95127; PB93-204303) Avail: CASI HC A03/MF A01

The vortex lattice method jointly used with a local conformal mapping (to transform the thin blade into a thick one) is described. In order to validate the aerodynamic code, the results are compared with wind tunnel tests for one flight case of the AH-1/OLS model rotor. The study of the wake shows 4 blade/wake interactions for blade 1 during one revolution but only two parallel interactions occur in the rotor plane; the comparison of the computed and measured blade pressures shows an overestimation on the advancing side and an acceptable agreement on the retreating side. ESA

N94-23254 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
BENT-TIP BLADE FOR AIRCRAFT ROTARY-WING Patent [PALE A EXTREMITE COURBE POUR VOILURE TOURNANTE D'AERONEF]
ALAIN E. VUILLET, inventor (to ONERA), JEAN J. PHILIPPE, inventor (to ONERA), and ANDRE DESOPPER, inventor (to ONERA) 30 Mar. 1993 29 p In FRENCH
(CA-PATENT-1-315-259; INT-PATENT-CLASS-B64C-27/46; CTN-94-60923) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A bent-tip blade for a rotary wing aircraft comprises an attachment for fixing to a hub, a standard part having a leading and trailing edge whose profile has a chord of constant or evolutive length C, and a tip which extends the standard part outwardly, the leading edge of which prolongs the leading edge of the standard part directly rearward. The tip is furthermore inclined downward, and this inclination extends along the entire span of the tip and is continuous after the joint with the standard part up to the furthest edge of the tip such that it follows a curve whose extrados is convex and whose intrados is concave. The tip is not folded around a chord on a part of its span, but is curved progressively downward over all its span. Wind tunnel tests have shown that this continuous curvature is favorable in stationary and forward flight. Compared with a rotary wing blade having a rectilinear and rectangular tip, the curved tip of the invention permits a power gain of at least five percent for a given mass of aircraft. CISTI

N94-23489*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SUMMARY OF LIFT AND LIFT/CRUISE FAN POWERED LIFT CONCEPT TECHNOLOGY
WOODROW L. COOK Aug. 1993 92 p
(Contract NASA ORDER A-25364-D)
(NASA-CR-177619; A-93113; NAS 1.26:177619) Avail: CASI HC A05/MF A01

A summary is presented of some of the lift and lift/cruise fan technology including fan performance, fan stall, ground effects, ingestion and thrust loss, design tradeoffs and integration, control effectiveness and several other areas related to vertical short takeoff and landing (V/STOL) aircraft conceptual design. The various subjects addressed, while not necessarily pertinent to specific short takeoff/vertical landing (STOVL) supersonic designs being considered, are of interest to the general field of lift and lift/cruise fan aircraft designs and may be of importance in the future. The various wind tunnel and static tests reviewed are: (1) the Doak VZ-4 ducted fan, (2) the 0.57 scale model of the Bell X-22 ducted fan aircraft, (3) the Avrocar, (4) the General Electric lift/cruise fan, (5) the vertical short takeoff and landing (V/STOL) lift engine configurations related to ingestion and consequent thrust loss, (6) the XV-5 and other fan-in-wing stall consideration, (7) hybrid configurations such as lift fan and lift/cruise fan or engines, and (8) the various conceptual design studies by air-frame contractors. Other design integration problems related to small and large V/STOL transport aircraft are summarized including lessons learned during more recent conceptual design studies related to a small executive V/STOL transport aircraft.
Author (revised)

N94-24181 Messier-Hispano-Bugatti S.A., Montrouge (France).
LANDING GEAR WITH SWIVELLING BEAM Patent [DISPOSITIF D'ATTERRISSAGE A POUTRE BASCULANTE]
MICHEL DERRIEN, inventor (to Messier-Hispano-Bugatti), JACQUES VEAUX, inventor (to Messier-Hispano-Bugatti), and JEAN-PIERRE HAINAUT, inventor (to Messier-Hispano-Bugatti) 12 Oct. 1993 14 p In FRENCH
(CA-PATENT-1323020; INT-PATENT-CLASS-B64C-025/34;

CTN-94-60931) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A landing gear apparatus is comprised of a pivoting casing in which a shock absorber rod is mounted projecting downward with respect to the casing and movable in an axial direction. A swivelling beam is mounted to pivot at a lower end from the shock absorber rod and supports a wheel train fore and aft. The upper branch of a linkage, comprising an upper and lower branch connected to each other in an articulated fashion, is connected to the casing in an articulated manner, and the lower branch is connected in an articulated manner to the swivelling beam. Blockage means are provided for limiting the downward pivoting movement of the upper branch of the linkage while the shock absorber rod is not completely extended. During all phases of pivoting of the swivelling beam, only the lower branch of the linkage pivots, such that the force transmitted by the linkage to the casing is directed following the longitudinal direction of the lower branch of the linkage. The blockage means can be either an abutment on the lower branch of the linkage or a telescoping connecting rod between the upper branch of the linkage and the casing. CISTI

N94-24250 Israel Aircraft Industries Ltd., Tashan. Wind Tunnels Center.

ON THE EFFECT OF THE DAMPING COEFFICIENTS ON THE TRAJECTORIES OF SYMMETRIC AND NON-SYMMETRIC STORES

MOSHE ZILBERMAN and ALEX CAZES *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 133-141 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The effect of the damping coefficients of stores, being released from a parent aircraft, on their trajectories was quantitatively analyzed. Trajectories which were obtained at the Israel Aircraft Industries (IAI) four-foot trisonic wind tunnel by using the Captive Trajectory System (CTS), were recalculated for various dynamic coefficients. Three types of stores were tested. The first store was an M117, which has an axisymmetric shape and is statically stable. The second type was a Multiple Ejection Rack (MER), which was asymmetrically loaded, and the third type of store was an MER which was loaded symmetrically. Two methods were utilized to recalculate the trajectories. The Zero-Order Correction (ZOC), in which the static coefficients were not corrected, and the First-Order Correction (FOC), in which the static loads were linearly extrapolated according to the corrected positions of the store. The main objectives of this study were threefold: (1) to study the effect of a particular damping coefficient on a trajectory which was obtained by the CTS; (2) to characterize the effect of the damping coefficients with respect to the nature of the store, namely, symmetric or non-symmetric, and (3) to compare the off-line correction, ZOC and FOC, with the original trajectories which were obtained by the CTS. Finally, the influence of the damping coefficients on the clearance in separation is quantitatively examined by a parametric study of the 6-degrees-of-freedom (6DOF) equations. ISA

N94-24259 Israel Aircraft Industries Ltd., Ben-Gurion Airport. LAHAV Engineering Dept.

REPAIR OF CRACKED ALUMINUM AIRCRAFT STRUCTURE WITH COMPOSITE PATCHES

N. SASSON, A. SIMON, H. LEIBOVICH (Israel Aircraft Industries Ltd., Tashan.), and A. K. GREEN (Israel Aircraft Industries Ltd., Tashan.) *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 213-224 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The concept of repairing cracked aluminum aircraft structures with composite patches was investigated both analytically and experimentally. Coupon tests provided basic mechanical properties of composite patches obtained using a repair procedure. A new surface treatment for bonding patches was developed and optimized. The damage repair process was substantiated by element and beam testing. Crack growth predictions were made using analytical stress intensity factors for the patched structure, and excellent correlation was obtained between observed and predicted values. Patches were very effective in reducing the crack growth rate. Cracks of unpatched element specimens which propagated to failure during random spectrum fatigue loading survived without failure for much longer lifetimes (approximately 3.5 times) under all tested environmental conditions. The process was substantiated by repairing and testing a defective beam element. ISA

N94-24261 Israel Aircraft Industries Ltd., Tashan.

DEVELOPMENT OF A DAMAGE TOLERANCE TOOL TO ANALYZE MULTIPLE-SITE DAMAGE IN AIRCRAFT STRUCTURE

A. BROT and A. NATHAN *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 237-245 25 Feb. 1993

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A multiple site damage (MSD) analytical model is presented that predicts the crack growth behavior of a series of cracks at a row of open holes. A coupon test program is described that serves to verify the accuracy of the analytical model. For both equal and unequal sized initial cracks, the analysis predicted lives that were 10-14% longer than the average test result. The results also show that, if MSD effects were to be neglected, a non-conservative error of nearly 100% would result. The results of a parametric study are presented that demonstrate when MSD effects are most significant. ISA

N94-24286 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

THE INFLUENCE OF ELASTIC PITCH VARIATIONS ON HELICOPTER FLIGHT MECHANICS

Z. BEIGLEMAN and A. ROSEN *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 469-481 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Due to the loads that act along a helicopter blade, it experiences elastic pitch variations. These elastic pitch variations are the result of elastic torsion along the blade and the flexibility of the pitch control system. The use of a simplified model, describing these elastic pitch variations, which is appropriate for flight mechanics analyses, is presented. Parameters which determine the elastic pitch variations include: the blade torsional stiffness, cross sectional locations of the center of mass and aerodynamic center, the airfoil aerodynamic moment coefficient, pitch control system flexibility, and damping along the blade and of the control system. The influence of such parameters on trim position, stability and control derivatives, stability roots, and time response is presented. ISA

N94-24304*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STUDIES OF SHUTTLE ORBITER ARRESTMENT SYSTEM

PAMELA A. DAVIS and SANDY M. STUBBS Dec. 1993 88 p Original contains color illustrations

(Contract RTOP 505-63-10-02)

(NASA-TP-3370; L-17186; NAS 1.60:3370) Avail: CASI HC A05/MF A01; 5 functional color pages

Scale model studies of the Shuttle Orbiter Arrestment System (AS) were completed with a 1/27.5-scale model at the NASA Langley Research Center. The purpose of these studies was to determine the proper configuration for a net arrestment system to bring the orbiter to a safe stop with minimal damage in the event of a runway overrun. Tests were conducted for runway on-centerline and off-centerline engagements at simulated speeds up to

approximately 100 knots (full scale). The results of these tests defined the interaction of the net and the orbiter, the dynamics of off-centerline engagements, and the maximum number of vertical net straps that may become entangled with the nose gear. In addition to these tests, a test program with a 1/8-scale model was conducted by the arrestment system contractor, and the results are presented in the appendix. Author (revised)

N94-24313# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
INTEGRATED AIRFRAME DESIGN TECHNOLOGY [LES TECHNOLOGIES POUR LA CONCEPTION INTEGREE DES CELLULES]
Dec. 1993 173 p In ENGLISH and FRENCH Workshop held in Antalya, Turkey, 19-20 Apr. 1993
(AGARD-R-794; ISBN-92-835-0729-0) Copyright Avail: CASI HC A08/MF A02

Integrated airframe design embraces the concept of bringing together all of the aspects of airframe design, including various disciplines such as structures, materials, aerodynamics, controls, and manufacturing, from conceptual design all the way through manufacturing. It also includes the sub-disciplines which are involved in each discipline and the interactions these have with one another. Moreover, an IAD process also affects the organizational structure of the personnel. In order to provide a broad-based approach to evaluating and identifying future research and development directions required to provide IAD technology, the First Integrated Airframe Design Technology Workshop, sponsored by AGARD, was held in Antalya, Turkey on 19-20 Apr. 1993. This document summarizes the output of that Workshop.

N94-24314*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NEW COMPUTING SYSTEMS, FUTURE COMPUTING ENVIRONMENT, AND THEIR IMPLICATIONS ON STRUCTURAL ANALYSIS AND DESIGN
AHMED K. NOOR and JERROLD M. HOUSNER *In* AGARD, Integrated Airframe Design Technology 25 p Dec. 1993
(Contract NCCW-11)
Copyright Avail: CASI HC A03/MF A02

Recent advances in computer technology that are likely to impact structural analysis and design of flight vehicles are reviewed. A brief summary is given of the advances in microelectronics, networking technologies, and in the user-interface hardware and software. The major features of new and projected computing systems, including high performance computers, parallel processing machines, and small systems, are described. Advances in programming environments, numerical algorithms, and computational strategies for new computing systems are reviewed. The impact of the advances in computer technology on structural analysis and the design of flight vehicles is described. A scenario for future computing paradigms is presented, and the near-term needs in the computational structures area are outlined.
Author (revised)

N94-24315# Wright Lab., Wright-Patterson AFB, OH. Manufacturing Technology Directorate.
EARLY MANUFACTURING CONSIDERATIONS IN DESIGN
WILLIAM C. KESSLER, GERALD C. SHUMAKER, and MICHAEL F. HITCHCOCK *In* AGARD, Integrated Airframe Design Technology 7 p Dec. 1993
Copyright Avail: CASI HC A02/MF A02

The successful and timely transition of new product technologies to weapon systems depends heavily on the technical maturity, flexibility, and cost effectiveness of the critical manufacturing processes and systems required to turn these technologies into tangible products. The whole concept of Integrated Product Process Development (a.k.a. Concurrent Engineering) encourages and facilitates the parallel design and development of these manufacturing processes and systems with the design and development of the product. As a result of new computer aided technologies and increased emphasis on manufacturing design, new tools and methodologies are emerging that will facilitate the early consideration of manufacturing in design. This paper will address the development of two such tools: Producibility Methodology; and Tools and Virtual Manufacturing. These tools will enhance the effectiveness of manufacturing engineers who are integrated product process development team members and enable design engineers to better understand the potential downstream implications of early design decisions.
Author (revised)

N94-24316# Deutsche Aerospace A.G., Munich (Germany).
APPLICATIONS OF CFD CODES AND SUPERCOMPUTERS TO AIRCRAFT DESIGN ACTIVITIES
W. SCHMIDT and P. W. SACHER *In* AGARD, Integrated Airframe Design Technology 9 p Dec. 1993 Sponsored in part by Aerospatiale; DLR; Aachen Univ.; Stuttgart Univ.; Dornier System G.m.b.H.; and Deutsche Airbus G.m.b.H.
Copyright Avail: CASI HC A02/MF A02

Integrated Design Technology has been pushed to a large extent by the tremendous progress achieved in the last two decades in the field of computational techniques with regard to flow simulation, engineering, and manufacturing. This paper concentrates on the impact of CFD on the overall design process reviewed from the view of aircraft industry in Germany. Selected examples will be given for applications of CFD during design and development of major products of European aerospace industry without claiming for completeness. General product categories and technology areas involved will be identified as having large potential for CFD and supercomputing efforts. In addition, present technology thrusts will be discussed, and examples for the impact of CFD and supercomputing demonstrated by applications in various programs will be given. Author (revised)

N94-24317*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILISTIC SIMULATION OF CONCURRENT ENGINEERING OF PROPULSION SYSTEMS
C. C. CHAMIS and S. N. SINGHAL (Sverdrup Technology, Inc., Brook Park, OH.) *In* AGARD, Integrated Airframe Design Technology 10 p Dec. 1993
Copyright Avail: CASI HC A02/MF A02

Technology readiness and the available infrastructure is assessed for timely computational simulation of concurrent engineering for propulsion systems. Results for initial coupled multidisciplinary, fabrication-process, and system simulators are presented including uncertainties inherent in various facets of engineering processes. An approach is outlined for computationally formalizing the concurrent engineering process from cradle-to-grave via discipline dedicated workstations linked with a common database. Author (revised)

N94-24318# British Aerospace Defence Ltd., Preston (England). Military Aircraft Div.
FRAMEWORKS FOR INTEGRATED AIRFRAME DESIGN
A. L. SHAW *In* AGARD, Integrated Airframe Design Technology 15 p Dec. 1993
Copyright Avail: CASI HC A03/MF A02

British Aerospace is Britain's largest Manufacturing Group. Its products are divided into the following groups: Defense Systems, Commercial Aircraft, Cars, Civil Engineering, Property Development, Construction, and Project Management. BAe Defense is the largest defense company in Europe with a turnover of 4.2 billion British pounds. Its exports account for over 70 percent of the total sales. The Military Aircraft Division is an important part of the BAe Defense group. Its major projects are centered around the HAWK, HARRIER, TORNADO, and the European Fighter Aircraft EFA projects.
Author (revised)

N94-24319# Deutsche Aerospace A.G., Munich (Germany). Military Aircraft Div.
THE PROCESS NETWORK IN THE DESIGN AND MANUFACTURING OF AIRCRAFT

J. KRAMMER and A. RUETTINGER *In* AGARD, Integrated Airframe Design Technology 10 p Dec. 1993

The first part of this paper presents some ideas for the investigation and improvement of developmental processes. Typical processes are shown using the Structured Analysis and Design Technique (SADT) and a process flow diagram. In the second part, a redesigned process chain for the design and manufacturing of complex composite parts is explained. Two examples show the functionality of the newly developed constructive design model for this process. Author (revised)

N94-24320# Deutsche Airbus G.m.b.H., Hamburg (Germany). Structural Mechanics Dept.
INTEGRATED STRESS AND STRENGTH ANALYSIS OF AIRPLANE STRUCTURES USING THE DATA PROCESSING TOOL ISSY
R. WERNER, M. WIEDEMANN, and B. EVERS *In* AGARD, Integrated Airframe Design Technology 3 p Dec. 1993

The Integrated Structural Mechanics System (ISSY) is a modular structured tool used to perform a variety of different structural calculations on aircraft structures. ISSY integrates all model generation, analysis and evaluation programs used in structural mechanics under one user interface, and operates a common data base for all these programs. ISSY can be used to generate and analyze calculation models of structural assemblies (fuselage, wings, stabilizers, etc). This is performed by an interactive preprocessor implemented in ISSY. These calculations provide data for both the finite element analysis and for strength analysis, thereby avoiding redundancy of data. Model generation is supported by the use of parameterized standard models (and/or standard sub-models). In addition, model generation is made easier by comprehensive ISSY libraries which provide material data on aluminum, composites, in addition to geometric data on profile sections and rivet allowables. The geometry input data can be directly copied from the component loft data files. The model input data and calculation results are stored in relational data tables which can be analyzed by the postprocessor implemented in ISSY. In addition other modules convert conventionally generated calculation models into ISSY format and generate load case data. To aid partners work on international joint projects, ISSY is compatible with both standard NASTRAN and ISSY processed input and output data. A documentation of model and result data can be obtained in every phase of the justification report. Author

N94-24321# McDonnell-Douglas Corp., Saint Louis, MO.
APPLICATION OF CONCURRENT ENGINEERING PRINCIPLES TO AIRCRAFT STRUCTURAL DESIGN
M. DROEGKAMP, T. W. HESTERMAN, B. L. MATTHEWS, T. M. WILSON, and JOHN M. COYLE *In* AGARD, Integrated Airframe Design Technology 9 p Dec. 1993

The process of designing aircraft structure requires many functional disciplines and associated interdisciplinary coupling. To achieve optimal performance, the various disciplines must work closely together and effectively exchange large amounts of pertinent data. In the past, this was accomplished either with independent analysis tools that were not tightly coupled or with a single analysis tool that lacked the required fidelity to truly support the needs of more than one discipline. In addition, the analyses were performed in series rather than concurrently. A major impediment to process improvement was the lack of a common geometry database that could be utilized by all disciplines required to support structural design. The rapid growth of computational capability and the gradual acceptance by engineers and management to the use of automated processes and common databases has allowed McDonnell Douglas Aerospace (MDA) to implement a concurrent engineering approach to structural design. Our present aircraft design process combines a common geometry approach and existing analysis tools with the power of engineering workstations to manipulate an integrated design database to arrive at an optimum design solution. Our modular approach divides the design process into smaller, more manageable tasks that can be performed concurrently. It achieves 'buy-in' from each engineering and manufacturing discipline by incorporating existing specialized design tools that have been developed by those groups and introduced into the process without taking away ownership. We use common geometry principles, neutral file structures, widely accepted third party and company proprietary applications coupled with consistent naming conventions and file management to achieve our integrated design methodology solution. The present system optimizes the vehicle structure for minimum weight against a given set of design requirements. It is currently used to evaluate advanced vehicles such as NASP and is also being applied to more conventional aircraft. In the future, capabilities will be added to this analysis system that allow it to be applied to detail design problems as well as increasing the fidelity of advanced design solutions. The major increase in capability will result from adding direct access to the computer aided design geometry and also in the incorporation of standard analysis checks into the system. We will design the architecture of the system such that new engineering and manufacturing applications can be easily added. This paper will discuss the evolution of the MDA integrated design methodology from the 80's to the present as well as our vision of the future. Author

N94-24322# Fokker B.V., Schipol-Oost (Netherlands).
SOME PRACTICAL PROBLEMS IN MULTIDISCIPLINARY DESIGN AND OPTIMISATION
D. J. LAAN, H. WALGEMOED, C. SCHIMMEL, and R. HOUWINK *In* AGARD, Integrated Airframe Design Technology 7 p Dec. 1993

Structural optimization software bears a great promise in multidisciplinary design as an effective way to find an optimal balance between the requirements from different disciplines. Due to the evolution of the airworthiness requirements and the increased complexity of aircraft systems it has become increasingly more difficult in the last few decades to establish the design loads. Thus, a clear need exists for quick and reliable load estimation procedures. The paper discusses some measures that can be taken to improve the load definition process. Finally, some examples of successful application of structural optimization software at Fokker Aircraft are given. The primary advantage of structural optimization software is that it aids a skilled designer in gaining a feel for the design space. It should aid the designer in his creative task instead of distracting his attention to using the software. This requires the software to be user friendly and to have built-in features for global and local sensitivity studies.
Derived from text

N94-24323# Deutsche Airbus G.m.b.H., Hamburg (Germany).
INFLUENCE OF ACTIVE CONTROLS ON THE DESIGN PROCESS OF A LARGE TRANSPORT AIRCRAFT
M. MOLZOW and H. ZIMMERMANN (Deutsche Airbus G.m.b.H., Bremen, Germany.) *In* AGARD, Integrated Airframe Design Technology 12 p Dec. 1993

The high complexity of an active controlled civil transport aircraft design with its multiple interactions between the different disciplines was presented. It was highlighted that in future design of this kind, different design procedures have to be established with the target to reduce the dominance of one discipline by a multidisciplinary optimization process to ensure an overall aircraft optimum. This has the consequence that the data availability in a certain quality (stiffnesses, aero data, systems data) must be better synchronized with the needs of the user of these data (handling quality, system, loads, flutter, structures) and that cost functions are introduced in the beginning of the design work to ensure a balanced design. It is the firm belief of the authors that already this would be an important step forward. Active Control systems are rather easily capable of being integrated by having in mind to use signals from additional sensors distributed over the A/C than are available from the ADIRU. There are some doubts that all these relations and interactions in real aircraft design can be

replaced one day by a totally automated process but certainly more parts have to be put into a process chain to improve quality and safe design time. Author (revised)

N94-24324# McDonnell-Douglas Aerospace, Long Beach, CA.
CURRENT AND FUTURE DESIGN METHODS FOR LARGE TRANSPORT AIRCRAFT
J. P. GIESING, G. T. J. TZONG, and B. E. SCHOFIELD *In* AGARD, Integrated Airframe Design Technology 15 p Dec. 1993 Prepared in cooperation with Douglas Aircraft Co., Inc., Long Beach, CA
Copyright Avail: CASI HC A03/MF A02

Current aircraft industry design practices produce high quality, safe, and affordable aircraft. However, future advanced and integrated methods offer the opportunity to significantly reduce the cost and development time of aircraft designs. This paper presents an overview of the current design process and an example for subsonic transport wing box design. It also describes a future process which is presently being implemented at the Douglas Aircraft Company, i.e. the Aeroelastic Design Optimization Program (ADOP), and its application to a similar subsonic transport wing. Specifically, stress and flutter are optimized and compression surface buckling and tension surface damage tolerance are integrated. Finally, the future direction of ADOP will be outlined which includes integration of aeroelastic loads, durability and damage tolerance, and concurrent structure and active controls optimization. Author

N94-24325# Alenia Aeronautica, Torino (Italy). Div. Velivoli Difesa.
THE INTEGRATION OF DESIGN AND MANUFACTURING PROCESSES AT ALENIA DVD
L. CHESTA, M. FLACCAVENTO, G. POLLANO, and F. STAROPOLI *In* AGARD, Integrated Airframe Design Technology 16 p Dec. 1993
Copyright Avail: CASI HC A03/MF A02

In aeronautics, the age of high creativity, like the one in the fifties with the introduction of jet engines or the one in the thirties which started the age of monoplanes with metallic shell structures, is passed. Today, we are in a situation in which the final increment in basic performance (maximum speed, maneuver capability) is usually excessively expensive. It is now necessary to look to marginal areas to gain improvements in performance, to use new materials such as carbon fibers to tailor the structure to specific needs, and to simplify, with the help of electronics and servomechanisms, complicated mechanical systems to obtain aircraft architectures otherwise impossible to fly. But this is not enough; it is absolutely necessary to also improve the cost effectiveness by increasing the reliability, availability, and supportability of the weapon system, thereby reducing the usage cost and the production cost of the aircraft. This is not any more achievable using the single man capabilities on a single discipline, but it requires a new type of working organization which uses sophisticated means of calculation, integrated in order to optimize the overall design, and which compresses the time of the process by exploiting the synergism of the interdisciplinary couplings, overlapping as much as possible the design and manufacturing phases. Alenia Defense Aircraft Division, being involved in several programs, both by itself and in international cooperation, has followed this evolution and is actively pursuing the adequacy of its operative structure to the new requirements by adopting advanced technology processes. Derived from text

N94-24327# Dassault (E. M.) Co., Saint Cloud (France).
TRENDS OF DESIGN METHODOLOGY OF AIRFRAME [TENDANCES DANS LA METHODE DE CONCEPTION DES CELLULES D'AVION MILITAIRE]
C. PETIAU *In* AGARD, Integrated Airframe Design Technology 6 p Dec. 1993 In FRENCH
Copyright Avail: CASI HC A02/MF A02

First, it is reminded that organization of airframe design is directly linked to the performances of available tools. As a matter of fact, they condition the number and nature of project iterations. The organization which should nowadays be recommended in view of the means of CAD, computation and mathematical optimization at our disposal is presented and analyzed. This leads to a first design, followed by experimental verifications with a key role for flight tests. The final design is checked with the help of calculations models calibrated on tests. Then the new tools which are the factors of future evolution of design methodology are examined: to dispose of 'Design History' corresponding to the whole data of the process; parametric CAD and shape optimization; multidisciplinary optimization; 'Feature' Design; improvement of computation methods. As a conclusion we insist on the fact that aircraft manufacturers, CAD suppliers, and scientific searchers will be well advised to create a dialogue as to future design methodology. Author (revised)

N94-24332*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
AIRCRAFT EMPENNAGE STRUCTURAL DETAIL DESIGN
GREG MEHOLIC, RHONDA BROWN, MELISSA HALL, ROBERT HARVEY, MICHAEL SINGER, and GUSTAVO TELLA 19 Apr. 1993 73 p
(Contract NASW-4435)
(NASA-CR-195496; NAS 1.26:195496) Avail: CASI HC A04/MF A01

This project involved the detailed design of the aft fuselage and empennage structure, vertical stabilizer, rudder, horizontal stabilizer, and elevator for the Triton primary flight trainer. The main design goals under consideration were to illustrate the integration of the control systems devices used in the tail surfaces and their necessary structural supports as well as the elevator trim, navigational lighting system, electrical systems, tail-located ground tie, and fuselage/cabin interface structure. Accommodations for maintenance, lubrication, adjustment, and repairability were devised. Weight, fabrication, and (sub)assembly goals were addressed. All designs were in accordance with the FAR Part 23 stipulations for a normal category aircraft. Author

N94-24401*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.
JB-300: AN ADVANCED MEDIUM SIZE TRANSPORT FOR 2005
GILES DEBROUWER, KATHERINE GRAHAM, JIM ISON, VINCE JUAREZ, STEVE MOSKALIK, JON PANKONIN, and ARNOLD WEINSTEIN May 1993 113 p Original contains color illustrations
(Contract NASW-4435)
(NASA-CR-195499; NAS 1.26:195499) Avail: CASI HC A06/MF A02; 2 functional color pages

In the fall of 1992, the TAC Team was presented with a Request for Proposal (PFP) for a mid-size (250-350 passenger) commercial transport. The aircraft was to be extremely competitive in the areas of passenger comfort, performance, and economic aspects. Through the use of supercritical airfoils, a technologically advanced Very High By-pass Ratio (VHBR) turbofan engine, a low overall drag configuration, a comparable interior layout, and mild use of composites, the JB-300 offers an economically viable choice to the airlines. The cents per passenger mile of the JB-300 is 1.76, which is considerably lower than current aircraft in the same range. Overall, the JB-300 is a technologically advanced aircraft, which will meet the demands of the 21st century. Author (revised)

N94-24462*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
NASA/USRA UNIVERSITY ADVANCED DESIGN PROGRAM, 1992-1993. THE DIAMONDBACK: A SIMULATED COMMERCIAL AIR TRANSPORTATION STUDY Final Report
Apr. 1993 151 p
(Contract NASW-4435)
(NASA-CR-195523; NAS 1.26:195523) Avail: CASI HC A08/MF A02

This document reports on the design of the Diamondback, an aircraft model of a 100-passenger aircraft designed to cruise at 28 ft/s and compete against the 40-passenger HB-40 in the fictional Aeroworld commercial transport market. Unlike conventional

aircraft, the Diamondback utilizes an innovative configuration known as the joined wing. The topics addressed include: economic/cost analysis, aerodynamics, weight and structures, propulsion, stability and control, and performance. CASI

N94-24479*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
DESIGN OF A VEHICLE BASED SYSTEM TO PREVENT OZONE LOSS
SEAN R. LYNN, DEBORAH BUNKER, THOMAS D. HESBACH, JR., EVERETT B. HOWERTON, G. HREINSSON, E. KIRK MISTR, MATTHEW E. PALMER, CLAIBORNE ROGERS, DAYNA S. TISCHLER, DANIEL J. WRONA et al. 28 Jul. 1993 70 p
(Contract NASW-4435)
(NASA-CR-195498; NAS 1.26:195498) Avail: CASI HC A04/MF A01

Reduced quantities of ozone in the atmosphere allow greater levels of ultraviolet light (UV) radiation to reach the earth's surface. This is known to cause skin cancer and mutations. Chlorine liberated from Chlorofluorocarbons (CFC's) and natural sources initiate the destruction of stratospheric ozone through a free radical chain reaction. The project goals are to understand the processes which contribute to stratospheric ozone loss, examine ways to prevent ozone loss, and design a vehicle-based system to carry out the prevention scheme. The 1992/1993 design objectives were to accomplish the first two goals and define the requirements for an implementation vehicle to be designed in detail starting next year. Many different ozone intervention schemes have been proposed though few have been researched and none have been tested. A scheme proposed by R.J. Cicerone, Scott Elliot and R.P.Turco late in 1991 was selected because of its research support and economic feasibility. This scheme uses hydrocarbon injected into the Antarctic ozone hole to form stable compounds with free chlorine, thus reducing ozone depletion. Because most polar ozone depletion takes place during a 3-4 week period each year, the hydrocarbon must be injected during this time window. A study of the hydrocarbon injection requirements determined that 100 aircraft traveling Mach 2.4 at a maximum altitude of 66,000 ft. would provide the most economic approach to preventing ozone loss. Each aircraft would require an 8,000 nm. range and be able to carry 35,000 lbs. of propane. The propane would be stored in a three-tank high pressure system. Missions would be based from airport regions located in South America and Australia. To best provide the requirements of mission analysis, an aircraft with L/D(sub cruise) = 10.5, SFC = 0.65 (the faculty advisor suggested that this number is too low) and a 250,000 lb TOGW was selected as a baseline. Modularity and multi-role functionality were selected to be key design features. Modularity provides ease of turnaround for the down-time critical mission. Multi-role functionality allows the aircraft to be used beyond its design mission, perhaps as an High Speed Civil Transport (HSCT) or for high altitude research. Author (revised)

N94-24492*# Ohio State Univ., Columbus.
NASA/USRA ADVANCED DESIGN PROGRAM
1992 79 p
(Contract NASW-4435)
(NASA-CR-195548; NAS 1.26:195548) Avail: CASI HC A05/MF A01

This report analyzes and presents a preliminary design for an experimental hypersonic vehicle. This plane will have a cruise speed of Mach 12 for one minute at an altitude of 120,000 feet. The major design areas of aerodynamics, propulsion, and weights are discussed in depth. An elementary analysis of thermal protection, trajectory, and cost is also presented. Finally, a discussion of future plans and recommendations is given, and overall conclusions are drawn. Author

N94-24498*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
AIRCRAFT WING STRUCTURE DETAIL DESIGN
GARRETT L. SAGER, RON ROBERTS, BOB MALLON, MOHAMED ALAMERI, and BILL STEINBACH 14 Apr. 1993 36 p
(Contract NASW-4435)
(NASA-CR-195485; NAS 1.26:195485) Avail: CASI HC A03/MF A01

The provisions of this project call for the design of the structure of the wing and carry-through structure for the Viper primary trainer, which is to be certified as a utility category trainer under FAR part 23. The specific items to be designed in this statement of work were Front Spar, Rear Spar, Aileron Structure, Wing Skin, and Fuselage Carry-through Structure. In the design of these parts, provisions for the fuel system, electrical system, and control routing were required. Also, the total weight of the entire wing planform could not exceed 216 lbs. Since this aircraft is to be used as a primary trainer, and the SOW requires a useful life of 107 cycles, it was decided that all of the principle stresses in the structural members would be kept below 10 ksi. The only drawback to this approach is a weight penalty. Derived from text

N94-24589*# Worcester Polytechnic Inst., Holden, MA.
NASA ADVANCED DESIGN PROGRAM. DESIGN AND ANALYSIS OF A RADIO-CONTROLLED FLYING WING AIRCRAFT
3 May 1993 100 p
(Contract NASW-4435)
(NASA-CR-195515; NAS 1.26:195515) Avail: CASI HC A05/MF A02

The main challenge of this project was to design an aircraft that will achieve stability while flying without a horizontal tail. The project focused on both the design, analysis and construction of a remotely piloted, elliptical shaped flying wing. The design team was composed of four sub-groups each of which dealt with the different aspects of the design, namely aerodynamics, stability and control, propulsion, and structures. Each member of the team initially researched the background information pertaining to specific facets of the project. Since previous work on this topic was limited, most of the focus of the project was directed towards developing an understanding of the natural instability of the aircraft. Once the design team entered the conceptual stage of the project, a series of compromises had to be made to satisfy the unique requirements of each sub-group. As a result of the numerous calculations and iterations necessary, computers were utilized extensively. In order to visualize the design and layout of the wing, engines and control surfaces, a solid modeling package was used to evaluate optimum design placements. When the design was finalized, construction began with the help of all the members of the project team. The nature of the carbon composite construction process demanded long hours of manual labor. The assembly of the engine systems also required precision hand work. The final product of this project is the Elang, a one-of-a-kind remotely piloted aircraft of composite construction powered by two ducted fan engines. Author (revised)

N94-24591*# Ohio State Univ., Columbus.
CONFIGURATION DEVELOPMENT STUDY OF THE OSU 1 HYPERSONIC RESEARCH VEHICLE
MATTHEW D. STEIN, CHRIS FRANKHAUSER, WARNER ZEE, MELVIN KOSANCHICK, III, NICK NELSON, and WILLIAM HUNT
31 May 1993 152 p
(Contract NASW-4435)
(NASA-CR-195522; NAS 1.26:195522) Avail: CASI HC A08/MF A02

In an effort to insure the future development of hypersonic cruise aircraft, the possible vehicle configurations were examined to develop a single-stage-to-orbit hypersonic research vehicle (HRV). Based on the needs of hypersonic research and development, the mission goals and requirements are determined. A body type is chosen. Three modes of propulsion and two liquid rocket fuels are compared, followed by the optimization of the body configuration through aerodynamic, weight, and trajectory studies. A cost analysis is included. Author (revised)

N94-24711*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.
THE CETACEOPTERYX: A GLOBAL RANGE MILITARY TRANSPORT AIRCRAFT
CHAD BRIVKALNS, NICOLE ENGLISH, TAHMINEH KAZEMI, KIM KOPEL, SETH KROGER, and ED ORTEGA 14 May 1993 109 p
(Contract NASW-4435)
(NASA-CR-195519; NAS 1.26:195519) Avail: CASI HC A06/MF A02

This paper presents a design of a military transport aircraft capable of carrying 800,000 lbs of payload from any point in the United States to any other point in the world. Such massive airlift requires aggressive use of advanced technology and a unique configuration. The Cetaceopteyx features a joined wing, canard and six turbofan engines. The aircraft has a cost 1.07 billion (1993) dollars each. This paper presents in detail the mission description, preliminary sizing, aircraft configuration, wing design, fuselage design, empennage design, propulsion system, landing gear design, structures, drag, stability and control, systems layout, and cost analysis of the aircraft. Author

N94-24726*# Lockheed Engineering and Sciences Co., Hampton, VA.
A PARAMETRIC STUDY OF HARMONIC ROTOR HUB LOADS
CHENGJIAN HE Nov. 1993 60 p
(Contract NAS1-19000; RTOP 505-63-36)
(NASA-CR-4558; NAS 1.26:4558) Avail: CASI HC A04/MF A01

A parametric study of vibratory rotor hub loads in a nonrotating system is presented. The study is based on a CAMRAD/JA model constructed for the GBH (Growth Version of Blackhawk Helicopter) Mach-scaled wind tunnel rotor model with high blade twist (-16 deg). The theoretical hub load predictions are validated by correlation with available measured data. Effects of various blade aeroelastic design changes on the harmonic nonrotating frame hub loads at both low and high forward flight speeds are investigated. The study aims to illustrate some of the physical mechanisms for change in the harmonic rotor hub loads due to blade design variations. Author (revised)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N94-24733 Naval Air Systems Command, Arlington, VA.
ADVANCED AVIONICS ARCHITECTURE AND TECHNOLOGY REVIEW. EXECUTIVE SUMMARY AND VOLUME 1: AVIONICS TECH NOLOGY. VOLUME 2: AVIONICS SYSTEMS ENGINEERING Final Report, Jul. 1992 - Aug. 1993
6 Aug. 1993 244 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A273630) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this study was to review the current technology base, developing technologies, and the potential to apply them to meet military avionics requirements. The review also examined the technology integration methods used in the avionics community in order to develop a more efficient and more affordable avionics architectural strategy for the future. It provides a bold vision for the application of advanced technology to naval avionics. This study was accomplished as a cooperative venture by members of the Naval Aviation Systems team and over 50 leading firms from the electronics and aerospace industries. The study team also included representatives from the Air Force, Advanced Research Projects Agency, National Institute for Standards and Technology, and the Defense Systems Management College. Their goal was to review emerging technologies, investigate their potential for application to naval avionics, and identify potential cost savings. The Joint Aeronautical Commanders Group (JACG) will use this study as a basis for developing and implementing a better acquisition partnership between the military services and industry. This report is the only comprehensive compilation of today's avionics technology. It is a great reference book that contains easily understandable descriptions of today's technologies, including bus architectures, back planes, processors, software, and just about every aspect of avionics design and development. DTIC

N94-24774# Naval Postgraduate School, Monterey, CA.
EVALUATION OF THE UH-1N INSTRUMENT PANEL M.S. Thesis
LAWRENCE E. MICCOLIS Sep. 1993 72 p
(AD-A273145) Avail: CASI HC A04/MF A01

This study evaluates the current configuration of the U.S. Marine Corps LJH-IN helicopter instrument panel. Additionally, the alternatives for proposed multifunction display (MFD) symbologies associated with the COMM/NAV Block Upgrade for the UH-IN were evaluated. A survey was administered to 43 LJH-IN operational pilots from both east and west coast squadrons. Pilots were asked to rate instruments and devices currently included on the instrument panel on three factors: criticality, frequency of use, and satisfaction with display. The top ten and bottom ten instruments were identified for each of these three factors; 20 instruments rated high on all three factors while 10 rated low on all three. Several candidates for redesign were identified. Proposed multifunction display symbol sets from the Naval Air Warfare Center Aircraft Division, Warminster (NAWCADWAR), and MIL-STD-1295 (Proposed) were also assessed. Respondents rated symbols for (1) heading scale, present heading, and NAV steering bug (a pointer); (2) airspeed and present airspeed; (3) vertical velocity; (4) attitude, horizon, pitch angle, and aircraft reference; (5) altitude scale, present altitude, and high/low altitude warning; (6) torque; and (7) bank of roll scale, and slip. In general, the NAWCADWAR symbol set was referred. DTIC

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.

N94-23253 Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).
TURBINE ENGINE WITH INDUCED PRE-SWIRL AT THE COMPRESSOR INLET Patent
ROGER LACHANCE, inventor (to Pratt and Whitney Aircraft of Canad, VASIL OZARAPOGLU, inventor (to Pratt and Whitney Aircraft of Canad, JEAN LETOURNEAU, inventor (to Pratt and Whitney Aircraft of Canad, and SVEIN HUBINETTE, inventor (to Pratt and Whitney Aircraft of Canad 11 May 1993 19 p
(CA-PATENT-1-317-467; INT-PATENT-CLASS-F01D-1/12; CTN-94-60922) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

An improved jet flap arrangement is provided for producing a pre-swirl at the compressor inlet of a gas turbine engine, in order to enhance engine stability and performance particularly at low-speed off-design conditions. According to the invention, an airflow path is defined between the shroud and hub of the engine for passing air to the compressor entry. A plurality of airfoils extends across the airflow path and upstream of the compressor entry. The airfoils are hollow and communicate with an air inlet in the shroud for communicating with a source of a pressurized gas flow. The airfoils have a leading and a trailing edge relative to the airflow path and a plurality of discrete openings which are closely spaced apart to define an axis extending across the airflow path

from the shroud to the hub and spaced a short distance from the trailing edge. These openings form nozzles for discharge of the pressurized gas flow, thereby forming a jet flap across the airflow path for creating a pre-swirl in the airflow path. The airfoils may be struts extending between the shroud and hub in the airflow path. Author (CISTI)

N94-23255 General Electric Co., Fairfield, CT.
COUNTERROTATING AIRCRAFT PROPULSOR BLADES Patent
JOEY L. NELSON, inventor (to General Electric Co.), SIDNEY B. ELSTON, inventor (to General Electric Co.), and WU-YANG TSENG, inventor (to General Electric Co.) 22 Jun. 1993 42 p
(CA-PATENT-1-319-357; INT-PATENT-CLASS-B64C-11/20; INT-PATENT-CLASS-B64C-11/48; CTN-94-60924) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A swept propeller blade is provided which is comprised of composite materials having the strength and airfoil configuration to provide an efficient blade for a counterrotating propeller system having highly swept, wide chord, thin blades for operating at transonic and supersonic speeds. A typical blade of the propulsor system includes an airfoil section having a tip end, a root end, and first and second surfaces between the ends intersecting in a convex leading edge and a concave trailing edge. Each surface is formed from a blade shell made of a plurality of angle plied composite laminates bonded together. A metallic blade spar is interposed between the first and second shells and is bonded to the shells for connecting the shell surfaces to the root end and for stiffening the blade. Foam filled airfoil cavities are created interposed between the first and second shells for decreasing the blade weight. A metallic plate sheath is bonded to the leading edge for preventing erosion and providing lightning protection. Counterweights in the blade spar fore and aft of the spar dovetail are adjustable to provide static balancing of the blade in radial and chord-wise directions. A polyurethane film is applied to the outer blade surface for protection. Author (CISTI)

N94-23466*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TRANSIENT EJECTOR ANALYSIS (TEA) CODE USER'S GUIDE
COLIN K. DRUMMOND Dec. 1993 51 p
(Contract RTOP 505-62-30)
(NASA-TM-106310; E-8050; NAS 1.15:106310) Avail: CASI HC A04/MF A01

A FORTRAN computer program for the semi analytic prediction of unsteady thrust augmenting ejector performance has been developed, based on a theoretical analysis for ejectors. That analysis blends classic self-similar turbulent jet descriptions with control-volume mixing region elements. Division of the ejector into an inlet, diffuser, and mixing region allowed flexibility in the modeling of the physics for each region. In particular, the inlet and diffuser analyses are simplified by a quasi-steady-analysis, justified by the assumption that pressure is the forcing function in those regions. Only the mixing region is assumed to be dominated by viscous effects. The present work provides an overview of the code structure, a description of the required input and output data file formats, and the results for a test case. Since there are limitations to the code for applications outside the bounds of the test case, the user should consider TEA as a research code (not as a production code), designed specifically as an implementation of the proposed ejector theory. Program error flags are discussed, and some diagnostic routines are presented. Author (revised)

N94-23519 Rolls-Royce Ltd., Derby (England).
ROLLS-ROYCE IN PERSPECTIVE: PAST, PRESENT AND FUTURE
FRANK TURNER 1991 37 p Presented at the 35th R. J. Mitchell Memorial Lecture to the Royal Aeronautical Society, Southampton, Hall of Aviation, United Kingdom, 6 Mar. 1991 Limited Reproducibility: More than 20% of this document may be affected by poor print
(PNR-90882; MISC-2514; ETN-93-93708) Copyright Avail: Issuing Activity (European Space Agency (ESA))

An historical account of the development of Rolls-Royce from the time their names first appeared together in 1904 on the classic radiator shape, which first adorned the little two cylinder ten horse power car, to the launch of the RB211 aircraft engine, is given. The historical account is presented under the following headings: the original Rolls-Royce cars, the Silver Ghost, subsequent car models, the entry of Rolls-Royce into aviation, the first aeroengine (the Eagle), second generation aeroengines, the Shneider trophy, the Merlin, birth of the gas turbine, Barnoldswick and the jet engine, the jet engine postwar, establishing the gas turbine in commercial aviation, the commercial turbojet and turbofan, the launch of the RB211, the company today, civil engines today, and the future. ESA

N94-23545*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HOLOGRAPHIC TESTING OF COMPOSITE PROPFANS FOR A CRUISE MISSILE WIND TUNNEL MODEL
CHRISTOPHER J. MILLER Jan. 1994 41 p
(Contract RTOP 535-03-10)
(NASA-TM-105271; E-8203; NAS 1.15:105271) Avail: CASI HC A03/MF A01

Each of the approximately 90 composite propfan blades constructed for a 55 percent scale cruise missile wind tunnel model were holographically tested to obtain natural frequencies and mode shapes. These data were used not only for quality assurance, but also to select sets of similar blades for each blade row. Presented along with the natural frequency data is a description of a computer-based image processing system developed to supplement the photographic based system for holographic image analysis and storage. The new system is quicker and cheaper, the holograms are indexed better, and several engineers can access the data simultaneously. The only negative effect is a slight reduction in image resolution, which does not influence the end use. Author (revised)

N94-23552*# Rensselaer Polytechnic Inst., Troy, NY.
A RANDOM DISTRIBUTION REACTING MIXING LAYER MODEL Final Report
RICHARD A. JONES Jan. 1994 17 p
(Contract NCC3-213; RTOP 505-62-52)
(NASA-CR-194445; E-8315; NAS 1.26:194445) Avail: CASI HC A03/MF A01

A methodology for simulation of molecular mixing and the resulting velocity and temperature fields has been developed. The ideas are applied to the flow conditions present in the NASA Lewis Planar Reacting Shear Layer (PRSL) facility, and results compared to experimental data. A gaussian transverse turbulent velocity distribution is used in conjunction with a linearly increasing time scale to describe the mixing of different regions of the flow. Equilibrium reaction calculations are then performed on the mix to arrive at a new species composition and temperature. Velocities are determined through summation of momentum contributions. The analysis indicates a combustion efficiency of the order of 80 percent for the reacting mixing layer, and a turbulent Schmidt number of 2/3. The success of the model is attributed to the simulation of large-scale transport of fluid. The favorable comparison shows that a relatively quick and simple PC calculation is capable of simulating the basic flow structure in the reacting and non-reacting shear layer present in the facility given basic assumptions about turbulence properties. Author

N94-23570 Rolls-Royce Ltd., Derby (England).
THE RB211: THE FIRST 25 YEARS
PHILIP RUFFLES 1992 33 p Presented at the 31st Short Brothers Commemorative Lecture to Royal Aeronautical Society, Queens University, Belfast, Ireland, 16 Jan. 1992 Limited Reproducibility: More than 20% of this document may be affected by poor print

(PNR-90977; MISC-2665; ETN-93-93707) Copyright Avail: Issuing Activity (European Space Agency (ESA))

The development of the RB211 high bypass turbofan engine is reviewed giving details on its early problems and inherent strengths, the dramatic evolution of the design and finally, how the engine family will address the future market. The RB211-22 first entered service in the L1011 Tristar with Eastern Airline in 1972. Now, twenty years later, the RB211 has been developed into an outstanding family of engines; the -524 for the Boeing 747 and 767, the smaller -535 on the Boeing 757 and the latest and most powerful Trent family, for the new Airbus A330, Boeing 777 and McDonnell Douglas MD-12 aircraft. The RN211 has now gained over 40 million hours experience with 64 customers and its evolutionary development has given rise to many unique innovations in design and manufacturing to meet the requirements of the customer. ESA

N94-23658*# Allied-Signal Aerospace Co., Phoenix, AZ.
THE 3-D CFD MODELING OF GAS TURBINE COMBUSTOR-INTEGRAL BLEED FLOW INTERACTION
D. Y. CHEN and R. S. REYNOLDS *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 359-380 Nov. 1993 Original contains color illustrations
Avail: CASI HC A03/MF A04; 5 functional color pages

An advanced 3-D Computational Fluid Dynamics (CFD) model was developed to analyze the flow interaction between a gas turbine combustor and an integral bleed plenum. In this model, the elliptic governing equations of continuity, momentum and the k-e turbulence model were solved on a boundary-fitted, curvilinear, orthogonal grid system. The model was first validated against test data from public literature and then applied to a gas turbine combustor with integral bleed. The model predictions agreed well with data from combustor rig testing. The model predictions also indicated strong flow interaction between the combustor and the integral bleed. Integral bleed flow distribution was found to have a great effect on the pressure distribution around the gas turbine combustor. Author

N94-23709 General Electric Co., Schenectady, NY. Corporate Research and Development.
EVALUATION OF REDUCING GAS TURBINE EMISSIONS THROUGH HYDROGEN-ENHANCED STEAM-INJECTED COMBUSTION Final Report, Nov. 1991 - Apr. 1993
J. R. MAUGHAN, J. H. BOWEN, S. G. KIMURA, D. H. COOKE, and G. JOSHI Apr. 1993 168 p Prepared in cooperation with Pullman Kellogg, Houston, TX. Sponsored by Gas Research Inst., Chicago, IL Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract GRI-5091-293-2188)
(PB94-109873; GRI-93/0272) Avail: Issuing Activity (National Technical Information Service (NTIS))

The potential for reducing emissions from gas turbines by injecting steam for NO(x) control and hydrogen for CO control is evaluated through laboratory-scale combustion experiments. Results showed that hydrogen addition into a steam-injected diffusion combustor at hydrogen/fuel molar ratios of approximately 20% was associated with somewhat increased NO(x) production and reduced CO emissions. Both effects are attributed to an increase in the local stoichiometric flame temperature. However, the decrease in CO was greater than the increase in NO(x), resulting in a net emissions benefit, or a shifting of the NO(x)-CO curve toward the origin. Consequently, a greater range of NO(x)/CO emissions targets could be achieved when hydrogen was available. NTIS

N94-24082*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CFD ASSESSMENT OF ORIFICE ASPECT RATIO AND MASS FLOW RATIO ON JET MIXING IN RECTANGULAR DUCTS
D. B. BAIN (Computational Fluid Dynamics Research Corp., Huntsville, AL.), C. E. SMITH (Computational Fluid Dynamics Research Corp., Huntsville, AL.), and J. D. HOLDEMAN Jan. 1994 27 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA Original contains color illustrations
(Contract NAS3-25967)
(NASA-TM-106434; E-8276; NAS 1.15:106434; AIAA PAPER 94-0218) Avail: CASI HC A03/MF A01; 8 functional color pages

Isothermal CFD analysis was performed on axially opposed rows of jets mixing with cross flow in a rectangular duct. Laterally, the jets' centerlines were aligned with each other on the top and bottom walls. The focus of this study was to characterize the effects of orifice aspect ratio and jet-to-mainstream mass flow ratio on jet penetration and mixing. Orifice aspect ratios (L/W) of 4-to-1, 2-to-1, and 1-to-1, along with circular holes, were parametrically analyzed. Likewise, jet-to-mainstream mass flow ratios (MR) of 2.0, 0.5, and 0.25 were systematically investigated. The jet-to-mainstream momentum-flux ratio (J) was maintained at 36 for all cases, and the orifice spacing-to-duct height (S/H) was varied until optimum mixing was attained for each configuration. The numerical results showed that orifice aspect ratio (and likewise orifice blockage) had little effect on jet penetration and mixing. Based on mixing characteristics alone, the 4-to-1 slot was comparable to the circular orifice. The 4-to-1 slot has a smaller jet wake which may be advantageous for reducing emissions. However, the axial length of a 4-to-1 slot may be prohibitively long for practical application, especially for MR of 2.0. The jet-to-mainstream mass flow ratio had a more significant effect on jet penetration and mixing. For a 4-to-1 aspect ratio orifice, the design correlating parameter for optimum mixing (C = (S/H)(sq. root J)) varied from 2.25 for a mass flow ratio of 2.0 to 1.5 for a mass flow ratio of 0.25. Author (revised)

N94-24106*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
IDENTIFICATION OF INTEGRATED AIRFRAME: PROPULSION EFFECTS ON AN F-15 AIRCRAFT FOR APPLICATION TO DRAG MINIMIZATION
GERARD S. SCHKOLNIK Nov. 1993 26 p Conference held in Monterey, CA, 9-11 Aug. 1993 See also A93-51359 Sponsored by NASA. Washington
(Contract RTOP 533-02-39)
(NASA-TM-4532; H-1946; NAS 1.15:4532; AIAA PAPER 93-3764) Copyright Avail: CASI HC A03/MF A01

The application of an adaptive real-time measurement-based performance optimization technique is being explored for a future flight research program. The key technical challenge of the approach is parameter identification, which uses a perturbation-search technique to identify changes in performance caused by forced oscillations of the controls. The controls on the NASA F-15 highly integrated digital electronic control (HIDEC) aircraft were perturbed using inlet cowl rotation steps at various subsonic and supersonic flight conditions to determine the effect on aircraft performance. The feasibility of the perturbation-search technique for identifying integrated airframe-propulsion system performance effects was successfully shown through flight experiments and postflight data analysis. Aircraft response and control data were analyzed postflight to identify gradients and to determine the minimum drag point. Changes in longitudinal acceleration as small as 0.004 g were measured, and absolute resolution was estimated to be 0.002 g or approximately 50 lbf of drag. Two techniques for identifying performance gradients were compared: a least-squares estimation algorithm and a modified maximum likelihood estimator algorithm. A complementary filter algorithm was used with the least squares estimator. Author

N94-24180 General Electric Co., Fairfield, CT.
WING MOUNTED UNDUCTED FAN ENGINE Patent
A. P. ADAMSON, inventor (to General Electric Co.) and WU-YANG TSENG, inventor (to General Electric Co.) 19 Oct. 1993 22 p
(CA-PATENT-1323353; INT-PATENT-CLASS-B64D-027/10; INT-PATENT-CLASS-B64D-027/02; CTN-94-60930) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

An aircraft propulsion system comprises a pusher type engine

including propulsor blades and an engine mounting means which minimizes the two per revolution excitation of the blades due to a wake interaction with the blades. One embodiment of the system is an aircraft engine comprising a plurality of propulsor blades which define an engine disk and a wake interaction zone across the disk having a radial location on the disk, wherein the relative strength of the dynamic loads acting on the propulsor blades is a function of the radial location having at least one relative minimum along the blade length. The location is such that the value of the function is essentially a relative minimum. A more particular embodiment is a wing mounted pusher aircraft engine comprising a plurality of propulsor blades defining an engine disk and a wake interaction zone across the disk having a radial location on the disk wherein the wake is shed from the aircraft wing. The relative strength of the dynamic loads acting on the blades is a function of the radial location, which is such that the value of the function is essentially a relative minimum. Author (CISTI)

N94-24251 Technion - Israel Inst. of Tech., Haifa. Turbo and Jet Engine Laboratory.

THRUST VECTORING THEORY, LABORATORY AND FLIGHT TESTS

BENJAMIN GAL-OR and VALERY SHERBAUM *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 142-153 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Fundamental concepts of thrust-vectored fighter aircraft are defined and represented by novel designs of roll-yaw-pitch vectoring nozzles designed for maximized Post-Stall (PST) agility. The concepts are employed to formulate a unified mathematical phenomenology of PST, thrust-vectoring-induced supermaneuverability and to define standard agility comparison maneuvers in the PST domain. New dynamic scale rules generate an unorthodox methodolgy which combines full-scale jet-engine laboratory tests of new vectorable nozzles and inlets with flying 1/7-scale vectored models of F-22, F-15, F-16 and other, tailless, stealth, vectored models. A general vectoring control rate control rule is also defined. ISA

N94-24253 Ben Gurion Univ. of the Negev, Beersheva (Israel). Dept. of Mechanical Engineering.

THE EFFECT OF HIGH ALTITUDE PRESSURE ON THE POWER AND EFFICIENCY OF AN AIRBORNE TWO-STROKE ENGINE

R. HARARI and E. SHER *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 159-165 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The effect of ambient pressure on the torque and fuel consumption characteristics of a crankcase-scavenged spark-ignition two-stroke engine has been investigated. The study includes an experimental part and a theoretical part. In the experimental part, the engine was tested under high-altitude conditions by using a simulator chamber where both the pressure at the inlet manifold and the pressure at the exhaust pipe were controlled separately. The influence of the simulation system on the engine performance has been investigated at sea level (s.l.) and the effect of the ambient pressure on the engine performance has been investigated in the range of 100 to 44 kPa, where the low pressure corresponds to a standard altitude of 21,000 feet (7 km). In the theoretical part a detailed computer program has been used to simulate the engine cycle under low ambient pressure. The computer program has been calibrated by using the s.l. experimental results. Very good agreement between the results of the theoretical model and the measurements under low ambient pressure conditions has been found over the entire range of operating conditions (100 to 44 kPa). An empirical correlation for the correction factor of the engine power has been suggested. The correction factor was found to be proportional to the ambient pressure raised to the power 1.5: ip/ip(sub s)= (P/P(sub s))(exp 1.5) Previous studies have suggested a power of 9/8 (1.125), but their validity was limited to a minimum ambient pressure of 70 kPa. ISA

N94-24270 Israel Aircraft Industries Ltd., Lod. BEDEK Aviation Division.

S-2E TRACKER MARITIME PATROL AIRCRAFT RE-ENGINE AND SYSTEM UPGRADE PROGRAM

ILAN BERLOWITZ, MEIR ZEIERMAN, and SCOTT MARTIN (Marsh Aviation Co., Scottsdale, AZ.) *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 321-332 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Due to its strong construction, resistance to the marine environment, and projected service life, the S-2E Tracker aircraft was chosen for its operational performance to be extended through re-engining, systems upgrading, and integration of new avionics. The aircraft was originally designed for carrier based antisubmarine missions and is ideally suited for efficient and effective maritime patrol. With the installation of rapid-response, 1645 horsepower, Garrett TPE331-15AW turbo-propeller engines and five blade composite reversible propellers, the S-2E/turbine becomes a high performance aircraft with a greater climb rate and 50 percent reduction in fuel consumption over the original S-2E piston aircraft. Intensive flight tests have proven a dramatic increase in mission capability with increased area coverage and flight safety improvements. Israel Aircraft Industries (IAI) is conducting a program to retrofit S-2E Tracker aircraft with Federal Aviation Administration (FAA) and MIL-STD certified, state-of-the-art engines, avionics, and sub-systems. ISA

N94-24326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MULTI-DISCIPLINARY COUPLING FOR INTEGRATED DESIGN OF PROPULSION SYSTEMS

C. C. CHAMIS and S. N. SINGHAL (Sverdrup Technology, Inc., Brook Park, OH.) *In* AGARD, Integrated Airframe Design Technology 12 p Dec. 1993

Copyright Avail: CASI HC A03/MF A02

Effective computational simulation procedures are described for modeling the inherent multi-disciplinary interactions for determining the true response of propulsion systems. Results are presented for propulsion system responses including multi-discipline coupling effects via (1) coupled multi-discipline tailoring, (2) an integrated system of multidisciplinary simulators, (3) coupled material-behavior/fabrication-process tailoring, (4) sensitivities using a probabilistic simulator, and (5) coupled materials/structures/fracture/probabilistic behavior simulator. The results show that the best designs can be determined if the analysis/tailoring methods account for the multi-disciplinary coupling effects. The coupling across disciplines can be used to develop an integrated interactive multi-discipline numerical propulsion system simulator. Author

N94-24490 Mitsubishi Heavy Industries Ltd., Tokyo (Japan).

GAS TURBINE AND OPERATING METHOD OF THE SAME Patent Application

SUSUMU MORISHITA, inventor (to Micromedia Ltd.), YOSHIAKI MIYAKE, inventor (to Micromedia Ltd.), and SEISHI UCHIDA, inventor (to Micromedia Ltd.) 23 Nov. 1992 18 p (CA-PATENT-APPL-SN-2043039; INT-PATENT-CLASS-F02C-007/042; CTN-94-60870) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A gas turbine is characterized by a centrifugal compressor driven by a high pressure turbine and a variable inlet guide vane (VIGV) located at the inlet of the compressor. An axial flow compressor is not provided between the centrifugal compressor

and the VIGV. A thrust gas turbine is provided, equipped with a centrifugal compressor which compresses air, a combustor for combustion of fuel using the pressurized air, and a turbine driven to rotate with a part of the energy of the gas produced in the combustor and which drives the compressor; this turbine is characterized by a VIGV at the compressor inlet. A method for operating a gas turbine is also disclosed, characterized in that output is varied by driving the VIGV while keeping the rotation at a high level. According to this invention, it is possible to reduce the flow rate of air taken into an engine so as to reduce the brake horsepower of the engine even at high engine rotation by throttling the VIGV. When the VIGV is opened suddenly, the flow rate increases and the output also increases rapidly; thus the engine output response time is determined almost entirely by the VIGV response time. Thus, an engine with high responsiveness and reliability may be realized according to the invention. Embodiments of the invention include various aircraft engines.
CISTI

N94-24594*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MIXING CHARACTERISTICS OF DIRECTLY OPPOSED ROWS OF JETS INJECTED NORMAL TO A CROSSFLOW IN A RECTANGULAR DUCT
D. S. LISCINSKY (United Technologies Research Center, East Hartford, CT.), B. TRUE (United Technologies Research Center, East Hartford, CT.), and J. D. HOLDEMAN Jan. 1994 12 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA Original contains color illustrations
(Contract NAS3-25954; RTOP 537-02-21)
(NASA-TM-106477; E-8405; NAS 1.15:106477; AIAA PAPER 94-0217) Avail: CASI HC A03/MF A01; 5 functional color pages

An experimental investigation of the mixing of nonreacting opposed rows of inline jets injected perpendicular to a uniform crossflow has been conducted in a rectangular duct. Planar Mie-scattering was used to measure the time-average concentration distribution of the jet fluid in planes perpendicular to the duct axis. Orifice configurations with geometric blockages ranging from 0.59 to 0.89 had similar mixing performance when compared at one-half duct height downstream of injection. Blockage was varied by changing the orifice aspect ratio from 1-to-1 to 1-to-1.5 while maintaining orifice spacing-to-duct height (S/H) at 0.425, jet-to-mainstream mass flow ratio (MR) at 2.0, and jet-to-mainstream momentum-flux ratio (J) at 48. The result indicates that the design correlating expression (at MR = 2) for optimum in line mixing of 2.5 approximately equal to (S/H)(square root of J) is independent of the Webb between adjacent orifices and therefore independent of orifice width. Experimental and numerical results for an orifice aspect ratio 1-to-1 case were in good agreement. The results of a comparison of inline 45 degrees slanted slot and round orifice configuration indicate that in order to obtain equivalent mean concentration distributions at the same J it is necessary to use a smaller S/H for the round orifice configuration. Conclusions about the performance of various orifice shapes can only be obtained from comparison of optimized configurations. Inline jets with different momentum-flux ratios on opposite sides were compared at a constant mass flow ratio. The orifice spacing chosen was previously found to be an optimum configuration when opposing values of J were equal and also an optimum for single side injection. Experimental and empirical results were in good agreement. Author

N94-24776# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.
ADVANCED CAPABILITY EXHAUST SYSTEMS/INTEGRATED PRODUCT DEVELOPMENT FOR ADVANCED NOZZLES (ACES/IPD) Technical Report, Sep. 1991 - Sep. 1992
AUSTIN L. ANDREWS and ALFREDO CIRES Dec. 1992 106 p
(Contract F33615-91-C-5733)
(AD-A273209; PW/GESP-FR-22402; WL-TR-93-8030) Avail: CASI HC A06/MF A02

The objective of the ACES/IPD program is to develop methodologies for incorporating integrated product development principles into the advanced exhaust nozzle development process to insure smooth transition to engineering development products, decreased development time, reduced life cycle costs, and increased system quality. This report documents the activities as part of tasks one and two of the ACES/IPD program. A comprehensive survey of Pratt and Whitney advanced nozzle programs was conducted and lessons learned were extracted to serve as a guide for future advanced technology exhaust system development. DTIC

08

AIRCRAFT STABILITY AND CONTROL

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

N94-23590*# Sverdrup Technology, Inc., Brook Park, OH.
A COMPARISON OF TWO MULTI-VARIABLE INTEGRATOR WINDUP PROTECTION SCHEMES Final Report
DUANE MATTERN Dec. 1993 11 p Presented at the 1993 AIAA Guidance, Navigation, and Control Conference, Monterey, CA, 9-11 Aug. 1993; sponsored by AIAA See also A93-51404
(Contract NAS3-25266; RTOP 505-62-50)
(NASA-CR-194436; E-8283; NAS 1.26:194436; AIAA PAPER 93-3812) Avail: CASI HC A03/MF A01

Two methods are examined for limit and integrator wind-up protection for multi-input, multi-output linear controllers subject to actuator constraints. The methods begin with an existing linear controller that satisfies the specifications for the nominal, small perturbation, linear model of the plant. The controllers are formulated to include an additional contribution to the state derivative calculations. The first method to be examined is the multi-variable version of the single-input, single-output, high gain, Conventional Anti-Windup (CAW) scheme. Except for the actuator limits, the CAW scheme is linear. The second scheme to be examined, denoted the Modified Anti-Windup (MAW) scheme, uses a scalar to modify the magnitude of the controller output vector while maintaining the vector direction. The calculation of the scalar modifier is a nonlinear function of the controller outputs and the actuator limits. In both cases the constrained actuator is tracked. These two integrator windup protection methods are demonstrated on a turbofan engine control system with five measurements, four control variables, and four actuators. The closed-loop responses of the two schemes are compared and contrasted during limit operation. The issue of maintaining the direction of the controller output vector using the Modified Anti-Windup scheme is discussed and the advantages and disadvantages of both of the IWP methods are presented. Author

N94-24244 California Univ., Los Angeles. Mechanical, Aerospace and Nuclear Engineering Dept.
AEROELASTIC, AEROMECHANICAL AND VIBRATION PROBLEMS IN HELICOPTERS
PERETZ P. FRIEDMANN *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 37-81 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

This paper describes and emphasizes the fundamental advances, achieved during the last two decades, in three important areas which have a central role in modern rotorcraft design. The topics considered are: (1) helicopter aeroelasticity, (2) aeromechanical problems, and (3) vibration and its alleviation using active controls. Each topic contains background to provide the reader with a certain perspective, illustrative examples and speculation on future research needs. ISA

N94-24287 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
CONTINUOUS GUST RESPONSE AND SENSITIVITY DERIVATIVES USING STATE-SPACE MODELS
ARIE ZOLE and MORDECHAY KARPEL *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 482-492 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The dynamic response to atmospheric turbulence plays an important role in the design of flight vehicles. The presented work is an extension to the work on multidisciplinary optimization of aeroservoelastic systems using reduced-size models. The continuous-gust turbulence and the response parameters are represented in statistical terms by power spectral density (PSD) functions and root mean square (RMS) values. The time domain, state-space optimization model is extended to deal with gust excitation and to produce RMS response of section loads, structural velocities, and accelerations. Recommendations are given for the application of the physically weighted minimum-state aerodynamic approximation technique such that there is no need to increase the (relatively small) number of aerodynamic states beyond those required for stability analysis. The plant states are augmented by gust-filter states in a way that produces a dynamic system excited by white noise at the gust-filter inputs. This representation facilitates direct RMS computations by solving matrix Liapunov equations. Analytical expressions for the sensitivity derivatives of the dynamic matrix with respect to structural and control design variables yield another set of Liapunov equations which can be efficiently solved for many response derivatives. The suggested model is demonstrated to be considerably more efficient than classical frequency-domain models. ISA

N94-24551*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
COCKPIT CONTROL SYSTEM CONCEPTUAL DESIGN
GREG MEHOLIC, RHONDA BROWN, MELISSA HALL, ROBERT HARVEY, MICHAEL SINGER, and GUSTAVO TELLA 15 Mar. 1993 39 p
(Contract NASW-4435)
(NASA-CR-195543; NAS 1.26:195543) Avail: CASI HC A03/MF A01

The purpose of this project was to provide a means for operating the ailerons, elevator, elevator trim, rudder, nosewheel steering, and brakes in the Triton primary flight trainer. The main design goals under consideration were to illustrate system and subsystem integration, control function ability, and producibility. Weight and maintenance goals were addressed. Derived from text

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

N94-23091*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLOW QUALITY STUDIES OF THE NASA LEWIS RESEARCH CENTER ICING RESEARCH TUNNEL DIFFUSER
E. ALLEN ARRINGTON (Sverdrup Technology, Inc., Brook Park, OH.), MARK T. PICKETT, and DAVID W. SHELDON Jan. 1994 18 p
(Contract RTOP 505-62-84)
(NASA-TM-106311; E-8051; NAS 1.15:106311) Avail: CASI HC A03/MF A01

The purpose was to document the airflow characteristics in the diffuser of the NASA Lewis Research Center Icing Research Tunnel and to determine the effects of vortex generators on the flow quality in the diffuser. The results were used to determine how to improve the flow in this portion of the tunnel so that it can be more effectively used as an icing test section and such that overall tunnel efficiency can be improved. The demand for tunnel test time and the desire to test models that are too large for the test section were two of the drivers behind this diffuser study. For all vortex generator configurations tested, the flow quality was improved. Author (revised)

N94-23303# Illinois Univ., Urbana. Dept. of Civil Engineering.
PERFORMANCE OF PREFABRICATED GEOCOMPOSITE SUBDRAINAGE SYSTEM IN AN AIRPORT RUNWAY Final Report
BARRY J. DEMPSEY Oct. 1993 80 p
(Contract DTFAC1-87-Z-02015)
(DOT/FAA/RD-93/23) Avail: CASI HC A05/MF A01

A Prefabricated Geocomposite Subdrainage (PGS) system installed in Runway O9-27 at Kewanee Municipal Airport in 1985 was evaluated. The study demonstrated that a PGS system could be installed within the active runway area at a distance of 12.5 ft on either side of the centerline. There were no problems with settlement or distresses along the installation location. Subdrainage outflow measurements indicated that 25 percent to 45 percent of the rainfall water infiltrated the pavement and passed through the PGS system. Subdrainage outflows varied but a maximum outflow of over 1700 gal/hr was measured during the study. It was observed that water flow from the pavement joints and cracks ceased once the PGS system was installed. The FWD data indicated that the subgrade soil beneath Runway 09-27 ranged from less than 1 ksi to generally 3 ksi. Although there was some improvement in subgrade strength during the study period it was not possible to conclude that subdrainage was totally responsible for this improvement. There was an indication from the data analysis that there could be some raveling in the lower half of the full-depth asphalt concrete layer. The PCI study conducted on Runway 09-27 provided results from 1981 to 1990. The PCI ratings obtained after installation of the PGS system in 1985 indicated the possibility of some overall improvement in pavement performance. Visual observations indicated that surface seepage of water and frost heave problems did not occur again after installation of subdrainage. Visual inspection in January 1993 indicated there was no evidence of longitudinal reflective cracking in the 3 in. asphalt concrete overlay, that was placed during the summer 1990, in the area above the PCS system. It would appear that the PGS system is continuing to function properly and that Runway 09-27 at Kewanee Municipal Airport is performing very well. Author

N94-23539*# Old Dominion Univ., Norfolk, VA. Dept. of Aerospace Engineering.
PRELIMINARY EDDY CURRENT MODELLING FOR THE LARGE ANGLE MAGNETIC SUSPENSION TEST FIXTURE Progress Report, 1 May - 31 Oct. 1993
COLIN BRITCHER Jan. 1994 20 p
(Contract NAG1-1056)
(NASA-CR-194772; NAS 1.26:194772) Avail: CASI HC A03/MF A01

This report presents some recent developments in the mathematical modeling of the Large Angle Magnetic Suspension Test Fixture (LAMSTF) at NASA Langley Research Center. It is shown that these effects are significant, but may be amenable to analysis, modeling and measurement. A theoretical framework is presented, together with a comparison of computed and experimental data. Author

N94-24072# Galaxy Scientific Corp., Pleasantville, NJ.
AIRPORT PAVEMENT TEST MACHINE DESIGN AND COST STUDY Final Report
GORDON F. HAYHOE, ROY D. MCQUEEN, and EDWARD H. GUO Oct. 1993 126 p
(Contract DTFA03-89-C-00043)
(DOT/FAA/CT-93/51) Avail: CASI HC A07/MF A02

A design study was conducted to determine the feasibility of

constructing and operating a test machine for performing accelerated airport pavement tests. The proposed design for the test machine satisfies the requirements of a comprehensive set of specifications formulated and developed by a government/industry working group. The primary purpose of the tests to be conducted with the test machine is to provide pavement response and performance data to be used in the development of new procedures for designing pavements for the next generation of large civil transport aircraft. The proposed test machine design allows for test pavements 60 feet wide by 900 feet long. Maximum load capacity is twelve wheels operating at 75,000 pounds each, for a maximum applied load of 900,000 pounds. Test speeds are 5 mph for normal testing and a maximum of 15 mph for special studies. Cost estimates were made for designing, constructing, and operating the test machine. The total initial cost required to design and construct the machine was estimated to be $15,000,000. Maximum annual operating costs after commissioning were estimated to be $2,300,000. Test pavement reconstruction accounts for $1,500,000 (65%) of the estimated annual operating cost. Author

N94-24123 Defence Research Establishment, Ottawa (Ontario). Radiation Effects Section.
TEM CELL SAFETY REPORT
J. S. SEREGELYI and C. GARDNER Apr. 1993 17 p
(DREO-TN-93-9; CTN-94-60919) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

In order to test the susceptibility of a piece of equipment to an electromagnetic pulse (EMP), an accurate electric and magnetic field is required. One means of generating such fields is with a transverse electromagnetic (TEM) cell. This device is essentially a square coaxial line with known field properties. Although the design of the Defence Research Establishment Ottawa's EMP TEM cell includes devices for the protection of both operator and machine, safe use of the system depends upon the operator. The potential hazards of this TEM cell system are described and appropriate precautions are recommended to be followed during operation and maintenance. Safe and reliable operation can be expected if the machine is operated by personnel acquainted with its function and who follow the procedures outlined. Author (CISTI)

N94-24247 Instituto de Estudos Avancados, Sao Jose dos Campos (Brazil).
AN INVESTIGATION ON A NEW TECHNIQUE TO IMPROVE THE PERFORMANCE OF THE SHOCK TUBE/TUNNEL TESTING IN THE EQUILIBRIUM INTERFACE CONDITION
MARCO A. S. MINUCCI, MARCO A. C. NASCIMENTO, and HENRY T. NAGAMATSU (Rensselaer Polytechnic Inst., Troy, NY.) *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 103-113 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

A 0.3-m diameter hypersonic shock tunnel has been designed and constructed to investigate the effect of a thin layer of a separating gas on the performance of the tunnel when operating in the equilibrium interface condition. The separating gas is placed between the drive gas, He, and the test gas, air. Preliminary experiments employing He, Ar and SF6 as the separating gases indicate a strong dependence of the final equilibrium interface pressure on the kind of gas used. These experiments showed that when SF6 is used, the highest equilibrium pressure is attained and that the time required to reach this pressure is the shortest when compared with the other two gases tested. It was observed that the separating gas acts as a gaseous piston enhancing the compression provided by the moving He/air interface. Tests involving the CO2 laser radiation absorption in SF6 were also conducted. These tests revealed not only the arrival of the gaseous piston at a given shock tunnel station but also the existence of SF6 leakage through the boundary layer. ISA

N94-24559# Federal Aviation Administration, Atlantic City, NJ.
COMBINED 1991 AND 1992 ROBINSON-22B (R-22) PARKING TEST RESULTS Technical Report, Sep. 1991 - Oct. 1992
ROSANNE M. WEISS Sep. 1993 71 p
(AD-A273550; DOT/FAA/CT-TN93/6) Avail: CASI HC A04/MF A01

Tests were conducted in the fall of 1991 and 1992 at the Federal Aviation Administration (FAA) Technical Center to examine issues regarding rotor tip clearances for parking areas at heliports. These tests were initiated as a follow-on to previous parking tests documented in DOT/FAA/CT-TN88/30, 'Heliport Surface Maneuvering Test Results,' and DOT/FAA/CT-TN/92/1, 'Helicopter Nighttime Parking Test Results-UH-I.' Since those tests utilized a medium-size helicopter with a rotor diameter of 48 feet, similar tests were requested using a smaller helicopter with a rotor diameter of less than 30 feet. The results of these follow-on parking tests which used a Robinson-22B (R-22) helicopter are documented. Over 480 maneuvers were conducted at the FAA Technical Center's National Concepts Development and Demonstration Heliport/Vertiport, Atlantic City International Airport, NJ. All were conducted under head, tail, and crosswind conditions, both with and without an obstacle on the helipad. Pilot subjective data, in reference to these maneuvers, were collected via post-maneuver and post-flight questions. Data collection and analysis methodology and objective, as well as subjective issues, are discussed. Statistical and graphical analysis of pilot performance and perception data are provided. Conclusions are drawn about considerations that must be given to parking clearance criteria at heliports. DTIC

N94-24739 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
PRE-DESIGN STUDY OF A GENERAL PURPOSE VEHICLE SIMULATOR PLATFORM
A. WINKENS Jul. 1992 107 p See also PB92-199660 Prepared in cooperation with Technische Univ., Munich Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB93-215366; M-662) Avail: Issuing Activity (National Technical Information Service (NTIS))

In supporting fundamental flight simulation techniques as a part of academic research, the Delft University of Technology has recently launched the BARESIM program, the development of an advanced general-purpose vehicle simulator facility. The Structures and Materials Group of the faculty of Aerospace Engineering participates in the program by the design and construction of the simulator platform. The report describes the results of a pre-design study of the platform structure, which is performed as a semester project in the scope of the European student-exchange-program ERASMUS between the Munich University of Technology and the Delft University of Technology. NTIS

10

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.

N94-23653*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
DEVELOPMENT AND APPLICATION OF AN EMPIRICAL PROBABILITY DISTRIBUTION FOR THE PREDICTION ERROR OF RE-ENTRY BODY MAXIMUM DYNAMIC PRESSURE
R. JAMES LANZI and BRETT T. VINCENT (Computer Sciences Corp., Wallops Island, VA.) *In* NASA. Lewis Research Center,

The Fifth Annual Thermal and Fluids Analysis Workshop p 269-280 Nov. 1993
Avail: CASI HC A03/MF A04; 5 functional color pages

The relationship between actual and predicted re-entry *maximum dynamic pressure is characterized using a probability* density function and a cumulative distribution function derived from sounding rocket flight data. This paper explores the properties of this distribution and demonstrates applications of this data with observed sounding rocket re-entry body damage characteristics to assess probabilities of sustaining various levels of heating damage. The results from this paper effectively bridge the gap existing in sounding rocket reentry analysis between the known damage level/flight environment relationships and the predicted flight environment. Author

N94-23654*# General Dynamics Corp., San Diego, CA. Space Systems Div.
PREDICTION OF THREE SIGMA MAXIMUM DISPERSED DENSITY FOR AEROSPACE APPLICATIONS
TERRI L. CHARLES and MICHAEL D. NITSCHKE *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 281-305 Nov. 1993
Avail: CASI HC A03/MF A04; 5 functional color pages

Free molecular heating (FMH) is caused by the transfer of energy during collisions between the upper atmosphere molecules and a space vehicle. The dispersed free molecular heating on a surface is an important constraint for space vehicle thermal analyses since it can be a significant source of heating. To reduce FMH to a spacecraft, the parking orbit is often designed to a higher altitude at the expense of payload capability. Dispersed FMH is a function of both space vehicle velocity and atmospheric density, however, the space vehicle velocity variations are insignificant when compared to the atmospheric density variations. The density of the upper atmosphere molecules is a function of altitude, but also varies with other environmental factors, such as solar activity, geomagnetic activity, location, and time. A method has been developed to predict three sigma maximum dispersed density for up to 15 years into the future. This method uses a state-of-the-art atmospheric density code, MSIS 86, along with 50 years of solar data, NASA and NOAA solar activity predictions for the next 15 years, and an Aerospace Corporation correlation to account for density code inaccuracies to generate dispersed maximum density ratios denoted as 'K-factors'. The calculated K-factors can be used on a mission unique basis to calculate dispersed density, and hence dispersed free molecular heating rates. These more accurate K-factors can allow lower parking orbit altitudes, resulting in increased payload capability. Author

N94-24121 Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
EXPERIMENTAL VERIFICATION OF AN ACOUSTIC TELEMETRY LINK BETWEEN AN AURORA AND CFAV QUEST
C. M. MCINTYRE, A. T. ASHLEY, J. W. MACDONALD, and R. L. G. WHITEHORNE Feb. 1993 30 p
(DREA-TC-93-304; CTN-94-60917) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

To evaluate airborne sonar concepts operationally on a ship-based system, a mechanism must be developed for transmitting both acoustic and nonacoustic data from an aircraft to the ship. An initial evaluation of an acoustic telemetry link between an Aurora patrol aircraft and the research ship CFAV Quest is presented. The link was designed to transmit continuous, real-time acoustic data from sixteen DIFAR sonobuoys between the Aurora and the Quest. In two recent trials of the acoustic telemetry link system, reliable transmission was obtained out to ranges of 50 nautical miles with a tracking antenna receiving system and to ranges of seven nautical miles with an omnidirectional antenna. In each case, the aircraft was required to fly a dedicated pattern to maintain the link and there were short periods during each pattern that the link was poor due to transmission shadows cast by the aircraft or the ship. The acoustic telemetry link system is described in detail along with an initial evaluation of the operating envelopes currently imposed on the Aurora and the Quest in order to obtain reliable transmission. Recommendations are given for improving the quality and flexibility of the link. Author (CISTI)

11

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

N94-23335# Federal Aviation Administration, Atlantic City, NJ.
INITIAL EVALUATION OF BURN CHARACTERISTICS OF PHENOLIC FOAM RUNWAY BRAKE ARRESTOR MATERIAL
DUNG DO, JOSEPH WRIGHT, and LAWRENCE HAMPTON Dec. 1993 46 p
(DOT/FAA/CT-TN93/7) Avail: CASI HC A03/MF A01

Tests of the burn characteristics of a phenolic foam, under evaluation as runway brake arrestor material, were conducted by the Fire Safety Branch of the Federal Aviation Administration (FAA) Technical Center. The purpose of these tests was to assess the fire propagation properties of phenolic foam when exposed to a free burning Jet A fuel fire and to determine the fire control time of phenolic foam immersed in a jet fuel fire when extinguished using three-percent aqueous film forming foam (AFFF). Three pool fire tests were conducted as follows: In the first and second tests, a 12-foot-square bed of phenolic foam material was placed adjacent to a 35-foot diameter jet fuel fire. This configuration resulted in ignition and flame propagation across to adjacent foam material, resulting in charring of over 30 percent of the exposed surface of the phenolic foam. In the third test, the phenolic foam material was immersed in the jet fuel fire to determine ease of extinguishment using conventional AFFF agent. The fire control time was three times longer than when the phenolic foam material was absent. The extinguishing time was an order of magnitude higher than that without the foam. In addition, the phenolic foam material was evaluated on the basis of FAA fire test requirements for cabin material. These small-scale tests measured burn length, weight loss, and heat release rate of the foam material in accordance with Federal Aviation Regulation (FAR) 25.853. These results showed the foam material passed the burn test requirements. Author (revised)

N94-24137 Institute for Aerospace Research, Ottawa (Ontario). Structures and Materials Lab.
A PREDICTION METHOD FOR THE COMPRESSIVE STRENGTH OF IMPACT DAMAGED COMPOSITE LAMINATES
Y. XIONG, C. POON, P. V. STRAZNICKY (Carleton Univ., Ottawa, Ontario.), and H. VIETINGHOFF (Carleton Univ., Ottawa, Ontario.) Sep. 1993 23 p
(CTN-94-60925) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

An analytical method for the prediction of the compressive strength of composite laminates containing impact damage has been developed. Using the characteristics of the impact damage detected by the ultrasonic time-of-flight C-scan technique, the state of the damage is modeled by an elliptical soft inclusion. The degradation of the elastic moduli of the material in the inclusion is determined by a sublaminate buckling analysis. The stress distribution in the laminate containing the inclusion with the reduced moduli is determined using a complex potential method and the stress results are used in conjunction with three failure criteria to predict the residual compressive strength. Compression after impact tests on flat laminates manufactured from the Toray T800H/3900-2 material have been conducted to produce experimental results for validating the analytical method. Good agreements between predicted residual compressive strengths and experimental results have been obtained. Author (CISTI)

N94-24228# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.

INTRODUCTION OF CERAMICS INTO AEROSPACE STRUCTURAL COMPOSITES [L'INTRODUCTION DES CERAMIQUES DANS LES COMPOSITES UTILISES DANS LES STRUCTURES DES SYSTEMES AEROSPATIAUX]

Nov. 1993 160 p In ENGLISH and FRENCH Workshop held in Antalya, Turkey, 21-22 Apr. 1993

(AGARD-R-795; ISBN-92-835-0728-2) Copyright Avail: CASI HC A08/MF A02

Ceramics have been considered over the last two decades as a possible alternative to refractory metals and alloys to be used as structural materials for aeronautical use. The main disadvantage of these materials is their brittleness and the very low value of the critical size of defects leading to fracture. The concept of ceramic matrix composites has been recognized as one of the ways to escape this difficulty. Extensive work has been performed to identify the mechanisms of crack propagation and general fracture for unidirectional composites, laminates or other fabrics, including the understanding of their long term response: creep and fatigue effects or environmental degradation. The Workshop which has been held by AGARD SMP at Antalya (Turkey), April 1993, aimed at reviewing the present knowledge on all these aspects.

N94-24231# Wright Research Development Center, Wright-Patterson AFB, OH.

INTERFACE EVALUATION IN CERAMIC COMPOSITES

PAUL D. JERO, TRIPLICANE A. PARTHASARATHY, and RONALD J. KERANS *In* AGARD, Introduction of Ceramics into Aerospace Structural Composites 10 p Nov. 1993

Copyright Avail: CASI HC A02/MF A02

The results of pushout tests on two ceramic matrix composites are presented and discussed. Emphasis is placed on the effect of interface roughness on the interfacial properties. Toward that end, techniques used to characterize fiber and interface topography are described and results presented. An advanced analysis, which takes account of the roughness contribution to the radial stress during debonding, is used to calculate interfacial properties. It is observed that the fiber fabrication technique has a profound effect on the nature of the interfacial topography. Author

N94-24269 Israel Aircraft Industries Ltd., Tashan.

ATTACHMENT METHODS IN COMPOSITE JOINTS - ANALYSIS OF TEST RESULTS BY CONTROLLED EXPERIMENTS METHOD

T. GOTTESMAN, D. PELED, N. SELA, and L. SOLOMON *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 310-320 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

Tests of composite cold-bonded and wet lay-up joints were performed for various loadings. The test results were completed by linear extrapolation and analyzed statistically by the controlled experiments method. Principal parameters concerning mechanical performance were identified and, accordingly, design improvements were recommended. ISA

N94-24301*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DISCRETE SENSITIVITY DERIVATIVES OF THE NAVIER-STOKES EQUATIONS WITH A PARALLEL KRYLOV SOLVER

KUMUD AJMANI and ARTHUR C. TAYLOR, III (Old Dominion Univ., Norfolk, VA.) Jan. 1994 13 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA

(Contract NCC3-233; RTOP 505-90-5K)

(NASA-TM-106481; ICOMP-94-2; E-8411; NAS 1.15:106481; AIAA PAPER 94-0091) Avail: CASI HC A03/MF A01

This paper solves an 'incremental' form of the sensitivity equations derived by differentiating the discretized thin-layer Navier Stokes equations with respect to certain design variables of interest. The equations are solved with a parallel, preconditioned Generalized Minimal RESidual (GMRES) solver on a distributed-memory architecture. The 'serial' sensitivity analysis code is parallelized by using the Single Program Multiple Data (SPMD) programming model, domain decomposition techniques, and message-passing tools. Sensitivity derivatives are computed for low and high Reynolds number flows over a NACA 1406 airfoil on a 32-processor Intel Hypercube, and found to be identical to those computed on a single-processor Cray Y-MP. It is estimated that the parallel sensitivity analysis code has to be run on 40-50 processors of the Intel Hypercube in order to match the single-processor processing time of a Cray Y-MP.

Author (revised)

N94-24565*# United Technologies Research Center, East Hartford, CT.

STUDY OF STREAMWISE VORTICITY-STIRRED COMBUSTION

WILLIAM T. PESCHKE and JOHN B. MCVEY Dec. 1993 74 p Sponsored by NASA. Lewis Research Center Original contains color illustrations

(Contract DAAL03-89-C-0018)

(NASA-CR-194450; NAS 1.26:194450; UTRC-R93-958160-1; ARL-CR-141) Avail: CASI HC A04/MF A01; 10 functional color pages

Experiments were conducted to establish the effects of the introduction of streamwise vorticity in combusting flows modeling those developed within small gas turbine engines. The objective of the effort was to determine whether this combustion concept has the potential for improving the volumetric heat release rates that characterize these engines. Water flow-visualization tests were performed to evolve lobed mixer configurations that, while generating vortex arrays within both the primary and secondary streams, would also provide rapid intermixing between the streams. These experiments resulted in the definition of enhanced-mixing configurations that were characterized, according to air bubble and dye trajectories, by strong interactions between the two streams. These interactions induced a substantial vertical interchange of primary and secondary fluids. Intermingling of the two fluids occurred throughout a region covering 80 percent of the height of the duct within distances from the lobe mixer trailing edge ranging from approximately one-half to one duct height. Combustion experiments were carried out in a high-pressure (7 atm) combustion apparatus using lobe-mixer combinations that exhibited the ability to induce rapid interchange between the primary and secondary streams. Direct observation and gas sampling were employed to characterize the fuel-air ratio distribution effected by the mixers. Flame geometries were compared with those developed during shear-layer combustion occurring downstream from a conventional splitter plate. The results show that the lobed mixers induce a rapid relocation of the fuel-air mixture entering the combustion test section. As contrasted with the 5- to 7-degree flame front angles that occurred during shear layer combustion, the flame front angles developed during combustion using the lobed mixers were more than twice as great, attaining levels approaching 20 degrees. Author

12

ENGINEERING

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

N94-22713# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
A MULTIGRID MULTIBLOCK SOLVER FOR COMPRESSIBLE TURBULENT FLOW
HANS G. M. KUERTEN and BERNARD J. GEURTS Mar. 1993 16 p
(ISSN 0169-2960)
(MEMO-1125; ETN-94-94761) Avail: CASI HC A03/MF A01

A multigrid multiblock method for compressible turbulent flow simulations is described and results obtained from calculations on a two element airfoil are presented. A vertex based spatial discretization method and explicit multistage Runge-Kutta time stepping are used. The slow convergence of a single grid method makes the multigrid method, which yields a speed up with a factor of about 12.5, indispensable. The numerical predictions are in good agreement with experimental results. The convergence of the multigrid process is shown to depend considerably on the ordering of the various loops. If the block loop is put inside the stage loop, the process converges more rapidly than if the block loop is situated outside the stage loop in the case where a three stage Runge-Kutta method is used. If a five stage scheme is used, the process does not converge in the latter block ordering. The process based on the five stage method is about 60% more efficient than with the three stage method. ESA

N94-22735*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE THIRD INTERNATIONAL MOBILE SATELLITE CONFERENCE (IMSC 1993)
ROBERT KWAN, comp., JACK RIGLEY, comp. (Communications Research Centre, Ottawa, Ontario.), and RANDY CASSINGHAM, ed. 1993 593 p Conference held in Pasadena, CA, 16-18 Jun. 1993 Prepared in cooperation with Communications Research Centre, Ottawa, Ontario
(Contract NAS7-918)
(NASA-CR-194516; JPL-PUBL-93-009; NAS 1.26:194516) Avail: CASI HC A25/MF A06

Satellite-based mobile communications systems provide voice and data communications to users over a vast geographic area. The users may communicate via mobile or hand-held terminals, which may also provide access to terrestrial cellular communications services. While the first and second International Mobile Satellite Conferences (IMSC) mostly concentrated on technical advances, this Third IMSC also focuses on the increasing worldwide commercial activities in Mobile Satellite Services. Because of the large service areas provided by such systems, it is important to consider political and regulatory issues in addition to technical and user requirements issues. Topics covered include: the direct broadcast of audio programming from satellites; spacecraft technology; regulatory and policy considerations; advanced system concepts and analysis; propagation; and user requirements and applications.

N94-22771*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ACTS BROADBAND AERONAUTICAL EXPERIMENT
BRIAN S. ABBE, THOMAS C. JEDREY, POLLY ESTABROOK, and MARTIN J. AGAN *In its* Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 205-210 1993
Avail: CASI HC A02/MF A06

In the last decade, the demand for reliable data, voice, and video satellite communication links between aircraft and ground to improve air traffic control, airline management, and to meet the growing demand for passenger communications has increased significantly. It is expected that in the near future, the spectrum required for aeronautical communication services will grow significantly beyond that currently available at L-band. In anticipation of this, JPL is developing an experimental broadband aeronautical satellite communications system that will utilize NASA's Advanced Communications Technology Satellite (ACTS) as a satellite of opportunity and the technology developed under JPL's ACTS Mobile Terminal (AMT) Task to evaluate the feasibility of using K/Ka-band for these applications. The application of K/Ka-band for aeronautical satellite communications at cruise altitudes is particularly promising for several reasons: (1) the minimal amount of signal attenuation due to rain; (2) the reduced drag due to the smaller K/Ka-band antennas (as compared to the current L-band systems); and (3) the large amount of available bandwidth. The increased bandwidth available at these frequencies is expected to lead to significantly improved passenger communications - including full-duplex compressed video and multiple channel voice. A description of the proposed broadband experimental system will be presented including: (1) applications of K/Ka-band aeronautical satellite technology to U.S. industry; (2) the experiment objectives; (3) the experiment set-up; (4) experimental equipment description; and (5) industrial participation in the experiment and the benefits. Author

N94-22772*# Federal Aviation Administration, Washington, DC.
THE FAA SATELLITE COMMUNICATIONS PROGRAM
KAREN L. BURCHAM *In* JPL, Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 213-218 1993
Avail: CASI HC A02/MF A06

The Federal Aviation Administration is developing satellite communications capabilities to enhance air traffic services, first in oceanic and remote regions, and later for United States domestic services. The program includes four projects which develop technical standards, assure adequate system performance, support implementation, and provide for research and development for selected areas of U.S. domestic satellite communications. The continuing focus is the application of automated data communications, which is already permitting enhanced and regular position reporting. Voice developments, necessary for non-routine communications, are also included among the necessary activities to improve ATC communications. Author

N94-22773*# Communications Research Centre, Ottawa (Ontario).
CANADIAN AERONAUTICAL MOBILE DATA TRIALS
ALLISTER PEDERSEN and ANDREA PEARSON (Telesat Mobile, Inc., Ottawa, Ontario.) *In* JPL, Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 219-224 1993
Avail: CASI HC A02/MF A06

This paper describes a series of aeronautical mobile data trials conducted on small aircraft (helicopters and fixed wing) utilizing a low-speed store-and-forward mobile data service. The paper outlines the user requirements for aeronautical mobile satellite communications. 'Flight following' and improved wide-area dispatch communications were identified as high priority requirements. A 'proof-of-concept' trial in a Cessna Skymaster aircraft is described. This trial identified certain development work as essential to the introduction of commercial service including antenna development, power supply modifications and doppler software modifications. Other improvements were also proposed. The initial aeronautical mobile data service available for pre-operational (Beta) trials is outlined. Pre-operational field trials commenced in October 1992 and consisted of installations on a Gralen Communications Inc. Cessna 177 and an Aerospatiale Astar 350 series light single engine helicopter. The paper concludes with a discussion of desirable near term mobile data service developments, commercial benefits, current safety benefits and potential future applications for improved safety. Author

N94-22775*# Vigyan Research Associates, Inc., Hampton, VA.
COCKPIT WEATHER GRAPHICS USING MOBILE SATELLITE COMMUNICATIONS
SHASHI SETH *In* JPL, Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 231-233 1993
(Contract NAS1-19595)
Avail: CASI HC A01/MF A06

Many new companies are pushing state-of-the-art technology to bring a revolution in the cockpits of General Aviation (GA) aircraft. The vision, according to Dr. Bruce Holmes - the Assistant Director for Aeronautics at National Aeronautics and Space Administration's (NASA) Langley Research Center, is to provide such an advanced flight control system that the motor and cognitive skills you use to drive a car would be very similar to the ones you would use to fly an airplane. We at ViGYAN, Inc., are currently developing a system called the Pilot Weather Advisor (PWxA), which would be a part of such an advanced technology flight management system. The PWxA provides graphical depictions of weather information in the cockpit of aircraft in near real-time, through the use of broadcast satellite communications. The purpose of this system is to improve the safety and utility of GA aircraft operations. Considerable effort is being extended for research in the design of graphical weather systems, notably the works of Scanlon and Dash. The concept of providing pilots with graphical depictions of weather conditions, overlaid on geographical and navigational maps, is extremely powerful. Author

N94-22835*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
L-BAND MOBILE TERMINAL ANTENNAS FOR HELICOPTERS
T. K. WU, K. FARAZIAN, N. GOLSHAN, D. DIVSALAR, and S. HINEDI *In its* Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 587-592 1993
Avail: CASI HC A02/MF A06

The feasibility of using a low gain antenna (LGA) as a mobile terminal antenna for a helicopter is described in this paper. The objectives are to select the lowest cost antenna system which can be easily mounted on a helicopter and capable of communicating with a satellite, and to determine the best antenna position on the helicopter to mitigate the signal blockage due to rotor blades and the multipath effect from the helicopter's body. The omnidirectional LGA is selected because it is simple, reliable, and low cost. The helix antenna is selected among the many LGA's because it is the most economical one and has the widest elevation beamwidth. Both 2-arm and 4-arm helices are studied experimentally to determine the antenna's performance and the scattering effects from the helicopter's body. It is found that the LGA should be located near the tail section and at least eight inches above the helicopter. Author (revised)

N94-22836*# Communications Research Centre, Ottawa (Ontario). Dept. of Communications.
AERONAUTICAL SATELLITE ANTENNA STEERING USING MAGNETIC FIELD SENSORS
JOHN SYDOR and MARTIAL DUFOUR *In* JPL, Proceedings of the Third International Mobile Satellite Conference (IMSC 1993) p 593-598 1993
Avail: CASI HC A02/MF A06

Designers of aeronautical satellite terminals are often faced with the problem of steering a directive antenna from an airplane or helicopter. This problem is usually solved by using aircraft orientation information derived from inertial sensors on-board the aircraft in combination with satellite ephemeris information calculated from geographic coordinates. This procedure works well but relies heavily on avionics that are external to the terminal. For the majority of small aircraft and helicopters which will form the bulk of future aeronautical satcom users, such avionics either do not exist or are difficult for the satellite terminal to interface with. At the Communications Research Center (CRC), work has been undertaken to develop techniques that use the geomagnetic field and satellite antenna pointing vectors (both of which are stationary in a local geographical area) to track the position of a satellite relative to a moving platform such as an aircraft. The performance of this technique is examined and a mathematical steering transformation is developed within this paper. Details are given regarding the experimental program that will be undertaken to test the concepts proposed herein. Author

N94-22854# Technische Hochschule, Aachen (Germany). Inst. fuer Strahlantriebe und Turboarbeitsmaschinen.
MEASUREMENT OF KINEMATICALLY UNSTATIONARY SEPARATED FLOWS [VERMESSUNG DER KINEMATIK INSTATIONAER ABGELOESTER STROEMUNGEN]
C. A. POENSGEN and H. E. GALLUS *In* Tech. Univ. Berlin, Experimental Methods in Separated Flows p 15-29 1991 In GERMAN
Avail: CASI HC A03/MF A01

The development of flow separation between the hub wall and the blade suction side in an axial compressor annular cascade is examined with several measurement techniques. The flow was first assumed to be stationary; separation could be estimated with flow visualization and pneumatic pressure measurements on lateral walls and blade surfaces were carried out for evaluating flow losses in the cascade. Measurements at airfoil surfaces with hot wire probes and hot film sensors gave information about the development of the blade boundary layer. The influence of the unstationary flow on the development of airfoil boundary layers and the separation at the hub with dependence of the aerodynamic loading is studied. Cylindrical bars were used instead of a real blading in order to obtain typical wakes without potential interactions between rotor and stator. Experimental examinations similar to the one described for the steady flow were carried out. It is found that flow losses increase in the airfoil boundary layer while they drop to the hub separation. By and large, the total losses are found to be lower with unsteady flow. ESA

N94-22914# Aeronautical Research Labs., Melbourne (Australia).
PROCEEDINGS OF WORKSHOP ON LASER DIAGNOSTICS IN *FLUID MECHANICS AND COMBUSTION*
1 Oct. 1993 183 p Workshop held in Fishermans Bend, Victoria, 30 Sep. - 1 Oct. 1993
(AD-A272808; DODA-AR-008-393) Avail: CASI HC A09/MF A02

Proceedings of the Workshop on Laser Diagnostics in Fluid Mechanics and Combustion are presented. Topics included are: Accuracy of Laser Doppler Anemometry; Applications of Raman-Rayleigh-LIF Diagnostics in Combustion Research; Phase Doppler Anemometer Technique Concepts and Applications; CARS; Particle Image Velocimetry; Practical Consideration in the Use and Design of Laser Velocimetry Systems in Turbomachinery Applications; Phase Doppler Measurements of Gas-Particle Flow Through a Tube Bank; Degenerate Four Wave Mixing for Shock Tunnel Studies of Supersonic Combustion; Laser Induced Photodissociation and Fluorescence (LIPF) of Sodium Species Present in Coal Combustion; 3D Holographic Measurements Inside a Spark Ignition Engine; Laser Doppler Velocimeter Measurements in Compressible Flow; Bursting in a Tornado Vortex; Quantitative Imaging of OH and Temperature Using a Single Laser Source and Single Intensified Camera; and Laser Doppler Measurements Inside an Artificial Heart Valve. DTIC

N94-22985# Amsterdam Univ. (Netherlands).
LOCAL GRID REFINEMENT METHOD FOR THE EULER EQUATIONS Ph.D. Thesis
H. T. M. VANDERMAAREL 23 Feb. 1993 149 p See also PB92-202274
(PB93-223329) Avail: CASI HC A07/MF A02

The thesis considers the Euler equations of fluid dynamics for a perfect gas. Our main interest is the numerical approximation of solutions of the steady, two-dimensional Euler equations, by a solution-adaptive method, which uses local grid refinement (enrichment) and a multigrid method to solve the system of discrete equations. The Euler equations model the flow of a compressible, inviscid fluid, without taking into account the conduction of heat. Aerospace aerodynamics is an area of application interested in a physical model that neglects viscosity and heat conduction effects

in the flow of a perfect gas. For an object moving through a gas, viscosity and heat conduction tend to play an important role only in the close vicinity of that object. Hence, in the 'outer' region (away from the object), a realistic description can often be made with the Euler equations. NTIS

N94-23000# Sandia National Labs., Albuquerque, NM.
DEVELOPMENT AND EXPERIMENTAL VALIDATION OF COMPUTATIONAL METHODS TO SIMULATE ABNORMAL THERMAL AND STRUCTURAL ENVIRONMENTS
J. L. MOYA, R. D. SKOCYPEC, and R. K. THOMAS 1993 13 p Presented at the Surety Technology Symposium, Chelyacinsk, Russia, 28 Sep. - 2 Oct. 1993
(Contract DE-AC04-76DP-00789)
(DE94-000554; SAND-93-2215C; CONF-9309215-3) Avail: CASI HC A03/MF A01

Over the past 40 years, Sandia National Laboratories (SNL) has been actively engaged in research to improve the ability to accurately predict the response of engineered systems to abnormal thermal and structural environments. These engineered systems contain very hazardous materials. Assessing the degree of safety/risk afforded the public and environment by these engineered systems, therefore, is of upmost importance. The ability to accurately predict the response of these systems to accidents (to abnormal environments) is required to assess the degree of safety. Before the effect of the abnormal environment on these systems can be determined, it is necessary to ascertain the nature of the environment. Ascertaining the nature of the environment, in turn, requires the ability to physically characterize and numerically simulate the abnormal environment. Historically, SNL has demonstrated the level of safety provided by these engineered systems by either of two approaches: a purely regulatory approach, or by a probabilistic risk assessment (PRA). This paper will address the latter of the two approaches. DOE

N94-23036*# Pennsylvania State Univ., University Park.
DROPLET TURBULENCE INTERACTIONS UNDER SUBCRITICAL AND SUPERCRITICAL CONDITIONS
E. B. COY, S. C. GREENFIELD, M. S. ONDAS, Y.-H. SONG, T. D. SPEGAR, and D. A. SANTAVICCA *In its* NASA Propulsion Engineering Research Center, Volume 2 p 39-45 Nov. 1993
Avail: CASI HC A02/MF A03

The goal of this research is to experimentally characterize the behavior of droplets in vaporizing liquid sprays under conditions typical of those encountered in high pressure combustion systems such as liquid fueled rocket engines. Of particular interest are measurements of droplet drag, droplet heating, droplet vaporization, droplet distortion, and secondary droplet breakup, under both subcritical and supercritical conditions. The paper presents a brief description of the specific accomplishments which have been made over the past year. Author (revised)

N94-23045*# Pennsylvania State Univ., University Park. Propulsion Engineering Research Center and Dept. of Mechanical Engineering.
DEVELOPMENT OF A DROPLET BREAKUP MODEL CONSIDERING AERODYNAMIC AND DROPLET COLLISION EFFECTS
K. L. WERT and H. R. JACOBS *In its* NASA Propulsion Engineering Research Center, Volume 2 p 82-87 Nov. 1993
Avail: CASI HC A02/MF A03

A model is currently under development to predict the occurrence and outcome of spray droplet breakup induced by aerodynamic forces and droplet collisions. It is speculated that these phenomena may be significant in determining the droplet size distribution in a spray subjected to acoustic velocity fluctuations. The goal is to integrate this breakup model into a larger spray model in order to examine the effects of combustion instabilities on liquid rocket motor fuel sprays. The model is composed of three fundamental components: a dynamic equation governing the deformation of the droplet, a criterion for breakage based on the amount of deformation energy stored in the droplet and an energy balance based equation to predict the Sauter mean diameter of the fragments resulting from breakup. Comparison with published data for aerodynamic breakup indicates good agreement in terms of predicting the occurrence of breakup. However, the model significantly over predicts the size of the resulting fragments. This portion of the model is still under development. Author

N94-23055*# Pennsylvania State Univ., University Park. Propulsion Engineering Research Center and Dept. of Mechanical Engineering.
EFFICIENCY AND RELIABILITY ENHANCEMENTS IN PROPULSION FLOWFIELD MODELING
PHILIP E. O. BUELOW, SANKARAN VENKATESWARAN, and CHARLES L. MERKLE *In its* NASA Propulsion Engineering Research Center, Volume 2 p 130-134 Nov. 1993
Avail: CASI HC A01/MF A03

The implementation of traditional CFD algorithms in practical propulsion related flowfields often leads to dramatic reductions in efficiency and/or robustness. The present research is directed at understanding the reasons for this deterioration and finding methods to circumvent it. Work to date has focussed on low Mach number regions, viscous dominated regions, and high grid aspect ratios. Time derivative preconditioning, improved definition of the local time stepping, and appropriate application of boundary conditions are employed to decrease the required time to obtain a solution, while maintaining accuracy. A number of cases having features typical of rocket engine flowfields are computed to demonstrate the improvement over conventional methods. These cases include laminar and turbulent high Reynolds number flat plate boundary layers, flow over a backward-facing step, a diffusion flame, and wall heat-flux calculations in a turbulent converging-diverging nozzle. Results from these cases show convergence that is virtually independent of the local Mach number and the grid aspect ratio, which translates to a convergence speed-up of up to several orders of magnitude over conventional algorithms. Current emphasis is in extending these results to three-dimensional flows with highly stretched grids.
Author (revised)

N94-23058*# Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering.
FOIL BEARING RESEARCH AT PENN STATE
MARC CARPINO *In its* NASA Propulsion Engineering Research Center, Volume 2 p 148-151 Nov. 1993
Avail: CASI HC A01/MF A03

Foil journal bearings consist of a compliant metal shell or foil which supports a rigid journal by means of a fluid film. Foil bearings are considered to be a potential alternative to rolling element or traditional rigid surface bearings in cryogenic turbomachinery applications. The prediction of foil bearing performance requires the coupled solution of the foil deflection and the fluid flow in the bearing clearance between the rotor and the foil. The investigations being conducted in the Department of Mechanical Engineering at Penn State are focused in three areas: theoretical prediction of steady state bearing performance, modeling of the dynamic bearing characteristics to determine performance in rotor systems, and experimental verification of analysis codes. The current status and results from these efforts will be discussed. Author

N94-23114# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
TWO-DIMENSIONAL NAVIER-STOKES COMPUTATIONS OF SUBSONIC AND SUPERSONIC FLOWS THROUGH TURBINE CASCADES
H. PAN 1993 38 p
(PB93-226223; ISBN-951-22-1482-2) Avail: CASI HC A03/MF A01

The report describes the computation of 2-D viscous flows in turbine cascades. The program is a 2-D FINFLO code developed at the Laboratory of Aerodynamics, Helsinki University of Technology. The original code was developed for external flows and dimensionless variables are employed in the computation. The external version of the code was modified to be suitable for internal flows and dimensional input-output quantities was used. A

subsonic 2-D axial turbine cascade flow case and a supersonic 2-D radial turbine cascade flow case was calculated. The results from the first case are compared with the results of the experiment conducted by NASA. NTIS

N94-23115 Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
POISS3: A 3D POISSON SMOOTHER OF STRUCTURED GRIDS
R. LEHTIMAEKI 1993 50 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (PB93-226231; SER-B-93-42) Avail: CASI HC A03

Flow solvers based on solving Navier-Stokes or Euler equations generally need a computational grid to represent the domain of the flow. A structured computational grid can be efficiently produced by algebraic methods like transfinite interpolation. Unfortunately, algebraic methods propagate all kinds of unsmoothness of the boundary into the field. Unsmoothness of the grid, in turn, can result in inaccuracy in the flow solver. In the present work a 3D elliptic grid smoother was developed. The smoother is based on solving three Poisson equations, one for each curvilinear direction. The Poisson equations formed in the physical region are first transformed to the computational (rectilinear) region. The resulting equations form a system of three coupled elliptic quasi-linear partial differential equations in the computational domain. A short review of the Poisson method is presented. The regularity of a grid cell is studied and a skewness value is developed. NTIS

N94-23215 General Electric Co., Fairfield, CT.
VIBRATION ISOLATING ENGINE MOUNT Patent
STANLEY I. BENDER, inventor (to General Electric Co.), PETER W. DAWES, inventor (to General Electric Co.), and LAWRENCE BUTLER, inventor (to General Electric Co.) 27 Jul. 1993 24 p (CA-PATENT-1-320-710; INT-PATENT-CLASS-B64D-27/26; INT-PATENT-CLASS-F16F-15/04; INT-PATENT-CLASS-F02C-7/20; CTN-94-60929) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

An improved engine suspension system is provided for attenuating vibration in a gas turbine engine. In one embodiment, the invention is directed to an aircraft engine suspension system for mounting a gas turbine engine to a supporting frame by mounts arranged in first and second parallel, spaced axial mounting planes of the engine. First and second vibration isolation mounts are aligned in the first mounting plane and couple the engine to the supporting frame. Each of the first and second mounts provides both radial and axial vibration damping to the engine as well as radial and axial stiffness. A third vibration isolation mount is aligned in the second mounting plane and couples the engine and support frame together to provide radial and tangential vibration damping to the engine as well as radial and tangential stiffness. The mounts are arranged axially and radially such that the suspension system is statically and dynamically determinate. Author (CISTI)

N94-23227# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
ACTIVITIES REPORT TO NATO Annual Report No. 33, Oct. 1991 - Sep. 1992
30 Sep. 1992 78 p
(ETN-94-95047) Avail: CASI HC A05/MF A01

Academic, research and financial developments at the von Karman Institute for Fluid Dynamics during the period from 1 Oct. 1991 - 30 Sep. 1992 are reported. The Institute is incorporated as an international scientific association with the following aims: to promote the training of scientists and engineers from NATO (North Atlantic Treaty Organization) countries in the field of fluid dynamics; to contribute to the dissemination of knowledge in the field of fluid dynamics; to undertake, to investigate, and to promote studies and research in the field of theoretical and experimental fluid dynamics, including numerical methods. Education and research are conducted within three broad areas of fluid dynamics, each of which is reflected in the name of a department: aeronautics/aerospace; environmental and applied fluid dynamics; and turbomachinery. ESA

N94-23498*# Old Dominion Univ., Norfolk, VA. Dept. of Engineering Technology.
FEASIBILITY OF DETECTING AIRCRAFT WAKE VORTICES USING PASSIVE MICROWAVE RADIOMETERS Final Report
RICHARD F. HARRINGTON Dec. 1993 47 p
(Contract NAS1-19858; RTOP 505-64-12-04)
(NASA-CR-191553; NAS 1.26:191553) Avail: CASI HC A03/MF A01

The feasibility of detecting the cold core of the wake vortex from the wingtips of an aircraft using a passive microwave radiometer was investigated. It was determined that there is a possibility that a cold core whose physical temperature drop is 10 C or greater and which has a diameter of 5 m or greater can be detected by a microwave radiometer. The radiometer would be a noise injection balanced Dicke radiometer operating at a center frequency of 60 GHz. It would require a noise figure of 5 dB, a predetection bandwidth of 6 GHz, and an integration time of 2 seconds resulting in a radiometric sensitivity of 0.018 K. However, three additional studies are required. The first would determine what are the fluctuations in the radiometric antenna temperature due to short-term fluctuations in atmospheric pressure, temperature, and relative humidity. Second, what is the effect of the pressure and temperature drop within the cold core of the wake vortex on its opacity. The third area concerns the possibility of developing a 60 GHz radiometer with a radio metric sensitivity an order of magnitude improvement over the existing state of the art. Author (revised)

N94-23513*# Queensland Univ., Saint Lucia (Australia). Dept. of Mechanical Engineering.
SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA, SUPPLEMENT 7
R. J. BAKOS, R. G. MORGAN, S. L. TUTTLE, G. M. KELLY, A. PAULL, J. M. SIMMONS, R. J. STALKER, M. V. PULSONETTI, D. BUTTSWORTH, G. A. ALLEN, JR. et al. Dec. 1993 143 p
(Contract NAGW-674; RTOP 505-70-62-02)
(NASA-CR-191572; NAS 1.26:191572) Avail: CASI HC A07/MF A02

Reports by the staff of the University of Queensland on various research studies related to the advancement of scramjet technology are presented. These reports document the tests conducted in the reflected shock tunnel T4 and supporting research facilities that have been used to study the injection, mixing, and combustion of hydrogen fuel in generic scramjets at flow conditions typical of hypersonic flight. In addition, topics include the development of instrumentation and measurement technology, such as combustor wall shear and stream composition in pulse facilities, and numerical studies and analyses of the scramjet combustor process and the test facility operation. This research activity is Supplement 7 under NASA Grant NAGW-674. Author

N94-23532*# Queensland Univ., Saint Lucia (Australia). Dept. of Mechanical Engineering.
SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA, SUPPLEMENT 8
R. J. STALKER, P. HOLLIS, G. A. ALLEN, G. T. ROBERTS, S. TUTTLE, R. J. BAKOS, R. G. MORGAN, M. V. PULSONETTI, C. BRESCIANINI, D. R. BUTTSWORTH et al. Dec. 1993 131 p
(Contract NAGW-674; RTOP 505-70-62-16)
(NASA-CR-191573; NAS 1.26:191573) Avail: CASI HC A07/MF A02

Reports by the staff of the University of Queensland on various research studies related to the advancement of scramjet technology are presented. These reports document the tests conducted in the reflected shock tunnel T4 and supporting research facilities that have been used to study the injection, mixing, and combustion of hydrogen fuel in generic scramjets at flow conditions typical of hypersonic flight. In addition, topics include the development of instrumentation and measurement technology, such as combustor wall shear and stream composition in pulse facilities, and numerical

studies and analyses of the scramjet combustor process and the test facility operation. This research activity is Supplement 8 under NASA Grant NAGW-674. Author

N94-23634*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE FIFTH ANNUAL THERMAL AND FLUIDS ANALYSIS WORKSHOP
Nov. 1993 533 p Workshop held in Brook Park, OH, 16-20 Aug. 1993; cosponsored by Ohio Aerospace Inst. Original contains color illustrations
(NASA-CP-10122; E-8094; NAS 1.55:10122) Avail: CASI HC A23/MF A04; 5 functional color pages

The Fifth Annual Thermal and Fluids Analysis Workshop was held at the Ohio Aerospace Institute, Brook Park, Ohio, cosponsored by NASA Lewis Research Center and the Ohio Aerospace Institute, 16-20 Aug. 1993. The workshop consisted of classes, vendor demonstrations, and paper sessions. The classes and vendor demonstrations provided participants with the information on widely used tools for thermal and fluid analysis. The paper sessions provided a forum for the exchange of information and ideas among thermal and fluids analysts. Paper topics included advances and uses of established thermal and fluids computer codes (such as SINDA and TRASYS) as well as unique modeling techniques and applications.

N94-23636*# Wright Lab., Wright-Patterson AFB, OH.
AN ENGINEERING CODE TO ANALYZE HYPERSONIC THERMAL MANAGEMENT SYSTEMS
VALERIE J. VANGRIETHUYSEN and CLARK E. WALLACE (Science Applications International Corp., Torrance, CA.) *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 13-26 Nov. 1993
Avail: CASI HC A03/MF A04; 5 functional color pages

Thermal loads on current and future aircraft are increasing and as a result are stressing the energy collection, control, and dissipation capabilities of current thermal management systems and technology. The thermal loads for hypersonic vehicles will be no exception. In fact, with their projected high heat loads and fluxes, hypersonic vehicles are a prime example of systems that will require thermal management systems (TMS) that have been optimized and integrated with the entire vehicle to the maximum extent possible during the initial design stages. This will not only be to meet operational requirements, but also to fulfill weight and performance constraints in order for the vehicle to takeoff and complete its mission successfully. To meet this challenge, the TMS can no longer be two or more entirely independent systems, nor can thermal management be an after thought in the design process, the typical pervasive approach in the past. Instead, a TMS that was integrated throughout the entire vehicle and subsequently optimized will be required. To accomplish this, a method that iteratively optimizes the TMS throughout the vehicle will not only be highly desirable, but advantageous in order to reduce the manhours normally required to conduct the necessary tradeoff studies and comparisons. A thermal management engineering computer code that is under development and being managed at Wright Laboratory, Wright-Patterson AFB, is discussed. The primary goal of the code is to aid in the development of a hypersonic vehicle TMS that has been optimized and integrated on a total vehicle basis. Author (revised)

N94-23644*# Pennsylvania State Univ., Erie. School of Engineering and Engineering Technology.
SOLUTION OF MIXED CONVECTION HEAT TRANSFER FROM ISOTHERMAL IN-LINE FINS
AMIR KHALILOLLAHI *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 127-136 Nov. 1993
Avail: CASI HC A02/MF A04; 5 functional color pages

Transient and steady state combined natural and forced convective flows over two in-line finite thickness fins (louvers) in a vertical channel are numerically solved using two methods. The first method of solution is based on the 'Simple Arbitrary Lagrangian Eulerian' (SALE) technique which incorporates mainly two computational phases: (1) a Lagrangian phase in which the velocity field is updated by the effects of all forces, and (2) an Eulerian phase that executes all advective fluxes of mass, momentum and energy. The second method of solution uses the finite element code entitled FIDAP. In the first part, comparison of the results by FIDAP, SALE, and available experimental work were done and discussed for steady state forced convection over louvered fins. Good agreements were deduced between the three sets of results especially for the flow over a single fin. In the second part and in the absence of experimental literature, the numerical predictions were extended to the transient transports and to the opposing flow where pressure drop is reversed. Results are presented and discussed for heat transfer and pressure drop in assisting and opposing mixed convection flows. Author (revised)

N94-23660*# Clemson Univ., SC. Dept. of Mechanical Engineering.
THE 3-D NUMERICAL STUDY OF AIRFLOW IN THE COMPRESSOR/COMBUSTOR PREDIFFUSER AND DUMP DIFFUSER OF AN INDUSTRIAL GAS TURBINE
AJAY K. AGRAWAL and TAH-TEH YANG *In* NASA. Lewis Research Center, The Fifth Annual Thermal and Fluids Analysis Workshop p 395-409 Nov. 1993
Avail: CASI HC A03/MF A04; 5 functional color pages

This paper describes the 3D computations of a flow field in the compressor/combustor diffusers of an industrial gas turbine. The geometry considered includes components such as the combustor support strut, the transition piece and the impingement sleeve with discrete cooling air holes on its surface. Because the geometry was complex and 3D, the airflow path was divided into two computational domains sharing an interface region. The body-fitted grid was generated independently in each of the two domains. The governing equations for incompressible Navier-Stokes equations were solved using the finite volume approach. The results show that the flow in the prediffuser is strongly coupled with the flow in the dump diffuser and vice versa. The computations also revealed that the flow in the dump diffuser is highly nonuniform. Author

N94-23694*# Technische Hogeschool, Twente (Netherlands). Dept. of Applied Mathematics.
COMPRESSIBLE TURBULENT FLOW SIMULATION WITH A MULTIGRID MULTIBLOCK METHOD
HANS KUERTEN and BERNARD GEURTS *In* NASA. Langley Research Center, The Sixth Copper Mountain Conference on Multigrid Methods, Part 1 p 305-315 Nov. 1993
Avail: CASI HC A03/MF A03

We describe a multigrid multiblock method for compressible turbulent flow simulations and present results obtained from calculations on a two-element airfoil. A vertex-based spatial discretization method and explicit multistage Runge-Kutta time-stepping are used. The slow convergence of a single grid method makes the multigrid method, which yields a speed factor of about 20, indispensable. The numerical predictions are in good agreement with experimental results. It is shown that the convergence of the multigrid process depends considerably on the ordering of the various loops. If the block loop is put inside the stage loop, the process converges more rapidly than if the block loop is situated outside the stage loop when a three-stage Runge-Kutta method is used. If a five-stage scheme is used, the process does not converge in the latter block ordering. Finally, the process based on the five-stage method is about 60 percent more efficient than with the three-stage method, if the block loop is inside the stage loop. Author (revised)

N94-23831* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
MAGNETIC POWER PISTON FLUID COMPRESSOR Patent
MAX G. GASSER, inventor (to NASA) 4 Jan. 1994 9 p Filed 2 Mar. 1993
(NASA-CASE-GSC-13565-1; US-PATENT-5,275,537;

US-PATENT-APPL-SN-024971; US-PATENT-CLASS-417-48; US-PATENT-CLASS-417-50; INT-PATENT-CLASS-F04B-37/00)
Avail: US Patent and Trademark Office

A compressor with no moving parts in the traditional sense having a housing having an inlet end allowing a low pressure fluid to enter and an outlet end allowing a high pressure fluid to exit is described. Within the compressor housing is at least one compression stage to increase the pressure of the fluid within the housing. The compression stage has a quantity of magnetic powder within the housing, is supported by a screen that allows passage of the fluid, and a coil for selectively providing a magnetic field across the magnetic powder such that when the magnetic field is not present the individual particles of the powder are separated allowing the fluid to flow through the powder and when the magnetic field is present the individual particles of the powder pack together causing the powder mass to expand preventing the fluid from flowing through the powder and causing a pressure pulse to compress the fluid.

Official Gazette of the U.S. Patent and Trademark Office

N94-23834*# European Space Agency. European Space Operations Center, Darmstadt (Germany). Mission Operations Dept.

COMMONALITY OF FLIGHT CONTROL SYSTEMS FOR SUPPORT OF EUROPEAN TELECOMMUNICATIONS MISSIONS

KURT DEBATIN *In* JPL, SpaceOps 1992: Proceedings of the Second International Symposium on Ground Data Systems for Space Mission Operations p 7-14 1 Mar. 1993
Avail: CASI HC A02/MF A10

This paper is concerned with the presentation of mission-independent software systems that provide a common software platform to ground data systems for mission operations. The objectives of such common software platforms are to reduce the cost of the development of mission-dedicated software systems and to increase the level of reliability of the ground data systems for mission operations. In accordance with this objective, the Multi-Satellite Support System (MSSS) was developed at the European Space Operations Center (ESOC). Between 1975 and 1992, the MSSS provided support to 16 European Space Agency (ESA) missions, among them very demanding science missions such as GEOS, EXOSAT, and Giotto. The successful support of these missions proved the validity of the MSSS concept with its extended mission-independent platform. This paper describes the MSSS concept and focuses on the wide use of MSSS as a flight control system for geosynchronous telecommunications satellites. Reference is made to more than 15 telecommunications missions that are operated from Western Europe using flight control systems with an underlying MSSS concept, demonstrating the benefits of a commonly used software platform. Finally, the paper outlines the design of the new generation of flight control systems, which is being developed at ESOC for this decade, following a period of more than 15 years of MSSS support. Author (revised)

N94-24034# Able Engineering Co., Inc., Santa Barbara, CA.

A NOVEL ROTARY ACTUATOR FOR SPACECRAFT

P. ALAN JONES, T. JEFFREY HARVEY, and SCOTT F. TIBBITTS (Starsys Research Corp., Boulder, CO.) *In* ESA, The Fifth European Space Mechanisms and Tribology Symposium 5 p Apr. 1993
Copyright Avail: CASI HC A01/MF A04

The design, development and testing of a new rotary actuator model, the AEC Able Engineering (ABLE) Repeatable Rotary Actuator (ARRA) are presented. The ARRA operates under a wide range of both torque and rotation angle. The ARRA system allows the torque and rotation of an individual actuator to be tailored to the specific mission requirements by modification of a single feature on just one part. The ARRA employs a high output parraffin linear actuator to supply linear motion that is converted to rotary motion by means of a tailorable helix cam. The use of a tailorable helix cam allows for the inclusion of multiple hingeline functions into a single mechanism. These functions include variable torque and stowed and deployed latching. This reliable device is one of the least costly controllable bidirectional units available. ESA

N94-24036# ETEL S.A., Motiers (Switzerland).

SENSORLESS, BRUSHLESS MOTOR TO DRIVE A SEALED FREON-AMMONIA PUMP

N. WAVRE *In* ESA, The Fifth European Space Mechanisms and Tribology Symposium 5 p Apr. 1993
Copyright Avail: CASI HC A01/MF A04

The performances of a brushless motor, including sleeve losses and electronic performances, specially designed to drive a sealed pump wheel are presented. Low flow rate pumps with high efficiency are expected for both Columbus and Hermes. The challenge was to design a motor as short as a magnetic coupling and to assemble the rotor directly on the pump wheel subassembly. The use of a new sensorless driver technique was proposed. The electronic driver, the motor and the pump are remarkably efficient for a low power system (30W). The pump assembly is extremely compact. ESA

N94-24055 Societe Nationale Industrielle Aerospatiale, Paris (France).

INTERNAL COMBUSTION ENGINE WITH A CENTRAL CRANKSHAFT AND INTEGRAL TANDEM ANNULAR PISTONS Patent [MOTEUR A COMBUSTION INTERNE A PISTONS ANNULAIRES, EN OPPOSITION ET SOLIDAIRES, ET A ARBRE CENTRAL]

BERNARD ESPARBES, inventor (to Micromedia Ltd.) 3 Aug. 1993 41 p In FRENCH
(CA-PATENT-1-320-878; INT-PATENT-CLASS-F02B-75/26; CTN-94-60928) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

An internal combustion engine with tandem annular pistons and a central crankshaft is disclosed, based on that found in British patent 11027 of 11 May 1914. The piston block formed by the two pistons presents, at each axial extremity, a double axial skirt fitted with an outer crown forming the head of the piston as such, and an inner crown forming an inlet pump with a holding chamber radially located at the inside of the corresponding annular cylinder, in which the piston head delimits a combustion chamber. Radial fingers, crossing axial openings of the crankcase and radial holes of the piston block, have their inner radial ends engaged within wavy sinusoidal peripheral slots arranged in a bulging central portion of the central crankshaft set into rotation by alternating axial movements of the piston block. The admission of fuel or combustion sustaining gas is ensured axially by the extremities, valves, and openings in the end plates closing the holding chambers in which the inner crowns slide, fitted with valves to act as an inlet pump. The invention is particularly applicable to aircraft engines in view of the ease in which the shaft rotation can be adapted to such a use. CISTI

N94-24128 General Electric Co., Fairfield, CT.

SEAL ASSEMBLY Patent

JONATHAN G. SALT, inventor (to General Electric Co.), RONALD W. KORZUN, inventor (to General Electric Co.), and DAVID R. ABBOTT, inventor (to General Electric Co.) 19 Jan. 1993 25 p
(CA-PATENT-163126888; INT-PATENT-CLASS-F16J-15/44; INT-PATENT-CLASS-F012C-7/28; CTN-94-60869) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A unitary annular seal structure is provided for attachment to a turbine nozzle in a gas turbine engine. The nozzle includes an annular platform disposed about a longitudinal axis of the engine. An annular array of vanes is secured to the platform. The seal structure includes an abradable annular seal member, a seal backing member, and a seal attachment ring. The ring includes an annular, radially extending, axially acting spring member positioned to cooperate with a plurality of radially extending tabs on the backing member. In use, the seal structure is positioned within a circular opening within the turbine nozzle. The nozzle includes a radially depending appendage formed as part of the nozzle platform. The spring member abuts one side of the appendage and the tabs are positioned to abut another side of

the appendage for holding the annular spring member in gas sealing engagement with the appendage to thus provide a seal against gas leakage and to restrain the seal structure axially. The spring member and tabs comprise a radially slideable joint for the seal structure. To restrict circumferential motion of the structure, slots are formed in the appendage for receiving the tabs. The seal is easily replaced by bending the tabs and sliding the seal structure axially out of the nozzle. Differential thermal expansion is accommodated by the slideable seal arrangement. CISTI

N94-24136 Defence Research Establishment Pacific, Victoria (British Columbia).
AN EVALUATION OF COMPTON SCATTER IMAGING USING COMSCAN
R. D. FINLAYSON, W. RAMSBOTTOM, and W. R. STURROCK May 1993 44 p
(DREP-TM-93-38; CTN-94-60921) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

A number of test samples, representative of aircraft materials and structures, were evaluated using a commercial x-ray backscatter radiation device called COMSCAN, developed by Philips. COMSCAN produces 22 simultaneous radiographic slices of a test object with only one-sided access. The slices, stored in computer memory, can then be paged through one at a time for viewing. The system has been integrated with a six-axis gantry robot system. During the COMSCAN evaluation, a number of test samples of graphite/epoxy, honeycomb, aluminum, and other low atomic number materials found on today's aircraft were scanned to determine the detectability of a variety of manufactured discontinuities including water in honeycomb, disbonds, delaminations, and corrosion. COMSCAN's ability to image a volume of 100 mm by 50 mm by 10 mm depth was very useful and allowed image display and analysis in both two and three dimensions. The collected images clearly show COMSCAN is well suited for detection of voids and defects where loss of material has occurred, such as corrosion pitting. COMSCAN, however, cannot detect delaminations. Author (CISTI)

N94-24146*# Stanford Univ., CA. Center for Turbulence Research.
LARGE EDDY SIMULATION OF A BOUNDARY LAYER WITH CONCAVE STREAMWISE CURVATURE
THOMAS S. LUND *In its* Annual Research Briefs, 1993 p 91-99 Dec. 1993
Avail: CASI HC A02/MF A04

One of the most exciting recent developments in the field of large eddy simulation (LES) is the dynamic subgrid-scale model. The dynamic model concept is a general procedure for evaluating model constants by sampling a band of the smallest scales actually resolved in the simulation. To date, the procedure has been used primarily in conjunction with the Smagorinsky model. The dynamic procedure has the advantage that the value of the model constant need not be specified a priori, but rather is calculated as a function of space and time as the simulation progresses. This feature makes the dynamic model especially attractive for flows in complex geometries where it is difficult or impossible to calibrate model constants. The dynamic model was highly successful in benchmark tests involving homogeneous and channel flows. Having demonstrated the potential of the dynamic model in these simple flows, the overall direction of the LES effort at CTR shifted toward an evaluation of the model in more complex situations. The current test cases are basic engineering-type flows for which Reynolds averaged approaches were unable to model the turbulence to within engineering accuracy. Flows currently under investigation include a backward-facing step, wake behind a circular cylinder, airfoil at high angles of attack, separated flow in a diffuser, and boundary layer over a concave surface. Preliminary results from the backward-facing step and cylinder wake simulations are encouraging. Progress on the LES of a boundary layer on a concave surface is discussed. Although the geometry of a concave wall is not very complex, the boundary layer that develops on its surface is difficult to model due to the presence of streamwise Taylor-Gortler vortices. These vortices arise as a result of a centrifugal instability associated with the convex curvature. Author (revised)

N94-24160*# Stanford Univ., CA.
NUMERICAL SIMULATION OF NON-NEWTONIAN FREE SHEAR FLOWS
G. M. HOMSY and J. AZAIEZ *In its* Annual Research Briefs, 1993 p 259-268 Dec. 1993
Avail: CASI HC A02/MF A04

Free shear flows, like those of mixing layers, are encountered in aerodynamics, in the atmosphere, and in the ocean as well as in many industrial applications such as flow reactors or combustion chambers. It is, therefore, crucial to understand the mechanisms governing the process of transition to turbulence in order to predict and control the evolution of the flow. Delaying transition to turbulence as far downstream as possible allows a gain in energy expenditure while accelerating the transition can be of interest in processes where high mixing is desired. Various methods, including the use of polymer additives, can be effective in controlling fluid flows. The drag reduction obtained by the addition of small amounts of high polymers has been an active area of research for the last three decades. It is now widely believed that polymer additives can affect the stability of a large variety of flows and that dilute solutions of these polymers have been shown to produce drag reductions of over 80 percent in internal flows and over 60 percent in external flows under a wide range of conditions. The major thrust of this work is to study the effects of polymer additives on the stability of the incompressible mixing layer through large scale numerical simulations. In particular, we focus on the two dimensional flow and examine how the presence of viscoelasticity may affect the typical structures of the flow, namely roll-up and pairing of vortices. Derived from text

N94-24165*# Stanford Univ., CA.
EFFECTS OF SHOCK STRENGTH ON SHOCK TURBULENCE INTERACTION
SANGSAN LEE *In its* Annual Research Briefs, 1993 p 329-345 Dec. 1993
Avail: CASI HC A03/MF A04

Direct numerical simulation (DNS) and linear analysis (LIA) of isotropic turbulence interacting with a shock wave are performed for several upstream shock normal Mach numbers (M(sub 1)). Turbulence kinetic energy (TKE) is amplified across the shock wave, but this amplification tends to saturate beyond M(sub 1) = 3.0. TKE amplification and Reynolds stress anisotropy obtained in DNS are consistent with LIA predictions. Rapid evolution of TKE immediate downstream of the shock wave persists for all shock strengths and is attributed to the transfer between kinetic and potential modes of turbulence energy through acoustic fluctuations. Changes in energy spectra and various length scales across the shock wave are predicted by LIA, which is consistent with DNS results. Most turbulence length scales decrease across the shock. Dissipation length scale (rho-bar q(exp 3) / epsilon), however, increases slightly for shock waves with M(sub 1) less than 1.65. Fluctuations in thermodynamic variables behind the shock wave stay nearly isentropic for M(sub 1) less than 1.2 and deviate significantly from isentropy for the stronger shock waves due to large entropy fluctuation generated through the interaction. Author (revised)

N94-24175# Lockheed Corp., Burbank, CA.
FLUSH HEAD FASTENER Patent
CHARLES R. SMITH, inventor (to Lockheed), ANTHONY E. BRINDISI, inventor (to Lockheed), and GERALD W. TYREE, inventor (to Lockheed) 13 Oct. 1992 25 p
(CA-PATENT-1308581; INT-PATENT-CLASS-F16B-19/00; INT-PATENT-CLASS-F16B-31/00; CTN-94-60872) Copyright
Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A flush head fastener is provided for joining two or more structural elements together, each element having a fastener hole

with a recess for receiving the fastener head in communication with one surface of the structural elements. The fastener comprises a shank, a head joined to the shank, and a layer of non-resilient material permanently joined to and generally covering the entire top surface of the fastener. This layer is readily reconfigurable relative to the fastener head and the structural elements such that upon installation of the fastener in the hole, the layer can be reshaped by deformation, filling any gap between the head, the layer of material of the fastener, and the recessed end of the hole. Excess material above that needed to blend the layer of material into substantial conformity with the one surface of the structural elements can be easily removed. The fastener of the invention is capable of producing an aerodynamically smooth external surface, even when the surface is curved, and can be used with both metal and composite materials. The fastener produces no electrical discontinuities on the surface after installation. The fastener of the invention is especially intended for use in fastening aerodynamic surfaces of aircraft onto the underlying structural elements. CISTI

N94-24177 Laval Univ. (Quebec). Ecole des Gradues.
EXPERIMENTAL STUDY OF A TURBULENT BOUNDARY LAYER IN PRESENCE OF EXTERNAL MANIPULATORS OF NACA 0009 PROFILE IN THE TRANSONIC REGIME M.S. Thesis [ETUDE EXPERIMENTALE D'UNE COUCHE LIMITE TURBULENTE EN PRESENCE DE MANIPULATEURS EXTERNES DE PROFIL NACA 0009 EN REGIME TRANSSONIQUE]
DIANE POIRIER May 1990 293 p In FRENCH
(ISBN-0-315-57633-2; CTN-94-60874) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

An experimental study was conducted to determine the effectiveness of manipulators of external-type turbulence on the reduction of wall drag in a turbulent boundary layer in the transonic regime. The manipulators used, NACA 0009 thin profile type, have an aerodynamic behavior inappropriate for this type of application. Flow visualizations show that the flow on the manipulator is complex, with regions of separation, as well as recirculation, and that the wake of the manipulator is sometimes very unstable. Some of such behavior may be the origin of the high levels of drag encountered and adversely affects the effectiveness of this method in the sense of net balance. The analysis of the average velocity profiles, downstream of the single manipulator, does not permit reaching definitive quantitative conclusions since it leads to abnormally high reductions of the coefficient of wall drag, due apparently to the presence of a longitudinal pressure gradient which was not considered in the equation of motion. CISTI

N94-24246 MacNeal-Schwendler Corp., Gouda (Netherlands).
THE PLASTIC RESPONSE OF A CYLINDRICAL SHELL SUBJECTED TO AN INTERNAL BLAST WAVE WITH A FINITE WIDTH SHOCK FRONT
Y. KIVITY, C. FLORIE, and H. LENSELINK *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 89-102 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

This paper considers the plastic deformation of a thin cylindrical shell subjected to an internal explosion. It is assumed that the explosive charge is placed on the axis of symmetry of the shell so that an axisymmetric blast wave is produced. The shell response is calculated assuming an elastic-perfectly plastic material. The plastic response is evaluated for two types of loads. In the first type, the blast is assumed to have an ideal shock front with a discontinuous jump to the peak pressure. In the second type of loading, the shock front has a finite rise-time. This type of loading was introduced to study the effect of finite width shock fronts. Such finite width shock fronts are typical of hydrocode calculations when simulating problems involving blast waves and their interactions with adjacent structures. It is found that for equal impulse loads, the numerical rise-time reduces the shell plastic response significantly. Numerical calculations with a three-dimensional hydrocode are presented to illustrate the analytical results. A generalization of the analysis is given which may be used to determine the required mesh resolution of a hydrocode calculation in order to obtain a prescribed accuracy in the shell response. ISA

N94-24249 Israel Aircraft Industries Ltd., Tashan. Aerodynamics Dept.
NEW FEATURES IN COMPUTATIONAL FLUID DYNAMICS (CFD) TECHNOLOGY AT THE TASHAN ENGINEERING CENTER AT IAI
B. EPSTEIN *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 125-132 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The presentation gives an overview of CFD (computational fluid dynamics) activities at the TASHAN Engineering Center of Israel Aircraft Industries (TECIAI), emphasizing new features in CFD technology. The first part starts with the description of purposes of industrial CFD at TECIAI. It then introduces the main codes developed 'in-house' during 1977-92, and explains the use of CFD codes in a typical cycle of CFD-aided aircraft design. The second part is devoted to state-of-the-art CFD technology with a number of typical applications given. Applications include complete aircraft analysis by a Multigrid Euler Code and incompressible 2-D Navier-Stokes calculations. ISA

N94-24260 Israel Aircraft Industries Ltd., Ben-Gurion Airport.
POST BUCKLING BEHAVIOUR OF STIFFENED COMPOSITE PANELS LOADED IN CYCLIC COMPRESSION AND SHEAR
A. SEGAL, Y. FROSTIG, D. SHALEV, T. WELLER (Technion - Israel Inst. of Tech., Haifa.), and Y. SHEINMAN (Technion - Israel Inst. of Tech., Haifa.) *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 225-236 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

This paper presents the summary of a multiphase experimental - analytical study of the post-buckling mechanical behavior of a graphite/epoxy integrally stiffened panel. The first phase of the study included cyclic compression tests in the post-buckling regime of flat panels stiffened by either 'I' or 'J' shaped stiffeners. Static residual strength of the panels after 250,000 cycles was greater than the reference strength; however, some stiffness loss was observed. A series of tests of individual stiffeners, identical to those in the panels, was also carried out and the results showed the same trends as had been observed in the panels. There were no cases of early failure during the cyclic tests. The second phase included an experimental study of the post-buckling behavior of cylindrical panels integrally stiffened in the axial and transverse directions. Panels were tested in cyclic compression, cyclic torsion, and in combinations of both. The panels were stressed through 40,000 cycles, damage was inflicted, and an additional 40,000 cycles were imposed. No damage development was observed. The third phase of the study included an analytical effort for the development of a computer code, PBCOMP, for the buckling and post-buckling analysis of stiffened laminated flat and curved panels. The results of this study clearly show a great potential for the safe use of stiffened graphite/epoxy panels in aircraft structures. ISA

N94-24276 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
MEAN STRESS MODELS FOR LOW CYCLE FATIGUE OF A NICKEL-BASE SUPERALLOY
DAINING FANG and AVRAHAM BERKOVITZ *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 374-386 25 Feb. 1993 Supported in part by Rolls-Royce Ltd., Derby, England

 Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The aim of this study was to relate observed Low Cycle Fatigue responses under asymmetric loading to mean-stress effects on the cyclic behavior and fatigue life of nickel-base Incoloy 901 superalloy at room temperature. Based on experimental data, a mean-stress-relaxation of mean-stress on the total strain range and on cyclic plasticity. It was found that cyclic softening and mean-stress relaxation began when plastic strain started to develop, and increased in importance with increasing strain range. Both depended on the plastic strain range rather than on monotonic plastic deformation. For any given strain ratio, there was a value of strain range corresponding to peak mean stress sustained. Beyond this strain range, mean stress relaxation began. A mean-stress strength constant, representing the apex on the sigma(sub m) axis of the Goodman diagram, was introduced in order to modify the Goodman criterion, resulting in a modified strain-life relation. Both the mean-stress-relaxation model and the strain-life model were evaluated against LCF testing data. ISA

N94-24289 Ottawa Univ. (Ontario). Faculty of Engineering.
ON THE DEFORMATION KINETICS CONSTITUTIVE LAW OF PLASTIC DEFORMATION: THE RATE EQUATION
A. S. KRAUSZ and K. KRAUSZ *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 502-510 25 Feb. 1993 Sponsored by Natural Sciences and Engineering Research Council of Canada
 Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The extensively used empirical models of plastic deformation, the sinh and power function law relations, are valid only in a limited range and are not suitable for extrapolation. At low stresses, the sinh either overestimates or greatly underestimates the strain rate. The power function relation, being the tangent of the logarithm of strain rate vs. logarithm of stress plot, is a fair approximation near to the inflexion point only. The constitutive law of plastic deformation provides a rigorous expression that describes the behavior of solids under the effects of both the applied stress and the temperature, for the full range of the applied stress. ISA

N94-24356*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE RADIATED NOISE FROM ISOTROPIC TURBULENCE REVISITED Final Report
GEOFFREY M. LILLEY Dec. 1993 56 p Submitted for publication
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191547; ICASE-93-75; NAS 1.26:191547) Avail: CASI HC A04/MF A01

The noise radiated from isotropic turbulence at low Mach numbers and high Reynolds numbers, as derived by Proudman (1952), was the first application of Lighthill's Theory of Aerodynamic Noise to a complete flow field. The theory presented by Proudman involves the assumption of the neglect of retarded time differences and so replaces the second-order retarded-time and space covariance of Lighthill's stress tensor, Tij, and in particular its second time derivative, by the equivalent simultaneous covariance. This assumption is a valid approximation in the derivation of the second partial derivative of Tij/derivative of t exp 2 covariance at low Mach numbers, but is not justified when that covariance is reduced to the sum of products of the time derivatives of equivalent second-order velocity covariances as required when Gaussian statistics are assumed. The present paper removes these assumptions and finds that although the changes in the analysis are substantial, the change in the numerical result for the total acoustic power is small. The present paper also considers an alternative analysis which does not neglect retarded times. It makes use of the Lighthill relationship, whereby the fourth-order Tij retarded-time covariance is evaluated from the square of similar second order covariance, which is assumed known. In this derivation, no statistical assumptions are involved. This result, using distributions for the second-order space-time velocity squared covariance based on the Direct Numerical Simulation (DNS) results of both Sarkar and Hussaini(1993) and Dubois(1993), is compared with the re-evaluation of Proudman's original model. These results are then compared with the sound power derived from a phenomenological model based on simple approximations to the retarded-time/space covariance of Txx. Finally, the recent numerical solutions of Sarkar and Hussaini(1993) for the acoustic power are compared with the results obtained from the analytic solutions. Author (revised)

N94-24360*# Northrop Corp., Hawthorne, CA. Electronics Systems Div.
DOPPLER GLOBAL VELOCIMETRY: DEVELOPMENT OF A FLIGHT RESEARCH INSTRUMENTATION SYSTEM FOR APPLICATION TO NON-INTRUSIVE MEASUREMENTS OF THE FLOW FIELD Final Report
HIROSHI KOMINE, STEPHEN J. BROSNAN, WILLIAM H. LONG, and EDDY A. STAPPAERTS 26 Jan. 1994 54 p Original contains color illustrations
(Contract NAS1-19440; RTOP 505-59-10-09)
(NASA-CR-191490; NAS 1.26:191490) Avail: CASI HC A04/MF A01; 4 functional color pages

Doppler Global Velocimetry (DGV) is a new diagnostic tool that offers potential for flow field measurements in flight by acquiring three-component velocity data in near real-time during flight maneuvers. The feasibility of implementation of a flight DGV system aboard NASA's High-Angle-of-Attack Research Vehicle (HARV) was addressed in this work by identifying the essential characteristics of a flight measurement system and by performing calibration and error tests. Results from this work were: an outline that establishes a preliminary basis for system configurations by analyzing measurement errors, installation issues, and operating requirements; measurement of the accuracy of the DGV technique using a laboratory breadboard DGV system based on a frequency-doubled Nd: YAG laser and iodine Absorption Line Filter (ALF), which showed excellent agreement between the DGV data and pilot measurements on a laminar flow jet with velocities of up to 150 m/sec; a survey of DGV system components and technologies that are relevant to the design of a flight measurement system, including a survey of cameras for the next generation DGV receivers; an assessment of the candidate lasers and absorption line filters for the flight system, resulting in a near-term recommendation of Nd: host lasers and an iodine ALF for both flight and wind tunnel applications. Author (revised)

N94-24362*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IMPROVED PRESSURE MEASUREMENT SYSTEM FOR CALIBRATION OF THE NASA LERC 10X10 SUPERSONIC WIND TUNNEL
PHILIP Z. BLUMENTHAL (Sverdrup Technology, Inc., Brook Park, OH.) and STEPHEN M. HELLAND Jan. 1994 16 p Proposed for presentation at the 40th International Instrumentation Symposium, Baltimore, MD, 1-5 May 1994; sponsored by the Instrument Society of America
(Contract NAS3-25266; RTOP 505-62-84)
(NASA-TM-106470; E-8338; NAS 1.15:106470) Avail: CASI HC A03/MF A01

This paper discusses a method used to provide a significant improvement in the accuracy of the Electronically Scanned Pressure (ESP) Measurement System by means of a fully automatic floating pressure generating system for the ESP calibration and reference pressures. This system was used to obtain test section Mach number and flow angularity measurements over the full envelope of test conditions for the 10 x 10 Supersonic Wind Tunnel. The uncertainty analysis and actual test data demonstrated that, for most test conditions, this method could reduce errors to about one-third to one-half that obtained with the standard system.
Author (revised)

N94-24440*# Texas A&M Univ., College Station. Mechanical Engineering Dept.
SIMULATION OF CRYOGENIC TURBOPUMP ANNULAR SEALS
ALAN B. PALAZZOLO *In* Alabama Univ., The 1993 NASA/ASEE Summer Faculty Fellowship Program 5 p Nov. 1993
Avail: CASI HC A01/MF A03

San Andres employed the NBS software package MIPROPS to account for density's dependence on pressure in the simulation of liquid annular seals. His example on a LH2 seal showed a significant change in the mass coefficient compared to a constant density model. San Andres, Yang, and Childs extended this analysis by including the pressure and temperature dependence of density, specific heat, viscosity, volumetric expansion, and thermal conductivity in a coupled solution of the energy, momentum, and continuity equations. Their example showed very significant changes in stiffness and inertia for a high speed (38,000 rpm), large L/D ratio (0.5) LOX seal, as compared to their constant temperature results. The current research rederived the San Andres-Yang-Childs (SYC) analysis and extended it to include not only the Moody friction model of SYC but also the Hir's friction model. The derivation begins with obtaining the local differential equations of continuity, momentum, and energy conservation in the seal. These equations are averaged across the film thickness to obtain the resulting 'bulk flow' differential equations. Shear stress and convective heat loss through the stator (seal) and rotor are related to the Moody and Hir's friction factor model. The Holman analogy is employed to relate heat conduction in or out of the fluid film's boundary layer to the friction induced shear stress.
Derived from text

N94-24478# Instituut TNO voor Bouwmaterialen en Bouwconstructies, Delft (Netherlands).
HYDRO-ELASTIC ANALYSIS USING A SELECTION OF COMMERCIAL ANALYSIS PROGRAMS Final Report No. 2
1993 70 p *Sponsored by Stichting Coordinatie Maritiem* Onderzoek, Rotterdam, The Netherlands
(PB94-118734; TNO-93-CMC-R0210-2) Copyright Avail: CASI HC A04/MF A01

It has been investigated whether and how a number of commercial finite element software systems can be used for predicting the response of a ship hull to excitation by a cavitating propeller. In this typical fluid-structure interaction problem, the cavitating propeller is represented as a monopole source. The software systems considered in this study are DIANA, MSC/NASTRAN, SYSNOISE, ABAQUS, and USA-CODE. For calculating the response for the frequency range of interest, it is sufficient to model the surrounding water by an incompressible fluid without free surface waves and radiation damping. It is shown how to model a monopole in a finite element response analysis if the system does not allow for a direct input of a monopole. It is found that software which uses boundary elements for describing the fluid domain is strongly preferable in this type of analysis. This saves the laborious work required for 3D meshing of the fluid domain and hence makes 3D response analyses of ship hulls feasible. For a two dimensional test case, results obtained with different software systems showed large deviations compared to each other and to an analytical solution. NTIS

N94-24481*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STAGNATION REGION HEAT TRANSFER: THE INFLUENCE OF TURBULENCE PARAMETERS, REYNOLDS NUMBER AND BODY SHAPE
G. JAMES VANFOSSEN and ROBERT J. SIMONEAU Feb. 1994 17 p Prepared for presentation at the 6th AIAA/ASME Thermophysics and Heat Transfer Conference, Colorado Springs, CO, 20-23 Jun. 1994; sponsored by AIAA, and ASME
(Contract RTOP 505-62-52)
(NASA-TM-106504; E-8534; NAS 1.15:106504) Avail: CASI HC A03/MF A01

The effect of velocity gradient on stagnation region heat transfer augmentation by free stream turbulence was investigated. Heat transfer was measured in the stagnation region of four models with elliptical leading edges with ratios of major to minor axes of 1:1, 1.5:1, 2.25:1, and 3:1. Four geometrically similar, square bar, square mesh, biplane grids were used to generate free stream turbulence with different intensities and length. Heat transfer measurements were made for the following ranges of parameters: Reynolds number, based on leading edge diameter, 37,000 to 228,000; dimensionless leading edge velocity gradient, 1.20 to 1.80; turbulence intensity, 1.1 to 15.9%; and length scale to leading edge diameter ratio, 0.05 to 0.30. Stagnation point heat transfer augmentation by free stream turbulence can be predicted using a modified version of a previously developed correlation for a circular leading edge. Heat transfer augmentation was independent of body shape at the stagnation point. The heat transfer distribution down-stream from the stagnation point can be predicted using the normalized laminar heat transfer distribution. Author

N94-24495*# *National Aeronautics and Space Administration.* Hugh L. Dryden Flight Research Facility, Edwards, CA.
THERMAL-FLUID ANALYSIS OF THE FILL AND DRAIN OPERATIONS OF A CRYROGENIC FUEL TANK
CRAIG A. STEPHENS (Planning Research Corp., Edwards, CA.), GREGORY J. HANNA (Hanna Technology Resources, Boulder, CO.), and LESLIE GONG Washington Dec. 1993 20 p Presented at the SEM Structural Testing Technology at High Temperature 2 Conference, Ojai, CA, 8-10 Nov. 1993
(Contract RTOP 505-70-63)
(NASA-TM-104273; H-1961; NAS 1.15:104273) Avail: CASI HC A03/MF A01

The Generic Research Cryogenic Tank was designed to establish techniques for testing and analyzing the behavior of reusable fuel tank structures subjected to cryogenic fuels and aerodynamic heating. The Generic Research Cryogenic Tank tests will consist of filling a pressure vessel to a prescribed fill level, waiting for steady-state conditions, then draining the liquid while heating the external surface to simulate the thermal environment associated with hypersonic flight. Initial tests of the Generic Research Cryogenic Tank will use liquid nitrogen with future tests requiring liquid hydrogen. Two-dimensional finite-difference thermal-fluid models were developed for analyzing the behavior of the Generic Research Cryogenic Tank during fill and drain operations. The development and results of the two-dimensional fill and drain models, using liquid nitrogen, are provided, along with results and discussion on extrapolating the model results to the operation of the full-size Generic Research Cryogenic Tank. These numerical models provided a means to predict the behavior of the Generic Research Cryogenic Tank during testing and to define the requirements for the Generic Research Cryogenic Tank support systems such as vent, drain, pressurization, and instrumentation systems. In addition, the fill model provided insight into the unexpected role of circumferential conduction in cooling the Generic Research Cryogenic Tank pressure vessel during fill operations. Author

N94-24640*# California Polytechnic State Univ., San Luis Obispo.
IMPLEMENTATION OF THE BALDWIN-BARTH TURBULENCE MODEL INTO THE ZETA CODE AND ITS DIAGNOSIS M.S. Thesis
SCOTT L. LOW 16 Jun. 1993 112 p Original contains color illustrations
(Contract NCA2-722)
(NASA-CR-194795; NAS 1.26:194795) Copyright Avail: CASI HC A06/MF A02; 14 functional color pages

The Baldwin-Barth turbulence model was implemented into Zeta, a time-accurate, zonal, integro-differential code for incompressible laminar and turbulent flows. The implementation procedure is patterned after the model subroutine in ARC2D. The results of ZETA with the Baldwin-Barth turbulence model were compared with experimental data, with ZETA using Baldwin-Lomax model, and with ARC2D using the Baldwin-Barth model. The Baldwin-Barth model subroutine was tested by inputting an ARC2D velocity solution of an NACA-0012 airfoil at R(sub e) = 3.9 x 10(exp 6) and alpha = 5 deg. The resultant turbulent viscosity

and Reynolds stresses compared favorably with the original data. For the same grid having grid points inside the laminar sublayer, which is necessary due to the one-equation nature of the model, ZETA however predicts early separation. It was found that the current ZETA has problem with such a fine grid. Further work is in progress to solve this problem. Author

N94-24699*# Arizona State Univ., Tempe. Telecommunications Research Center.
ADVANCED ELECTROMAGNETIC METHODS FOR AEROSPACE VEHICLES Semiannual Progress Report, 1 Jul. - 31 Dec. 1993
CONSTANTINE A. BALANIS, WEIMIN SUN, EL-BUDAWY EL-SHARAWY, JAMES T. ABERLE, CRAIG R. BIRTCHER, JIAN PENG, PANAYIOTIS A. TIRKAS, WILLIAM V. ANDREW, DAVID KOKOTOFF, and FRANK ZAVOSH 1993 97 p
(Contract NAG1-1082)
(NASA-CR-195111; NAS 1.26:195111; TRC-EM-CAB-9401)
Avail: CASI HC A05/MF A02

The Advanced Helicopter Electromagnetics (AHE) Industrial Associates Program has fruitfully completed its fourth year. Under the support of the AHE members and the joint effort of the research team, new and significant progress has been achieved in the year. Following the recommendations by the Advisory Task Force, the research effort is placed on more practical helicopter electromagnetic problems, such as HF antennas, composite materials, and antenna efficiencies. In this annual report, the main topics to be addressed include composite materials and antenna technology. The research work on each topic has been driven by the AHE consortium members' interests and needs. The remarkable achievements and progresses in each subject is reported respectively in individual sections of the report. The work in the area of composite materials includes: modeling of low conductivity composite materials by using Green's function approach; guidelines for composite material modeling by using the Green's function approach in the NEC code; development of 3-D volume mesh generator for modeling thick and volumetric dielectrics by using FD-TD method; modeling antenna elements mounted on a composite Comanche tail stabilizer; and antenna pattern control and efficiency estimate for a horn antenna loaded with composite dielectric materials. Derived from text

N94-24751*# Auburn Univ., AL. Dept. of Mechanical Engineering.
INFLUENCE OF BACKUP BEARINGS AND SUPPORT STRUCTURE DYNAMICS ON THE BEHAVIOR OF ROTORS WITH ACTIVE SUPPORTS Semiannual Status Report
GEORGE T. FLOWERS Feb. 1994 9 p
(Contract NAG3-1507)
(NASA-CR-195106; NAS 1.26:195106) Avail: CASI HC A02/MF A01

Substantial progress has been made toward the goals of this research effort in the past six months. A simplified rotor model with a flexible shaft and backup bearings has been developed. The model is based upon the work of Ishii and Kirk. Parameter studies of the behavior of this model are currently being conducted. A simple rotor model which includes a flexible disk and bearings with clearance has been developed and the dynamics of the model investigated. The study consists of simulation work coupled with experimental verification. The work is documented in the attached paper. A rotor model based upon the T-501 engine has been developed which includes backup bearing effects. The dynamics of this model are currently being studied with the objective of verifying the conclusions obtained from the simpler models. Parallel simulation runs are being conducted using an ANSYS based finite element model of the T-501. Derived from text

13

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

N94-23704# Sandia National Labs., Albuquerque, NM.
CONTROL ALGORITHMS FOR EFFECTIVE OPERATION OF VARIABLE-SPEED WIND TURBINES
Oct. 1993 45 p
(Contract DE-AC04-94AL-85000)
(DE94-002607; SAND-90-7112) Avail: CASI HC A03/MF A01

This report describes a computer code, called ASYM, and provides results from its application in simulating the control of the 34-m Test Bed vertical-axis wind turbine (VAWT) in Bushland, Texas. The code synthesizes dynamic wind speeds on a second-by-second basis in the time domain. The wind speeds conform to a predetermined spectral content governed by the hourly average wind speed that prevails at each hour of the simulation. The hourly average values are selected in a probabilistic sense through the application of Markov chains, but their cumulative frequency of occurrence conforms to a Rayleigh distribution that is governed by the mean annual wind speed of the site selected. The simulated wind speeds then drive a series of control algorithms that enable the code to predict key operational parameters such as number of annual starts and stops, annual energy production, and annual fatigue damage at a critically stressed joint on the wind turbine. This report also presents results from the application of ASYM that pertain to low wind speed cut-in and cut-out conditions and controlled operation near critical speed ranges that excite structural vibrations that can lead to accelerated fatigue damage. DOE

N94-24104*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE ATMOSPHERIC EFFECTS OF STRATOSPHERIC AIRCRAFT: A THIRD PROGRAM REPORT
RICHARD S. STOLARSKI, ed. and HOWARD L. WESOKY, ed. (National Aeronautics and Space Administration, Washington, DC.) Washington NASA Nov. 1993 405 p
(NASA-RP-1313; NAS 1.61:1313) Avail: CASI HC A18/MF A04

A third report from the Atmospheric Effects of Stratospheric Aircraft (AESA) component of NASA's High-Speed Research Program (HSRP) is presented. Market and technology considerations continue to provide an impetus for high-speed civil transport research. A recent United Nations Environment Program scientific assessment showed that considerable uncertainty still exists about the possible impact of aircraft on the atmosphere. The AESA was designed to develop the body of scientific knowledge necessary for the evaluation of the impact of stratospheric aircraft on the atmosphere. The first Program report presented the basic objectives and plans for AESA. This third report marks the midpoint of the program and presents the status of the ongoing research on the impact of stratospheric aircraft on the atmosphere as reported at the third annual AESA Program meeting in June 1993. The focus of the program is on predicted atmospheric changes resulting from projected HSCT emissions. Topics reported on cover how high-speed civil transports (HSCT) might affect stratospheric ozone, emissions scenarios and databases to assess potential atmospheric effects from HSCT's, calculated results from 2-D zonal mean models using emissions data, engine trace constituent measurements, and exhaust plume/aircraft wake vortex interactions. Author (revised)

N94-24380*# National Center for Atmospheric Research, Boulder, CO.
AVIATION WEATHER PROGRAM (AWP)
BRANT FOOTE *In* NASA. Goddard Space Flight Center, Report

of the Proceedings of the Colloquium and Workshop on Multiscale Coupled Modeling p 11 Jun. 1993
Avail: CASI HC A01/MF A02

The Aviation Weather Program (AWP) combines additional weather observations, improved forecast technology, and more efficient distribution of information to pilots, controllers, and automated systems to improve the weather information provided to the air traffic control system, pilots, and other users of aviation weather information. Specific objectives include the needs to: improve airport and en-route capacity by accurate, high resolution, timely forecasts of changing weather conditions affecting airport and en-route operations; improve analyses and forecasts of upper-level winds for efficient flight planning and traffic management; and increase flight safety through improved aviation weather hazard forecasting (e.g. icing, turbulence, severe storms, microbursts, or strong winds). The AWP would benefit from participation in a cooperative multiscale experiment by obtaining data for: evaluation of aviation weather forecast products, analysis of four dimensional data assimilation schemes, and experimental techniques for retrieving aerosol and other visibility parameters. A multiscale experiment would also be helpful to AWP by making it possible to evaluate the added benefit of enhanced data sets collected during the experiment on those forecast and analysis products. The goals of the Coperative Multiscale Experiment (CME) are an essential step in attaining the long-term AWP objective of providing two-to-four hour location-specific forecasts of significant weather. Although the possibility of a funding role for the AWP in the CME is presently unclear, modest involvement of Federal Aviation Administration (FAA)/AWP personnel could be expected.
Derived from text

15

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.

N94-23252*# Boeing Defense and Space Group, Seattle, WA.
TOWARDS THE FORMAL SPECIFICATION OF THE REQUIREMENTS AND DESIGN OF A PROCESSOR INTERFACE UNIT: HOL LISTINGS
DAVID A. FURA, PHILLIP J. WINDLEY (Idaho Univ., Moscow.), and GERALD C. COHEN Nov. 1993 247 p
(Contract NAS1-18586; RTOP 505-64-10-07)
(NASA-CR-191465; NAS 1.26:191465) Avail: CASI HC A11/MF A03

This technical report contains the HOL listings of the specification of the design and major portions of the requirements for a commercially developed processor interface unit (or PIU). The PIU is an interface chip performing memory interface, bus interface, and additional support services for a commercial microprocessor within a fault-tolerant computer system. This system, the Fault-Tolerant Embedded Processor (FTEP), is targeted towards applications in avionics and space requiring extremely high levels of mission reliability, extended maintenance-free operation, or both. This report contains the actual HOL listings of the PIU specification as it currently exists. Section two of this report contains general-purpose HOL theories that support the PIU specification. These theories include definitions for the hardware components used in the PIU, our implementation of bit words, and our implementation of temporal logic. Section three contains the HOL listings for the PIU design specification. Aside from the PIU internal bus (I-Bus), this specification is complete. Section four contains the HOL listings for a major portion of the PIU requirements specification. Specifically, it contains most of the definition for the PIU behavior associated with memory accesses initiated by the local processor. Derived from text

N94-23332*# Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
A RELIABLE ALGORITHM FOR OPTIMAL CONTROL SYNTHESIS Final Technical Report, Jan. 1991 - Dec. 1992
BRETT VANSTEENWYK and UY-LOI LY 1992 178 p
(Contract NAG2-691)
(NASA-CR-194809; NAS 1.26:194809) Avail: CASI HC A09/MF A02

In recent years, powerful design tools for linear time-invariant multivariable control systems have been developed based on direct parameter optimization. In this report, an algorithm for reliable optimal control synthesis using parameter optimization is presented. Specifically, a robust numerical algorithm is developed for the evaluation of the H(sup 2)-like cost functional and its gradients with respect to the controller design parameters. The method is specifically designed to handle defective degenerate systems and is based on the well-known Pade series approximation of the matrix exponential. Numerical test problems in control synthesis for simple mechanical systems and for a flexible structure with densely packed modes illustrate positively the reliability of this method when compared to a method based on diagonalization. Several types of cost functions have been considered: a cost function for robust control consisting of a linear combination of quadratic objectives for deterministic and random disturbances, and one representing an upper bound on the quadratic objective for worst case initial conditions. Finally, a framework for multivariable control synthesis has been developed combining the concept of closed-loop transfer recovery with numerical parameter optimization. The procedure enables designers to synthesize not only observer-based controllers but also controllers of arbitrary order and structure. Numerical design solutions rely heavily on the robust algorithm due to the high order of the synthesis model and the presence of near-overlapping modes. The design approach is successfully applied to the design of a high-bandwidth control system for a rotorcraft. Author

N94-24122 Defence Research Establishment Pacific, Victoria (British Columbia).
A COLOUR IMAGE PROCESSING ALGORITHM TO IDENTIFY COPPER-BASED PARTICLES IN FILTER DEBRIS SAMPLES
K. K. YEUNG, G. A. LUOMA, and A. J. MCKENZIE Mar. 1993 27 p
(DREP-TM-93-19; CTN-94-60918) Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

In oil-wetted aircraft machinery fitted with coarse filtration systems, sufficient fine particulate wear debris passes through the filter to enable meaningful spectrometric oil analysis (SOA) of the oil sample debris for off-line condition monitoring. The use of fine filters in F404 engines has severely limited the usefulness of oil analysis techniques because the filters remove almost all the debris of significance. Filter debris analysis (FDA) has been developed as an alternative off-line monitoring procedure for those engines. FDA can also supplement conventional oil analysis for condition monitoring of machinery with coarse filtration by evaluating the accumulated wear debris generated between filter changes. The method has been very successful at predicting wear anomalies and is being adopted into the routine maintenance procedures for selected machinery. The main drawbacks of FDA are that it is time consuming, manpower intensive, and prone to subjective interpretation. The use of computer-aided image analysis to interpret filter debris is being investigated with the goal of incorporating FDA results into an expert system for condition monitoring. Results of image capture and interpretation of FDA are presented, and implications of these developments on condition monitoring of oil-wetted machinery are discussed. Author (CISTI)

N94-24262 Israel Aircraft Industries Ltd., Tashan.
COMPUTER BASED EXPERT SYSTEM FOR BATTLE DAMAGE REPAIR OF COMPOSITE STRUCTURES
S. GALI, Z. KARUCHRO, D. NAOR, I. KRESSEL, H. LEBOVITZ, J. BARON (Israeli Air Force, Zahal.), and J. GERRASSY (Israeli Air Force, Zahal.) *In* Israel Society of Aeronautics and

Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 246-250 25 Feb. 1993
Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The computerized system, REPCOMP, developed for damage repair of composite structures, is an expert system for the design of damage repair. REPCOMP provides detailed repair instructions and drawings, taking into consideration strength and stiffness requirements as well as aerodynamics, weight, and other design considerations. The REPCOMP expert system is being developed for the two major paths in damage repair of composite structures, which are: permanent damage repair, suitable for long-term use in civil and military aircraft, and A/C battle damage repair (ABDR), suitable for field repair of military aircraft during battle. REPCOMP operates on a portable computer (pc), using the Microsoft Windows graphical environment. It is an independent system and can be used in any field repair base. Currently the program handles the ABDR path. ISA

N94-24445*# Texas A&I Univ., Kingsville. Dept. of Electrical Engineering and Computer Science.
EVALUATION OF THE EFFICIENCY AND FAULT DENSITY OF SOFTWARE GENERATED BY CODE GENERATORS
BARBARA SCHREUR *In* Alabama Univ., The 1993 NASA/ASEE Summer Faculty Fellowship Program 4 p Nov. 1993
Avail: CASI HC A01/MF A03

Flight computers and flight software are used for GN&C (guidance, navigation, and control), engine controllers, and avionics during missions. The software development requires the generation of a considerable amount of code. The engineers who generate the code make mistakes and the generation of a large body of code with high reliability requires considerable time. Computer-aided software engineering (CASE) tools are available which generates code automatically with inputs through graphical interfaces. These tools are referred to as code generators. In theory, code generators could write highly reliable code quickly and inexpensively. The various code generators offer different levels of reliability checking. Some check only the finished product while some allow checking of individual modules and combined sets of modules as well. Considering NASA's requirement for reliability, an in house manually generated code is needed. Furthermore, automatically generated code is reputed to be as efficient as the best manually generated code when executed. In house verification is warranted.
Derived from text

N94-24463*# Boeing Defense and Space Group, Seattle, WA.
TOWARDS THE FORMAL SPECIFICATION OF THE REQUIREMENTS AND DESIGN OF A PROCESSOR INTERFACE UNIT
DAVID A. FURA, PHILLIP J. WINDLEY (Idaho Univ., Moscow.), and GERALD C. COHEN Dec. 1993 90 p
(Contract NAS1-18586; RTOP 505-64-10-07)
(NASA-CR-4521; NAS 1.26:4521) Avail: CASI HC A05/MF A01

Work to formally specify the requirements and design of a Processor Interface Unit (PIU), a single-chip subsystem providing memory interface, bus interface, and additional support services for a commercial microprocessor within a fault-tolerant computer system, is described. This system, the Fault-Tolerant Embedded Processor (FTEP), is targeted towards applications in avionics and space requiring extremely high levels of mission reliability, extended maintenance free operation, or both. The approaches that were developed for modeling the PIU requirements and for composition of the PIU subcomponents at high levels of abstraction are described. These approaches were used to specify and verify a nontrivial subset of the PIU behavior. The PIU specification in Higher Order Logic (HOL) is documented in a companion NASA contractor report entitled 'Towards the Formal Specification of the Requirements and Design of a Processor Interfacs Unit - HOL Listings.' The subsequent verification approach and HOL listings are documented in NASA contractor report entitled 'Towards the Formal Verification of the Requirements and Design of a Processor Interface Unit' and NASA contractor report entitled 'Towards the Formal Verification of the Requirements and Design of a Processor Interface Unit - HOL Listings.' Author (revised)

16

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.

N94-22959 Southampton Univ. (England). Inst. of Sound and Vibration Research.
A MODELLING OF THE NOISE FROM SIMPLE CO-AXIAL JETS. PART 2: IN A SIMULATED FLIGHTSTREAM
M. J. FISHER and G. A. PRESTON Nov. 1993 41 p
(ISVR-TR-226) Copyright Avail: Issuing Activity

This report forms part of a continuing study of co-axial jet noise, and describes the work undertaken to predict the noise emitted by a cold, co-axial, co-planar jet within a flow to simulate flight. Three sound producing regions, identified in a previous report, appear to behave in flight exactly as a single jet does, with sound levels reduced over the whole spectrum by an amount proportional to the relative velocity ratio; the sum of the three corrected spectra predicts the co-axial jet spectrum to a useful degree of accuracy.
Author

N94-23464*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REFRACTION OF HIGH FREQUENCY NOISE IN AN ARBITRARY JET FLOW
ABBAS KHAVARAN (Sverdrup Technology, Inc., Brook Park, OH.) and EUGENE A. KREJSA Jan. 1994 19 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract NAS3-25266; RTOP 537-02-23)
(NASA-TM-106465; E-8330; NAS 1.15:106465; AIAA PAPER 94-0139) Avail: CASI HC A03/MF A01

Refraction of high frequency noise by mean flow gradients in a jet is studied using the ray-tracing methods of geometrical acoustics. Both the two-dimensional (2D) and three-dimensional (3D) formulations are considered. In the former case, the mean flow is assumed parallel and the governing propagation equations are described by a system of four first order ordinary differential equations. The 3D formulation, on the other hand, accounts for the jet spreading as well as the axial flow development. In this case, a system of six first order differential equations are solved to trace a ray from its source location to an observer in the far field. For subsonic jets with a small spreading angle both methods lead to similar results outside the zone of silence. However, with increasing jet speed the two prediction models diverge to the point where the parallel flow assumption is no longer justified. The Doppler factor of supersonic jets as influenced by the refraction effects is discussed and compared with the conventional modified Doppler factor. Author (revised)

N94-23698*# Barron Associates, Inc., Standardsville, VA.
ADAPTIVE NONLINEAR POLYNOMIAL NEURAL NETWORKS FOR CONTROL OF BOUNDARY LAYER/STRUCTURAL INTERACTION Final Report, 16 Jan. - 15 Aug. 1991
B. EUGENE PARKER, JR., RICHARD L. CELLUCCI, DEAN W. ABBOTT, ROGER L. BARRON, PAUL R. JORDAN, III, and H. VINCENT POOR (Princeton Univ., NJ.) Dec. 1993 70 p
(Contract NAS1-19271; RTOP 324-01-00; SBIR-02.10-4400)
(NASA-CR-189645; NAS 1.26:189645) Avail: CASI HC A04/MF A01

The acoustic pressures developed in a boundary layer can interact with an aircraft panel to induce significant vibration in the panel. Such vibration is undesirable due to the aerodynamic drag

and structure-borne cabin noises that result. The overall objective of this work is to develop effective and practical feedback control strategies for actively reducing this flow-induced structural vibration. This report describes the results of initial evaluations using polynomial, neural network-based, feedback control to reduce flow induced vibration in aircraft panels due to turbulent boundary layer/structural interaction. Computer simulations are used to develop and analyze feedback control strategies to reduce vibration in a beam as a first step. The key differences between this work and that going on elsewhere are as follows: that turbulent and transitional boundary layers represent broadband excitation and thus present a more complex stochastic control scenario than that of narrow band (e.g., laminar boundary layer) excitation; and secondly, that the proposed controller structures are adaptive nonlinear infinite impulse response (IIR) polynomial neural network, as opposed to the traditional adaptive linear finite impulse response (FIR) filters used in most studies to date. The controllers implemented in this study achieved vibration attenuation of 27 to 60 dB depending on the type of boundary layer established by laminar, turbulent, and intermittent laminar-to-turbulent transitional flows. Application of multi-input, multi-output, adaptive, nonlinear feedback control of vibration in aircraft panels based on polynomial neural networks appears to be feasible today. Plans are outlined for Phase 2 of this study, which will include extending the theoretical investigation conducted in Phase 2 and verifying the results in a series of laboratory experiments involving both bum and plate models. Author (revised)

N94-24163*# Colorado Univ., Boulder.
SOUND RADIATION DUE TO BOUNDARY LAYER TRANSITION
MENG WANG *In* Stanford Univ., Annual Research Briefs, 1993 p 299-312 Dec. 1993
Avail: CASI HC A03/MF A04

This report describes progress made to date towards calculations of noise produced by the laminar-turbulence transition process in a low Mach number boundary layer formed on a rigid wall. The primary objectives of the study are to elucidate the physical mechanisms by which acoustic waves are generated, to clarify the roles of the fluctuating Reynolds stress and the viscous stress in the presence of a solid surface, and to determine the relative efficiency as a noise source of the various transition stages. In particular, we will examine the acoustic characteristics and directivity associated with three-dimensional instability waves, the detached high-shear layer, and turbulent spots following a laminar breakdown. Additionally, attention will be paid to the unsteady surface pressures during the transition, which provide a source of flow noise as well as a forcing function for wall vibration in both aeronautical and marine applications. Derived from text

N94-24172*# McDonnell-Douglas Aerospace, Long Beach, CA. Transport Aircraft.
VARIABILITY OF MEASURED SONIC BOOM SIGNATURES. VOLUME 1: TECHNICAL REPORT Final Report
K. R. ELMER and M. C. JOSHI Jan. 1994 43 p
(Contract NAS1-19060; RTOP 537-03-21-03)
(NASA-CR-191483-VOL-1; NAS 1.26:191483-VOL-1) Avail: CASI HC A03/MF A01

Sonic boom signatures from two databases, the BOOMFILE and the XB-70, were analyzed in terms of C-weighted sound exposure level (CSEL), A-weighted sound exposure level (ASEL), and Stevens Mark VII perceived level (PLdB), as well as the more traditional peak positive overpressure and rise time. The variability of these parameters due to propagation through atmosphere was analyzed for different aircraft Mach number and altitude groups. The low Mach number/low altitude group had significantly greater variation in rise time, overpressure, and loudness level than the high Mach number/high altitude group. The loudness of measured booms were found to have a variation of up to 25 dB relative to the loudness of boom predicted for a non-turbulent atmosphere. This is due primarily to the steeper ray paths of the high Mach number/high altitude group and the corresponding shorter distances traveled by these rays through the lower atmosphere resulting in reduced refraction effects. The general trend of decreased overpressure and loudness level with increasing lateral distance was also seen. Sonic boom signatures from early morning flights had less variation in rise time and overpressure than afternoon flights because of reduced turbulence. Measures of asymmetry (difference between compression and expansion portion of the signature) showed that the variability in Delta loudness level was greater than the variability in Delta overpressure due to the large influence of turbulence on rise time. Lastly, analysis of data within 50 percent of lateral cutoff showed that the mean value for overpressure and loudness level was independent of time of day but that the frequency with which it occurred was greater in the morning. This is a clear indicator of increased turbulence in the afternoon. Author (revised)

N94-24173*# McDonnell-Douglas Aerospace, Long Beach, CA. Transport Aircraft.
VARIABILITY OF MEASURED SONIC BOOM SIGNATURES. VOLUME 2: DATA REPORT Final Report
K. R. ELMER and M. C. JOSHI Jan. 1994 148 p
(Contract NAS1-19060; RTOP 537-03-21-03)
(NASA-CR-191483-VOL-2; NAS 1.26:191483-VOL-2) Avail: CASI HC A07/MF A02

Sonic boom signatures from two databases, the BOOMFILE and the XB-70, were analyzed in terms of C-weighted sound exposure level (CSEL), A-weighted sound exposure level (ASEL), and Stevens Mark VII perceived level (PLdB), as well as the more traditional peak positive overpressure and rise time. The variability of these parameters due to propagation through atmosphere was analyzed for different aircraft Mach number and altitude groups. The low Mach number/low altitude group had significantly greater variation in rise time, overpressure, and loudness level than the high Mach number/high altitude group. The loudness of measured booms were found to have a variation of up to 25 dB relative to the loudness of boom predicted for a non-turbulent atmosphere. This is due primarily to the steeper ray paths of the high Mach number/high altitude group and the corresponding shorter distances traveled by these rays through the lower atmosphere resulting in reduced refraction effects. The general trend of decreased overpressure and loudness level with increasing lateral distance was also seen. Sonic boom signatures from early morning flights had less variation in rise time and overpressure than afternoon flights because of reduced turbulence. Measures of asymmetry (difference between compression and expansion portion of the signature) showed that the variability in Delta loudness level was greater than the variability in Delta overpressure due to the large influence of turbulence on rise time. Lastly, analysis of data within 50 percent of lateral cutoff showed that the mean value for overpressure and loudness level was independent of time of day but that the frequency with which it occurred was greater in the morning. This is a clear indicator of increased turbulence in the afternoon. Author (revised)

N94-24207*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
JOINT ACOUSTIC PROPAGATION EXPERIMENT (JAPE-91) WORKSHOP
WILLIAM L. WILLSHIRE, JR., comp. and DAVID CHESTNUTT, comp. Dec. 1993 190 p Workshop held in Hampton, VA, 28 Apr. 1993 Sponsored in part by Univ. of Mississippi, Oxford
(Contract RTOP 505-63-70-02)
(NASA-CP-3231; L-17331; NAS 1.55:3231) Avail: CASI HC A09/MF A02

The Joint Acoustic Propagation Experiment (JAPE), was conducted at the White Sands Missile Range, New Mexico, USA, during the period 11-28 Jul. 1991. JAPE consisted of various short and long range propagation experiments using various acoustic sources including speakers, propane cannons, helicopters, a 155 mm howitzer, and static high explosives. Of primary importance to the performance of theses tests was the extensive characterization of the atmosphere during these tests. This atmospheric characterization included turbulence measurements. A workshop to disseminate the results of JAPE-91 was held in Hampton, VA,

on 28 Apr. 1993. This report is a compilation of the presentations made at the workshop along with a list of attendees and the agenda.

N94-24208*# Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
JOINT ACOUSTIC PROPAGATION EXPERIMENT (JAPE)
BENNY L. CARNES, ROBERT O. OLSEN (Army Research Lab., White Sands Missle Range, NM.), and BRUCE W. KENNEDY (New Mexico State Univ., Las Cruces.) *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 1-17 Dec. 1993
Avail: CASI HC A03/MF A02

The Joint Acoustic Propagation Experiment (JAPE), performed under the auspices of NATO and the Acoustics Working Group, was conducted at White Sands Missile Range, New Mexico, USA, during the period 11-28 Jul. 1991. JAPE consisted of 220 trials using various acoustic sources including speakers, propane cannon, various types of military vehicles, helicopters, a 155mm howitzer, and static high explosives. Of primary importance to the performance of these tests was the intensive characterization of the atmosphere before and during the trials. Because of the wide range of interests on the part of the participants, JAPE was organized in such a manner to provide a broad cross section of test configurations. These included short and long range propagation from fixed and moving vehicles, terrain masking, and vehicle detection. A number of independent trials were also performed by individual participating agencies using the assets available during JAPE. These tests, while not documented in this report, provided substantial and important data to those groups. Perhaps the most significant feature of JAPE is the establishment of a permanent data base which can be used by not only the participants but by others interested in acoustics. A follow-on test was performed by NASA LaRC during the period 19-29 Aug. 1991 at the same location. These trials consisted of 59 overflights of supersonic aircraft in order to establish the relationship between atmospheric turbulence and the received sonic boom energy at the surface. Author (revised)

N94-24209*# Atlas Elektronik G.m.b.H., Bremen (Germany).
SOME RESULTS GAINED FROM JAPE: AN OVERVIEW
GUNNAR R. BECKER *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 19-30 Dec. 1993
Avail: CASI HC A03/MF A02

During JAPE, a variety of sound propagation experiments were conducted including long range measurements and investigations of the masking of sound by natural barriers. An overview of the measurements is given. A comparison between measured SPL's and theoretical estimates is presented. Author (revised)

N94-24214*# Institut Franco-Allemand de Recherches, Saint-Louis (France).
JAPE 91: INFLUENCE OF TERRAIN MASKING OF THE ACOUSTIC PROPAGATION OF HELICOPTER NOISE
P. NAZ *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 79-85 Dec. 1993 Sponsored in part by Direction de Reserches Etudes et Techniques, Paris, France
Avail: CASI HC A02/MF A02

The acoustic propagation in the case of a noise source masked by a small element of terrain has been investigated experimentally. These data have been measured during the 'terrain masking' experiment of the NATO JAPE 91 experimental campaign. The main objective of that experiment was to study the acoustic detection of a helicopter masked by a small hill. Microphones have been placed at different locations on the shadow zone of the hill to study the effect of the terrain obstruction on sound propagation. The results presented come from data measured by Atlas Elektronik and by ISL, and have been processed together. The terrain obstruction causes an excess attenuation of the SPL (Sound Pressure Level) for all the frequencies, but this attenuation is more effective for the high frequencies than for the low frequencies. Results typical of diffraction phenomena have been observed; the SPL is minimal at the foot of the hill and is relatively constant beyond it. Author

N94-24215*# Mississippi Univ., University. National Center for Physical Acoustics.
COMPARISONS OF CALCULATED AND MEASURED HELICOPTER NOISE NEAR INSTRUMENT HILL
HENRY E. BASS and CHULSOO YOU *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 87-92 Dec. 1993
Avail: CASI HC A02/MF A02

The polar parabolic equation (POPE) method solves for the diffraction of sound by a curved surface including a realistic sound speed profile. POPE is outlined briefly to describe diffraction which propagates the field over a hill. Experimental data are compared with POPE predictions using the measured sound speed profile and ground impedance. Two trial cases are considered for the comparisons: the helicopter located at the base of the hill and far away from the base of the hill, respectively. The physical mechanisms for sound propagation over a hill are examined with and of POPE calculations and experimental data. The shedding of rays from the hillside gives an interference effect with a wave along the flat surface beyond the base of a hill. Author

N94-24219*# National Research Council of Canada, Ottawa (Ontario).
BEAMFORMING IN AN ACOUSTIC SHADOW Abstract Only
DAVID HAVELOCK, MICHAEL STINSON, and GILLES DAIGLE *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 129 Dec. 1993
Avail: CASI HC A01/MF A02

The sound field deep within an acoustic shadow region is less well understood than that outside the shadow region. Signal levels are substantially lower within the shadow, but beamforming difficulties arise for other reasons such as loss of spatial coherence. Based on analysis of JAPE-91 data, and other data, three types of characteristic signals within acoustic shadow regions are identified. These signal types may correspond to different, intermittent signal propagation conditions. Detection and classification algorithms might take advantage of the signal characteristics. Frequency coherence is also discussed. The extent of coherence across frequencies is shown to be limited, causing difficulties for source classification based on harmonic amplitude relationships. Discussions emphasize short-term characteristics on the order of one second. A video presentation on frequency coherence shows the similarity, in the presence of atmospheric turbulence, between the received signal from a stable set of harmonics generated by a loudspeaker and that received from a helicopter hovering behind a hill. Author

N94-24220*# Army Engineer Waterways Experiment Station, Vicksburg, MS.
ANALYSIS OF PASSIVE ACOUSTIC RANGING OF HELICOPTERS FROM THE JOINT ACOUSTIC PROPAGATION EXPERIMENT
BENNY L. CARNES and JOHN C. MORGAN *In* NASA. Langley Research Center, Joint Acoustic Propagation Experiment (JAPE-91) Workshop p 131-170 Dec. 1993
Avail: CASI HC A03/MF A02

For more than twenty years, personnel of the U.S.A.E. Waterways Experiment Station (WES) have been performing research dealing with the application of sensors for detection of military targets. The WES research has included the use of seismic, acoustic, magnetic, and other sensors to detect, track, and classify military ground targets. Most of the WES research has been oriented toward the employment of such sensors in a passive mode. Techniques for passive detection are of particular interest in the Army because of the advantages over active detection. Passive detection methods are not susceptible to interception, detection, jamming, or location of the source by the threat. A decided advantage for using acoustic and seismic sensors for detection in tactical situations is the non-line-of-sight capability;

i.e., detection of low flying helicopters at long distances without visual contact. This study was conducted to analyze the passive acoustic ranging (PAR) concept using a more extensive data set from the Joint Acoustic Propagation Experiment (JAPE).
Author (revised)

N94-24307*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
UNSTRUCTURED ADAPTIVE MESH COMPUTATIONS OF ROTORCRAFT HIGH-SPEED IMPULSIVE NOISE
ROGER STRAWN (Army Aviation Systems Command, Moffett Field, CA.), MICHAEL GARCEAU (Stanford Univ., CA.), and RUPAK BISWAS Oct. 1993 13 p Presented at the AIAA 15th Aeroacoustics Conference, Long Beach, CA, 25-27 Oct. 1993
(Contract NAS2-13721)
(NASA-CR-195090; NAS 1.26:195090; RIACS-TR-93-10; AIAA PAPER 93-4359) Avail: CASI HC A03/MF A01

A new method is developed for modeling helicopter high-speed impulsive (HSI) noise. The aerodynamics and acoustics near the rotor blade tip are computed by solving the Euler equations on an unstructured grid. A stationary Kirchhoff surface integral is then used to propagate these acoustic signals to the far field. The near-field Euler solver uses a solution-adaptive grid scheme to improve the resolution of the acoustic signal. Grid points are locally added and/or deleted from the mesh at each adaptive step. An important part of this procedure is the choice of an appropriate error indicator. The error indicator is computed from the flow field solution and determines the regions for mesh coarsening and refinement. Computed results for HSI noise compare favorably with experimental data for three different hovering rotor cases.
Author (revised)

N94-24514 Institut Franco-Allemand de Recherches, Saint-Louis (France).
VALIDATION OF THE ROTAC CODE FOR THE ROTOR NOISE PREDICTION
P. GNEMMI, J. HAERTIG, and C. JOHE 1992 18 p See also PB93-204303 Sponsored by Direction des Recherches, Etudes et Techniques and Centre de Documentation de l'Armement Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB93-204311; ISL-CO-228/92) Avail: CASI HC A03

The blade/vortex interaction noise and the thickness noise are the impulsive noises radiated by a helicopter rotor flying at low speed. A prediction code of the thickness and loading noises applied to a helicopter rotor has been developed at ISL. This code, named ROTAC, is very briefly described here. In order to validate this acoustic code, calculations are compared with measurements obtained by ISL and by a DLR US-ARMY collaboration. The thickness noise of a rotor in hover and forward flight is correctly predicted up to a tip Mach number near 0.88. For a flight configuration with occurrence of blade/vortex interaction, the small number of blade pressure measurements does not allow the determination of the amplitude of the loading noise but these entry data make it possible to examine qualitatively the agreement between calculations and measurements. NTIS

17

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.

N94-23562*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
BIBLIOGRAPHY OF LEWIS RESEARCH CENTER TECHNICAL PUBLICATIONS ANNOUNCED IN 1992
Nov. 1993 440 p
(NASA-TM-106035; E-7602; NAS 1.15:106035) Avail: CASI HC A19/MF A04

This compilation of abstracts describes and indexes the technical reporting that resulted from the scientific and engineering work performed and managed by the Lewis Research Center in 1992. All the publications were announced in the 1992 issues of STAR (Scientific and Technical Aerospace Reports) and/or IAA (International Aerospace Abstracts). Included are research reports, journal articles, conference presentations, patents and patent applications, and theses. Author (revised)

N94-24337*# National Aeronautics and Space Administration, Washington, DC.
NASA HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PROGRAM Annual Report, 1992
LEE HOLCOMB, PAUL SMITH, and PAUL HUNTER Dec. 1993 141 p
(NASA-TM-4554; NAS 1.15:4554) Avail: CASI HC A07/MF A02

The National Aeronautics and Space Administration's HPCC program is part of a new Presidential initiative aimed at producing a 1000-fold increase in supercomputing speed and a 100-fold improvement in available communications capability by 1997. As more advanced technologies are developed under the HPCC program, they will be used to solve NASA's 'Grand Challenge' problems, which include improving the design and simulation of advanced aerospace vehicles, allowing people at remote locations to communicate more effectively and share information, increasing scientist's abilities to model the Earth's climate and forecast global environmental trends, and improving the development of advanced spacecraft. NASA's HPCC program is organized into three projects which are unique to the agency's mission: the Computational Aerosciences (CAS) project, the Earth and Space Sciences (ESS) project, and the Remote Exploration and Experimentation (REE) project. An additional project, the Basic Research and Human Resources (BRHR) project exists to promote long term research in computer science and engineering and to increase the pool of trained personnel in a variety of scientific disciplines. This document presents an overview of the objectives and organization of these projects as well as summaries of individual research and development programs within each project. Author (revised)

19

GENERAL

N94-23135*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LEWIS RESEARCH CENTER R AND D FACILITIES
Jun. 1991 55 p Original contains color illustrations
(NASA-TM-109400; NAS 1.15:109400) Avail: CASI HC A04/MF A01; 51 functional color pages

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Author (revised)

N94-24585*# National Aeronautics and Space Administration, Washington, DC.
JAPANESE AEROSPACE SCIENCE AND TECHNOLOGY 1992. A BIBLIOGRAPHY WITH INDEXES
Washington May 1993 1017 p
(NASA-SP-7104; NAS 1.21:7104) Avail: CASI HC A99/MF A10

This report contains 4271 annotated references to reports and journal articles of Japaness intellectual origin entered into the NASA scientific and technical information system during 1992. Representative subject areas of interest include: adaptive control, antireflection coatings, fiber reinforced composites, gallium arsenide lasers, laser interferometry, reduced gravity (microgravity), and VHSIC (circuits). Author

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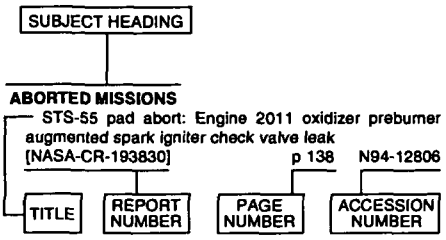

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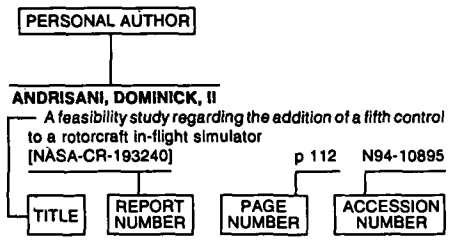

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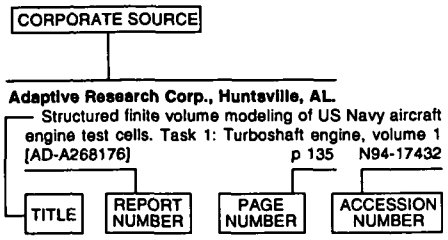

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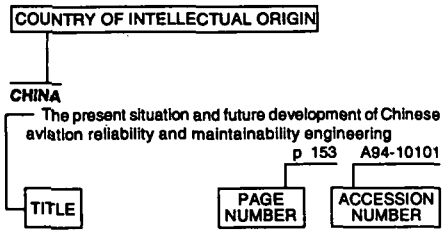

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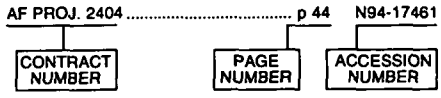

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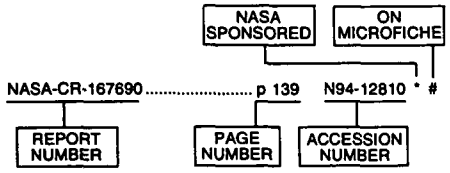

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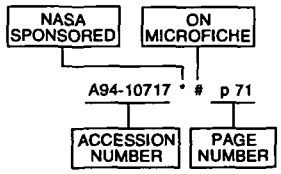

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Wilson Library
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University, MS 38677
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UNIV. OF MISSOURI - COLUMBIA
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MONTANA

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Documents Div.
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NEVADA

UNIV. OF NEVADA
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Reno, NV 89557
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General Library
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Albuquerque, NM 87131-1466
(505) 277-5441 Fax: (505) 277-6019

NEW MEXICO STATE LIBRARY
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Santa Fe, NM 87503
(505) 827-3826 Fax: (505) 827-3820

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NEW YORK STATE LIBRARY
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(518) 474-5563 Fax: (518) 474-5786

NORTH CAROLINA

UNIV. OF NORTH CAROLINA - CHAPEL HILL
CB#3912, Davis Library
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(919) 962-1151 Fax: (919) 962-0484

NORTH DAKOTA

NORTH DAKOTA STATE UNIV. LIB.
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In cooperation with Univ. of North Dakota, Chester Fritz Library
Grand Forks

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(405) 521-2502, ext. 252, 253
Fax: (405) 525-7804

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(405) 744-6546 Fax: (405) 744-5183

OREGON

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Portland, OR 97207
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Austin, TX 78711
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Documents Dept.
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(806) 742-2268 Fax: (806) 742-1920

UTAH

UTAH STATE UNIV.
Merrill Library & Learning Resources Center, UMC-3000
Documents Dept.
Logan, UT 84322-3000
(801) 750-2684 Fax: (801) 750-2677

VIRGINIA

UNIV. OF VIRGINIA
Aldermman Library
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Charlottesville, VA 22903-2498
(804) 824-3133 Fax: (804) 924-4337

WASHINGTON

WASHINGTON STATE LIBRARY
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(206) 753-4027 Fax: (206) 753-3546

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Govt. Documents Section
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Morgantown, WV 26506
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Madison, WI 53706
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Documents Div.
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