NASA SP-7037 (304)
May 1994

AERONAUTICAL ENGINEERING

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A CONTINUING BIBLIOGRAPHY WITH INDEXES

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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

This publication was prepared by the NASA Center for AeroSpace Information,
800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934, (301) 621-0390.

INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 453 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)	N94-24785 — N94-28398
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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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED
ON MICROFICHE

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

NASA SPONSORED

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)

Copyright

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.

01

AERONAUTICS (GENERAL)

N94-24923 Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
GENERAL AVIATION ACTIVITY SURVEY Annual Summary Report, 1992
1992 217 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DTFA01-93-Y-1021)
(AD-A273284; FAA-APO-93-10) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The results of the annual General Aviation Activity Survey are presented. The survey is conducted by the FAA to obtain information on the flight activity of the United States registered general aviation aircraft fleet. Breakdowns of active aircraft, annual flight hours, average flight hours and other statistics by manufacturer/model group, aircraft type, state and region of based aircraft, and primary use are included. Also included are fuel consumption, lifetime airframe hours, engine hours, miles flown estimates, estimates of the number of landings, IFR hours flown, and grade of fuel consumed by the general aviation fleet. DTIC

N94-25068 General Electric Co., Cincinnati, OH. Aircraft Engines.
AVIATION: THE TIMELESS INDUSTRY
BRIAN H. ROWE *In* National Academy of Engineering, The Future of Aerospace: Proceedings of a Symposium Held in Honor of Alexander H. Flax p 29-36 1993
Copyright Avail: Issuing Activity

From an engineering perspective, we may be entering the most exciting, rewarding, and interesting time during which one can work in the U.S. air transportation industry. At the same time, we may be entering a period of steadily declining U.S. leadership in civil aeronautics - if we allow ourselves to become complacent. This paradox stems from the fact that world airline economics are in dreadful shape, even though opportunities for technical advances in civil aviation abound. To maintain our leadership in this environment, we must shift our focus from 'high-tech' to cost-conscious designs made possible through concurrent engineering, coupled with better-than-ever customer support. Derived from text

N94-25096*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA LARC WORKSHOP ON GUIDANCE, NAVIGATION, CONTROLS, AND DYNAMICS FOR ATMOSPHERIC FLIGHT, 1993
CAREY S. BUTTRILL, ed. Dec. 1993 565 p Workshop held in Hampton, VA, 18-19 Mar. 1993
(Contract RTOP 505-64-52-01)
(NASA-CP-10127; NAS 1.55:10127) Avail: CASI HC A24/MF A04

This publication is a collection of materials presented at a NASA workshop on guidance, navigation, controls, and dynamics (GNC&D) for atmospheric flight. The workshop was held at the NASA Langley Research Center on March 18-19, 1993. The workshop presentations describe the status of current research in the GNC&D area at Langley over a broad spectrum of research branches. The workshop was organized in eight sessions: overviews, general, controls, military aircraft, dynamics, guidance, systems, and a panel discussion. A highlight of the workshop was the panel discussion which addressed the following issue: 'Direction of guidance, navigation, and controls research to ensure U.S. competitiveness and leadership in aerospace technologies.'

N94-25097*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
US GENERAL AVIATION: THE INGREDIENTS FOR A RENAISSANCE. A VISION AND TECHNOLOGY STRATEGY FOR US INDUSTRY, NASA, FAA, UNIVERSITIES
BRUCE HOLMES *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 1-53 Dec. 1993
Avail: CASI HC A04/MF A04

General aviation today is a vital component in the nation's air transportation system. It is threatened for survival but has enormous potential for expansion in utility and use. This potential for expansion is fueled by new satellite navigation and communication systems, small computers, flat panel displays, and advanced aerodynamics, materials and manufacturing methods, and propulsion technologies which create opportunities for new levels of environmental and economic acceptability. Expanded general aviation utility and use could have a large impact on the nation's jobs, commerce, industry, airspace capacity, trade balance, and quality of life. This paper presents, in viewgraph form, a general overview of U.S. general aviation. Topics covered include general aviation shipment and billings; airport and general aviation infrastructure; cockpit, airplane, and airspace technologies; market demand; air traffic operations and aviation accidents; fuel efficiency comparisons; and general aviation goals and strategy. CASI

N94-26212# National Aerospace Lab., Amsterdam (Netherlands).
TECHNICAL AND SCIENTIFIC RESEARCH FOR AERONAUTICS AND ASTRONAUTICS [TECHNISCH-WETENSCHAPPELIJK ONDERZOEK VOOR LUCHT- EN RUIMTEVAART]
Dec. 1992 18 p In DUTCH
(ETN-94-95392) Avail: CASI HC A03/MF A01

The activities of the National Aerospace Laboratory (NLR) are surveyed. In the field of aerodynamics research, activities are conducted in the low speed, high speed, supersonic, and Dutch-German wind tunnels, and in the laboratory for propulsion aerodynamics and aeroacoustics. In the domain of aircraft and helicopters, flight tests are performed, and research is conducted on two laboratory aircraft, a flight simulator, and an air traffic simulator. In the construction and materials division loading and fatigue of aircraft structures, as well as new materials, are investigated. In the field of astronautics, satellite positioning; microgravity; automation and robotics; temperature control; and Earth observation are studied. Information systems for aerospace applications are developed. Aerospace pollution and environmental control by aircrafts and satellites are investigated. ESA

N94-26596*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SHAKE TEST RESULTS OF THE MDHC TEST STAND IN THE 40- BY 80-FOOT WIND TUNNEL
BENTON H. LAU and RANDALL PETERSON Jan. 1994 40 p
(Contract RTOP 505-59-36)
(NASA-TM-108801; A-94029; NAS 1.15:108801) Avail: CASI HC A03/MF A01

A shake test was conducted to determine the modal properties of the MDHC (McDonnell Douglas Helicopter Company) test stand installed in the 40- by 80- Foot Wind Tunnel at Ames Research Center. The shake test was conducted for three wind-tunnel balance configurations with and without balance dampers, and with the snubber engagement to lock the balance frame. A hydraulic shaker was used to apply random excitation at the rotor hub in the longitudinal and lateral directions. A GenRad 2515 computer-aided test system computed the frequency response functions at the rotor hub and support struts. From these response functions, the modal properties, including the natural frequency, damping ratio, and mode shape were calculated. The critical modes with low damping ratios are identified as the test-stand second longitudinal mode for the dampers-off configuration, the test-stand yaw mode for the dampers-on configuration, and the test stand first longitudinal mode for the balance-frame locked configuration. Author

N94-27284*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FAA/NASA JOINT UNIVERSITY PROGRAM FOR AIR TRANSPORTATION RESEARCH, 1992-1993
FREDERICK R. MORRELL, Comp. Feb. 1994 161 p Conference held in Athens, OH, 17-18 Jun. 1993; sponsored in part by FAA
(Contract NGL-22-009-640; NGL-31-001-252; NGR-36-009-017)
(NASA-CP-3246; NAS 1.55:3246; DOT/FAA/CT-94/03) Avail: CASI HC A08/MF A02

The research conducted during the academic year 1992-1993 under the FAA/NASA sponsored Joint University Program for Air Transportation Research is summarized. The year end review was held at Ohio University, Athens, Ohio, 17-18 June 1993. The Joint University Program is a coordinated set of three grants sponsored by the Federal Aviation Administration and NASA Langley Research Center, one each with the Massachusetts Institute of Technology, Ohio University, and Princeton University. Completed works, status reports, and annotated bibliographies are presented for research topics, which include navigation, guidance, and control theory and practice, aircraft performance, human factors and air traffic management. An overview of the year's activities for each university is also presented.

N94-27960# Federal Aviation Administration, Washington, DC.
THE 1993 FEDERAL AVIATION ADMINISTRATION PLAN FOR RESEARCH, ENGINEERING AND DEVELOPMENT
Feb. 1994 198 p
Avail: CASI HC A09/MF A03

The FAA manages and operates the National Airspace System (NAS), a significant national resource. However, the demands on this system are continuously growing, and changing technologies provide the opportunity to dramatically improve system effectiveness and efficiency. To this end, the FAA's Research, Engineering, and Development (RE&D) Program is an investment in the future that will sustain the United States' preeminence in aviation throughout the world. Without this investment, the United States leadership would erode. Thus, the importance of aviation to the Nation mandates a comprehensive RE&D program to ensure both the safety of public air transportation and the fulfillment of national priorities and policy goals. Various aspects of the RE&D Program plan are discussed. Derived from text

02

AERODYNAMICS

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

N94-24849 Mississippi State Univ., Mississippi State.
NUMERICAL FLOW SIMULATION FOR COMPLETE VEHICLE CONFIGURATIONS Final Report, 1 Apr. 1990 - 31 Mar. 1993
BHARAT K. SONI 1 Sep. 1993 74 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract F49620-90-C-0027)
(AD-A273588; AFOSR-93-0863TR) Avail: CASI HC A04

In the spirit of the Air Force Office of Scientific Research's (AFOSR) initiative to promote university/industry collaborative research, a collaborative project entitled, Numerical Flow Simulation for Complete Vehicle Configurations has been executed by the National Science Foundation Engineering Research Center for Computational Field Simulation (NSF ERC) at Mississippi State University. The industrial participants include McDonnell Aircraft Company, McDonnell Douglas Research and Development Company, and Teledyne Brown Engineering Company. The research and development activities of this effort are focused on the advancement of methodologies to increase the efficiency, quality, and productivity of an overall CFD simulation associated with geometrically complex configurations. The progress realized in the aforestated development is presented in this report. Progress concerning efforts designed to increase the efficiency and productivity of an overall CFD simulation process--from geometry definition to post processing of results as applied to complete aircraft configurations--is presented. This progress has been brought about through enhancements in geometry processing, surface grid generation, grid refinement, grid adaptation, and domain decomposition strategies. DTIC

N94-25051 Department of the Navy, Washington, DC.
REGULATED DRAG AREA PARACHUTE Patent
ELSA J. HENNINGS, inventor (to Navy) 28 Sep. 1993 11 p Filed 8 Apr. 1992
(AD-D015992; US-PATENT-5,248,117; US-PATENT-APPL-SN-866649; US-PATENT-CLASS-244-152)
Avail: US Patent and Trademark Office

The disclosed invention is a regulated drag area parachute for decelerating a manned ejection seat or an ejectable capsule at a low altitude from an aircraft or other air vehicle. This parachute comprises a canopy composed of two portions, suspension lines, and a means for controlling the inflation of the canopy so that the two portions of the canopy inflate independently from one another. This means for controlling the inflation of the canopy provides a manner to regulate the rate of infraction of the lower portion of the canopy. Thus, the invention allows the top, or apex portion of the canopy, to inflate rapidly while the remaining portion of the canopy can be inflated subsequently and in a controlled manner so that the effective drag area of the canopy can be regulated during the deployment of the parachute. DTIC

N94-25110*# Lockheed Engineering and Sciences Co., Hampton, VA. Aircraft Guidance and Control Branch.
NONLINEAR AERODYNAMIC MODELING USING MULTIVARIATE ORTHOGONAL FUNCTIONS
EUGENE A. MORELLI *In* NASA. Langley Research Center, NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 389-400 Dec. 1993
Avail: CASI HC A03/MF A04

The problem to be addressed in this work is that of modeling nondimensional force and moment aerodynamic coefficients over the entire subsonic envelope. The particular application discussed here is the Z force coefficient for the F-18 High Angle of Attack Research Vehicle (HARV). Author

N94-25137# Defence Research Agency, Farnborough (England).
SUB-SONIC FLOW ABOUT A SLENDER PROFILE IN A TUNNEL HAVING PERFORATED WALLS [DOZVUKOVOE OBTEKANIE TONKOGO PROFILYA V KANALE S PERFORIROVANNYMI STENKAMI]
S. A. GLASKOV 8 Feb. 1993 16 p Transl. into ENGLISH from Uchenye Zapiski Tsagi (Russia), v. 22, no. 2, 1991 p 3-12
(AD-A273184; DRA-LIBRARY-TRANS-2202) Avail: CASI HC A03/MF A01

A solution has been found for the problem of flow about a profile by an ideal incompressible liquid in a tunnel, the upper and lower walls of which may have varying porosity, depending on whether gas flows in or out of the tunnel. Calculations have been made of the distributions of pressure on the walls of the tunnel and on the profile located at an angle of attack on the axis of symmetry of the tunnel. DTIC

N94-25173*# Sverdrup Technology, Inc., Brook Park, OH.
ANALYTICAL SKIN FRICTION AND HEAT TRANSFER FORMULA FOR COMPRESSIBLE INTERNAL FLOWS Final Report
LAWRENCE J. DECHANT and MARC J. TATTAR (Ohio Aerospace Inst., Brook Park.) Jan. 1994 20 p
(Contract NAS3-25266; RTOP 505-69-50)
(NASA-CR-191185; E-8096; NAS 1.26:191185) Avail: CASI HC A03/MF A01

An analytic, closed-form friction formula for turbulent, internal, compressible, fully developed flow was derived by extending the incompressible law-of-the-wall relation to compressible cases. The model is capable of analyzing heat transfer as a function of constant surface temperatures and surface roughness as well as analyzing adiabatic conditions. The formula reduces to Prandtl's law of friction for adiabatic, smooth, axisymmetric flow. In addition, the formula reduces to the Colebrook equation for incompressible, adiabatic, axisymmetric flow with various roughnesses. Comparisons with available experiments show that the model averages roughly 12.5 percent error for adiabatic flow and 18.5 percent error for flow involving heat transfer. Author (revised)

N94-25182*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IMPROVING DIFFUSING S-DUCT PERFORMANCE BY SECONDARY FLOW CONTROL
BRUCE A. REICHERT and BRUCE J. WENDT Feb. 1994 12 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-106492; E-8479; NAS 1.15:106492; AIAA PAPER 94-0365) Avail: CASI HC A03/MF A01

The objective of this research was to study ways to reduce inlet flow distortion (i.e., total pressure nonuniformity) and improve total pressure recovery in a diffusing S-duct. This was accomplished by controlling the development of secondary flows within the duct through the use of tapered-fin type vortex generators. Reported are results for the bare duct and seven different configurations of vortex generators. Data presented for each configuration include surface static pressure, surface flow visualization, and exit plane total pressure and transverse velocity. The performance of each configuration was assessed by calculating total pressure recovery and inlet distortion descriptors from the data and comparing them to the values for the bare duct. The best configuration tested reduced distortion (as measured by the DC(45) and DC(90) descriptors) by more than 50 percent while improving total pressure recovery by 0.5 percent. These results should provide valuable guidance in designing vortex generator installations in ducts and for assessing the accuracy of computational fluid dynamics (CFD) methods to calculate duct flows with installed vortex generators. Author (revised)

N94-25187*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF AN EXTENDABLE SLAT ON THE STALL BEHAVIOR OF A VR-12 AIRFOIL
P. PLANTIN DEHUGUES (Ministere des Affaires Etrangeres, Paris, France.), K. W. MCALISTER (Army Aviation Systems Command, Moffett Field, CA.), and C. TUNG (Army Aviation Systems Command, Moffett Field, CA.) Sep. 1993 65 p
(Contract RTOP 505-61-51)
(NASA-TP-3407; A-93056; NAS 1.60:3407; ATCOM-TR-93-A-002) Avail: CASI HC A04/MF A01

Experimental and computational tests were performed on a VR-12 airfoil to determine if the dynamic-stall behavior that normally accompanies high-angle pitch oscillations could be modified by segmenting the forward portion of the airfoil and extending it ahead of the main element. In the extended position the configuration would appear as an airfoil with a leading-edge slat, and in the retracted position it would appear as a conventional VR-12 airfoil. The calculations were obtained from a numerical code that models the vorticity transport equation for an incompressible fluid. These results were compared with test data from the water tunnel facility of the Aeroflightdynamics Directorate at Ames Research Center. Steady and unsteady flows around both airfoils were examined at angles of attack between 0 and 30 deg. The Reynolds number was fixed at 200,000 and the unsteady pitch oscillations followed a sinusoidal motion described by alpha = alpha(sub m) + 10 deg sin(omega t). The mean angle (alpha(sub m)) was varied from 10 to 20 deg and the reduced frequency from 0.05 to 0.20. The results from the experiment and the calculations show that the extended-slat VR-12 airfoil experiences a delay in both static and dynamic stall not experienced by the basic VR-12 airfoil. Author

N94-25461# Institut Franco-Allemand de Recherches, Saint-Louis (France).
DETAILED DESCRIPTION OF TWO CALCULATION PROGRAMS FOR INCOMPRESSIBLE, STEADY STATE BOUNDARY LAYER FLOWS, APPLIED TO DETERMINE THE AERODYNAMIC CHARACTERISTICS OF NACA12 AND OA312 FOILS AT LOW REYNOLDS NUMBERS [DESCRIPTION DETAILLEE DE DEUX PROGRAMMES DE CALCUL DE COUCHE LIMITE STATIONNAIRE, INCOMPRESSIBLE, UTILISES POUR LA DETERMINATION DES CARACTERISTIQUES AERODYNAMIQUES DES PROFILS NACA12 ET OA312 A FAIBLE NOMBRE DE REYNOLDS]
P. WERNERT 29 Apr. 1992 37 p In FRENCH
(ISL-N-604/92; ETN-94-95117) Avail: CASI HC A03/MF A01

In the scope of the study concerning unsteady flows due to oscillating foils, the steady pressure field was measured. Boundary layer computer programs were applied to calculate C(sub x), C(sub z), and C(sub m) coefficients. The two programs used for calculating boundary layer characteristics of oscillating foils in incompressible flows were CLTHA1 and THDIM. Both programs are based on the Thwaites integral method for laminar flows. The turbulent boundary layer is calculated with CLTHA1 by applying a Lazareff-Semezis modified integration method and with THDIM by the Head method. The block diagrams of both programs are included. ESA

N94-25517# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
ANALYSIS AND CHARACTERISTICS OF COMPRESSOR STALL PRECURSOR SIGNALS IN FORWARD AND AFT SWEPT HIGH SPEED COMPRESSOR M.S. Thesis
BERNARD J. FRANK Dec. 1993 127 p
(AD-A273820; AFIT/GAE/ENY/93D-14) Avail: CASI HC A07/MF A02

The stall characteristics of four single-stage transonic compressor rotors were investigated as they were throttled to stall. Forward-swept, backward-swept, and straight leading edge rotors were examined. Three methods of analysis--windowed power spectrum densities of pressure and spatial Fourier coefficients, phase tracking analysis, and system identification--were used to identify the first appearance of modal waves and their accompanying frequencies in order to identify a stall warning time. A direct correlation between the amount of stall warning time and the shape of the compressor characteristic was found. Specifically, if the compressor characteristic had a significant period of flat or positive slope, more stall warning was noted. It was also found that the forward-swept rotor consistently provided more stall warning time than the backward-swept and straight leading edge rotors. DTIC

N94-25592# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

EVALUATION OF A CONCENTRATION PROBE FOR APPLICATION IN A SUPERSONIC FLOW FIELD M.S. Thesis

JOHN S. ALSUP Dec. 1993 67 p

(AD-A273915; AFIT/GAE/ENY/93D-3) Avail: CASI HC A04/MF A01

Aspirating, concentration probes are used to measure binary gas concentrations in a supersonic flow. In the past, a tank discharge method has been used to calibrate concentration probes. An alternate calibration method has been developed and tested on a probe in a steady, subsonic/sonic flow. This study evaluated the calibration and performance of a concentration probe in a steady, supersonic flow over a range of mixture ratios of air and helium. The results of this study and a comparison of the two calibration methods are presented. DTIC

N94-26104# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

CALCULATION OF VISCOUS DRAG OF TWO LOW ANGLE OF ATTACK SUPERCRITICAL PROFILES [BERAEKNING AV VISKOESA MOTSTAANDET FOER TVAA SUPERKRISTISKA PROFILER VID LAAGA ANFALLSVINKLAR]

S. PAASO 3 May 1984 40 p In SWEDISH Sponsored by Foersvarets Materialverk, Stockholm, Sweden

(FFA-TN-1984-22; ETN-94-93902) Avail: CASI HC A03/MF A01

Two supercritical profile calculations were carried out to determine which profile is better at subcritical Mach numbers. The tests were carried out on natural scale Reynolds numbers and on prototype Reynolds numbers. The NACA 64A010 profile was included in the test to check control the results obtained by the programs and the formulas used and to compare the supercritical profiles with a NACA type profile. The supercritical profiles appeared to have similar drag curves, and the NACA 64A010 showed lower drag at low angle of attack. The prototype drag profiles differ a little in relation to the natural profile. ESA

N94-26131*# Sverdrup Technology, Inc., Brook Park, OH.

PERFORMANCE OF RENORMALIZATION GROUP ALGEBRAIC TURBULENCE MODEL ON BOUNDARY LAYER TRANSITION SIMULATION Final Report

KYUNG H. AHN Feb. 1994 19 p

(Contract NAS3-25266; RTOP 535-03-10)

(NASA-CR-194466; E-8521; NAS 1.26:194466) Avail: CASI HC A03/MF A01

The RNG-based algebraic turbulence model, with a new method of solving the cubic equation and applying new length scales, is introduced. An analysis is made of the RNG length scale which was previously reported and the resulting eddy viscosity is compared with those from other algebraic turbulence models. Subsequently, a new length scale is introduced which actually uses the two previous RNG length scales in a systematic way to improve the model performance. The performance of the present RNG model is demonstrated by simulating the boundary layer flow over a flat plate and the flow over an airfoil. Author (revised)

N94-26143*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

CORRELATION OF AIRLOADS ON A TWO-BLADED HELICOPTER ROTOR

FRANCISCO J. FERNANDEZ and WAYNE JOHNSON (Johnson Aeronautics, Palo Alto, CA.) Apr. 1993 26 p

(Contract RTOP 505-59-36)

(NASA-TM-103982; A-93001; NAS 1.15:103982) Avail: CASI HC A03/MF A01

Airloads measured on a two-bladed helicopter rotor in flight during the Ames' Tip Aerodynamic and Acoustic Test are compared with calculations from a comprehensive helicopter analysis (CAMRAD/JA), and the pressures compared with calculations from a full-potential rotor code (FPR). The flight-test results cover an advance ratio range of 0.19 to 0.38. The lowest-speed case is characterized by the presence of significant blade-vortex interactions. Good correlation of peak-to-peak vortex-induced loads and the corresponding pressures is obtained. Results of the correlation for this two-bladed rotor are substantially similar to those for three- and four-bladed rotors, including the tip-vortex core size for best correlation, calculation of the peak-to-peak loads on the retreating side, and calculation of vortex iduced loads on inboard radial stations. The higher-speed cases are characterized by the presence of transonic flow on the outboard sections of the blade. Comparison of calculated and measured airloads on the advancing side is not considered appropriate because the presence of shocks makes chordwise integration of the measured data difficult. However, good correlation of the corresponding pressures is obtained. Author

N94-26154*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMMENTS REGARDING TWO UPWIND METHODS FOR SOLVING TWO-DIMENSIONAL EXTERNAL FLOWS USING UNSTRUCTURED GRIDS

W. L. KLEB Feb. 1994 29 p

(Contract RTOP 232-01-04-04)

(NASA-TM-109078; NAS 1.15:109078) Avail: CASI HC A03/MF A01

Steady flow over the leading portion of a multicomponent airfoil section is studied using computational fluid dynamics (CFD) employing an unstructured grid. To simplify the problem, only the inviscid terms are retained from the Reynolds-averaged Navier-Stokes equations - leaving the Euler equations. The algorithm is derived using the finite-volume approach, incorporating explicit time-marching of the unsteady Euler equations to a time-asymptotic, steady-state solution. The inviscid fluxes are obtained through either of two approximate Riemann solvers: Roe's flux difference splitting or van Leer's flux vector splitting. Results are presented which contrast the solutions given by the two flux functions as a function of Mach number and grid resolution. Additional information is presented concerning code verification techniques, flow recirculation regions, convergence histories, and computational resources. Author (revised)

N94-26191# Naval Postgraduate School, Monterey, CA.

COMPUTATIONAL INVESTIGATION OF THE COMPRESSIBLE DYNAMIC STALL CHARACTERISTICS OF THE SIKORSKY SSC-A09 AIRFOIL M.S. Thesis

THOMAS A. JOHNSTON Sep. 1993 260 p

(AD-A274867) Avail: CASI HC A12/MF A03

Steady and unsteady two dimensional flowfield analysis was conducted for a Sikorsky SSC-A09 airfoil in compressible, high Reynolds number flows. Limited verification with experimental measurement was achieved. Computational methods included a steady, linear panel method with compressibility corrections; a laminar and turbulent boundary layer method; an unsteady, linear panel method; and a numerical solution method of the thin layer, compressible Navier-Stokes equations using a body-fitted C-type computational grid. The Baldwin-Lomax, two-layer, zero-equation turbulence model was used. Wind tunnel wall interference effects were ignored. Steady and unsteady airloads and instantaneous flow pictures are presented. In steady flow with little or no separation, computed lift, drag, pitching moment, and skin friction coefficients, as well as displacement thickness and boundary layer velocity profiles at several angles of attack, were generally found to be in good agreement with experimental data. DTIC

N94-26248# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
MODELLING OF IONISATION REACTIONS AND OF THE RESULTING ELECTRIC FIELDS IN ONE-DIMENSIONAL HYPERSONIC SHOCK WAVES WITH THE DIRECT SIMULATION MONTE CARLO METHOD
M. A. GALLIS and J. K. HARVEY Jul. 1992 13 p
(Contract AT/2037/331) (ISSN 0308-7247)
(IC-AERO-92-01; ETN-94-95226) Avail: CASI HC A03/MF A01

The direct simulation Monte Carlo method is applied to ionized hypersonic rarefied flows. Calculations of the reaction rates are made with the method proposed by G.A. Bird and with the maximum entropy approach, which is extended to include reactions between monatomic and ionized particles. The assumptions made for the simulation of plasmas are discussed. A method for the treatment of electrons and the calculation of the electric field is described. The new approach for modeling plasmas is compared with the current modeling technique and both methods are compared with experimental data. Calculations for two normal shock wave test cases were performed: a real air test case at Mach 29 and an atomic hydrogen test case at Mach 60. The approach is in good agreement with the experimental data and offers a better explanation of the effects of nonequilibrium phenomena in the flow. ESA

N94-26342# Aeronautical Research Labs., Melbourne (Australia).
LOW-SPEED PRESSURE DISTRIBUTION MEASUREMENTS OVER THE AFT-FUSELAGE, FINS, AND STABILATORS OF A 1/9TH SCALE F/A-18 WIND-TUNNEL MODEL
L. D. MACLAREN and H. A. QUICK Oct. 1993 93 p
(AD-A274870; ARL-RR-9; DODA-AR-008-367) Avail: CASI HC A05/MF A01

The steady-state *aerodynamic* pressure distribution over the aft fuselage, fin and stabilator of a 1/9th scale F/A-18 model has been measured for varying conditions at low speeds. Pressure distributions are presented in the form of a parametric study and the integration of the pressures to obtain total loads is included to indicate the overall effects of angle of attack, sideslip, stabilator deflection and the LEX fence. The results from these wind tunnel tests have illustrated the degree to which vortical flow dominates the conditions over the aft end of the aircraft, due to the presence of the primary LEX vortex and to local separations from sharp edged surfaces. DTIC

N94-26483*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INVESTIGATION OF THE AERODYNAMIC ENVIRONMENT FOR AN ADVANCED LIGHTWEIGHT ROTOR IN FORWARD FLIGHT. VOLUME 4: LASER VELOCIMETER WAKE DATA, ADVANCE RATIO OF 0.037 (Diskette Supplement)
W. DERRY MACE (Lockheed Engineering and Sciences Co., Hampton, VA.), JOE W. ELLIOTT, MARTIN A. PERYEA (Bell Helicopter Co., Fort Worth, TX.), ALBERT G. BRAND (Bell Helicopter Co., Fort Worth, TX.), and TOM L. WOOD (Bell Helicopter Co., Fort Worth, TX.) Nov. 1993 423 p Sponsored by Army Aviation and Troop Command, St. Louis, MO Diskette supplement: IBM compatible 1.4 Mbyte 3.5-inch diskette in MS-DOS format
(Contract RTOP 505-59-87-85; DA PROJ. 1L1-61102-AH-45)
(NASA-TM-109040-VOL-4; NAS 1.15:109040-VOL-4;
ATCOM-TR-93-A-012-VOL-4; NONP-SUPPL-DK-94-205048)
Avail: CASI SET A22 (HC,DK)

An Advanced Lightweight Rotor (ALR) model was tested in high-speed forward flight, mu = 0.37, at the 14- by 22-Foot Subsonic Tunnel at LaRC. A two-component laser velocimeter was used to obtain azimuthally dependent velocities in the inflow region and in the wake of the rotor. Data are presented without analysis. Author (revised)

N94-26489*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INVESTIGATION OF THE AERODYNAMIC ENVIRONMENT FOR AN ADVANCED LIGHTWEIGHT ROTOR IN FORWARD FLIGHT. VOLUME 1: LASER VELOCIMETER INFLOW DATA, ADVANCE RATIO OF 0.37, THRUST COEFFICIENT OF 0.0081 AND HOVER TIP SPEED OF 603 FEET/SECOND (Diskette Supplement)
W. DERRY MACE (Lockheed Engineering and Sciences Co., Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), MARTIN A. PERYEA (Textron Bell Helicopter, Fort Worth, TX.), ALBERT G. BRAND (Textron Bell Helicopter, Fort Worth, TX.), and TOM L. WOOD (Textron Bell Helicopter, Fort Worth, TX.) Nov. 1993 383 p Diskette supplement: IBM compatible 1.4 Mbyte 3.5-inch diskette in MS-DOS format
(Contract RTOP 505-59-87-85; DA PROJ. 1L1-61102-AH-45)
(NASA-TM-109040-VOL-1; NAS 1.15:109040-VOL-1;
ATCOM-TR-93-A-012-VOL-1; NONP-SUPPL-DK-94-205049)
Avail: CASI SET A22 (HC,DK)

An Advanced Lightweight Rotor (ALR) model was tested in high-speed forward flight, mu = 0.37, at the 14- by 22-Foot Subsonic Tunnel at LaRC. A two-component laser velocimeter was used to obtain azimuthally dependent velocities in the inflow region and in the wake of the rotor. Data are presented without analysis. Author (revised)

N94-26492*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INVESTIGATION OF THE AERODYNAMIC ENVIRONMENT FOR AN ADVANCED LIGHTWEIGHT ROTOR IN FORWARD FLIGHT. VOLUME 2: LASER VELOCIMETER INFLOW DATA, ADVANCE RATIO OF 0.37, THRUST COEFFICIENT OF 0.0064 AND HOVER TIP SPEED OF 710 FEET/SECOND (Diskette Supplement)
W. DERRY MACE (Lockheed Engineering and Sciences Co., Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Fort Eustis, VA.), MARTIN A. PERYEA (Textron Bell Helicopter, Fort Worth, TX.), ALBERT G. BRAND (Textron Bell Helicopter, Fort Worth, TX.), and TOM L. WOOD (Textron Bell Helicopter, Fort Worth, TX.) Nov. 1993 381 p Diskette supplement: IBM compatible 1.4 Mbyte 3.5-inch diskette in MS-DOS format
(Contract RTOP 505-59-87-85; DA PROJ. 1L1-61102-AH-45)
(NASA-TM-109040-VOL-2; NAS 1.15:109040-VOL-2;
ATCOM-TR-93-A-012-VOL-2; NONP-SUPPL-DK-94-205050)
Avail: CASI SET A22 (HC,DK)

An Advanced Lightweight Rotor (ALR) model was tested in high-speed forward flight, mu = 0.37, at the 14- by 22-Foot Subsonic Tunnel at LaRC. A two-component laser velocimeter was used to obtain azimuthally dependent velocities in the inflow region and in the wake of the rotor. Data are presented without analysis. Author (revised)

N94-26497*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INVESTIGATION OF THE AERODYNAMIC ENVIRONMENT FOR AN ADVANCED LIGHTWEIGHT ROTOR IN FORWARD FLIGHT. VOLUME 3: LASER VELOCIMETER INFLOW DATA, ADVANCE RATIO OF 0.37, THRUST COEFFICIENT OF 0.0064 AND HOVER TIP SPEED OF 603 FEET/SECOND (Diskette Supplement)
W. DERRY MACE (Lockheed Engineering and Sciences Co., Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), MARTIN A. PERYEA (Textron Bell Helicopter, Fort Worth, TX.), ALBERT G. BRAND (Textron Bell Helicopter, Fort Worth, TX.), and TOM L. WOOD (Textron Bell Helicopter, Fort Worth, TX.) Nov. 1993 384 p Diskette supplement: IBM compatible 1.4 Mbyte 3.5-inch diskette in MS-DOS format
(Contract RTOP 505-59-87-85; DA PROJ. 1L1-61102-AH-45)
(NASA-TM-109040-VOL-3; NAS 1.15:109040-VOL-3;

ATCOM-TR-93-A-012-VOL-3; NONP-SUPPL-DK-94-209487)
Avail: CASI SET A22 (HC,DK)

An Advanced Lightweight Rotor (ALR) model was tested in high-speed forward flight, mu = 0.37, at the 14- by 22-Foot Subsonic Tunnel at LaRC. A two-component laser velocimeter was used to obtain azimuthally dependent velocities in the inflow region and in the wake of the rotor. Data are presented without analysis. Author (revised)

N94-26535# Naval Postgraduate School, Monterey, CA.
A FINITE WAKE THEORY FOR TWO-DIMENSIONAL ROTARY WING UNSTEADY AERODYNAMICS M.S. Thesis
MARK A. COUCH 23 Sep. 1993 69 p
(AD-A274921) Avail: CASI HC A04/MF A01

The unsteady aerodynamic forces and moments of an oscillating airfoil for the fixed wing case were determined by Theodorsen along with the development of a lift deficiency function. Loewy subsequently developed an analogous lift deficiency function for the rotary wing case in which there are an infinite number of layers of shed vorticity, or wakes, below the reference airfoil. With the advent of computer panel codes that calculate the time histories of the wakes generated by oscillating airfoils, a theory is developed for the rotary wing case in which there are a finite number of layers of shed vorticity below the reference airfoil. This theory includes a lift deficiency function that is completely analogous to Loewy and Theodorsen. It has long been recognized that an airfoil oscillating in pure plunge produces a propulsive force (Katzmayr effect). Garrick used Theodorsen's work to develop equations for the propulsive force that include the lift deficiency function as a parameter. When either Loewy's lift deficiency function or the finite wake lift deficiency function is used, the effect of the propulsive force is greatly enhanced with the proper phase relationship of the wakes. The finite wake theory along with Garrick's work is used to describe the performance characteristics of Higher Harmonic Control. Specifically for the OH-6A, coupled pitch-plunge motion results in a propulsive force that significantly reduces the rotor drag force. DTIC

N94-26538*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A COMPARATIVE STUDY OF SERIAL AND PARALLEL AEROELASTIC COMPUTATIONS OF WINGS
CHANSUP BYUN (MCAT Inst., Moffett Field, CA.) and GURU P. GURUSWAMY Jan. 1994 24 p
(Contract RTOP 505-10-11)
(NASA-TM-108805; A-94039; NAS 1.15:108805) Avail: CASI HC A03/MF A01

A procedure for computing the aeroelasticity of wings on parallel multiple-instruction, multiple-data (MIMD) computers is presented. In this procedure, fluids are modeled using Euler equations, and structures are modeled using modal or finite element equations. The procedure is designed in such a way that each discipline can be developed and maintained independently by using a domain decomposition approach. In the present parallel procedure, each computational domain is scalable. A parallel integration scheme is used to compute aeroelastic responses by solving fluid and structural equations concurrently. The computational efficiency issues of parallel integration of both fluid and structural equations are investigated in detail. This approach, which reduces the total computational time by a factor of almost 2, is demonstrated for a typical aeroelastic wing by using various numbers of processors on the Intel iPSC/860. Author (revised)

N94-26547*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL PREDICTION OF ISOLATED PERFORMANCE OF AN AXISYMMETRIC NOZZLE AT MACH NUMBER 0.90
JOHN R. CARLSON Feb. 1994 26 p
(Contract RTOP 505-62-30-01)
(NASA-TM-4506; L-17248; NAS 1.15:4506) Avail: CASI HC A03/MF A01

An improved ability to predict external propulsive performance was incorporated into the three-dimensional Navier-Stokes code PAB3D. The improvements are the ability to account for skin friction and external pressure forces. Performance parameters for two axisymmetric supersonic cruise nozzle configurations were calculated to test the improved methodology. Internal and external flow-field regions were computed using a two-equation kappa-epsilon turbulent viscous-stress model. The computed thrust-minus-drag ratios were within 1 percent of the absolute level of experimental data and the trends of data were predicted accurately. The predicted trend of integrated nozzle pressure drag matched the trend of the integrated experimental pressure drag over a range of nozzle pressure ratios, but absolute drag levels were not accurately predicted. Author (revised)

N94-26548*# Analytical Services and Materials, Inc., Hampton, VA.
THE MEASUREMENT OF DISTURBANCE LEVELS IN THE LANGLEY RESEARCH CENTER 20-INCH MACH 6 TUNNEL Final Report
P. C. STAINBACK and L. R. KUBENDRAN Mar. 1994 23 p
(Contract NAS1-19320; RTOP 505-70-59-03)
(NASA-CR-4571; NAS 1.26:4571) Avail: CASI HC A03/MF A01

Constant-temperature anemometry was used to measure the disturbance levels in the Langley Research Center 20-inch Mach 6 Tunnel over a limited range of total pressures. The measurements were made using a dual wire probe where each wire was operated at a high but different overheat. The fluctuating voltages were digitized and a system of two equations was solved to obtain the instantaneous mass flow and total temperature fluctuations as a function of time. Statistical techniques were used to obtain statistical quantities of interest. Author

N94-26602*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PILOTED SIMULATION STUDY OF AN ILS APPROACH OF A TWIN-PUSHER BUSINESS/COMMUTER TURBOPROP AIRCRAFT CONFIGURATION
DONALD R. RILEY, JAY M. BRANDON, and LOUIS J. GLAAB (Lockheed Engineering and Sciences Co., Hampton, VA.) Jan. 1994 120 p
(Contract RTOP 535-03-01-03)
(NASA-TM-4516; L-17215; NAS 1.15:4516) Avail: CASI HC A06/MF A02

A six-degree-of-freedom nonlinear simulation of a twin-pusher, turboprop business/commuter aircraft configuration representative of the Cessna ATPTB (Advanced turboprop test bed) was developed for use in piloted studies with the Langley General Aviation Simulator. The math models developed are provided, simulation predictions are compared with with Cessna flight-test data for validation purposes, and results of a handling quality study during simulated ILS (instrument landing system) approaches and missed approaches are presented. Simulated flight trajectories, task performance measures, and pilot evaluations are presented for the ILS approach and missed-approach tasks conducted with the vehicle in the presence of moderate turbulence, varying horizontal winds and engine-out conditions. Six test subjects consisting of two research pilots, a Cessna test pilot, and three general aviation pilots participated in the study. This effort was undertaken in cooperation with the Cessna Aircraft Company. Author (revised)

N94-26672 Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
AN INVESTIGATION INTO THE AERODYNAMIC EFFECTS OF WING PATCHES M.S. Thesis
CAMERON LINDSAY CARNEGIE 5 Oct. 1992 121 p
(ISBN-0-315-84121-4; CTN-94-61058) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

Many of the aircraft battle damage repair methods involve application of a patch as thick as 12.7 mm over the damaged area to compensate for loss of structural and skin strength. The effect of such patches on the aerodynamics of the CF-18 aircraft

wing is investigated. Boundary layer information was obtained by a series of wind tunnel tests on chamfered and unchamfered plates of various thicknesses at Reynolds numbers of 2,100 to 33,650. The results were expressed as polynomial curve fits with Delta H (the difference in shape factor across the patch edge) and (Delta Theta)/h (the ratio between the difference in momentum thickness across the patch edge and the step height or patch thickness) as functions of h divided by the initial momentum thickness. These plate correlation curves were then encoded into the Stalled Airfoil Modelling Package, which was used to analyze the effect of the patches on the flow over the CF-18 wing profile. The results revealed that even for the thickest patch (12.7 mm), the influence on lift is limited at low angles of attack but increases for angles of attack over 3 deg. The influence of the patches on drag is generally much greater and can double the drag coefficient with the thickest patches. A computer code listing is included.
Author (CISTI)

N94-26693*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL AND THEORETICAL STUDY OF AERODYNAMIC CHARACTERISTICS OF SOME LIFTING BODIES AT ANGLES OF ATTACK FROM -10 DEGREES TO 53 DEGREES AT MACH NUMBERS FROM 2.30 TO 4.62
M. LEROY SPEARMAN and ABEL O. TORRES Mar. 1994 25 p
(Contract RTOP 505-69-20-01)
(NASA-TM-4528; L-17269; NAS 1.15:4528) Avail: CASI HC A03/MF A01

Lifting bodies are of interest for possible use as space transportation vehicles because they have the volume required for significant payloads and the aerodynamic capability to negotiate the transition from high angles of attack to lower angles of attack (for cruise flight) and thus safely reenter the atmosphere and perform conventional horizontal landings. Results are presented for an experimental and theoretical study of the aerodynamic characteristics at supersonic speeds for a series of lifting bodies with 75 deg delta planforms, rounded noses, and various upper and lower surface cambers. The camber shapes varied in thickness and in maximum thickness location, and hence in body volume. The experimental results were obtained in the Langley Unitary Plan Wind Tunnel for both the longitudinal and the lateral aerodynamic characteristics. Selected experimental results are compared with calculated results obtained through the use of the Hypersonic Arbitrary-Body Aerodynamic Computer Program.
Author (revised)

N94-26702# Institute for Aerospace Research, Ottawa (Ontario).
INFLUENCE OF THE TRANSONIC DOUBLET IN THE FARFIELD OF A LIFTING AIRFOIL
M. MOKRY Oct. 1993 19 p
(IAR-AN-78; NRC-32161; CTN-94-61016) Avail: CASI HC A03/MF A01

In consideration of a need to extend the range of applicability of a linear method of correction for subsonic wind tunnel wall interference on airfoils to cases where the local supersonic pockets are extensive yet do not reach the upper and lower test section walls, a computational fluid dynamics based method for calculating the strength of the transonic doublet for a lifting, supercritical airfoil is presented. Experimentation with the finite volume, time-stepping solver of the Euler equation demonstrates that the computational domain used with the vortex boundary condition in farfield can be substantially reduced if the doublet term is also included. The increase of doublet strength due to nonlinear compressibility effects is a function of the far-upstream Mach number and lift coefficient, and is of an order of magnitude of the doublet strength based on the cross sectional area of the airfoil. The open-jet formula was shown to provide a sufficiently accurate incremental velocity correction to the previously corrected wind tunnel data by the linear subsonic method of Mokry and Ohman (1980).
Author (CISTI)

N94-26706*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FIBER-OPTIC-BASED LASER VAPOR SCREEN FLOW VISUALIZATION SYSTEM FOR AERODYNAMIC RESEARCH IN LARGER SCALE SUBSONIC AND TRANSONIC WIND TUNNELS
GARY E. ERICKSON and ANDREW S. INENAGA (Aerometrics, Inc., Sunnyvale, CA.) Jan. 1994 69 p
(Contract RTOP 505-68-30-03)
(NASA-TM-4514; L-17198; NAS 1.15:4514) Avail: CASI HC A04/MF A01

Laser vapor screen (LVS) flow visualization systems that are fiber-optic based were developed and installed for aerodynamic research in the Langley 8-Foot Transonic Pressure Tunnel and the Langley 7- by 10-Foot High Speed Tunnel. Fiber optics are used to deliver the laser beam through the plenum shell that surrounds the test section of each facility and to the light-sheet-generating optics positioned in the ceiling window of the test section. Water is injected into the wind tunnel diffuser section to increase the relative humidity and promote condensation of the water vapor in the flow field about the model. The condensed water vapor is then illuminated with an intense sheet of laser light to reveal features of the flow field. The plenum shells are optically sealed; therefore, video-based systems are used to observe and document the flow field. Operational experience shows that the fiber-optic-based systems provide safe, reliable, and high-quality off-surface flow visualization in smaller and larger scale subsonic and transonic wind tunnels. The design, the installation, and the application of the Langley Research Center (LaRC) LVS flow visualization systems in larger scale wind tunnels are highlighted. The efficiency of the fiber optic LVS systems and their insensitivity to wind tunnel vibration, the tunnel operating temperature and pressure variations, and the airborne contaminants are discussed.
Author (revised)

N94-27161*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LEADING-EDGE VORTEX-SYSTEM DETAILS OBTAINED ON F-106B AIRCRAFT USING A ROTATING VAPOR SCREEN AND SURFACE TECHNIQUES (Videotape Supplement)
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 See also N94-23512 Videotape supplement: 14 min., color, sound, VHS
(Contract RTOP 505-59-30-03)
(NASA-TP-3374-VIDEO-SUPPL; L-0793-127; NAS 1.60:3374-VIDEO-SUPPL; NONP-SUPPL-VT-94-209775) Avail: CASI VHS A01/BETA A22

In this video the following sequences are presented: flight-test operational procedures; animation of post-processing key elements; digitization process of flight video tape; extractor procedure demonstration; reconstructor procedure demonstration; reconstructor used to compare flight results from 1985 with those in 1991; enhancer procedure demonstration; and mapping of oil-flow photograph onto surface geometry for comparison with vapor-screen-determined vortex characteristics.
Author

N94-27235# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.
WIND TUNNEL INVESTIGATION OF AN STOL AIRCRAFT MODEL: AN EFFECT OF ENGINE NACELLE SHAPE [STOL ZENKI MOKEI FUDO SHIKEN: ENJIN NASERU KEIJO KOKA]
HITOSHI TAKAHASHI Jan. 1993 27 p In JAPANESE Prepared in cooperation with STOL Research Aircraft Group
(ISSN 0452-2982)
(NAL-TM-653; JTN-94-80621) Avail: CASI HC A03/MF A01

In initial wind tunnel tests on STOL experimental aircraft developed and researched by the National Aerospace Laboratory, a simulator engine nacelle which is longer and larger than that of 8 percent scales of FJR engines used in actual aircraft, was installed and tested on a model. To estimate ASKA's aerodynamics force data from wind tunnel data, the data was modified to take into account the different shapes of engine nacelle used in the simulated engine and that used in an 8 percent scale FJR (Fan Jet Research) engine. To confirm the adequacy of the modification, wind tunnel tests were conducted on a model with 8 percent scales FJR engine. From the comparison of the present test data with the initial test data and modified data, it was found that the correction of forces was overestimated and the correction of moments was fairly good. Author (NASDA)

N94-27554 National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.

HIGH-LIFT SYSTEM ANALYSIS METHOD USING UNSTRUCTURED MESHES

K. M. J. DECOCK 15 Sep. 1992 30 p Presented at the AGARD FDP Meeting and Symposium on High-Lift System Aerodynamics, Banff, Canada, 5-8 Oct. 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(NLR-TP-92351-U; ETN-94-95452; AD-B175579) Avail: CASI HC A03

A two dimensional high lift configuration analysis method is described. The flow model used is based on the Euler equations, discretized on unstructured meshes. The generation of the unstructured meshes is based on the principle of successive grid adaption with respect to the geometry. This approach makes later extension towards fully integrated grid adaption with respect to the solution straightforward. The main characteristics of the Euler solver are upwind flux difference splitting of the convective part of the Euler equations (second order accurate discretization in space) and four stage Runge-Kutta local time stepping. Results obtained with this analysis method are shown for the NACA0012 airfoil and three element airfoils. ESA

N94-27592# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. Grenzschichten und Unterschallstroemungen.

CONTROL OF LEADING-EDGE SEPARATION ON AN AIRFOIL BY LOCALIZED EXCITATION [STEUERUNG DER VORDERKANTENABLOSUNG AN EINEM FLUGELPROFIL DURCH LOKALE ANREGUNG]

ALEXANDER DOVGAL (Academy of Sciences, USSR, Novosibirsk.) May 1993 56 p Sponsored by Alexander von Humbolt Foundation

(ISSN 0939-2963)

(DLR-FB-93-16; ETN-94-95494) Avail: CASI HC A04/MF A01

The experimental investigation on the control of the separated flow over a low Reynolds number airfoil placed at high angles of attack was carried out. To reduce the separated flow and improve the airfoil's performance, some kind of periodic forcing can be used. A version of this control method consists in excitation of the flow through a narrow slot at the surface of the model near its leading edge. Such a technique was examined with emphasis on its operational principles. The study continues others concerning the use of a localized excitation for the separation control and makes clear some details about mechanisms responsible for the effect of the excitation on a separating flow. ESA

N94-27741# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. Hochgeschwindigkeits-Aerodynamik.

METHODS IN UNSTEADY AERODYNAMICS [VERFAHREN IN DER INSTATIONAEREN AERODYNAMIK]

WOLFGANG GEISSLER Jun. 1993 515 p In GERMAN

(ISSN 0939-2963)

(DLR-FB-93-21; ETN-94-95498) Avail: CASI HC A22/MF A04

Methods in unsteady aerodynamics used for the solution of aeroelastic and partly also for aeroacoustic problems are described. After a discussion of the necessary fundamental fluid mechanic inputs, the development and application of integral equation methods are described in two and three space dimensions for subsonic and supersonic flows. Unsteady airfoil flows as well as flows about wings, bodies, engine cowls, and aerodynamic interference problems between accelerated moving (oscillating) aircraft components are investigated. To handle nonlinear problems of unsteady flows with shock waves and/or with separation, corresponding numerical methods were discussed. In all cases comparisons with experimental data were performed. ESA

N94-27902*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.

INVESTIGATION OF AERODYNAMIC DESIGN ISSUES WITH REGIONS OF SEPARATED FLOW

TOM GALLY *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 89-90 Dec. 1993

Avail: CASI HC A01/MF A03

Existing aerodynamic design methods have generally concentrated on the optimization of airfoil or wing shapes to produce a minimum drag while satisfying some basic constraints such as lift, pitching moment, or thickness. Since the minimization of drag almost always precludes the existence of separated flow, the evaluation and validation of these design methods for their robustness and accuracy when separated flow is present has not been aggressively pursued. However, two new applications for these design tools may be expected to include separated flow and the issues of aerodynamic design with this feature must be addressed. The first application of the aerodynamic design tools is the design of airfoils or wings to provide an optimal performance over a wide range of flight conditions (multipoint design). While the definition of 'optimal performance' in the multipoint setting is currently being hashed out, it is recognized that given a wide range of flight conditions, it will not be possible to ensure a minimum drag constraint at all conditions, and in fact some amount of separated flow (presumably small) may have to be allowed at the more demanding flight conditions. Thus a multipoint design method must be tolerant of the existence of separated flow and may include some controls upon its extent. The second application is in the design of wings with extended high speed buffet boundaries of their flight envelopes. Buffet occurs on a wing when regions of flow separation have grown to the extent that their time varying pressures induce possible destructive effects upon the wing structure or adversely effect either the aircraft controllability or passenger comfort. A conservative approach to the expansion of the buffet flight boundary is to simply expand the flight envelope of nonseparated flow under the assumption that buffet will also thus be alleviated. However, having the ability to design a wing with separated flow and thus to control the location, extent and severity of the separated flow regions may allow aircraft manufacturers to gain an advantage in the early design stages of an aircraft, when configuration changes are relatively inexpensive to make. The goal of the summer research at NASA Langley Research Center (LaRC) was twofold: first, to investigate a particular airfoil design problem observed under conditions of strong shock induced flow separation on the upper surface of an airfoil at transonic conditions; and second, to suggest and investigate design methodologies for the prediction (or detection) and control of flow separation. The context of both investigations was to use an existing two dimensional Navier-Stokes flow solver and the constrained direct/iterative surface curvature (CDISC) design algorithm developed at LaRC. As a lead in to the primary task, it was necessary to gain a familiarity with both the design method and the computational analysis and to perform the FORTRAN coding needed to couple them together. Derived from text

N94-27919*# Virginia State Univ., Petersburg. Dept. of Engineering Technology.

AERODYNAMIC HEATING IN HYPERSONIC FLOWS

C. SUBBA REDDY *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 154-155 Dec. 1993

Avail: CASI HC A01/MF A03

Aerodynamic heating in hypersonic space vehicles is an important factor to be considered in their design. Therefore the designers of such vehicles need reliable heat transfer data in this respect for a successful design. Such data is usually produced by testing the models of hypersonic surfaces in wind tunnels. Most of the hypersonic test facilities at present are conventional blow-down tunnels whose run times are of the order of several seconds. The surface temperatures on such models are obtained using standard techniques such as thin-film resistance gages, thin-skin transient calorimeter gages and coaxial thermocouple or video acquisition systems such as phosphor thermography and infrared thermography. The data are usually reduced assuming that the model behaves like a semi-infinite solid (SIS) with constant properties and that heat transfer is by one-dimensional conduction only. This simplifying assumption may be valid in cases where models are thick, run-times short, and thermal diffusivities small. In many instances, however, when these conditions are not met, the assumption may lead to significant errors in the heat transfer results. The purpose of the present paper is to investigate this aspect. Specifically, the objectives are as follows: (1) to determine the limiting conditions under which a model can be considered a semi-infinite body; (2) to estimate the extent of errors involved in the reduction of the data if the models violate the assumption; and (3) to come up with correlation factors which when multiplied by the results obtained under the SIS assumption will provide the results under the actual conditions. Author (revised)

N94-27929*# California Univ., Davis. Dept. of Mechanical and Aeronautical Engineering.

PREDICTION OF LEADING-EDGE TRANSITION AND RELAMINARIZATION PHENOMENA ON A SUBSONIC MULTI-ELEMENT HIGH-LIFT SYSTEM

C. P. VANDAM *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 194-195 Dec. 1993

Avail: CASI HC A01/MF A03

Boundary-layer transition and relaminarization may have a critical effect on the flow development about multi-element high-lift systems of subsonic transport jets with swept wings. The purpose of the research is to study these transition phenomena in the leading-edge region of the various elements of a high-lift system. The flow phenomena studied include transition to the attachment-line flow, relaminarization, and crossflow instability, and transition. The calculations are based on pressure distributions measured in flight on the NASA Transport Systems Research Vehicle (Boeing 737-100) at a wing station where the flow approximated infinite swept wing conditions. The results indicate that significant regions of laminar flow can exist on all flap elements in flight. In future flight experiments (planned for January-February, 1994) the extent of these regions, the transition mechanisms and the effect of laminar flow on the high-lift characteristics of the multi-element system will be further explored. Author (revised)

N94-27930*# California State Univ., Los Angeles. Dept. of Mechanical Engineering.

COMPUTATION OF TRANSONIC VISCOUS FLOW PAST THE NTF 65-DEGREE DELTA WING

CHIVEY WU *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 196-199 Dec. 1993

Avail: CASI HC A01/MF A03

This project is a continuation of the work performed in the summers of 1991 and 1992, during which a 9-block structured grid for the computational domain around each of the four NTF 65-degree Delta Wing models with the sting mount were created. The objective of the project is to validate and supplement the test data on the wing models by computing the viscous flow field about the models. Author

N94-27955 ESDU International Ltd., London (England).

NORMAL FORCE OF LOW ASPECT RATIO CROPPED-DELTA WINGS AT PRE-STALL ANGLES OF ATTACK AND SUBSONIC SPEEDS

Dec. 1993 17 p

(ISSN 0141-397X)

(ESDU-93034; ISBN-0-85679-887-8) Avail: ESDU

ESDU 93034 presents graphical data at taper ratios of 0, 0.5, and 1, applying at Mach numbers of 0.5 and below, at at Mach numbers of 0.8 and 0.95. They were obtained by correlating experimental data drawn from the literature for delta, cropped delta, and rectangular thin, uncambered and untwisted, sharp-edge wings of aspect ratio from 0.2 to 4 and apply up to angles of attack of 35 degrees, that is up to the stall. Below an angle of attack of 5 degrees, the normal force is obtained from the normal-force curve slop at zero angle of attack, and a graph is provided for that based on the method of ESDU 70011. The accuracy of the method is within 5%. ESDU

N94-28021# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

COMPARISON OF THE INTERACTIONS OF TWO AND THREE DIMENSIONAL TRANSVERSE JETS WITH A HYPERSONIC FREE STREAM

H. E. G. POWRIE, G. J. BALL, and R. A. EAST *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 8 p Nov. 1993 Sponsored by Defence Research Agency

Copyright Avail: CASI HC A02/MF A04

The interaction between a three dimensional (circular) sonic jet and a Mach 6.69 cross flow on a flat plate has been investigated experimentally. The results are compared with data from a two dimensional (slot) sonic jet in the same flow. In both cases the undisturbed flow on the plate is laminar. Heat transfer and oil flow visualization have been used to identify separation and reattachment within the flow field which, for the case of circular injection, has revealed a number of vortex cells in the region ahead of the jet. For the two dimensional interaction there is only evidence of one vortex pair in this region; however, a complex flow downstream of the slot jet has been observed. The influence of injectant gas type on the two dimensional interaction flow field is limited to a weak molecular weight dependence implied by separation length data. In contrast, for three dimensional injection, jet gas composition is found to have a marked effect on the size of the interaction flow field, as well as influencing surface heat transfer rate in the vicinity of the injector. Author (revised)

N94-28022# Institut Franco-Allemand de Recherches, Saint-Louis (France).

EXPERIMENTS ON INTERACTION FORCE OF JETS IN HYPERVELOCITY CROSS-FLOW IN A SHOCK TUNNEL

K. W. NAUMANN, H. ENDE, G. MATHIEU, and A. GEORGE *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 12 p Nov. 1993

Copyright Avail: CASI HC A03/MF A04

This paper discusses experiments on side-jet control efficiency in the hypervelocity flow of a shock tunnel. The parameters of the test flow represent the Mach number, Reynolds number, velocity, and density of tropospheric hypervelocity flight. The experiments are carried out with a model, which is equipped with pyrotechnical charges, a settling chamber, laterally blowing jets, and a set of small accelerometers. The pyrotechnically supplied side-jets also are roughly adequate to those used in sound vehicles. Extensive jet gas diagnostics yield the parameters of the gas and the nozzle flow. The accelerometers incorporated in the model allow direct millisecond aerodynamic force measurement. To provide free-flight during the testing time, a fast-acting mounting support releases the model and grips it again when the test flow has passed the model. Using measured acceleration and Pitot pressure histories allows direct straightforward time-dependent evaluation of the aerodynamic coefficients. The procedure is insensitive to disturbances in the starting phase of the flow or moderate flow variations. The results quantify the force, which is produced by interaction of side-jets and ambient flow, and acts on the surface of the model. At the tropospheric hypervelocity conditions of our test, the interaction force on a flat plate substantially increases jet thrust. Moreover, the results quantify the time necessary to establish quasistationary flow for the actual test conditions. Author (revised)

N94-28027# Deutsche Aerospace A.G., Munich (Germany). Military Aircraft Div.
EFFECTS, LIMITS, AND LIMITATIONS OF SPANWISE BLOWING
W. H. STAUDACHER *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

Concentrated spanwise blowing over wings is a technique using mainly the secondary (= nonreactive) effects of a jet in crossflow, with the primary intention to generate and/or stabilize and control separated rolled-up leading edge vortex systems. This means an indirect application of a crossflow jet via triggering another crossflow phenomenon, the L.E. vortex. Based on the results of extensive experimental research, the merits and shortcomings of this technique are overviewed concerning aerodynamic performances, and stability and control aspects. The limits of aerodynamics efficiency are established on an empirical/theoretical basis and compared to experimental results. There is found a definite upper and lower boundary. The author's view is given concerning the practical (non-) applicability of this simple technique and the reasons for missing examples in operational aircraft are discussed via comparison to competitive approaches. Author

N94-28029# Stanford Univ., CA.
THEORETICAL AND EXPERIMENTAL INVESTIGATION OF A DELTA WING WITH TURBULENT LEADING-EDGE JETS
K. J. CRAIG, L. ROBERTS, D. I. GREENWELL (Bath Univ., England.), and N. J. WOOD (Bath Univ., England.) *In* AGARD, *Computational and Experimental Assessment of Jets in Cross Flow* 13 p Nov. 1993
Copyright Avail: CASI HC A03/MF A04

Control of the separated flow over a delta wing using Tangential Leading-Edge Blowing has been investigated experimentally and computationally. Tangential Leading-Edge Blowing describes the injection of momentum into the cross flow plane of the wing by thin Coanda wall jets located at the point of cross flow separation. The concept is shown to be capable of generating significant asymmetry in the vortical flowfield, and hence a lateral control capability, up to very high angles of attack. The primary effects of jet blowing have been modeled using a Navier-Stokes computation with an algebraic turbulence model. Author

N94-28039# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Aerodynamique.
EXPERIMENTAL STUDY ON THE INTERACTIONS BETWEEN A TRANSVERSE HEATED SUPERSONIC JET AND AN EXTERNAL SUPERSONIC FLOW [ETUDE EXPERIMENTALE SUR LES INTERACTIONS ENTRE UN JET SUPERSONIQUE CHAUFFE TRANSVERSAL ET UN ECOULEMENT SUPERSONIQUE EXTERNE]
R. GAILLARD, P. GEFFROY, L. JACQUIN, and G. LOSFELD *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 12 p Nov. 1993 In FRENCH
Copyright Avail: CASI HC A03/MF A04

This paper presents the techniques implemented as well as a collection of the results obtained during an experimentation leading to the S5 wind tunnel of ONERA in the case of a transverse jet of Mach number equal to 2, strongly heated, emerging in a perpendicular flow of the same Mach number. The flow is qualified by means of a miniature 5 hole probe, by thermocouples and tridirectional laser velocimetry. The effects of the temperature on the average and turbulent properties of the jet are discussed. Clear strioscopies are also presented. They highlight the strongly nonstationary nature of this interaction. Transl. by FLS

N94-28040# City Univ., London (England). Dept. of Mechanical Engineering and Aeronautics.
INCLINED AIR-JETS USED AS VORTEX GENERATORS TO SUPPRESS SHOCK-INDUCED SEPARATION
H. H. PEARCEY, K. RAO, and D. M. SYKES *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 10 p Nov. 1993 Sponsored by British Aerospace Defence Ltd.
Copyright Avail: CASI HC A02/MF A04

Experiments have been performed to assess the effectiveness of air-jet vortex generators as alternative to vanes in suppressing shock-induced separation. It is shown that a single jet inclined to the plane of the surface and skewed to the direction of the undisturbed stream produces a single strong vortex and can therefore be treated as the equivalent of a single vane. It follows that jets can be installed in arrays to correspond to arrays of vane vortex generators. A spanwise array of jets is shown to produce closely similar results to an array of co-rotating vane vortex generators of the type that has now been used in very many applications to suppress the effects of shock-induced separation. Air-jet vortex generators should therefore be equally effective in practice and may have significant inherent advantages for many applications. The vortex generators were effective for shock upstream Mach numbers up to and beyond 1.6. The maximum effectiveness occurred close to the generators but they remained reasonably effective for a range of shock positions of up to 50% chord. Some initial pointers are given on the influence of certain design parameters and on what considerations would apply in tailoring the jets to specific applications. Author

N94-28057 ESDU International Ltd., London (England).
CONTRIBUTION OF BODY-MOUNTED FINS AND TAILPLANES TO LATERAL DERIVATIVES DUE TO SIDESLIP AT SUBSONIC SPEEDS FOR GENERAL BODY WIDTH TO HEIGHT RATIO
Apr. 1993 35 p
(ISSN 0141-397X)
(ESDU-93007; ISBN-0-85679-859-2) Avail: ESDU

ESDU 93007 applies to single or twin fins on aircraft at angles of attack up to 6 degrees and angles of sideslip up to 4 degrees. It treats a wider range of body height/width ratios than ESDU 82010 which deals with the single body mounted fin for geometries typical of transport aircraft where body height/width ratio is close to one. The fin sideforce is calculated by applying a semi-empirical interference factor to a basic lift-curve slope estimated from ESDU 70011 for the wing obtained when the fin is reflected about its root chord. The interference factor takes account of body, wing and tailplane interference, and three factors are provided depending on the relative positions of all lifting surfaces. For twin fins a further empirical factor is applied. Yawing and rolling moments follow once the point of action of the sideforce is known; the point empirically determined in ESDU 82010 based on an assumed elliptical loading along the fin quarter-chord line was found to be satisfactory here as well. Methods are also given for estimating the small contributions to the yawing and rolling moments from a body-mounted tailplane. Plots of predicted results against experimental data extracted from 24 sources in the literature (together with some unpublished results) show the sideforce, yawing moment and rolling moment derivatives to be estimated within 0.08, 0.04 and 0.02 respectively. The ranges of geometry covered by the test data are tabulated, and two fully worked examples illustrate the use of the methods. ESDU

N94-28063 ESDU International Ltd., London (England).
LIFT-CURVE SLOPE FOR STRUCTURAL RESPONSE CALCULATIONS
Dec. 1993 20 p
(ISSN 0143-2702)
(ESDU-93013; ISBN-0-85679-865-7) Avail: ESDU

ESDU 93013 provides data for the rate of change with wind direction of the force components in the directions of the principal axes of the structure. The values are an essential input to the calculation methods of ESDU 89049 and 91010 for calculating the response of structures to buffeting by across-wind turbulence and the response in galloping, respectively. For building shapes, essentially prismatic blocks with only small edge rounding, tables give values for the two components for a range of cross-section aspect ratios and three levels of along-wind turbulence intensity; the values were obtained from the force correlations in ESDU 80003. For beam sections, values for both components are given for angle, channel, I-, H-, T- and X-sections and for two channel sections back-to-back; the data were obtained from the correlations in ESDU 82007. For bridge decks, data extracted from the literature are given for the across-wind component (that is, the rate of change of lift with wind direction) for over 30 different types of bridge. Where available, data are included on the solidity and aspect ratio of the barrier and on the turbulence levels in the original wind-tunnel tests. ESDU

N94-28071*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
NONEQUILIBRIUM RADIATION AND CHEMISTRY MODELS FOR AEROCAPTURE VEHICLE FLOWFIELDS Final Report
LELAND A. CARLSON Mar. 1994 189 p
(Contract NAG1-1003)
(NASA-CR-195706; NAS 1.26:195706; TAMRF-6382-94-01)
Avail: CASI HC A09/MF A02

The primary accomplishments of the project were as follows: (1) From an overall standpoint, the primary accomplishment of this research was the development of a complete gasdynamic-radiatively coupled nonequilibrium viscous shock layer solution method for axisymmetric blunt bodies. This method can be used for rapid engineering modeling of nonequilibrium re-entry flowfields over a wide range of conditions. (2) Another significant accomplishment was the development of an air radiation model that included local thermodynamic nonequilibrium (LTNE) phenomena. (3) As part of this research, three electron-electronic energy models were developed. The first was a quasi-equilibrium electron (QEE) model which determined an effective free electron temperature and assumed that the electronic states were in equilibrium with the free electrons. The second was a quasi-equilibrium electron-electronic (QEEE) model which computed an effective electron-electronic temperature. The third model was a full electron-electronic (FEE) differential equation model which included convective, collisional, viscous, conductive, vibrational coupling, and chemical effects on electron-electronic energy. (4) Since vibration-dissociation coupling phenomena as well as vibrational thermal nonequilibrium phenomena are important in the nonequilibrium zone behind a shock front, a vibrational energy and vibration-dissociation coupling model was developed and included in the flowfield model. This model was a modified coupled vibrational dissociation vibrational (MCVDV) model and also included electron-vibrational coupling. (5) Another accomplishment of the project was the usage of the developed models to investigate radiative heating. (6) A multi-component diffusion model which properly models the multi-component nature of diffusion in complex gas mixtures such as air, was developed and incorporated into the blunt body model. (7) A model was developed to predict the magnitude and characteristics of the shock wave precursor ahead of vehicles entering the Earth's atmosphere. (8) Since considerable data exists for radiating nonequilibrium flow behind normal shock waves, a normal shock wave version of the blunt body code was developed. (9) By comparing predictions from the models and codes with available normal shock data and the flight data of Fire II, it is believed that the developed flowfield and nonequilibrium radiation models have been essentially validated for engineering applications. Derived from text

N94-28072*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
AN INITIAL INVESTIGATION INTO METHODS OF COMPUTING TRANSONIC AERODYNAMIC SENSITIVITY COEFFICIENTS Final Report
LELAND A. CARLSON Mar. 1994 118 p
(Contract NAG1-793)
(NASA-CR-195705; NAS 1.26:195705; TAMRF-5802-94-01)
Avail: CASI HC A06/MF A02

The primary accomplishments of the project are as follows: (1) Using the transonic small perturbation equation as a flowfield model, the project demonstrated that the quasi-analytical method could be used to obtain aerodynamic sensitivity coefficients for airfoils at subsonic, transonic, and supersonic conditions for design variables such as Mach number, airfoil thickness, maximum camber, angle of attack, and location of maximum camber. It was established that the quasi-analytical approach was an accurate method for obtaining aerodynamic sensitivity derivatives for airfoils at transonic conditions and usually more efficient than the finite difference approach. (2) The usage of symbolic manipulation software to determine the appropriate expressions and computer coding associated with the quasi-analytical method for sensitivity derivatives was investigated. Using the three dimensional fully conservative full potential flowfield model, it was determined that symbolic manipulation along with a chain rule approach was extremely useful in developing a combined flowfield and quasi-analytical sensitivity derivative code capable of considering a large number of realistic design variables. (3) Using the three dimensional fully conservative full potential flowfield model, the quasi-analytical method was applied to swept wings (i.e. three dimensional) at transonic flow conditions. (4) The incremental iterative technique has been applied to the three dimensional transonic nonlinear small perturbation flowfield formulation, an equivalent plate deflection model, and the associated aerodynamic and structural discipline sensitivity equations; and coupled aeroelastic results for an aspect ratio three wing in transonic flow have been obtained. Derived from text

N94-28076 ESDU International Ltd., London (England).
PROGRAM FOR CALCULATION OF MAXIMUM LIFT COEFFICIENT OF PLAIN AEROFOILS AND WINGS AT SUBSONIC SPEEDS
Aug. 1993 27 p
(ISSN 0141-397X)
(ESDU-93015; ISBN-0-85679-867-3) Avail: ESDU

ESDU 93015 introduces a Fortran program for aerofoils and wings without high-lift devices. For aerofoils the method of ESDU 84026 is used, which itself relies on the prediction of lift-curve slope from ESDU Aero W.01.01.05. Sections can have a rough leading-edge (such as would result from ice formation) or a smooth leading-edge. The program applies a test to the section geometry data to determine whether the section has rear loading and trailing-edge thickness; such modern aerofoils have a higher maximum lift. If the user has not specified the section is modern, and the test shows that it is, the program will compute on that basis and print a warning. For wings the method of ESDU 89034 is used and assumes smooth leading-edges. The program first finds the spanwise location of peak loading for the given planform at each Mach number. The section geometry at each of those locations is then input, together with a camber and twist distribution which may be linear or non-linear. In the latter case, aerofoil data are also required at the wing root and at 2/3 of span to calculate the zero lift incidence at those two sections. The input and output formats are fully explained and illustrated with worked examples. The program is provided on disc (uncompiled) in the software volume as ESDUpac A9315. ESDU

N94-28091 ESDU International Ltd., London (England).
COMPUTATION OF STATIC PRESSURE DOWNSTREAM OF A NORMAL SHOCK FOR HYPERSONIC FLIGHT (AMBIENT TEMPERATURE KNOWN)
Aug. 1993 16 p
(ISSN 0141-4054)
(ESDU-93020; ISBN-0-85679-873-8) Avail: ESDU

ESDU 93020 is ancillary to and is for use in conjunction with ESDU 88025, which provides a definitive method for deriving primary air-data parameters in hypersonic flight with excellent precision, provided an accurate value of static pressure is available. ESDU 93020 provides an accurate means of deriving this static pressure without relying on a static pressure system. It is not possible to evaluate the relationship between the sensed static pressure and the real ambient pressure when the air is calorically and thermally imperfect as it is behind the shock in hypersonic flight. The static pressure is then used in the method of ESDU 88025. ESDU 93020 uses the ratio of static to total pressures behind a normal (detached) shock which is given in terms of quantities tabulated in ESDU 88025 and requires a knowledge of total temperature and pressure. However, it also requires a knowledge of the ambient temperature and the lapse rate, either from meteorological balloons or satellite observation, although an accuracy of 4 or 5 K for ambient temperature will be satisfactory. A worked example illustrates the use of the method for the same flight conditions used in the example in ESDU 88025. ESDU

N94-28140 ESDU International Ltd., London (England).
WING LIFT INCREMENT AT ZERO ANGLE OF ATTACK DUE TO DEPLOYMENT OF SINGLE-SLOTTED FLAPS AT LOW SPEEDS
Dec. 1993 17 p Supersedes Aero-F.01.01.08
(ISSN 0141-397X)
(ESDU-93019; AERO-F.01.01.08; ISBN-0-85679-872-X) Avail: ESDU

ESDU 93019 presents an empirical method that depends on determining the increment for an aerofoil representative of the wing and applying factors to allow for three-dimensional and part-span effects. ESDU 86033 is used to predict the increment for the aerofoil, depending on the extended deployed chord, and the section included trailing-edge angle. That increment is factored by the ratio of the wing to aerofoil lift curve slopes obtained respectively from ESDU 70011 and Aero W.01.01.05, thereby, accounting for aspect ratio, taper, and sweep effects. Finally, part-span factors are applied that depend on the spanwise center of pressure of the loading due to incidence obtained from ESDU 83040. The range of parameters for which the method was validated are tabulated and include aspect ratios of 3.7 to 9, taper ratios from 0.2 to 1, leading-edge sweep up to 48 degrees, Mach numbers up to 0.26, and flap deflections of 10 to 45 degrees. Sketches show the correlation between experimental results drawn from the literature and predicted results; for all results, 90 percent were correlated within 15 percent while for part-span cases alone 80 percent of the data were correlated to within 5 percent. A worked example illustrates the use of the method. ESDU

N94-28144 ESDU International Ltd., London (England).
EXAMPLES OF EXCRESCENCE DRAG PREDICTION FOR TYPICAL WING COMPONENTS OF A SUBSONIC TRANSPORT AIRCRAFT AT THE CRUISE CONDITION
Dec. 1993 88 p
(ISSN 0141-397X)
(ESDU-93032; ISBN-0-85679-885-1) Avail: ESDU

ESDU 93032 illustrates the application to a real situation of the ESDU data on drag due to cavities, grooves, steps, ridges, and control gaps, and the drag magnification factor applied to them to account for the effects of a nonuniform pressure distribution. An aileron, a leading-edge slat, a spoiler, a trailing-edge flap, a typical fuel tank access door, and a main undercarriage unit door are considered. For each component the necessary information is provided: graphs of flow data (Mach number, velocity, temperature, and density) and a detailed sketch showing all dimensions and sealing arrangement. Two cases are treated for each component: an ideal state with airtight seals and no avoidable surface mismatches, and a situation with poor sealing or surface mismatches. The comparison between results for the two cases illustrates the penalties from poor sealing or fits, and the possible effects of in-service deterioration. Detailed calculations are given for one feature of each excrescence, and the complete drag calculation is summarized in tabular form. The major contributions to the drag of each component are discussed and methods of reducing them are considered. The results from all the examples are finally reviewed to indicate the basic principles in design for low excrescence drag, and, to show their relative importance, the contribution of each component is expressed as a fraction of a plausible total excrescence drag for the wing. ESDU

N94-28188*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGH-SPEED RESEARCH: SONIC BOOM, VOLUME 1
THOMAS A. EDWARDS, ed. Feb. 1994 231 p Conference held in Moffett Field, CA, 12-14 May 1993; sponsored by NASA
(Contract RTOP 537-03-21)
(NASA-CP-10132; A-94045; NAS 1.55:10132) Avail: CASI HC A11/MF A03

The second High-Speed Research Program Sonic Boom Workshop was held at NASA Ames Research Center May 12-14, 1993. The workshop was organized into three sessions dealing with atmospheric propagation, acceptability, and configuration design. Volume 1 includes papers on atmospheric propagation and acceptability studies. Significant progress is noted in these areas in the time since the previous workshop a year earlier. In particular, several papers demonstrate an improved capability to model the effect of atmospheric turbulence on sonic booms. This is a key issue in determining the stability and acceptability of shaped sonic booms. In the area of acceptability, the PLdB metric has withstood considerable scrutiny and is validated as a loudness metric for a wide variety of sonic boom shapes. The differential loudness of asymmetric sonic booms is better understood, too.

N94-28189*# Pennsylvania State Univ., University Park. Graduate Program in Acoustics.
PROGRESS IN MODELING ATMOSPHERIC PROPAGATION OF SONIC BOOMS
ALLAN D. PIERCE *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 1-18 Feb. 1994
Avail: CASI HC A03/MF A03

The improved simulation of sonic boom propagation through the real atmosphere requires greater understanding of how the transient acoustic pulses popularly termed sonic booms are affected by humidity and turbulence. A realistic atmosphere is invariably somewhat turbulent, and may be characterized by an ambient fluid velocity v and sound speed c that vary from point to point. The absolute humidity will also vary from point to point, although possibly not as irregularly. What is ideally desired is a relatively simple scheme for predicting the probable spreads in key sonic boom signature parameters. Such parameters could be peak amplitudes, rise times, or gross quantities obtainable by signal processing that correlate well with annoyance or damage potential. The practical desire for the prediction scheme is that it require a relatively small amount of knowledge, possibly of a statistical nature, concerning the atmosphere along, the propagation path from the aircraft to the ground. The impact of such a scheme, if developed, implemented, and verified, would be that it would give the persons who make planning decisions a tool for assessing the magnitude of environmental problems that might result from any given overflight or sequence of overflights. The technical approach that has been followed by the author and some of his colleagues is to formulate a hierarchy of simple approximate models based on fundamental physical principles and then to test these models against existing data. For propagation of sonic booms and of other types of acoustic pulses in nonturbulent model atmospheres, there exists a basic overall theoretical model that has evolved as an outgrowth of geometrical acoustics. This theoretical model depicts the sound as propagating within ray tubes in a manner analogous to sound in a waveguide of slowly varying cross-section. Propagation along the ray tube is quasi-one-dimensional, and a wave equation for unidirectional wave propagation is used. A nonlinear term is added to this equation to account for nonlinear steepening, and the formulation has been carried through to allow for spatially varying sound speed, ambient density, and ambient wind velocities. The model intrinsically neglects diffraction, so it cannot take into account what has previously been mentioned in the literature as possibly important mechanisms for turbulence-related distortion. The model as originally developed could predict an idealized N-waveform which often agrees with data in terms of peak amplitude and overall positive phase duration. It is possible, moreover, to develop simple methods based on the physics of relaxation processes for incorporating molecular relaxation into the quasi-one-dimensional model of nonlinear propagation along ray tubes.
Derived from text

N94-28190*# Pennsylvania State Univ., University Park. Graduate Program in Acoustics.
IMPLICATIONS FOR HIGH SPEED RESEARCH: THE RELATIONSHIP BETWEEN SONIC BOOM SIGNATURE DISTORTION AND ATMOSPHERIC TURBULENCE

VICTOR W. SPARROW and THOMAS A. GIONFRIDDO *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 19-64 Feb. 1994
Avail: CASI HC A03/MF A03

In this study there were two primary tasks. The first was to develop an algorithm for quantifying the distortion in a sonic boom. Such an algorithm should be somewhat automatic, with minimal human intervention. Once the algorithm was developed, it was used to test the hypothesis that the cause of a sonic boom distortion was due to atmospheric turbulence. This hypothesis testing was the second task. Using readily available sonic boom data, we statistically tested whether there was a correlation between the sonic boom distortion and the distance a boom traveled through atmospheric turbulence. Derived from text

N94-28191*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Mechanical Engineering.
INTERACTION OF THE SONIC BOOM WITH ATMOSPHERIC TURBULENCE
ZVI RUSAK and JULIAN D. COLE *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom,, Volume 1 p 65-91 Feb. 1994
Avail: CASI HC A03/MF A03

Theoretical research was carried out to study the effect of free-stream turbulence on sonic boom pressure fields. A new transonic small-disturbance model to analyze the interactions of random disturbances with a weak shock was developed. The model equation has an extended form of the classic small-disturbance equation for unsteady transonic aerodynamics. An alternative approach shows that the pressure field may be described by an equation that has an extended form of the classic nonlinear acoustics equation that describes the propagation of sound beams with narrow angular spectrum. The model shows that diffraction effects, nonlinear steepening effects, focusing and caustic effects and random induced vorticity fluctuations interact simultaneously to determine the development of the shock wave in space and time and the pressure field behind it. A finite-difference algorithm to solve the mixed type elliptic-hyperbolic flows around the shock wave was also developed. Numerical calculations of shock wave interactions with various deterministic and random fluctuations will be presented in a future report. Author (revised)

N94-28192*# Texas Univ., Austin. Applied Research Labs.
SONIC BOOM PROPAGATION THROUGH TURBULENCE: A RAY THEORY APPROACH
LEICK D. ROBINSON *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 93-107 Feb. 1994
Avail: CASI HC A03/MF A03

A ray theory approach is used to examine the propagation of sonic booms through a turbulent ground layer, and to make predictions about the received waveform. The rays are not propagated one at a time, as is typical in ray theory; instead, sufficient rays to represent a continuous wave front are propagated together. New rays are interpolated as needed to maintain the continuity of the wave front. In order to predict the received boom signature, the wave front is searched for eigenrays after it has propagated to the receiver. The Comte-Bellot turbulence model is used to generate an instantaneous 'snapshot' of the turbulent field. The transient acoustic wave is assumed to be sufficiently short in duration such that the time-dependacde of the turbulent field may be neglected. Author (revised)

N94-28193*# Texas Univ., Austin. Applied Research Labs.
THE PROPAGATION OF SPARK-PRODUCED N WAVES THROUGH TURBULENCE
BART LIPKENS *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 109-132 Feb. 1994
Avail: CASI HC A03/MF A03

A model experiment was designed and built to simulate the propagation of sonic booms through atmospheric turbulence. The setup of the model experiment is described briefly. Measurements of the N waves after they propagated across the turbulent velocity field reveal the same waveform distortion and change in rise time as for sonic booms. The data from the model experiment is used to test sonic boom models. Some models yield predictions for the waveform distortion, while others give estimates of the rise time of the sonic booms. A new theoretical model for the propagation of plane N waves through a turbulent medium is described. Derived from text

N94-28194*# Wyle Labs., Inc., Arlington, VA.
ON THE AGING OF SONIC BOOMS
KENNETH J. PLOTKIN *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 133-151 Feb. 1994
Avail: CASI HC A03/MF A03

This paper presents view-graphs and notes on sonic boom aging. Topic covered include sonic boom propagation, George's minimized F-function, final minimum shock boom, amplitude and age parameters, off-track aging, scaling flight test experiments, the potential for thin shocks, and results of a Boomfile flight test that showed significant waveform distortion. CASI

N94-28315 Canadian Aeronautics and Space Inst., Ottawa (Ontario).
ABSTRACTS OF PAPERS PRESENTED AT THE 4TH CASI AERODYNAMICS SYMPOSIUM
1993 153 p Symposium held in Toronto, Ontario, 3-4 May 1993 Prepared in cooperation with National Research Council of Canada, Ottawa, Ontario Original contains color illustrations (ISBN-0-920203-01-9; CTN-94-61078) Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A symposium on aerodynamics was held to provide opportunities to exchange views on current technical topics. Papers were presented on wind tunnel tests, aerodynamic interactions, cabin noise suppression, propeller loads, turbine cascades, T-tail configurations, wind tunnel models, aircraft configurations, laminar / turbulent transitions, boundary layer prediction, shock wave interaction, Euler and Navier-Stokes flow computations, aerodynamic loads, ducted tip wings, airfoil stall modelling, flow modelling, drag prediction, nacelle design, computational grid generation, flow measurement, flow around airfoils, ice accretion on wings, and wind tunnel sidewall interference. Separate abstracts have been prepared for 37 papers from this symposium. Author (CISTI)

N94-28316 Institute for Aerospace Research, Ottawa (Ontario).
WIND TUNNEL INVESTIGATION OF PROPFAN SLIPSTREAM/WING INTERACTIONS ON A DE HAVILLAND AIR MOTOR POWERED SEMISPAN MODEL AT MACH NUMBERS 0.6 AND 0.7
V. D. NGUYEN, L. H. OHMAN (De Havilland Aircraft Co. of Canada Ltd., Downsview, Ontario.), and R. J. D. POOLE (De Havilland Aircraft Co. of Canada Ltd., Downsview, Ontario.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 1-4 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A wind tunnel investigation was carried out to assess the aerodynamic interactions of the propeller slipstream on a three dimensional wing of supercritical design, and to determine the flow characteristics immediately behind the propeller plane. A semispan model comprising a fuselage, zero sweep wing, and a powered nacelle was tested, to be representative of a generic model suitable for the design and performance analysis of a possible future transport aircraft. The wing was instrumented with 288 surface pressure orifices and the wing pressure distributions were measured and integrated to yield lift, drag, and pitching moment coefficients. Corrections for wall interference were made using the software package of Mokry et al (1987). Flow characteristics behind the propeller plane were determined using special five-hole probe rakes. The balance data indicated that the model force and moment coefficients were significantly affected by the propeller action. The slipstream was found to have at least an equally large effect as the propeller thrust negating the thrust component on the pitching moment. An increase in section lift coefficient was indicated for the propeller upwash zone and a decrease in the downwash zone. The propeller and its slipstream had little effect on the shock locations on the upper wing when the flow became supercritical. Author (CISTI)

N94-28317 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario).

FLOW FIELD INVESTIGATION IN THE NEAR SLIPSTREAM OF AN 8-BLADED PROPFAN ON THE DE HAVILLAND WTEJ HALF-MODEL AT MACH NUMBERS 0.6 AND 0.7

L. H. OHMAN, R. J. D. POOLE, V. D. NGUYEN (Institute for Aerospace Research, Ottawa, Ontario.), and J. BEENEN (Institute for Aerospace Research, Ottawa, Ontario.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 5-8 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Flow field data were acquired in the near slipstream of an 8-bladed 15-in. diameter propfan, nacelle mounted on a half-model wing configuration in a wind tunnel. The generally accepted five-hole probe technique was employed for the flow field measurements, with the probe heads located behind the propeller plane. Data were acquired at Mach numbers 0.6 and 0.7 at a Reynolds number of about 7.5 million. The propeller rpm and model angle of attack were varied moderately at each Mach number. It is shown that the radial flow angle was dominated by the nacelle geometry and virtually unaffected by the propeller action. The distribution of the circumferential flow angle and the propeller induced swirl angle was very non-uniform, mainly due to the effect of wing-lift induced upwash. The total pressure distribution was similar in character to that of the swirl angle. The Mach number losses or gains due to the action of the propeller were small. The value of the power coefficient derived from the motor power, with the survey rakes mounted, was found to be sensitive to rake orientation. A single-probe measurement investigation revealed that for the blade loading conditions used, probe arrangement indeed had a significant interference effect on the circumferential flow angle. For higher blade loadings, the probe interference effects became negligible. Author (CISTI)

N94-28323 Institute for Aerospace Research, Ottawa (Ontario).

MEASUREMENTS OF STEADY AND DYNAMIC PRESSURE ON AN F/A-18 WIND TUNNEL MODEL AT HIGH ANGLES OF ATTACK

F. C. TANG and B. H. K. LEE *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 29-32 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A wind tunnel investigation was conducted to expand the knowledge of high angle of attack aerodynamics and the structure of vortical flows. Measurements were made in the transonic test section of a 1.5 by 1.5-m wind tunnel using a six percent scale model of a F/A-18 aircraft in the Mach number regime of 0.25 to 0.9. Pressures on the upper and lower starboard leading edge extension and wing surfaces were measured and oil dots flow visualization experiments were carried out. The surface skin friction lines show presence of wing-tip and leading-edge vortices. Three dimensional pressure distribution plots of the wing surface show low pressure regions typical of those detected in the presence of vortical flow. The results are in good correlation with those obtained from flow visualization. Spectral analyses of the wing surface pressure signals indicate that the unsteady pressures can be represented by a Gaussian distribution. The deduced wing normal force has statistical properties resembling that of a Gaussian random process. At Mach number 0.6, the wing normal force coefficient varies with angles of attack monotonically. The fluctuating normal force coefficient rises rapidly at angles of attack around 25 degrees. The increase of unsteadiness is due to the bursting of vortex ahead of the wing at higher angles of attack. Author (CISTI)

N94-28328 Toronto Univ. (Ontario). Inst. for Aerospace Studies.

EXPERIMENTAL STUDY ON THE SHOCK WAVE INTERACTION WITH A HYPERSONIC BOUNDARY LAYER NEAR A CONVEX CORNER

R. J. HAWBOLDT, P. A. SULLIVAN, and J. J. GOTTLIEB *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 49-52 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

For many proposed scramjet engine inlet geometries, a thick boundary layer can develop on a long external compression surface before the flow is turned around a convex corner into the engine by an oblique shock wave. Separation at the corner is possible, thereby reducing the performance of the inlet. Experiments were conducted in a hypersonic gun tunnel to compare the onset and extent of separation of a laminar boundary layer caused by a shock wave impinging near a convex corner to the case of a shock reflecting from a flat plate. Some data were also provided for the validation of computational fluid dynamics codes. Surface static pressure was measured on a planar model that comprised a flat shock generator plate and an instrumented plate configured as either a flat plate or as a convex corner. The surface static pressure distribution was measured through four shock wave and flat plate boundary layer interactions and over two different convex corners. The interactions fell into three categories depending on the location of the separation and reattachment points with respect to the convex corner. The extent of flow separation is minimized when the separation point is located at the convex corner. For laminar flow, the ideal of perfect shock cancellation at the convex corner is unattainable. Author (CISTI)

N94-28329 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario). Research and Development Methods Group.

EULER AND NAVIER-STOKES WING/FUSELAGE COMPUTATIONS OF THE DE HAVILLAND DASH 8 AIRCRAFT

I. FEJTEK and G. D. JONES *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 53-56 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Computational techniques have been developed for the accurate calculation of the flow field in the wing/fuselage junction area of aircraft. Solving the Euler equations coupled with an integral boundary layer analysis for the wing/fuselage problem presents difficulties in modelling confluent boundary layers. Solution of the Navier-Stokes equations offers the potential for far greater accuracy for this type of calculation. The thin-layer approximation is made both normal to the wing and to the fuselage to compute the boundary layers. The equations are transformed into a generalized, body-fitted, curvilinear coordinate system and nondimensionalized with respect to freestream flow values. The system of equations is closed by relating the pressure to the conservative flow variables through the equation of state for a perfect gas. The numerical algorithm used to solve the three dimensional compressible thin-layer Navier-Stokes equations is an implicit, time accurate scheme called LU-ADI factorization. The computational grid is single-block and structured, with the wing and wake lying on one boundary of the computational domain. Results are presented for a preliminary solution obtained for the Dash-8 aircraft at zero angle of incidence and Mach number 0.6, showing rapid deceleration of flow ahead of the leading edge of the wing root. Author (CISTI)

N94-28330 Institute for Aerospace Research, Ottawa (Ontario). High Speed Aerodynamics Lab.

APPLICATION OF THE INFLUENCE FUNCTION METHOD USING THE INTERFERENCE DISTRIBUTED LOADS CODE TO PREDICTION OF STORE AERODYNAMIC LOAD DURING SEPARATION FROM THE CF-18 FIGHTER AIRCRAFT

AHMED MALEK *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics

Symposium p 57-60 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A hybrid numerical and experimental technique was used to predict aerodynamic loads for a series of external stores for the CF-18 aircraft. The method recognizes that every store has a unique response to the local flow angularities, both the upwash and sidewash, in the proximity of the parent aircraft. The numerical technique, based on the influence function method (IFM), requires that the store of interest be calibrated in a known nonuniform flow field and that the parent aircraft flowfield angularities are known at the store flight regimes of interest. In recognition of the costly wind tunnel test data required by the method's calibration process, a numerical tool, the Interference Distributed Loads (IDL) code, was used in conjunction with the IFM to calculate the influence coefficients of the store of interest. Upwash and sidewash distributions in the under-wing flow field of a CF-18 model were obtained from wind tunnel measurements and the IFM/IDL method was used to predict the aerodynamic loads for a particular CF-18 external store. The predictions were compared with previous calculations in which stores calibration was performed in a flow field generated by an ogive-cylinder body. The IFM/IDL method provided better prediction of store moment coefficients, while the previous method gives better prediction of the store force coefficients. Author (CISTI)

N94-28331 British Columbia Univ., Vancouver. Dept. of Mechanical Engineering.
AERODYNAMIC PERFORMANCE OF NOVEL DUCTED-TIP WINGS
S. Z. DUAN and S. I. GREEN *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 61-64 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Experiments were conducted in a low speed wind tunnel to study the impact of a ducted-tip wing on lift/drag performance. The wing tested was a rectangular planform NACA 66-209 airfoil fitted with 92 surface pressure taps and fitted with a variety of wing tips. The first type of tip was a nearly circular section duct attached to the wing, ranging from the full chord to 65 percent of chord length. The second kind of tip was a pair of NACA 0006 short airfoils joined at both span ends, resulting in a rectangular box assembly. A simple tip extension forming a square cut wing was used for baseline performance measurements. The partial chord ducted wing tip had superior performance to all the other tip geometries, and results are presented showing lift coefficient, drag coefficient and lift/drag ratio, and pressure distribution. At modest angles of attack, the ducted tip is significantly less efficient than a conventional tip, while at angles of attack of about 8 deg or more, the ducted tip has up to 6 percent better lift/drag performance than a square cut wing tip of equal span. The main cause of this performance improvement is the greatly reduced induced drag at high lift coefficients. It is suggested that there is a significant role for the ducted tip design in both military and civilian propeller applications. Author (CISTI)

N94-28332 Nanyang Technological Inst. (Singapore).
POTENTIAL FLOW MODELLING OF AIRFOIL STALL
W. W. H. YEUNG and G. V. PARKINSON (British Columbia Univ., Vancouver.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 65-68 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Examples are presented of recent work using classical analytical methods to model airfoil stall. Where separated flow is involved as with airfoils near stall, it is realistic to assume that the airfoil surface exposed to the wake is at constant pressure, and that the shear layers bounding the wake can be simulated by free streamlines. The airfoil pressure loading and the flow pattern outside the wake can then be determined using the powerful properties of singularities in creating the flow models and conformal mapping in solving the resulting boundary value problems. The method is first applied to single and two-element airfoils experiencing trailing edge stall. For a single airfoil, a simple series of conformal transformations is used to map a Joukowsky airfoil, with part of its upper surface removed, onto a circle for which the flow problem is solved. The simplicity of this method permits its extension to airfoil-flap configurations in which trailing edge stall occurs on the flap. The pressure distribution calculated by the theory for a single Joukowsky airfoil closely matching a NACA 23012 profile was compared to wind tunnel measurements and showed good agreement. Author (CISTI)

N94-28333 British Columbia Univ., Vancouver. Dept. of Mechanical Engineering.
NON-ISOENERGETIC INVISCID SLOT FLOW
D. M. STROPKY, I. S. GARTSHORE, and M. SALCUDEAN *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 69-72 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A new method was developed for predicting the flow from an arbitrarily inclined slot into a uniform free stream of arbitrarily different density and total pressure. With inviscid flow, the streamline separating the injectant and main stream can be considered as a solid boundary. The flowfield is divided into two zones, an internal region containing the slot fluid and an external region composed of the free stream fluid. Each region is solved independently, while the dividing streamline shape that provides continuity of static pressure is determined via an iterative procedure. Selected results are presented, showing that inviscid theory, when carefully applied, can describe the essential features of the flow provided some allowance is made for separation from the downstream lip at higher mass flow ratios and higher slot angles, and provided that the mainstream boundary layer is thin relative to the slot width. For application to secondary injection devices such as film-cooled turbine blades, the method shows that diffusive effects in most cases are not important for predicting the mass flow ratio. Author (CISTI)

N94-28334 Canadair Ltd., Montreal (Quebec).
CALCULATION OF UNSTEADY INCOMPRESSIBLE INVISCID FLOW ABOUT WINGS AND BODIES USING CANAERO-T PANEL MODEL
F. I. TEZOK and J. T. CONWAY (Agder Coll. of Engineering, Gromstad, Norway.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 73-77 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

CANAERO-T is a low order, time-stepping panel method modeling the unsteady potential flow around a configuration using linear source panels on the surface and bi-linearly varying doublet panel distribution along the span and camber surface. The implementation and testing of the CANAERO-T unsteady code is described, along with a description of the mathematical formulation of the method, some features of which appear to be unique. Results and discussions are presented for the case of an impulsively started wing, an impulsively started oscillating wing, and a submarine performing a slow oscillation of drift angle. Pressure distributions and wake structures calculated for the wings are illustrated. The oscillating wing solution clearly shows an oscillatory shape of the wake and a wake self interaction causing a mushrooming effect in the wake geometry downstream. Author (CISTI)

N94-28335 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario). Research and Development Methods Group.
DRAG PREDICTION BY WAKE INTEGRALS USING 3-D MULTI-GRID EULER METHOD (MGAERO)
G. C. WALLER *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 78-81 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A method of drag prediction for Euler methods by integration of flow properties across the model wake developed by van Dam was applied to the MGAERO three dimensional multi-grid program used in aircraft aerodynamic design. Van Dam derived integral expressions for lift and drag based on the equations of motion for steady, inviscid three dimensional flow about a lifting wing. In MGAERO, the van Dam method is applied by placing a survey plane normal to freestream downstream of the model, and the cross-flow velocity components are calculated over a rectangular mesh. The derivative of the velocities gives local vorticity, which in turn is integrated to give local stream function. These variables give the lift and induced drag terms; wave drag is derived from the integral of entropy over the survey plane. The MGAERO wave drag estimate value compares sensibly with van Dam's estimates for a NACA-0012 airfoil, and the MGAERO wake integral drag value is greatly improved over the surface pressure integration value. In applying wake integral drag estimation to the design of a high-wing turboprop configuration, good agreement in lift curve and induced drag was obtained with a vortex lattice panel program. The MGAERO program represents a more detailed model of the aircraft and its flowfield, so that more subtle design changes can be evaluated against drag. Author (CISTI)

N94-28337 Toronto Univ. (Ontario). Inst. for Aerospace Studies.

VISCOUS AIRFOIL COMPUTATIONS USING ADAPTIVE STRUCTURED GRIDS

D. J. HALL and D. W. ZINGG *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 86-89 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A solution adaptive grid generator can reduce the numerical errors in fluid flow computations by clustering grid points in regions of high error. A study of adaptive redistribution applied to viscous airfoil flows is presented which uses the adaptive method of Eiseman. An elliptic system of partial differential equations is formulated with control functions which adaptively cluster points to specified regions in each coordinate direction. The adaptive grid generation scheme is applied to C-grid configurations about airfoil sections. Results are presented for unadapted hypberbolic and elliptic grids as well as for adapted elliptic grids. Parametric studies were conducted to determine a suitable set of input parameters for both boundary layer and streamwise pressure adaptation. Several forms of the weight function were investigated and it was found that a Mach number gradient formulation with a clustering parameter dependent on the grid geometry gives good results. The results show that grid adaptation effectively reduces the lift and overall drag errors for all cases and all grids studied. The magnitude of the error reduction depends on both the flow characteristics and the initial grid. In particular, errors in friction drag are substantially reduced. Author (CISTI)

N94-28338 Institute for Aerospace Research, Ottawa (Ontario). High Speed Aerodynamics Lab.

SOLUTION OF THE EULER EQUATIONS USING UNSTRUCTURED GRIDS

D. J. JONES and B. MACLEOD *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 90-93 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Unstructured grids have many advantages over structured grids in solving computational problems of aerodynamic interest. A technique for generating unstructured grids has been developed, based on Voronoi regions and Delaunay triangulation, which can produce grids with nearly equilateral triangles in two dimensions. In an application of the technique, the Delaunay grid was obtained and then the method of Stolcis and Johnston (1990), based largely on Jameson's method, was used to obtain solutions to the Euler equations. Emphasis was first placed on supersonic flow situations including a rare application to symmetric blunt body flows. The development was recently extended to subsonic free stream situations for airfoils as part of a validation exercise. Results from four cases are illustrated: flow around a cylinder at Mach 3, Mach 1.2 flow around a NACA 0012 airfoil at 7 deg angle of attack, flow around a sphere at Mach 1.08, and Mach 0.75 flow around a RAE2822 airfoil at 3 deg angle of attack. Author (CISTI)

N94-28339 Toronto Univ. (Ontario). Inst. for Aerospace Studies.

ATTACHED AND SEPARATED TRAILING EDGE FLOW MEASUREMENTS WITH A TRIPLE-SPLIT HOT-FILM PROBE

M. D. DOIRON, D. W. ZINGG, and P. GODIN *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 94-97 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Attached and separated trailing-edge flow measurements with a triple-split hot-film probe are presented. The probe, consisting of three nickel films deposited on a quartz cylinder and operating on the basis of variations in local convective heat transfer coefficient, has the potential to provide inexpensive measurements of separated flows. Measurements of mean-flow and turbulent stresses near the trailing edge of a 17 percent thick airfoil with moderate aft-loading were obtained at zero and 9.2 deg angles of attack at a Mach number of 0.15. Computations were also performed using the Baldwin-Lomax algebraic model and the Baldwin-Barth one-equation model (1990). Computed and measured force and moment coefficients, surface pressure distributions, and mean velocity and turbulent shear stress profiles are compared. The computations show reasonable agreement with the experimental measurements for the attached flow case but differ substantially when the flow is separated. Author (CISTI)

N94-28340 Institute for Aerospace Research, Ottawa (Ontario).

A STUDY OF BLUNT TRAILING EDGE AIRFOILS USING THE NAVIER STOKES CODE: ARC2D

M. KHALID and D. J. JONES *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 98-101 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

The performance of a number of turbulence models is compared in terms of their ability to predict viscous flow in the boundary layer and near-wake region of airfoil profiles with blunt trailing edges. The Baldwin-Lomax model (1978) uses different expressions for tubulent viscosity in the inner and outer viscous region, with a blending formula in the overlap region. This approach was also adapted in the current Johnson-King model (1985), which relates the nonequilibrium eddy viscosity to the maximum shear stress distribution in the chordwise direction, which in turn is obtained from the kinetic energy equation. The other two models evaluated were the Baldwin-Barth and the mixing length models. For velocity profiles, the Johnson-King model provided the closest approximation to experimental data. The computations, and to some extent the velocity profile measurements, demonstrated the existence of a complex vortical flow system behind the trailing edge of an airfoil. This system influences the flow field in a global sense and has some bearing on airfoil aerodynamic performance. Author (CISTI)

N94-28341 Toronto Univ. (Ontario). Inst. for Aerospace Studies.

THIN-LAYER NAVIER-STOKES COMPUTATIONS FOR MULTI-ELEMENT AIRFOILS

A. R. WILKINSON, T. E. NELSON, D. W. ZINGG, and G. W. JOHNSTON *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 102-105 1993

Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Recent work on grid generation and Navier-Stokes computations for multi-element airfoils is presented. Decomposition of the flow domain into topologically rectangular blocks is accomplished using an automated procedure. The compressible thin-layer Navier-Stokes equations are solved using the diagonal form of the implicit approximate factorization algorithm of Beam and Warming (1986) extended for multiblock grids. Turbulence is modelled using the one-equation model of Baldwin and Barth (1990). The accuracy of the flow solver was investigated by detailed comparisons with experiment for several high-lift geometries with varying amounts of separation. Accurate results are generally obtained for attached and mildly separated flows. When the region of separated flow is larger, its thickness tends to be underestimated, and as a consequence, maximum lift and post-stall behavior are not predicted accurately. Although the turbulence model is a major source of error, other sources of error such as the thin-layer approximation and the treatment of the turbulent normal stresses cannot be ignored. Author (CISTI)

N94-28344 National Research Council of Canada, Ottawa (Ontario).
SOLUTION-ADAPTIVE SIMULATION OF TRANSONIC CASCADE FLOWS
T. C. CURRIE *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 114-117 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A solution adaptive, two-dimensional code has been developed to solve the Euler or Navier-Stokes equations on triangular grids. The Euler fluxes of mass, momentum, and energy are integrated over the faces of non-overlapping polygonal cells formed from the median dual of a triangular mesh. Interfacial fluxes are evaluated using Roe's flux difference splitting scheme (1981). A Galerkin discretization of the viscous terms is used, assuming piecewise linear variation of the primitive variables within the triangular cells. The discretized equations are solved with either a multigrid accelerated Runge-Kutta time-marching scheme or a fully implicit Newton-Raphson procedure. The multigrid algorithm is a particularly simple one adapted from a scheme originally developed by Denton (1984) and later by Wang et. al. (1991) for structured grids. The code described has been validated against several benchmarks including inviscid flow in a supersonic compressor cascade and laminar flow over a flat plate. Author (CISTI)

N94-28346 Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
PRELIMINARY ASSESSMENT OF AERODYNAMIC EFFECTS OF WING REPAIR PATCHES
R. J. KIND and C. CARNEGIE *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 122-125 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A preliminary assessment was obtained of the possible negative effects of aircraft damage repair patches on the aerodynamic performance of a CF-18 aircraft wing. Wind tunnel tests were conducted to measure the effects of patches of various thickness on two-dimensional boundary layers. The wind tunnel data were used to develop a set of correlation curves for describing the main effects of patches on boundary layers. These correlations are incorporated into computations for analysis of two-dimensional viscous incompressible flow, including stall effects, over airfoils. An inviscid potential flow (panel method) program is coupled with a boundary layer program into which the correlations are incorporated. Boundary layer displacement and separation effects modify the potential flow solution, and the predicted drag and lift on the airfoil. The results suggest that half-inch thick patches on a CF-18 wing would cause large reductions in lift at angles of attack near that for section stall, but that only moderate lift reductions would occur at lower angles of attack, provided that most of the pressure recovery aft of the suction peak has occurred before the flow reaches the patch. Patches cause substantial drag increases at all angles of attack below stall. Author (CISTI)

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AIR TRANSPORTATION AND SAFETY

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

N94-24841# National Transportation Safety Board, Washington, DC. Office of Research and Engineering.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA. US GENERAL AVIATION CALENDAR YEAR 1990
17 Dec. 1993 83 p
(PB94-126869; NTSB/ARG-93/02) Avail: CASI HC A05/MF A01

This report presents a statistical compilation and review of general aviation accidents which occurred in 1990 in the United States, its territories and possessions, and in international waters. The accidents reported are all those involving U.S. registered aircraft not conducting operations under 14 CFR 121, 14 CFR 125, 14 CFR 127, or 14 CFR 135. This report is divided into five actions: all accidents, fatal accidents, serious injury accidents, property damage accidents, and midair collision accidents. Several tables present accident parameters for 1990 accidents only, and each section includes tabulations which present comparative statistics for 1990 and for the five-year period 1985-1989. Author (revised)

N94-24864# Anacapa Sciences, Inc., Fort Rucker, AL.
AVIATION SYSTEM SAFETY RISK MANAGEMENT TOOL ANALYSIS. VOLUME 2: APPENDICES Final Report
D. C. THILL and D. B. HAMMILTON Oct. 1993 372 p
(Contract MDA903-92-D-0025)
(AD-A273502; ARL-CR-120-VOL-2) Avail: CASI HC A16/MF A03

U.S. Army risk management is a process used to minimize loss of life, injuries, and property damage. One step in the risk management process is risk assessment. Currently, risk assessment assigns a probability value for an identified hazard, based on a subjective evaluation. The need exists to assign objective probability values when assessing the risks imposed by aircraft component and part failures. This research extracted UH-60 and UH-1 helicopter part failure data for a ten-year period from the Army Safety Management Information System (ASMIS) data base. Data inconsistencies were corrected, the corrected data were organized into groups, and failure rates were calculated. The results established that component and part failure analyses can be successfully conducted using available data bases and that these data can be used to quantify hazard probabilities for failed aircraft components and parts. Volume one of this report describes the methodology used to obtain the failure rates, presents the results of the analyses, discusses potential uses for the data, and provides recommendations for further research. Volume two provides a table of part failure rates and a list of records for the UH-60 (see Appendix A) and for the UH-1 (see Appendix B). DTIC

N94-24941# Federal Aviation Administration, Atlantic City, NJ.
FULL-SCALE FIRE TESTING OF SEAT COMPONENT MATERIALS
PATRICIA GAHILL Oct. 1993 26 p
(AD-A273499; DOT/FAA/CT-TN93/13) Avail: CASI HC A03/MF A01

Full-scale fire testing was conducted in a furnished aircraft cabin to compare a currently used thermoplastic material and a new thermoplastic material with low heat and smoke release characteristics used in forming seat components. This testing was conducted due to questions concerning the exemption of seat components from the heat release and smoke requirement mandated for certain large surface area components in the aircraft fuselage. Results of the fullscale testing showed no significant difference in temperatures, smoke levels, or oxygen depletion between the two materials. While carbon monoxide and carbon dioxide emissions were slightly higher with the currently used material, it cannot be concluded that this material was the cause. Based on the overall data, it appears that the small amount of seat component material is not significantly contributing to increased fire hazards. DTIC

N94-25141# Army Aeromedical Research Lab., Fort Rucker, AL.
PROJECTED EFFECTIVENESS OF AIRBAG SUPPLEMENTAL RESTRAINT SYSTEMS IN US ARMY HELICOPTER COCKPITS Final Report
DENNIS F. SHANAHAN, SAMUEL G. SHANNON, and JAMES E. BRUCKART Sep. 1993 27 p
(Contract DA PROJ. 3M1-62787-A-878)
(AD-A273250) Avail: CASI HC A03/MF A01
Despite significant advances in accident prevention, crashworthiness, and individual protective equipment, head and torso injuries continue to cause death and disabling injuries in survivable Army helicopter accidents. Most of these injuries are caused by the occupant striking internal structures. The purpose of this study was to review Army helicopter accident records to determine the number of fatal and disabling injuries in pilots and copilots that could be prevented with the introduction of an airbag supplemental restraint system into U.S. Army helicopter cockpits. DTIC

N94-25153# General Accounting Office, Washington, DC. National Security and International Affairs Div.
C-17 LOT 3 PRODUCTION CONTRACT
24 Sep. 1993 6 p
(AD-A273180; GAO/NSIAD-93-301R) Avail: CASI HC A02/MF A01
This report responds to your request for information on the estimated cost at completion for the C-17 program's lot III production contract. Specifically, you requested that we (1) review the basis for the Defense Plant Representative Office's (DPRO) modification to its original cost estimate and (2) provide our assessment of whether costs are likely to exceed the C-17 lot III contract ceiling price. DTIC

N94-25175# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: IN-FLIGHT LOSS OF PROPELLER BLADE AND UNCONTROLLED COLLISION WITH TERRAIN MITSUBISHI MU-2B-60, N86SD, ZWINGLE, IOWA, 19 APRIL 1993
16 Nov. 1993 130 p
(PB93-910409; NTSB/AAR-93/08) Avail: CASI HC A07/MF A02
The in-flight loss of propellar blade and subsequent crash of an Mu-2B-60 airplane, operated by the South Dakota Department of Transportation, while the flightcrew was attempting an approach to an emergency landing at Dubuque Regional Airport, Dubuque, Iowa, on 19 April 1993 is explained. The safety issues discussed include the propeller hub design, certification and continuing airworthiness, and air traffic control training. Recommendations concerning these issues were made to the Federal Aviation Administration. Author (revised)

N94-25272*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONFLICT-FREE TRAJECTORY PLANNING FOR AIR TRAFFIC CONTROL AUTOMATION
RHONDA SLATTERY and STEVE GREEN Jan. 1994 19 p
Original contains color illustrations
(Contract RTOP 505-64-13)
(NASA-TM-108790; A-93132; NAS 1.15:108790) Avail: CASI HC A03/MF A01; 6 functional color pages
As the traffic demand continues to grow within the National Airspace System (NAS), the need for long-range planning (30 minutes plus) of arrival traffic increases greatly. Research into air traffic control (ATC) automation at ARC has led to the development of the Center-TRACON Automation System (CTAS). CTAS determines optimum landing schedules for arrival traffic and assists controllers in meeting those schedules safely and efficiently. One crucial element in the development of CTAS is the capability to perform long-range (20 minutes) and short-range (5 minutes) conflict prediction and resolution once landing schedules are determined. The determination of conflict-free trajectories within the Center airspace is particularly difficult because of large variations in speed and altitude. The paper describes the current design and implementation of the conflict prediction and resolution tools used to generate CTAS advisories in Center airspace. Conflict criteria (separation requirements) are defined and the process of separation prediction is described. The major portion of the paper will describe the current implementation of CTAS conflict resolution algorithms in terms of the degrees-of-freedom for resolutions as well as resolution search techniques. The tools described in this paper have been implemented in a research system designed to rapidly develop and evaluate prototype concepts and will form the basis for an operational ATC automation system. Author (revised)

N94-25273# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT: CONTROLLED FLIGHT INTO TERRAIN GP EXPRESS AIRLINES, INC., N115GP BEECHCRAFT C-99, SHELTON, NEBRASKA, 28 APRIL 1993
19 Jan. 1994 67 p
(PB94-910401; NTSB/AAR-94/01/SUM) Avail: CASI HC A04/MF A01
The crash of N115GP into terrain at Shelton, Nebraska is explained. The safety issues discussed include attempted aerobatic maneuvers in commercial aircraft, check flights among peers, management responsibility to instill commitment of flight safety, and Federal Aviation Administration oversight of 14 CFR Part 135 operations. Author (revised)

N94-25780# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague (Netherlands). Physics and Electronics Lab.
A FEASIBILITY STUDY ON BIRD CLASSIFICATION WITH NEURAL NETWORK Final Report
P. P. MEILER Jun. 1992 61 p
(AD-A273753; FEL-91-A301; TDCK-TD-91-4352) Avail: CASI HC A04/MF A01
This study shows that it is feasible to classify flying birds using radar and neural network technology. The Royal Dutch Airforce is interested in the capability to classify birds because this capability can be used to avoid collisions between birds and airplanes. The Automatic Gain Control (AGC) signal which is generated by the Flycatcher tracking radar has a relationship with the wing stroke pattern of a bird. An automatic system to classify birds using the AGC signal could be used in a bird collision warning system. Such a system does not yet exist. A prototype of a bird classification system has been implemented and evaluated. Test results based on simulated AGC data show that the prototype is able to classify birds. The prototype uses simulated AGC data because there is not yet enough real AGC data available to use neural network technology. Acquisition of real AGC data is too expensive to be done in the framework of a feasibility study. According to the test results it is recommended to acquire real AGC data. DTIC

N94-26293 Aerospatiale, Toulouse (France).
SYSTEM FOR GENERATING, ABOARD AN AIRCRAFT, DURING TAKEOFF, OF A SIGNAL CAPABLE OF PRODUCING AN ALERT OR AN ALARM, IN CASE OF MALFUNCTION Patent [SYSTEME POUR L'ELABORATION A BORD D'UN AERONUF D'UN SIGNAL D'INFORMATION PENDANT LE DECOLLAGE AVEC ALERTE OU ALARM EN CAS D'ANOMALIE]
JEAN-LOUIS BONAFE, inventor (to Aerospatiale) 13 Dec. 1991 15 p In FRENCH Filed 13 Jun. 1990
(CA-PATENT-APPL-SN-2,018,940; INT-PATENT-CLASS-G01C2300; CA-PATENT-CLASS-354-25; CTN-92-60366) Copyright Avail: Micromedia Ltd., Technical

Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC

A system is disclosed for generating an alarm signal on an aircraft in case of takeoff malfunctions. According to the invention, means are provided for delivering signals representative of the theoretical and real accelerations of the aircraft, at a given instant. Other means are provided for calculating the predicted real distance travelled by the aircraft at a theoretical aircraft velocity corresponding to the real aircraft velocity, and for calculating the ratio of the above calculated distance to the theoretical distance travelled by the aircraft. The above ratio is compared to a predetermined level guaranteeing a minimum safe distance for braking and stopping the aircraft. An information signal is supplied to alarm means which are capable of emitting an alarm signal if the above ratio is greater than or equal to the predetermined level. According to another characteristic of the invention, the system includes means for determining the variation in the longitudinal component of the wind and for providing alarm signals when this variation is greater than or equal to a predetermined level. CISTI

N94-27081# Federal Aviation Administration, Atlantic City, NJ.
IMPACT OF IMPROVED MATERIALS AND CABIN WATER SPRAY ON COMMUTER AIRCRAFT POSTCRASH FIRE SURVIVABILITY
TIMOTHY R. MARKER Nov. 1993 35 p
(AD-A274421; DOT/FAA/CT-TN93/40) Avail: CASI HC A03/MF A01

Twelve full-scale tests were conducted in a modified Metro-liner fuselage to study the impact of using improved fire retardant materials and a cabin water spray system on postcrash fire survivability. Currently, commuter category aircraft as defined in Part 23 are exempt from meeting the stringent Federal Aviation Regulations (FAR's) requiring seat cushion fire blocking layers and low heat/smoke release panels in large transport aircraft. A zoned cabin water spray system which allowed for the individual activation of spray zones depending on cabin temperature was designed and installed in the fuselage. The system consisted of four 100 inch long zones, each containing 6 nozzles. Of the twelve tests, five were run with the water spray system and a different combination of cabin materials. These five tests were repeated without the water spray system in order to establish baseline data for each material combination. Two additional tests were conducted to investigate the impact of a partially obstructed forward test and also to evaluate the effect that the channel-type floor geometry used in the Metro-liner aircraft has on flame propagation during a cabin fire. Temperature, smoke levels, and gas concentrations were continuously monitored at a forward cabin location and each test was recorded on video. DTIC

N94-27285*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
AN INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 1992-1993
ROBERT W. SIMPSON *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 3-8 Feb. 1994
Avail: CASI HC A02/MF A02

An investigation of air transportation technology at MIT during 1992 - 1993 is presented. One completed project and two continuing research activities are under the sponsorship of the FAA/NASA Joint University Program. The completed project was on tracking aircraft around a turn with wind effects. Active research projects are on ASLOTS - an interactive adaptive system of automated approach spacing of aircraft and alerting in automated and datalink capable cockpits. Author (revised)

N94-27287*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
A DATA FUSION ALGORITHM FOR MULTI-SENSOR MICROBURST HAZARD ASSESSMENT
CRAIG R. WANKE and R. JOHN HANSMAN *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 17-28 Feb. 1994 See also A92-55328 Submitted for publication Sponsored in part by FAA
(Contract NGL-22-009-640; F19628-90-C-0002)
Avail: CASI HC A03/MF A02

A recursive model-based data fusion algorithm for multi-sensor microburst hazard assessment is described. An analytical microburst model is used to approximate the actual windfield, and a set of 'best' model parameters are estimated from measured winds. The winds corresponding to the best parameter set can then be used to compute alerting factors such as microburst position, extent, and intensity. The estimation algorithm is based on an iterated extended Kalman filter which uses the microburst model parameters as state variables. Microburst state dynamic and process noise parameters are chosen based on measured microburst statistics. The estimation method is applied to data from a time-varying computational simulation of a historical microburst event to demonstrate its capabilities and limitations. Selection of filter parameters and initial conditions is discussed. Computational requirements and datalink bandwidth considerations are also addressed. Author

N94-27288*# Ohio Univ., Athens. Dept. of Electrical and Computer Engineering.
INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT OHIO UNIVERSITY, 1992-1993
ROBERT W. LILLEY *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 31-33 Feb. 1994
Avail: CASI HC A01/MF A02

The Joint University Program in Air Transportation Systems provides opportunities for progress by students, staff and faculty at the Avionics Engineering Center, Ohio University. During the 1992-93 year, four conference papers and two M.S. theses were produced; these are summarized in the bibliography. The conference papers are included in their entirety, for reference. Author

N94-27294*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT PRINCETON UNIVERSITY, 1992-1993
ROBERT F. STENGEL *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 87-97 Feb. 1994
Avail: CASI HC A03/MF A02

The Air Transportation Research Program at Princeton University proceeded along five avenues during the past year: (1) Flight Control System Robustness; (2) Microburst Hazards to Aircraft; (3) Wind Rotor Hazards to Aircraft; (4) Intelligent Aircraft/Airspace Systems; and (5) Aerospace Optical Communications. This research resulted in a number of publications, including theses, archival papers, and conference papers. An annotated bibliography of publications that appeared between June 1992 and June 1993 is included. The research that these papers describe was supported in whole or in part by the Joint University Program, including work that was completed prior to the reporting period. Author (revised)

N94-27296*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
OPTIMAL NONLINEAR ESTIMATION FOR AIRCRAFT FLIGHT CONTROL IN WIND SHEAR
SANDEEP S. MULGUND *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 111-130 Feb. 1994
Avail: CASI HC A03/MF A02

The most recent results in an ongoing research effort at Princeton in the area of flight dynamics in wind shear are described. The first undertaking in this project was a trajectory optimization study. The flight path of a medium-haul twin-jet transport aircraft was optimized during microburst encounters on final approach.

The assumed goal was to track a reference climb rate during an aborted landing, subject to a minimum airspeed constraint. The results demonstrated that the energy loss through the microburst significantly affected the qualitative nature of the optimal flight path. In microbursts of light to moderate strength, the aircraft was able to track the reference climb rate successfully. In severe microbursts, the minimum airspeed constraint in the optimization forced the aircraft to settle on a climb rate smaller than the target. A tradeoff was forced between the objectives of flight path tracking and stall prevention. Author (revised)

N94-27746# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Transport Research Div.
METHODOLOGY DEVELOPMENT OF FORECASTING INTER-REGIONAL AIR TRANSPORT DEMAND IN CHINA [ENTWICKLUNG VON PROGNOSEMETHODEN FUER DIE INTERREGIONALE LUFTVERKEHRSNACHFRAGE IN CHINA]
MING ZHANG (Chinese Aeronautical Establishment, Beijing.), MINGMING FENG (Chinese Aeronautical Establishment, Beijing.), HANS-GUSTAV NUESSER, and DIETER WILKEN Jul. 1993 84 p
(ISSN 0939-2963)
(DLR-FB-93-24; ETN-94-95500) Avail: CASI HC A05/MF A01

The selection and calibration of three types of mode specific models to be used to forecast air transport demand in China are described. These mode specific models are the growth factor method, a direct demand travel flow, and a trip generation model. For a forecast application with data available in China, a combined flow and trip generation model is recommended, which was calibrated on the basis of cross sectional data as well as time series data. For improving the forecast method, it is suggested to collect multimodal data of travel flows in the domestic air transport network of China. ESA

N94-27766# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: RUNWAY DEPARTURE FOLLOWING LANDING AMERICAN AIRLINES FLIGHT 102, MCDONNELL DOUGLAS DC-10-30, N139AA, DALLAS/FORT WORTH INTERNATIONAL AIRPORT, TEXAS, APRIL 14, 1993
14 Feb. 1994 173 p
(PB94-910402; NTSB/AAR-94/01; REPT-6109B) Avail: CASI HC A08/MF A02

This report explains the runway departure of American Airlines flight 102, a DC-10-30, after landing at Dallas/Fort Worth International Airport, Texas, on April 14, 1993. The safety issues discussed in the report include weather conditions affecting the flight, flight crew and air traffic control training and procedures, airplane emergency evacuation lighting, and runway maintenance. Recommendations concerning these issues were made to the Federal Aviation Administration, Dallas/Fort Worth International Airport, and American Airlines, Inc. Author

N94-27881# National Transportation Safety Board, Washington, DC.
SPECIAL INVESTIGATION REPORT: SAFETY ISSUES RELATED TO WAKE VORTEX ENCOUNTERS DURING VISUAL APPROACH TO LANDING
Feb. 1994 98 p
(PB94-917002; NTSB/SIR-94/01; REPT-6264) Avail: CASI HC A05/MF A02

Since December 1992, there have been five accidents and incidents in which an airplane on approach to landing encountered the wake vortex of a preceding Boeing 767 (B-767). Thirteen occupants died in two of the accidents. The encounters, which occurred during visual conditions, were severe enough to create an unrecoverable loss of control for a Cessna Citation, a Cessna 182, and an Israel Aircraft Industries Westwind. Additionally, there were significant but recoverable losses of control for a McDonnell Douglas MD-88 and a B-737 (both required immediate and aggressive flight control deflections by their flight crews). Safety Board data show that between 1983 and 1993, there were at least 61 accidents and incidents in the United States, including the 5 mentioned above, that resulted from probable encounters with wake vortices. In these 61 encounters, 27 occupants were killed, 8 were seriously injured, and 40 airplanes were substantially damaged or destroyed. The Safety Board conducted a special investigation to examine in detail the circumstances surrounding the five recent accidents and incidents to determine what improvements may be needed in existing procedures to reduce the likelihood of wake vortex encounters. The Safety Board's investigation initially focused on why the B-757 appeared to be involved in a disproportionate number of wake vortex encounters. Several reports indicated that the B-757 generated wake vortices that were more severe than would be expected for an airplane of its weight. However, as a result of a thorough study and analysis of the issue, the Safety Board found little technical evidence to support the notion that the wake vortex of a B-757 is significantly stronger than indicated by its weight. Derived from text

N94-28230# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
LUFTHANSA YEARBOOK 1992 [LUFTHANSA JAHRBUCH 1992]
ELISABETH HEIDAN, DIRK HOEFINGHOFF, and DIERK WUENSCHE Oct. 1992 301 p In GERMAN
(ISSN 0176-5086)
(DSK-9734-H-92; ETN-94-95278) Copyright Avail: CASI HC A14/MF A03

In the perspective of the single European market, the following aspects of air traffic are investigated from the Lufthansa point of view: flight safety, European community environment policy, and development of harmonization among air traffic authorities in Europe. Other topics are included, such as the new Munich airport, A-340 test program, influence of economical recession on air traffic, effect of deregulation in the U.S., and integrators in air freight market.
ESA

N94-28231# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
THE SINGLE EUROPEAN MARKET AND AIR TRAFFIC CHANCES AND RISKS [BINNENMARKT UND LUFTVERKEHR: CHANCEN UND RISIKEN]
MANFRED MOMBERGER *In its* Lufthansa Yearbook 1992 p 32-43 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A03/MF A03

The new competition conditions in air business, due to the single European market, are examined. The Brussels commission proposed a liberalization law, which guarantees price freedom and allows any service to be offered by any airline in any country of the European community; former capacity restrictions were suppressed. Freight and charter activities were submitted to the same conditions. In order to avoid the excesses of American deregulation, which causes a concentration of traffic on big, dominating companies, a liberalization through elimination of unnecessary rules was desired by European bureaucracy. The future development of air traffic is found to be currently restricted by the lack of runway capacity in European airports. Prices are assumed to be increased since the government aids are suppressed. The problem of airline mergers and cooperations, which could cause the overwhelming supremacy of United Airlines, British Airways and Japan Airlines, was examined. ESA

N94-28232# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
DEREGULATION OF AIR TRAFFIC IN AMERICA: A MODEL TO BE INITIATED? [DEREGULIERUNG DES LUFTVERKEHRS IN AMERIKA: NACHAHMENSWERTES MODELL?]
HENRY A. SCHRADER *In its* Lufthansa Yearbook 1992 p 44-53 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The consequences of deregulation in the U.S. are reviewed and their transposition to the European case are examined. After fifteen years of deregulation three airlines are dominating the commercial aviation market and the other ones are facing overcapacity problems. Oil crisis, economic recession, and deregulation of the American financial system from 1984 to 1990 played an important role in the sluggishness of the current aviation market. Some advantages were offered to the consumer by deregulation: price drop, increased choice of proposed flights such as regional lines and development of a so called social tourism, enhanced by low prices. On the other hand, some point to point connections disappeared so that passengers had to be in transit in overcrowded hubs and service quality dropped. If a similar liberalization occurs in Europe the influence of national administrations might avoid such excesses and allow profitability and travel easiness to be combined. ESA

N94-28233# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
AIR TRAFFIC OF THE EUROPEAN COMMUNITY WITH EUROPEAN NEIGHBORS [DER LUFTVERKEHR DER EG MIT DEN EUROPAEISCHEN NACHBARN]
STEFAN BEYHOFF *In its* Lufthansa Yearbook 1992 p 54-59 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The European air transportation market is examined considering the changes due to the single European market and the political and economical evolutions in Eastern Europe. For EFTA (European Free Trade Association) countries (Finland, Iceland, Norway, Austria, Sweden, and Switzerland) a solution was found: the treaty on European economic space applies the liberalization rules to the EFTA countries which asked for European Community membership. As regards countries from Eastern Europe, bilateral agreements currently exist between individual states; with the countries from the former Soviet Union, the situation is even more confused. It is noticed that, in the case of integration of Eastern Europe states in the European Community, flight safety and infrastructure problems make a differentiated utilization of liberalization measures necessary. ESA

N94-28234# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
A SKY ABOVE EUROPE [EIN HIMMEL UEBER EUROPA]
HELGA L. HILLEBRAND *In its* Lufthansa Yearbook 1992 p 60-69 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The necessary integration of European flight safety is examined in the framework of the single European market. Members of ECAC (European Civil Aviation Conference) decided in 1990 to develop the four phases EATCHIP (European Air Traffic Control Harmonization and Integration Program) and to buy and operate the needed equipments for harmonization measures. First phase of EATCHIP will allow air space to be structured and some new routes to be opened. The second phase will supply a detailed planning of middle term harmonization; third phase will be devoted to the structure of a European radar system; with the fourth phase an improved onboard/ground communication system will be introduced. EATMS (European Air Traffic Management System) was developed in cooperation with ICAO (International Civil Aviation Organization), European Community Commission and European industry. APATSI (Airport/Air Traffic System Interface) was created for determining requirements and equipments for a new airport management strategy. A central flow management unit will allow a modern data base to be available. It is concluded that a European, well organized flight security system allows air traffic to be increased by 80%. ESA

N94-28235# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
THE SINGLE EUROPEAN MARKET: ECONOMICAL ADVANCE, ECOLOGICAL PROBLEM? [DER EG-BINNENMARKT: OEKONOMISCHER FORTSCHRITT OEKOLOGISCHES PROBLEM?]
HORST BUSACKER *In its* Lufthansa Yearbook 1992 p 70-79 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The impact on the environment of air traffic increase due to the single European market is addressed and the chances of the European Community for a successful protection of environment are evaluated. The evolution of the European environmental policy was explained, since the 1972 Paris summit, where chiefs of states and governments decided to work for a better quality of life, until the creation of European Environment Agency and the writing of the single European act, which outlines the responsibility of member states in environment protection. Environmental damages due to air traffic were recalled: aircraft noise, harmful emissions such as carbon, sulfur and nitrogen oxides, waste treatment and ground water protection. Current activities for international standardization of aircraft nuisances are reported: the Committee on Aviation Environmental Protection of ICAO (International Civil Aviation Organization), the abatement of nuisances caused by air transport group of ECAC (European Civil Aviation Conference) decided the nitrogen oxide emissions have to be dropped from 40%; the European Commission edited a green book titled 'A common strategy for a sustainable mobility'. ESA

N94-28236# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
THE ADVANTAGES OF THE LOCATION GERMANY MUST NOT BE JEOPARDIZED IN AIR TRAFFIC [VORTEILE DES STANDORTS DEUTSCHLAND IN LUFTVERKEHR NICHT GEFAEHRDEN]
WOLF-RUEDIGER USSLER *In its* Lufthansa Yearbook 1992 p 80-89 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The relationships between air traffic and industry in Germany are studied. It is noted that good air transportation capabilities are necessary for the installation of foreign companies in German cities and that Germany is the biggest air traffic market in Europe. Considering the expected increase in air traffic, airport capacities and infrastructures and air space control are shown to be insufficient and ineffective, and the need for political measures and important investments is ascertained. The high level of financial charges weighing on German companies is shown to be an important disadvantage regarding competitiveness, nevertheless high wages are the condition for social and political stability and high productivity, which are symbols of German quality. It is concluded that the harmonization process due to the single European market, which is a necessary condition for fair economical competition, will enhance the advantages of Germany as a geographic node and a door towards Eastern Europe. ESA

N94-28237# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
LUFTHANSA FACING THE SINGLE EUROPEAN MARKET [LUFTHANSA VOR DEM BINNENMARKT]
AXEL C. PFEIL *In its* Lufthansa Yearbook 1992 p 90-104 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A03/MF A03

Lufthansa's situation in the context of a single European market and the changes in the global air transportation industry is described. Lufthansa must compete with European airlines, American carriers, and Asiatic air companies whose cost structures are extremely favorable. Business and private travelers have become more and more sensitive to prices, customer faithfulness is disappearing, infrastructure capacities are too limited and expensive, and high speed trains are gaining market shares. The growth strategy of Lufthansa is based on the following: its well known strength; strategic alliances with Scandinavian Airlines, Swissair, and Austrian Airlines; and selective participation in key markets. The introduction of a profit center organization and the splitting of the global company into more flexible structures are assumed to make Lufthansa a competitive airline. ESA

N94-28238# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
AIR TRAFFIC ADMINISTRATION ENROUTE TO EUROPE [LUFTFAHRTVERWALTUNG AUF DEM WEG NACH EUROPA]
JOCHEN PIEPER *In its* Lufthansa Yearbook 1992 p 105-108

Oct. 1992 In GERMAN
Copyright Avail: CASI HC A01/MF A03

Joint Aviation Authorities in the framework of the single European market and based on the recommendations of ICAO (International Civil Aviation Organization) are presented. Twelve joint aviation regulations were edited in 1992. The regulations address definitions, technical rules, turbofans, propfans, auxiliary power turbines, maintenance and time since overall, sailplanes, and all weather operations. ECAC (European Civil Aviation Conference) was in charge of air transportation personnel; the member states must accept the qualification of any pilot from another member state. Nevertheless training rules were compared in all states and discrepancies found could lead to pilot technical and theoretical testing. A common training program for pilots was written. The program will be mandatory for flight crew licensing. ESA

N94-28239# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
MUNICH AIRPORT: THE NEW LUFTHANSA HUB [FLUGHAFEN MUENCHEN: DIE NEUE LUFTHANSA-DREHSCHEIBE]
HORST WAEHNER *In its* Lufthansa Yearbook 1992 p 112-121
Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The new Munich airport (Germany), which is regarded as an example of functionality and successful integration in the landscape, is described. The airport offers to passengers central check-in in the main building with suburban railway connection and decentral checking in the four areas of the terminal. A personal transport system was developed for comfortable connections. Lufthansa was involved in the airport planning and supplied its knowhow for fashioning passenger areas. Daily, nonstop flights to 47 European cities and to New York, Miami, and Tokyo are proposed. Three hall modules compose a functional entity for import, export, and transit freight with a payload capacity of 250,000 tons. A new maintenance hall was built. Forty-three aircraft can be checked out each day. It can be concluded that Munich airport is user friendly, environmentally safe, and technically advanced. ESA

N94-28240# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
AIR TRAFFIC IN RECESSION [LUFTVERKEHR IN DER REZESSION]
ERICH MEIER *In its* Lufthansa Yearbook 1992 p 122-129 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The air transportation market is analyzed in the framework of the current economic crisis. It is noticed that recession hurt air traffic in 1974/1975 and from 1980 to 1982; nevertheless the current situation seems to be the most difficult in the history of air transportation. It is recalled that signs of economic recession were visible before the Gulf War, but airlines were too optimistic in considering the eight previous years of prosperity. Air transportation is shown to be an early indicator of crisis; however, most airlines were not prepared for the recession and consistently overestimated the necessary capacity. The most recent studies conclude that the current crisis is only an episodic phenomenon. An annual growth rate of world air traffic of 5.5 percent is predicted until the year 2000. ESA

N94-28241# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
GERMAN-AMERICAN RELATIONS IN AIR TRAFFIC ARE TO BE CRITICIZED [DEUTSCHE-AMERIKANISCHE LUFTVERKEHRSBEZIEHUNGEN UN DER KRITIK]
GEORG W. REHM *In its* Lufthansa Yearbook 1992 p 130-135
Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The consequences of the arrival of numerous American airlines on the North Atlantic market are examined. The equilibrium in European/American air transportation is found to be disturbed; American companies can build hubs with their shuttle flights in Europe while Europeans do not have equivalent opportunities in the U.S. After the German reunification, Lufthansa thinks that the validity area of 1978 traffic agreement must be extended. Price war caused high losses and some airlines were suspected of dumping and 'predatory pricing'. ESA

N94-28242# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
A340 TESTING [AIRBUS A340 IM TEST]
UDO GUENZEL *In its* Lufthansa Yearbook 1992 p 136-141
Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The quadrijet, long range A340 aircraft is described. After the first testing flights, reliability, security, aerodynamic quality, and starting power are proved to be totally satisfying, and landing powers are even surpassed. The 2000 flight test hours were planned so that Joint Aviations Authorities simultaneously give airworthiness certificate to both versions of the aircraft, A340-200 and A340-300. Test aircraft were equipped with a telemetry facility for direct online data transfer from test flight operations to a special control center, which could supply information to the test crew. Turbofan thrust was measured at several flight altitudes; external and internal noise and aircraft stability were evaluated. The fly by wire technology was particularly examined, in order for aerodynamic controls, flaps and redundancy systems to be tested. The CFM56 turbofan is depicted as an environmentally safe, low consumption and low noise gas turbine engine. ESA

N94-28243# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
FIRST CANADAIR JET FLIES FOR LUFTHANSA CITY LINE [ERSTER CANADAIR JET FLIEGT FUER LUFTHANSA CITYLINE]
KLAUS MUELLER *In its* Lufthansa Yearbook 1992 p 142-145
Oct. 1992 In GERMAN
Copyright Avail: CASI HC A01/MF A03

The new Canadair jet, which is a 50 seat, short range aircraft, derived from the Challenger CL-601 business travel aircraft, is described. The aircraft was developed for takeoff and landing on small airports without modern runways. It is equipped with two General Electric CF34-3A1 turbofan engines with thrust inverters, which are environmentally safe: low fuel consumption, nitrogen oxide emissions and noise levels. Hot air is used for deicing of lift wings and turbine inlets. The cockpit is equipped with headup guidance system, electronic flight information system, EICAS (Engine Indication and Crew Alerting System), and dual flight management system. The Canadair Jet is the first aircraft of its category to be certificated for all weather operations and is equipped with collision and shear wind warning systems. ESA

N94-28244# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
INTEGRATORS: A CHALLENGE FOR AIR CARGO [INTEGRATORS: HERAUSFORDERUNG FUER DIE LUFTFRACHT]
ERWIN MARUHN *In its* Lufthansa Yearbook 1992 p 146-152
Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

Activities of integrators, which have deeply modified the freight market, whose annual growth is predicted to be of 6.5% until the year 2000, are described. New logistics and distribution concepts allowed a large development of just in time delivery; integrators appeared in the U.S. after the air cargo deregulation act in 1977. Their advantages are quickness, reliability and service quality, enhanced by a uniform organization, use of modern telecommunication technologies and sending handling, based on the hub and spoke system, in a harmonized network. In order to react to this concurrence, Lufthansa created a 'collect and deliver' company, which supplies house to house carriage with combined ground and air transportation, and cooperates in Traxon, a global information system, with other companies involved in air cargo, such as Air France, Japan Airlines and Cathay Pacific. In 1990, Lufthansa took a financial stake in DHL integrator. It is concluded that only customers can jeopardize the place of the integrators on freight market. ESA

N94-28245# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
POWERFUL SELLING AND SALES STRATEGY [SCHLAGKRAEFTIGE VERKAUFS- UND VERTRIEBSSTRATEGIE]
ADRIAN VONDOERNBERG *In its* Lufthansa Yearbook 1992 p 156-165 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03
The commercial strategy of Lufthansa for reacting to air traffic changes is described. A stricter organization structure was developed for marketing and selling. An offensive marketing communication program was developed for defining the Lufthansa product on the market and for dismantling selling barriers by customers and dispatch clerks. The partnership concept was used to enhance cooperation with middle class travel agencies; regional offices created customer advisory boards in order to maintain narrow contacts with users. The passenger service was improved with a new customer system: bonus program, accelerated check-in, self service facilities and better lounges are now proposed. Lufthansa decided these modifications in order to assess its leadership on quality, considering the increasing concurrence of the strongly growing private travel market. ESA

N94-28246# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
LUFTHANSA LONG RANGE SERVICES: MORE SIMPLICITY [EINFACH EIN BISSCHEN MEHR: LUFTHANSA-LANGSTRECKENSERVICE]
DIERK WUENSCHE *In its* Lufthansa Yearbook 1992 p 166-171 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03
The long range service strategy of Lufthansa is described. It was decided to fullfil the individual wishes of international travelers, with larger comfort and improved meals. The complete B747 fleet was provided with new equipments. First and Business classes were supplied with greater spacing of seats, and an entertainment facility with an in-seat video system. All improvements were examined during test flights and a survey was made among passengers to obtain their opinion. ESA

N94-28247# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
LUFTHANSA AND EUROPE [LUFTHANSA UND OSTEUROPA]
DIRK HOEFINGHOFF *In its* Lufthansa Yearbook 1992 p 172-175 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A01/MF A03
The air transportation market towards countries from East Europe is investigated. Germany is geographically the biggest turntable in Europe for West to East air traffic. Lufthansa is a leader on this market with 220 flights per week to 14 East European towns and offers its technology and knowhow to former communist countries in order for infrastructure problems, such as communication, maintenance and safety deficiencies, to be solved. The concurrence is strong in East European transportation, since air companies can offer low price products and are buying modern, western aircraft; Lufthansa decided to open offices in all capitals in order to protect its leadership. ESA

N94-28248# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
KNOW-HOW EXPORT: LUFTHANSA TECHNOLOGY AT SHANNON [KNOW-HOW-EXPORT: LUFTHANSA-TECHNIK IN SHANNON]
HERBERT A. GROEGER *In its* Lufthansa Yearbook 1992 p 176-179 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A01/MF A03
Lufthansa created in 1989 Shannon Aerospace, in cooperation with the GPA leasing firm and Swissair. Shannon Aerospace is an overhaul center in Ireland, which is particularly dedicated to airframe maintenance. The three companies made heavy investments for personnel training. The enterprise philosophy and culture for Shannon Aerospace are focused on quality, customer information and environment protection. ESA

N94-28249# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
AFTER THIRTY YEARS: FAREWELL OF EUROPA JET [NACH FAST DREISSIG JAHREN: ABSCHIED VON EUROPA JET]
HEINRICH GROSSBONGARDT *In its* Lufthansa Yearbook 1992 p 180-185 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03
The role of Boeing 727 in Lufthansa operations is explained. Lufthansa ordered the first Boeing 727 in 1961, which had a cruise velocity of 900 kph and could land on short runways. During thirty years, 61 Europa Jets from several generations flew for Lufthansa and showed high safety and reliability performances; nine quick change versions were bought so that the transformation in 25 minutes from a passenger aircraft to a cargo aircraft was possible. From the beginning, Boeing 727 was regarded by the passengers as the most comfortable civil aircraft. In 1992 Autumn the last Boeing 727 are replaced by A-320 aircraft, whose specific consumption and loading on environment are lower. It is noticed that Lufthansa Boeing 727 carried 60 million passengers 500 million km. ESA

N94-28345 Ecole Polytechnique, Montreal (Quebec). Dept. of Mechanical Engineering.
ICE ACCRETION ON AIRCRAFT WINGS
P. TRAN, M. T. BRAHIMI, and I. PARASCHIVOIU *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 118-121 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)
A three dimensional inviscid code for ice accretion on wings (Tran et al, 1992) was modified to account for viscous effects by matching the flow field to solutions obtained with a boundary layer calculation code. The flow field calculation uses a viscous inviscid interaction technique involving a panel method based on the integral singularity method, a boundary layer correction, and a suitable matching procedure using the transpiration velocity model. The numerical solution for analyzing the ice accretion consists in computing the flow characteristics around the wing and then calculating the impingement of droplets on the wing. The laminar boundary layer calculation is based on the method of Thwaites (1960) and the transition to turbulent flow is calculated using Michel's (1951) criterion. Droplet trajectories are calculated by assuming that the volume and density of the droplet remain constant and the initial droplet velocity equals the freestream velocity. The velocity field is used to compute the trajectory of a given droplet to determine whether it impinges on the wing. The droplet impact point calculation is two-dime nsional. Comparison of ice accretion obtained with INTERICE for a NACA 0012 airfoil are presented, showing good agreement with experimental results. The importance of viscous effects near the leading edge is noted. Author (CISTI)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

N94-25100*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DIFFERENTIAL GPS FOR AIR TRANSPORT: STATUS
RICHARD M. HUESCHEN *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 97-114 Dec. 1993
Avail: CASI HC A03/MF A04

The presentation presents background on what the Global Navigation Satellite System (GNSS) is, desired target dates for initial GNSS capabilities for aircraft operations, and a description of differential GPS (Global Positioning System). The presentation also presents an overview of joint flight tests conducted by LaRC and Honeywell on an integrated differential GPS/inertial reference unit (IRU) navigation system. The overview describes the system tested and the results of the flight tests. The last item presented is an overview of a current grant with Ohio University from LaRC which has the goal of developing a precision DGPS navigation system based on interferometry techniques. The fundamentals of GPS interferometry are presented and its application to determine attitude and heading and precision positioning are shown. The presentation concludes with the current status of the grant.
Derived from text

N94-25444# Federal Aviation Agency, Oklahoma City, OK. Civil Aeromedical Inst.
AUTOMATION AND COGNITION IN AIR TRAFFIC CONTROL: AN EMPIRICAL INVESTIGATION Final Report
O. U. VORTAC (Oklahoma Univ., Norman.), MARK B. EDWARDS (Oklahoma Univ., Norman.), DANA K. FULLER (Oklahoma Univ., Norman.), and CAROL A. MANNING Feb. 1994 20 p
(Contract DTFA02-91-C-91089)
(DOT/FAA/AM-94/3) Avail: CASI HC A03/MF A01

Several investigators have expressed concern that the imminent automation of air traffic control may have negative consequences on cognitive functioning, and ultimately on performance. These possibilities were investigated empirically by comparing normal, conventional air traffic control with an experimental condition designed to resemble an extreme version of automation. Overall, measures of performance were comparable between conditions. Most of the cognitive measures (attentional demands, visual search, recall of flights, and recall of flight data) were not impaired by the automation analog. Instead, two prospective measures (prospective memory, planning) showed improved performance. The prospective memory advantage is particularly surprising given that the automation-analog group was unable to manipulate external memory aids. Possible reasons for the prospective memory advantage include a reduced workload which allows the controller to get the necessary information in other ways, and a change in the nature of the task resulting from the 'automation' of the strip management module.
Author (revised)

N94-25495*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
APPLICATION OF AIRCRAFT NAVIGATION SENSORS TO ENHANCED VISION SYSTEMS
BARBARA T. SWEET *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 79-95 Dec. 1993
Avail: CASI HC A03/MF A04

In this presentation, the applicability of various aircraft navigation sensors to enhanced vision system design is discussed. First, the accuracy requirements of the FAA for precision landing systems are presented, followed by the current navigation systems and their characteristics. These systems include Instrument Landing System (ILS), Microwave Landing System (MLS), Inertial Navigation, Altimetry, and Global Positioning System (GPS). Finally, the use of navigation system data to improve enhanced vision systems is discussed. These applications include radar image rectification, motion compensation, and image registration.
Author

N94-25504*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPANSION-BASED PASSIVE RANGING
YAIR BARNIV *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 235-286 Dec. 1993
Avail: CASI HC A04/MF A04

This paper describes a new technique of passive ranging which is based on utilizing the image-plane expansion experienced by every object as its distance from the sensor decreases. This technique belongs in the feature/object-based family. The motion and shape of a small window, assumed to be fully contained inside the boundaries of some object, is approximated by an affine transformation. The parameters of the transformation matrix are derived by initially comparing successive images, and progressively increasing the image time separation so as to achieve much larger triangulation baseline than currently possible. Depth is directly derived from the expansion part of the transformation. To a first approximation, image-plane expansion is independent of image-plane location with respect to the focus of expansion (FOE) and of platform maneuvers. Thus, an expansion-based method has the potential of providing a reliable range in the difficult image area around the FOE. In areas far from the FOE the shift parameters of the affine transformation can provide more accurate depth information than the expansion alone, and can thus be used similarly to the way they have been used in conjunction with the Inertial Navigation Unit (INU) and Kalman filtering. However, the performance of a shift-based algorithm, when the shifts are derived from the affine transformation, would be much improved compared to current algorithms because the shifts--as well as the other parameters--can be obtained between widely separated images. Thus, the main advantage of this new approach is that, allowing the tracked window to expand and rotate, in addition to moving laterally, enables one to correlate images over a very long time span which, in turn, translates into a large spatial baseline resulting in a proportionately higher depth accuracy.
Derived from text

N94-25788# Federal Aviation Administration, Atlantic City, NJ.
AIRBORNE DATA LINK OPERATIONAL EVALUATION TEST PLAN
ALBERT J. REHMANN and R. H. MOGFORD (Computer Technology Associates, Inc., Pleasantville, NJ.) Aug. 1993 47 p
(AD-A274096; DOT/FAA/CT-TN93/30) Avail: CASI HC A03/MF A01

This plan describes an end-to-end study of operational concepts and procedures associated with the introduction of electronic data communications between flight crews and air traffic controllers. Full performance controllers from terminal facilities will interact with type-related line pilots in four cockpit simulators networked into the Federal Aviation Administration Technical Center's Air Traffic Control Laboratory. Measures of human performance will gain insight into flight crew alerting, display, placement, and the utility of voice annunciation of data link messages. Direct measures of workload, communications efficiency, data link attention time (measured by head position), and aircraft state will be gathered and translated into recommendations for the cockpit display configuration.
DTIC

N94-25808# Technical Research Centre of Finland, Espoo. Machine Automation Lab.
DEAD RECKONING NAVIGATION
HANNU HAKALA Sep. 1992 88 p Sponsored by Technology Development Center, Finland
(ISSN 1235-0605)
(VTT-TIED-1402; ISBN-951-38-4216-9; ETN-94-95249) Copyright Avail: CASI HC A05/MF A01

Navigation systems for automotive navigation are considered. Basic in-car navigation is based on dead reckoning, which is enhanced with methods like map matching, proximity beacons, or satellite navigation systems. The method of dead reckoning in vehicle navigation applications is described. The terminology used in this area is explained. The basic theory of dead reckoning is given. The principles of common types of odometers and differential odometer are described. Examples of odometer realizations and distance measurement devices are presented. The other component of dead reckoning calculations, heading, can be measured with magnetic compasses, gyroscopes, optical gyros, and other means. These methods are explained and component realizations are shown. Inertial navigation systems are described. Dead reckoning and inertial navigation methods are compared.
ESA

N94-25810# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
ANALYSIS AND SIMULATION OF A GPS RECEIVER DESIGN USING COMBINED DELAY-LOCK AND MODIFIED TANLOCK LOOPS M.S. Thesis
GEORGE D. HARRIS Dec. 1993 93 p
(AD-A274037; AFIT/GE/ENG/93D-13) Avail: CASI HC A05/MF A01

The purpose of this thesis was to investigate the performance of two types of tracking loops used in global positioning system (GPS) receivers. The first loop, the delay-lock loop (DLL), is responsible for maintaining synchronization with the received PN sequence. The second loop, the modified tanlock loop (MTLL), is responsible for maintaining synchronization with the carrier signal. The performance of the two loops is investigated first separately then their performance is evaluated when operated together. This thesis is an investigation on the ability of these two loops to overcome corruption of the input signal due to noise. Expanding the dynamic operating range of these loops can significantly improve GPS receiver operation. Results indicate the performance of the loops was better than theoretical predictions by maintaining lock across a wide range of loop gains and SNR's. However, when the loops were combined, the loops did not perform as predicted by theory. All simulations display phenomena which was not present in the theoretical predictions. DTIC

N94-26197 Federal Aviation Administration, Atlantic City, NJ. Technical Center.
***AIR TRAFFIC CONTROLLER WORKING MEMORY: CONSIDERATIONS IN AIR TRAFFIC CONTROL TACTICAL OPERATIONS* Technical Report, Oct. 1992 - Sep. 1993**
EARL S. STEIN and DANIEL GARLAND Sep. 1993 71 p
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A273722; DOT/FAA/CT-TN-93/37) Avail: CASI HC A04

The Air Traffic Control (ATC) environment is characterized by a continuous sequence of ever-changing, transient information, such as a series of aircraft being handled by an air traffic controller which must be encoded and retained, primarily, for tactical use (3 to 5 minutes) and secondarily, for strategic planning. This information is complicated by the limitations and constraints of human memory, in particular, working memory. Working memory can potentially degrade performance. The primary objective of this report is to raise an awareness of the memory requirements of ATC tactical operations by presenting information on working memory processes that are relevant to ATC tasks, and the vulnerability of these processes to disruption. This report focuses on developing an understanding of the role working memory plays in air traffic controller performance by emphasizing the constraints, and the factors that may overcome or minimize memory loss of critical ATC information. Two hundred twenty-nine references are cited in this report. DTIC

N94-26309# Pacific Northwest Lab., Richland, WA.
DIFFERENTIAL GLOBAL POSITIONING SYSTEM FOR THE SURFACE-TOWED ORDNANCE LOCATING SYSTEM: TESTING, RESULTS, AND USER'S GUIDE
T. L. STEWART and C. W. HUBBARD Oct. 1993 64 p
(Contract DE-AC06-76RL-01830)
(DE94-002980; PNL-8921) Avail: CASI HC A04/MF A01

Researchers at the Pacific Northwest Laboratory integrated and tested a Global Positioning System (GPS) for use with the Naval Explosive Ordnance Disposal Technology Center's (NEODTC) Surface-Towed Ordnance Locating System (STOLS). The GPS automatically and continuously provides latitude, longitude, and elevation information at the mobile GPS unit. The results of testing the GPS are shown in this report. The results reveal accuracies in the submeter range in real time and within a few centimeters using post-processing software. A description of hardware and software components is also included, along with system drawings and parts lists. DOE

N94-26493# Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
MIMO RECURSIVE LEAST SQUARES CONTROL ALGORITHM FOR THE AN/FPN-44A LORAN-C TRANSMITTER M.S. Thesis
JOHN D. WOOD Sep. 1993 107 p
(AD-A274820) Avail: CASI HC A06/MF A02

A multiple-input, multiple-output (MIMO) recursive least squares (RLS) algorithm is developed to shape and control the Loran-C RF pulse of the AN/FPN-44A tube type transmitter. The control algorithm is incorporated into a transmitter simulation program, where it seeks to produce an optimal transmitter drive waveform (TDW). An optimal TDW produces a near ideal RF pulse. The control algorithm uses a MIMO reference model of the transmitter; parameters of the model are obtained using recursive least squares multichannel time series techniques. The MIMO reference model has the ability to adapt to the non-LTI characteristics of the simulated transmitter. The MIMO RLS control algorithm is implemented in both an ideal and a realistic noisy environment. In the ideal environment, when representing the RF pulse with parameters of its half-cycle peak amplitudes and zero-crossings, the MIMO RLS controller is able to shape the RF pulse and control its zero-crossings. Quantization and system noise in the non-ideal environment results in performance deterioration of the control algorithm. The performance of the MIMO RLS algorithm is compared against another method of control, the steepest descent algorithm. DTIC

N94-26539# Technische Univ., Delft (Netherlands). Mathematische Geodesie en Puntsbepaling.
***HIGH-PRODUCTION GLOBAL POSITIONING SYSTEM METHODS FOR SURVEY APPLICATIONS: THE PSEUDO-KINEMATIC METHOD WITH THE TRIMVEC PROGRAMMING SYSTEM* Thesis [HOGE-PRODUKTIE GPS TEN BEHOEVE VAN LANDMEETKUNDIGE TOEPASSIGEN: DE PSEUDO-KINEMATISCHE METHODE METDE TRIMVEC-PROGRAMMATUUR]**
M. W. SCHRAM Aug. 1992 140 p In DUTCH
(ETN-94-95035) Avail: CASI HC A07/MF A02

Four productive GPS (Global Positioning System) methods were developed to overcome the long observation period of the static method. The semi kinematic, pseudo kinematic, 'rapid static', and continuous kinematic methods are presented. The applicability of the pseudo kinematic method was investigated, using the Trimvec programming system. The pseudo kinematic method provides a 30% higher production than the static method. The highest production is obtained for baselines of about 10 km. ESA

N94-26826# Systems Control Technology, Inc., Arlington, VA.
ROTORCRAFT LOW ALTITUDE IFR BENEFIT/COST ANALYSIS: CONCLUSIONS AND RECOMMENDATIONS Final Report
ROBERT K. ANOLL, ROBERT B. NEWMAN, and EDWIN D. MCCONKEY Oct. 1993 153 p
(Contract DTFA01-87-C-00014)
(AD-A274241; SCT-92RR-8; DOT/FAA/RD-93/22) Avail: CASI HC A08/MF A02

The Rotorcraft Master Plan advocates the establishment of additional communications, navigation, and surveillance (CNS) facilities, as well as the analysis and development of systems to satisfy the increasing demand for widespread instrument flight rules (IFR) rotorcraft operations within the National Airspace System (NAS). The objective of this study is to determine if there is an economic basis for improvement of these low altitude IFR services within the NAS in order to better support rotorcraft IFR operations. The findings of this study will aid FAA decision making in that regard. In view of prior implementation decisions on LORAN-C and GPS, the emphasis in this effort is on communications, surveillance, procedural changes, and avionics. This report is the last of a series of three reports that address rotorcraft low altitude benefit/cost analysis. This final report reviews the operational requirements and constraints for specific rotorcraft missions identified in the previous reports in this series. It also reviews all of the alternatives identified for improving rotorcraft operations.

The alternatives considered include additional communications and surveillance equipment, both existing equipment and future systems identified in the Aviation Systems Capital Investment Plan (CIP), and the air traffic control (ATC) procedural changes. A benefit/cost (B/C) analysis is conducted for each communication, surveillance, and procedural improvement identified. DTIC

N94-27071# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DEVELOPMENT OF A PERFORMANCE EVALUATION TOOL (MMSOFE) FOR DETECTION OF FAILURES WITH MULTIPLE MODEL ADAPTIVE ESTIMATION (MMAE) M.S. Thesis
ROBERT L. NIELSEN Dec. 1993 180 p
(AD-A274218; AFIT/GE/ENG/93S-37) Avail: CASI HC A09/MF A02

Multiple model Kalman Filter (KF) techniques are used extensively for Multiple Model Adaptive Estimation (MMAE), Multiple Model Adaptive Control (MMAC), and Distributed Kalman Filter (DKF) applications to determine Bayesian-blended optimal estimates of states, uncertain parameters, and optimal control signals. Multiple model methods are used for sensor management, Failure Detection and Isolation (FDI), and other Guidance and Control (G and C) applications. A simulation tool called the Multiple Model Simulation for Optimal Filter Evaluation (MMSOFE) has been in this research. MMSOFE is based on the well-benchmarked single Kalman filter tool called Multimode Simulation for Optimal Filter Evaluation (MSOFE). MMSOFE is a highly portable and versatile multiple and single Kalman filter evaluation tool. It is capable of performing simulations with one filter or up to 98 elemental filters in a multiple model adaptive filter structure. It can be adapted easily for other multiple model applications. MMSOFE was applied to failure detection and isolation of measurement jamming and spoofing-type failures, similar to jamming and spoofing of a Global Positioning System (GPS). A satellite orbit estimation test case was used. DTIC

N94-27210 National Defence Research Establishment, Stockholm (Sweden). Dept. of Weapon Systems, Effects and Protection.
SATELLITE NAVIGATION SYSTEM GPS: A REVIEW OF PRINCIPLES AND PERFORMANCE AND DEVELOPMENTS IN GENERAL [SATELLITNAVIGERINGSSYSTEMET GPS: OEVERSIKT OEVER FUNKTION OCH PRESTANDA SAMT UTVECKLINGSTENDENSER I STORT]
S. ARNZEN Jun. 1993 65 p In SWAHILI
(PB94-124534; FOA-C-20931-2.1) Avail: Issuing Activity (National Technical Information Service (NTIS))

The report gives a summary of principles and performance, obtained accuracy, and developments in general for the US DoD owned GPS-system. Additionally, the Russian Glonass and other interesting civilian systems are shortly described. The main part of the docment was prepared as an appendix to a study at the military staff level called 'Satellite navigation systems.' The study was prepared in 1991/92 with the aim of supporting the supreme commander in the decision of how to handle the use of GPS in the armed forces in the near future. NTIS

N94-27275 Hazeltine Corp., Braintree, MA.
AUTOMATIC, REAL-TIME FAULT MONITOR VERIFYING NETWORK IN A MICROWAVE LANDING SYSTEM Patent
DARRELL D. ROELOFS, inventor (to Hazeltine), ALFRED R. LOPEZ, inventor (to Hazeltine), and KENNETH R. DORIS, inventor (to Hazeltine) 14 Dec. 1993 20 p
(CA-PATENT-1325261; INT-PATENT-CLASS-G01S-007/40; CTN-94-61096) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A system for automatic real-time verification of the fault monitoring of an executive monitor of a microwave landing system (MLS) is disclosed. When an internally generated out-of-tolerance or erroneous signal is detected by the monitor, the system generates an alarm and declares it valid. The system also includes a station control board connected on line with the executive monitor which provides a signal to the monitor representative of erroneous or out-of-tolerance data in order to initiate an alarm in the executive monitor. The actual data obtained by the executive monitor is stored until proper fault monitoring verification occurs. A filter counting means is employed to record a history of the out-of-tolerance data received by the executive monitor so that the filter counting means can be preconditioned during the verification process to receive one additional out-of-tolerance sample to thereby generate an alarm within the executive monitor. A switch is used to permit an internally generated out-of-tolerance sample to be analyzed instead of the sampled information generated by the antenna system. Author (CISTI)

N94-27290*# Ohio Univ., Athens. Avionics Engineering Center.
IMPROVED MODELING OF GPS SELECTIVE AVAILABILITY
MICHAEL S. BRAASCH, ANNMARIE FINK, and KEITH DUFFUS *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 45-54 Feb. 1994 Presented at the Institute of Navigation 1993 National Technical Meeting, San Francisco, CA, 20-22 Jan. 1993
(Contract NGR-36-009-017)
Avail: CASI HC A02/MF A02

Selective Availability (SA) represents the dominant error source for stand-alone users of the Global Positioning System (GPS). Even for DGPS, SA mandates the update rate required for a desired level of accuracy in realtime applications. As was witnessed in the recent literature, the ability to model this error source is crucial to the proper evaluation of GPS-based systems. A variety of SA models were proposed to date; however, each has its own shortcomings. Most of these models were based on limited data sets or data which were corrupted by additional error sources. A comprehensive treatment of the problem is presented. The phenomenon of SA is discussed and a technique is presented whereby both clock and orbit components of SA are identifiable. Extensive SA data sets collected from Block 2 satellites are presented. System Identification theory then is used to derive a robust model of SA from the data. This theory also allows for the statistical analysis of SA. The stationarity of SA over time and across different satellites is analyzed and its impact on the modeling problem is discussed. Author

N94-27291*# Ohio Univ., Athens. Avionics Engineering Center.
REALTIME MITIGATION OF GPS SA ERRORS USING LORAN-C
SOO Y. BRAASCH *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 55-61 Feb. 1994 Presented at the Wild Goose Association, Annual Convention and Technical Symposium, Birmingham, England, 24-27 Aug. 1992 Sponsored in part by FAA
(Contract NGR-36-009-17)
Avail: CASI HC A02/MF A02

The hybrid use of Loran-C with the Global Positioning System (GPS) was shown capable of providing a sole-means of enroute air radionavigation. By allowing pilots to fly direct to their destinations, use of this system is resulting in significant time savings and therefore fuel savings as well. However, a major error source limiting the accuracy of GPS is the intentional degradation of the GPS signal known as Selective Availability (SA). SA-induced position errors are highly correlated and far exceed all other error sources (horizontal position error: 100 meters, 95 percent). Realtime mitigation of SA errors from the position solution is highly desirable. How that can be achieved is discussed. The stability of Loran-C signals is exploited to reduce SA errors. The theory behind this technique is discussed and results using bench and flight data are given. Author (revised)

N94-27292*# Ohio Univ., Athens. Avionics Engineering Center.
A GPS COVERAGE MODEL
TRENT A. SKIDMORE *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 63-72 Feb. 1994 Presented at the Institute of Navigation 1992 National Technical Meeting,

Washington, DC, 29 Jun. - 1 Jul. 1992 See also A94-12567
(Contract NGR-36-009-017; DTRS57-87-C-00006)
Avail: CASI HC A02/MF A02

The results of several case studies using the Global Positioning System coverage model developed at Ohio University are summarized. Presented are results pertaining to outage area, outage dynamics, and availability. Input parameters to the model include the satellite orbit data, service area of interest, geometry requirements, and horizon and antenna mask angles. It is shown for precision-landing Category 1 requirements that the planned GPS 21 Primary Satellite Constellation produces significant outage area and unavailability. It is also shown that a decrease in the user equivalent range error dramatically decreases outage area and improves the service availability. Author (revised)

N94-27293*# Ohio Univ., Athens.
GROUND STATION SITING CONSIDERATIONS FOR DGPS
JAMES D. WAID *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 73-83 Feb. 1994 Presented at the Institute of Navigation 1993 National Technical Meeting, San Francisco, CA, 20-22 Jan. 1993 Sponsored in part by FAA
(Contract NAG1-1423; NGR-36-009-017)
Avail: CASI HC A03/MF A02

Aircraft guidance and positioning in the final approach and landing phases of flight requires a high degree of accuracy. The Global Positioning System operating in differential mode (DGPS) is being considered for this application. Prior to implementation, all sources of error must be considered. Multipath was shown to be the dominant source of error for DGPS and theoretical studies verified that multipath is particularly severe within the final approach and landing regions. Because of aircraft dynamics, the ground station segment of DGPS is the part of the system where multipath can most effectively be reduced. Ground station siting will be a key element in reducing multipath errors for DGPS system. This situation can also be improved by using P-code or narrow correlator C/A-code receivers along with a multipath rejecting antenna. A study of GPS multipath errors for a stationary DGPS ground station is presented. A discussion of GPS multipath error characteristics are presented along with some actual multipath data. The data was collected for different ground station siting configurations using P-code, standard C/A-code, and narrow correlator C/A-code receiver architectures and two separate antenna constructions. Author (revised)

N94-27297*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
AIR TRAFFIC MANAGEMENT AS PRINCIPLED NEGOTIATION BETWEEN INTELLIGENT AGENTS
J. P. WANGERMANN *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 131-140 Feb. 1994
Avail: CASI HC A02/MF A02

The major challenge facing the world's aircraft/airspace system (AAS) today is the need to provide increased capacity, while reducing delays, increasing the efficiency of flight operations, and improving safety. Technologies are emerging that should improve the performance of the system, but which could also introduce uncertainty, disputes, and inefficiency if not properly implemented. The aim of our research is to apply techniques from intelligent control theory and decision-making theory to define an Intelligent Aircraft/Airspace System (IAAS) for the year 2025. The IAAS would make effective use of the technical capabilities of all parts of the system to meet the demand for increased capacity with improved performance. Author

N94-27423*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PACKET RADIO DATA LINK APPLICATIONS IN THE NASA LANGLEY RESEARCH CENTER TRANSPORT SYSTEMS RESEARCH VEHICLE
WESLEY C. EASLEY, DONALD CARTER, and DAVID G. MCLUER (Lockheed Engineering and Sciences Co., Hampton, VA.) Jan. 1994 30 p
(Contract RTOP 505-64-13-11)
(NASA-TM-109071; NAS 1.15:109071) Avail: CASI HC A03/MF A01

An amateur packet radio system operating in the very high frequency (VHF) range has been implemented in the Transport Systems Research Vehicle at the NASA Langley Research Center to provide an economical, bidirectional, real-time, ground-to-air data link. The packet system has been used to support flight research involving air traffic control (ATC), differential global positioning systems (DGPS), and windshear terminal doppler weather radar (TDWR). A data maximum rate of 2400 baud was used. Operational reliability of the packet system has been very good. Also, its versatility permits numerous specific configurations. These features, plus its low cost, have rendered it very satisfactory for support of data link flight experiments that do not require high data transfer rates. Author (revised)

N94-27667 Defence Research Establishment Pacific, Victoria (British Columbia). Research and Development Branch.
DIFFERENTIAL GPS METHODS AND PERFORMANCE FOR MARINE APPLICATIONS Final Report
GERARD LACHAPELLE Jan. 1993 58 p
(Contract DREP-W7708-2-0529/01-XSA)
(DREP-93-09; DSIS-94-00049; CTN-94-61119) Avail: CASI HC A04/MF A01

A survey is provided of current and emerging technology in differential dynamic global positioning systems (GPS), particularly in the marine environment. Measures of accuracy for GPS positions are defined. Error sources in GPS include receiver noise, multipath reflection, combined receiver noise and multipath, orbital errors, loss of phase lock, cycle slip detection and recovery, ionospheric group delay and carrier phase advance, ionospheric scintillation, tropospheric refractivity, and selective availability. The concepts of differential GPS are outlined along with a description of algorithms and procedures. Differential GPS reduces or eliminates orbital, ionospheric, tropospheric, selective availability, and clock errors and provides better quality control, but amplifies the remaining errors. Measured performance of differential GPS systems are summarized, with emphasis on new technology and algorithms. These algorithms and technologies include single and double difference methods, carrier phase smoothing, and carrier phase ambiguity resolution. Results are presented for a case study examining the performance of P code receivers and high performance C/A code receivers in a survey launch environment. Future issues and trends in differential GPS are addressed in the areas of equipment, methodologies, and infrastructure. Author (CISTI)

N94-27768*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.
REFINEMENT FOR FAULT-TOLERANCE: AN AIRCRAFT HAND-OFF PROTOCOL
KEITH MARZULLO, FRED B. SCHNEIDER, and JON DEHN Apr. 1994 20 p
(Contract NAG2-593; N00140-87-C-8904; N00014-91-J-1219; NSF CCR-87-01103; NSF CCR-90-14363)
(NASA-CR-195697; NAS 1.26:195697; TR-94-1417) Avail: CASI HC A03/MF A01

Part of the Advanced Automation System (AAS) for air-traffic control is a protocol to permit flight hand-off from one air-traffic controller to another. The protocol must be fault-tolerant and, therefore, is subtle -- an ideal candidate for the application of formal methods. This paper describes a formal method for deriving fault-tolerant protocols that is based on refinement and proof outlines. The AAS hand-off protocol was actually derived using this method; that derivation is given. Author

N94-27831 National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
FLIGHT TESTING OF GPS AND GPS-AIDED SYSTEMS
O. B. M. PIETERSEN, M. A. G. PETERS, and N. VANDRIEL 16 Mar. 1992 17 p Presented at the 80th AGARD Flight Mechanics

Panel on Flight Testing Symposium, Chania, Crete, 11-14 May 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(NLR-TP-92151-U; ETN-94-95444) Avail: CASI HC A03

Flight test programs carried out are described: trials to investigate the suitability of differential global positioning system (GPS) for precision approaches; trials to determine the advantages of aiding a GPS receiver by inertial navigation system (INS) and of the use of null steering antennas; and trials to evaluate an in house developed navigation filter in which three navigation sensors, GPS, INS, and terrain referenced navigation (TRN), were integrated. An integrated navigation system is concluded to offer a greater robustness and a higher accuracy of the navigation solution, taking into account the weaknesses the individual sensors have. Differential GPS can eliminate a number of systematic errors, improving the attainable accuracy. ESA

N94-27918*# Saint Cloud State Coll., MN. Dept. of Electrical Engineering.
A SIMULATION OF GPS AND DIFFERENTIAL GPS SENSORS
JAMES M. RANKIN *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 149-153 Dec. 1993
Avail: CASI HC A01/MF A03

The Global Positioning System (GPS) is a revolutionary advance in navigation. Users can determine latitude, longitude, and altitude by receiving range information from at least four satellites. The statistical accuracy of the user's position is directly proportional to the statistical accuracy of the range measurement. Range errors are caused by clock errors, ephemeris errors, atmospheric delays, multipath errors, and receiver noise. Selective Availability, which the military uses to intentionally degrade accuracy for non-authorized users, is a major error source. The proportionality constant relating position errors to range errors is the Dilution of Precision (DOP) which is a function of the satellite geometry. Receivers separated by relatively short distances have the same satellite and atmospheric errors. Differential GPS (DGPS) removes these errors by transmitting pseudorange corrections from a fixed receiver to a mobile receiver. The corrected pseudorange at the moving receiver is now corrupted only by errors from the receiver clock, multipath, and measurement noise. This paper describes a software package that models position errors for various GPS and DGPS systems. The error model is used in the Real-Time Simulator and Cockpit Technology workstation simulations at NASA-LaRC. The GPS/DGPS sensor can simulate enroute navigation, instrument approaches, or on-airport navigation. Author (revised)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N94-24787*# Naval Postgraduate School, Monterey, CA.
CONCEPTUAL DESIGN PROPOSAL: HUGO GLOBAL RANGE/MOBILITY TRANSPORT AIRCRAFT
TOM JOHNSTON, DAVE PERRETTA, DOUG MCBANE, GREG MORIN, GREG THOMAS, JOE WOODWARD, and STEVE GULAKOWSKI Mar. 1993 116 p
(Contract NASW-4435)
(NASA-CR-195501; NAS 1.26:195501) Avail: CASI HC A06/MF A02

With the collapse of the former Soviet Union and the emergence of the United Nations actively pursuing a peace keeping role in world affairs, the United States has been forced into a position as the world's leading peace enforcer. It is still a very dangerous world with seemingly never ending ideological, territorial, and economic disputes requiring the U.S. to maintain a credible deterrent posture in this uncertain environment. This has created an urgent need to rapidly transport large numbers of troops and equipment from the continental United States (CONUS) to any potential world trouble spot by means of a global range/mobility transport aircraft. The most recent examples being Operation Desert Shield/Storm and Operation Restore Hope. To meet this challenge head-on, a request for proposal (RFP) was developed and incorporated into the 1992/1993 AIAA/McDonnell Douglas Corporation Graduate Team Aircraft Design Competition. The RFP calls for the conceptual design and justification of a large aircraft capable of power projecting a significant military force without surface transportation reliance. Derived from text

N94-24796*# United Technologies Corp., Stratford, CT. Aircraft Div.
WIND TUNNEL TEST OF A VARIABLE-DIAMETER TILTROTOR (VDTR) MODEL
DAVID MATUSKA, ALLEN DALE, and PETER LORBER Jan. 1994 230 p
(Contract NAS2-13484)
(NASA-CR-177629; A-94018; NAS 1.26:177629) Avail: CASI HC A11/MF A03

This report documents the results from a wind tunnel test of a 1/6th scale Variable Diameter Tiltrotor (VDTR). This test was a joint effort of NASA Ames and Sikorsky Aircraft. The objective was to evaluate the aeroelastic and performance characteristics of the VDTR in conversion, hover, and cruise. The rotor diameter and nacelle angle of the model were remotely changed to represent tiltrotor operating conditions. Data is presented showing the propulsive force required in conversion, blade loads, angle of attack stability and simulated gust response, and hover and cruise performance. This test represents the first wind tunnel test of a variable diameter rotor applied to a tiltrotor concept. The results confirm some of the potential advantages of the VDTR and establish the variable diameter rotor a viable candidate for an advanced tiltrotor. This wind tunnel test successfully demonstrated the feasibility of the Variable Diameter rotor for tilt rotor aircraft. A wide range of test points were taken in hover, conversion, and cruise modes. The concept was shown to have a number of advantages over conventional tiltrotors such as reduced hover downwash with lower disk loading and significantly reduced longitudinal gust response in cruise. In the conversion regime, a high propulsive force was demonstrated for sustained flight with acceptable blade loads. The VDTR demonstrated excellent gust response capabilities. The horizontal gust response correlated well with predictions revealing only half the response to turbulence of the conventional civil tiltrotor. Author (revised)

N94-24803*# California Polytechnic State Univ., San Luis Obispo.
VLCT-13: A COMMERCIAL TRANSPORT FOR THE 21ST CENTURY
PAMELA BEAL, TERRI SOWELS, HITOSHI TAKAHASHI, MATT COTTON, WILL BALANON, and MANUEL PARAYO 14 May 1993 72 p
(Contract NASW-4435)
(NASA-CR-195492; NAS 1.26:195492) Avail: CASI HC A04/MF A01

The growth of the Pacific Rim market has spurred airframers to begin feasibility studies of a large commercial transport. By the year 2001, 30 million travelers are expected to travel the Transpacific. A transport capable of hauling 800 PAX and 30,000 pounds of cargo, 7,000 nm is of specific interest. Special problems associated with this design are configuration, landing gear, passenger safety, airport compatibility, and engine thrust. A group of students at the California Polytechnic State University at San Luis Obispo developed a very large commercial transport, VLCT-13, conventional looking design which is both comfortable and economical. Passenger comfort includes seat pitches of 34 in and 40 in, width's of 23 in and 25 in, respectfully, and a 27 ft diameter cross section. A direct operating cost of 2.3 cents per passenger per seat-mile is estimated for this airplane design. The airplane market price is estimated to be $195 million 1993 dollars based on an aircraft take off weight of 1.4 million pounds. The problems associated with the VLCT-13 are discussed and possible solutions are presented. Author (revised)

N94-24817*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
THE BLUE EMU Final Design Proposal
DOUG DESCALZI, JOHN GILLETT, CARLTON GORDON, ED KEENER, KEN NOVAK, and LAURA PUENTE Apr. 1993 125 p
(Contract NASW-4435)
(NASA-CR-195535; NAS 1.26:195535) Avail: CASI HC A06/MF A02

The primary goal in designing the Blue Emu was to provide an airline with a cost efficient and profitable means of transporting passengers between the major cities in Aeroworld. The design attacks the market where a demand for inexpensive transportation exists and for this reason the Blue Emu is an attractive investment for any airline. In order to provide a profitable aircraft, special attention was paid to cost and economics. For example, in manufacturing, simplicity was stressed in structural design to reduce construction time and cost. Aerodynamic design employed a tapered wing which reduced the induced drag coefficient while also reducing the weight of the wing. Even the propulsion system was selected with cost effectiveness in mind, yet also to maintain the marketability of the aircraft. Thus, in every aspect of the design, consideration was given to economics and marketability of the final product. Author (revised)

N94-24837*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
THE AIRPLANE: A SIMULATED COMMERCIAL AIR TRANSPORTATION STUDY Final Design Proposal
MARK DAUTEUIL, PETE GENIESSE, MICHAEL HUNNIFORD, KATHLEEN LAWLER, ELENA QUIRK, and MICHAEL TOGNARELLI Apr. 1993 176 p
(Contract NASW-4435)
(NASA-CR-195525; NAS 1.26:195525) Avail: CASI HC A09/MF A02

The 'Airplane' is a moderate-range, 70 passenger aircraft. It is designed to serve demands for flights up to 10,000 feet and it cruises at 32 ft/s. The major drivers for the design of the Airplane are economic competitiveness, takeoff performance, and weight minimization. The Airplane is propelled by a single Astro 15 electric motor and a Zinger 12-8 propeller. The wing section is a Spica airfoil which, because of its flat bottom, provides simplicity in manufacturing and thus helps to cut costs. The wing is constructed of a single load bearing mainspar and shape-holding ribs coated with Monokote skin, lending to a light weight structural makeup. The fuselage houses the motor, flight deck and passenger compartments as well as the fuel and control actuating systems. The wing will be attached to the top of the fuselage as will the fuel and control actuator systems for easy disassembly and maintenance. The aircraft is maneuvered about its pitch axis by means of an aft elevator on the flat plate horizontal tail. The twin vertical tail surfaces are also flat plates and each features a rudder for both directional and roll control. Along with wing dihedral, the rudders will be used to roll the aircraft. The Airplane is less costly to operate at its own maximum range and capacity as well as at its maximum range and the HB-40's maximum capacity than the HB-40. Derived from text

N94-24915*# Naval Postgraduate School, Monterey, CA.
DUMBO HEAVY LIFTER AIRCRAFT
PETER RIESTER, COLLEEN ELLIS, MICHAEL WAGNER, SCOTT ORREN, BYRON SMITH, MICHAEL SKELLY, CRAIG ZGRAGGEN, and MATT WEBBER Sep. 1992 102 p
(Contract NASW-4435)
(NASA-CR-195500; NAS 1.26:195500) Avail: CASI HC A06/MF A02

The world is rapidly changing from one with two military superpowers, with which most countries were aligned, to one with many smaller military powers. In this environment, the United States cannot depend on the availability of operating bases from which to respond to crises requiring military intervention. Several studies (e.g. the SAB Global Reach, Global Power Study) have indicated an increased need to be able to rapidly transport large numbers of troops and equipment from the continental United States to potential trouble spots throughout the world. To this end, a request for proposals (RFP) for the concept design of a large aircraft capable of 'projecting' a significant military force without reliance on surface transportation was developed. These design requirements are: minimum payload of 400,000 pounds at 2.5 g maneuver load factor; minimum unfueled range of 6,000 nautical miles; and aircraft must operate from existing domestic air bases and use existing airbases or sites of opportunity at the destination. Derived from text

N94-24953*# Maryland Univ., College Park.
AEROELASTIC RESPONSE AND STABILITY OF TILTROTORS WITH ELASTICALLY-COUPLED COMPOSITE ROTOR BLADES Ph.D. Thesis
MARK W. NIXON 1993 448 p
(NASA-TM-108758; NAS 1.15:108758) Avail: CASI HC A19/MF A04

There is a potential for improving the performance and aeroelastic stability of tiltrotors through the use of elastically-coupled composite rotor blades. To study the characteristics of tiltrotors with these types of rotor blades it is necessary to formulate a new analysis which has the capabilities of modeling both a tiltrotor configuration and an anisotropic rotor blade. Background for these formulations is established in two preliminary investigations. In the first, the influence of several system design parameters on tiltrotor aeroelastic stability is examined for the high-speed axial flight mode using a newly-developed rigid-blade analysis with an elastic wing finite element model. The second preliminary investigation addresses the accuracy of using a one-dimensional beam analysis to predict frequencies of elastically-coupled highly-twisted rotor blades. Important aspects of the new aeroelastic formulations are the inclusion of a large steady pylon angle which controls tilt of the rotor system with respect to the airflow, the inclusion of elastic pitch-lag coupling terms related to rotor precone, the inclusion of hub-related degrees of freedom which enable modeling of a gimballed rotor system and engine drive-train dynamics, and additional elastic coupling terms which enable modeling of the anisotropic features for both the rotor blades and the tiltrotor wing. Accuracy of the new tiltrotor analysis is demonstrated by a comparison of the results produced for a baseline case with analytical and experimental results reported in the open literature. Two investigations of elastically tailored blades on a baseline tiltrotor are then conducted. One investigation shows that elastic bending-twist coupling of the rotor blade is a very effective means for increasing the flutter velocity of a tiltrotor, and the magnitude of coupling required does not have an adverse effect on performance or blade loads. The second investigation shows that passive blade twist control via elastic extension-twist coupling of the rotor blade has the capability of significantly improving tiltrotor aerodynamic performance. This concept, however, is shown to have, in general, a negative impact on stability characteristics. Author

N94-24966*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.
THE AC-120: THE ADVANCED COMMERCIAL TRANSPORT
DAVID DURAN, ERNEST GRIFFIN, SAUL MENDOZA, SON NGUYEN, TIM PICKETT, and CLEMM NOERNBERG 14 May 1993 89 p Original contains color illustrations
(Contract NASW-4435)
(NASA-CR-195491; NAS 1.26:195491) Avail: CASI HC A05/MF A01: 3 functional color pages

The main objective of this design was to fulfill a need for a new airplane to replace the aging 100 to 150 passenger, 1500 nautical mile range aircraft such as the Douglas DC9 and Boeing 737-100 airplanes. After researching the future aircraft market, conducting extensive trade studies, and analysis on different configurations, the AC-120 Advanced Commercial Transport final design was achieved. The AC-120's main design features include the incorporation of a three lifting surface configuration which is powered by two turboprop engines. The AC-120 is an economically sensitive aircraft which meets the new FM Stage Three noise requirements, and has lower NO(x) emissions than current turbofan powered airplanes. The AC-120 also improves on its contemporaries in passenger comfort, manufacturing, and operating cost. Author (revised)

N94-24968*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

INTEGRATED DESIGN AND MANUFACTURING FOR THE HIGH SPEED CIVIL TRANSPORT Final Report

Jun. 1993 201 p

(Contract NASW-4435)

(NASA-CR-195511; NAS 1.26:195511) Avail: CASI HC A10/MF A03

In June 1992, Georgia Tech's School of Aerospace Engineering was awarded a NASA University Space Research Association (USRA) Advanced Design Program (ADP) to address 'Integrated Design and Manufacturing for the High Speed Civil Transport (HSCT)' in its graduate aerospace systems design courses. This report summarizes the results of the five courses incorporated into the Georgia Tech's USRA ADP program. It covers AE8113: Introduction to Concurrent Engineering, AE4360: Introduction to CAE/CAD, AE4353: Design for Life Cycle Cost, AE6351: Aerospace Systems Design One, and AE6352: Aerospace Systems Design Two. AE8113: Introduction to Concurrent Engineering was an introductory course addressing the basic principles of concurrent engineering (CE) or integrated product development (IPD). The design of a total system was not the objective of this course. The goal was to understand and define the 'up-front' customer requirements, their decomposition, and determine the value objectives for a complex product, such as the high speed civil transport (HSCT). A generic CE methodology developed at Georgia Tech was used for this purpose. AE4353: Design for Life Cycle Cost addressed the basic economic issues for an HSCT using a robust design technique, Taguchi's parameter design optimization method (PDOM). An HSCT economic sensitivity assessment was conducted using a Taguchi PDOM approach to address the robustness of the basic HSCT design. AE4360: Introduction to CAE/CAD permitted students to develop and utilize CAE/CAD/CAM knowledge and skills using CATIA and CADAM as the basic geometric tools. AE6351: Aerospace Systems Design One focused on the conceptual design refinement of a baseline HSCT configuration as defined by Boeing, Douglas, and NASA in their system studies. It required the use of NASA's synthesis codes FLOPS and ACSYNT. A criterion called the productivity index (P.I.) was used to evaluate disciplinary sensitivities and provide refinements of the baseline HSCT configuration. AE6352: Aerospace Systems Design Two was a continuation of Aerospace Systems Design One in which wing concepts were researched and analyzed in more detail. FLOPS and ACSYNT were again used at the system level while other off-the-shelf computer codes were used for more detailed wing disciplinary analysis and optimization. The culmination of all efforts and submission of this report conclude the first year's efforts of Georgia Tech's NASA USRA ADP. It will hopefully provide the foundation for next year's efforts concerning continuous improvement of integrated design and manufacturing for the HSCT. Author (revised)

N94-24969*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.

AIRCRAFT EMPENNAGE STRUCTURAL DETAIL DESIGN

DAVID LESNEWSKI, RUSS M. SNOW, LISA M. COMBS, DAVID PAUFLER, GEORGE SCHNIEDER, and ROXANNE ATHOUSAKE 15 Apr. 1993 56 p

(Contract NASW-4435)

(NASA-CR-195486; NAS 1.26:195486) Avail: CASI HC A04/MF A01

The purpose of this project is to provide an empennage structural assembly that will withstand the operational loads defined in FAR Part 23, as well as those specified in the statement of work, i.e. snow, rain, humidity, tiedown forces, etc. The goal is to provide a simple yet durable lightweight structure that will transfer the aerodynamic forces produced by the tail surfaces through the most efficient load path to the airframe. The structure should be simple and cost-effective to manufacture and repair. All structures meet or exceed loading and fatigue criteria. The structure provides for necessary stiffness and ease of maintenance.
Author (revised)

N94-24972*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.

A GLOBAL RANGE MILITARY TRANSPORT: THE OSTRICH

JOHN AGUIAR, CECILIA BOOKER, ERIC HOFFMAN, JAMES KRAMAR, ORLANDO MANAHAN, RAY SERRANZANA, and MIKE TAYLOR 14 May 1993 103 p

(Contract NASW-4435)

(NASA-CR-195494; NAS 1.26:195494) Avail: CASI HC A06/MF A02

Studies have shown that there is an increasing need for a global range transport capable of carrying large numbers of troops and equipment to potential trouble spots throughout the world. The Ostrich is a solution to this problem. The Ostrich is capable of carrying 800,000 pounds 6,500 n.m. and returning with 15 percent payload, without refueling. With a technology availability date in 2010 and an initial operating capability of 2015, the aircraft incorporates many advanced technologies including laminar flow control, composite primary structures, and a unique multibody design. By utilizing current technology, such as using McDonnell Douglas C-17 fuselage for the outer fuselages on the Ostrich, the cost for the aircraft was reduced. The cost of the Ostrich per aircraft is $1.2 billion with a direct operating cost of $56,000 per flight hour. The Ostrich will provide a valuable service as a logistical transport capable of rapidly projecting a significant military force or humanitarian aid anywhere in the world. Author (revised)

N94-24974*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.

AIRCRAFT WING STRUCTURAL DETAIL DESIGN (WING, AILERON, FLAPS, AND SUBSYSTEMS)

ROBERT DOWNS, MIKE ZABLE, JAMES HUGHES, TERRY HEISER, and KENNETH ADRIAN 14 Apr. 1993 40 p

(Contract NASW-4435)

(NASA-CR-195487; NAS 1.26:195487) Avail: CASI HC A03/MF A01

The goal of this project was to design, in detail, the wing, flaps, and ailerons for a primary flight trainer. Integrated in this design are provisions for the fuel system, the electrical system, and the fuselage/cabin carry-through interface structure. This conceptual design displays the general arrangement of all major components in the wing structure, taking into consideration the requirements set forth by the appropriate sections of Federal Aviation Regulation Part 23 (FAR23) as well as those established in the statement of work. Derived from text

N94-24975*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering Dept.

WEASEL WORKS SA-150: DESIGN STUDY OF A 100 TO 150 PASSENGER TRANSPORT AIRCRAFT

KEVIN ALKEMA, MICHAEL COMEAUX, TIMOTHY GILBERT, VICTOR PARA, and GEORGE TOEPFER 14 May 1993 110 p

(Contract NASW-4435)

(NASA-CR-195489; NAS 1.26:195489) Avail: CASI HC A06/MF A02

As the year 2000 rapidly approaches, the airlines are faced with an extremely competitive and environmentally restrictive marketplace. In order to survive, commercial air carriers will need to find new ways to lower their direct operating costs, increase load factors and comply with tightening federal and international constraints. The SA-150 has been designed to meet these demands by focusing on the areas of aerodynamic efficiency, an improved level of passenger comfort, and a limited application of advanced technology. The SA-150 has been optimized for a 500 nmi. mission to help the airlines meet the challenges of the short haul, quick turnaround flight. With a maximum capacity of 124 passengers, and full baggage, the SA-150 is also capable of covering a range of 1500 nmi. This additional range capability will provide the airlines with flexibility when scheduling their routes. The aircraft features a 'V' tail, fly-by-wire system and is powered by two turbofans mounted under a twelve aspect ratio wing. The SA-150 will have an initial production run of 800 units and have a purchase price of $37.7 million in 1993 dollars. Author

N94-25001*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
THE BUNNY: A SIMULATED COMMERCIAL AIR TRANSPORTATION STUDY Final Design Proposal
DAVID FULTON, PATRICK GALLAGHER, WILLIAM GRANNAN, JENNIFER MARTIN, NICOLE MASTEJ, and BRETT WUJEK Apr. 1993 123 p
(Contract NASW-4435)
(NASA-CR-195537; NAS 1.26:195537) Avail: CASI HC A06/MF A02

The Bunny is a single-engine, 100 passenger commercial transport designed to serve the high density short-to-medium range markets in AEROWORLD. The aircraft's design range is 10,000 feet at a cruise velocity of 30 ft/s. The aircraft features a low wing which incorporates polyhedral for roll control. Yaw and pitch control are accomplished by a rudder and elevator, respectively. Propulsion is provided by a nose-mounted Astro 15 electric motor powered by thirteen 1.2 V, 1000 mah batteries with a Zinger 12-6 propeller. The aircraft is structurally designed with a safety factor of 1.5 and is constructed primarily of balsa, bass, and birch wood. Passenger seating is arranged on two levels, with three-abreast on the lower level and two-abreast on the upper level. The factors which had the most significant influence on the final design were the direct operating cost and the take-off distance. The primary strength of The Bunny is its ability to compete economically with the HB-40. At full capacity and mid-range fuel costs, the cost per seat per thousand feet (CPSK) of this aircraft is 25% less than the HB-40. Another principal strength is its ability to operate in all airports in AEROWORLD. Also, The Bunny's two-piece removable wing is an advantage from a transportability standpoint.
Derived from text

N94-25002*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
THE GOLD RUSH: A SIMULATED COMMERCIAL AIR TRANSPORTATION STUDY
AMANDA CLARKE, CHRIS DEGIORGIO, EDMUND GALKA, ALBERT STUMM, LISA VALENTA, and TOM WINTER Apr. 1993 121 p
(Contract NASW-4435)
(NASA-CR-195528; NAS 1.26:195528) Avail: CASI HC A06/MF A02

The remotely piloted vehicle (RPV) GoldRush was designed to complete the mission of transporting passengers in AeroWorld at a lower cost per seat per thousand feet (CPSPK) than the competition, the HB-40. There were two major factors which were constant considerations in the design process. The cost of manufacturing was the most important. In light of this, the designs were kept as simple as possible while considering trade-offs in performance. For example, the wing was not tapered so that several ribs could be cut at one time. Also of major importance was the takeoff distance. In order to serve all the cities in AeroWorld it was necessary to maintain a takeoff distance requirement of 24 feet. The takeoff distance proved to be the number one force in driving the design process. The Astro 25 engine and 13 inch propellor, a large wing area, and the high lift Wortmann airfoil were all chosen in order to satisfy this objective.
Derived from text

N94-25004*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
THE TRITON: DESIGN CONCEPTS AND METHODS
GREG MEHOLIC, MICHAEL SINGER, PERCY VANRYN, RHONDA BROWN, GUSTAVO TELLA, and BOB HARVEY 7 Dec. 1992 48 p
(Contract NASW-4435)
(NASA-CR-195542; NAS 1.26:195542) Avail: CASI HC A03/MF A01

During the design of the C & P Aerospace Triton, a few problems were encountered that necessitated changes in the configuration. After the initial concept phase, the aspect ratio was increased from 7 to 7.6 to produce a greater lift to drag ratio (L/D = 13) which satisfied the horsepower requirements (118 hp using the Lycoming O-235 engine). The initial concept had a wing planform area of 134 sq. ft. Detailed wing sizing analysis enlarged the planform area to 150 sq. ft., without changing its layout or location. The most significant changes, however, were made just prior to inboard profile design. The fuselage external diameter was reduced from 54 to 50 inches to reduce drag to meet the desired cruise speed of 120 knots. Also, the nose was extended 6 inches to accommodate landing gear placement. Without the extension, the nosewheel received an unacceptable percentage (25 percent) of the landing weight. The final change in the configuration was made in accordance with the stability and control analysis. In order to reduce the static margin from 20 to 13 percent, the horizontal tail area was reduced from 32.02 to 25.0 sq. ft. The Triton meets all the specifications set forth in the design criteria. If time permitted another iteration of the calculations, two significant changes would be made. The vertical stabilizer area would be reduced to decrease the aircraft lateral stability slope since the current value was too high in relation to the directional stability slope. Also, the aileron size would be decreased to reduce the roll rate below the current 106 deg/second. Doing so would allow greater flap area (increasing CL(sub max)) and thus reduce the overall wing area. C & P would also recalculate the horsepower and drag values to further validate the 120 knot cruising speed.
Author (revised)

N94-25017*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
THE RTL-46: A SIMULATED COMMERCIAL AIR TRANSPORTATION STUDY Final Report
CHRISTIAN DUNBAR, JOHN PRETTE, GERALD ANDERSEN, MARTIN SPRUNCK, CHRISTINE VOGEL, and FRANCISCO RIVERA Apr. 1993 128 p
(Contract NASW-4435)
(NASA-CR-195524; NAS 1.26:195524) Avail: CASI HC A07/MF A02

The RTL-46 provides an aircraft which utilizes advanced technology within the fictional Aeroworld market to better service the air travel customers and airlines of Aeroworld. The RTL-46 is designed to serve the portion of the travel market which flies less than 10,000 feet per flight. The design cruise velocity for the aircraft is 35 ft/sec, which rapidly expedites travel through Aeroworld. The major focus of the endeavor was to design an aircraft which would serve the Aeroworld market better than the existing aircraft, the HB-40. This could have been done through targeting another portion of the Aeroworld market or through serving the current HB-40 market more effectively. Due to the fact that approximately 70 percent of the potential Aeroworld passengers desired flights of 10,000 ft or less, this range became the target market for the RTL-46. Derived from text

N94-25021*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
DESIGN PROJECT: VIPER
STEPHEN HAITHCOCK, KYLE KONCAK, RICH NEUFANG, DAVID PAUFLER, RUSS SNOW, and FRANK WLAD 1992 47 p
(Contract NASW-4435)
(NASA-CR-195484; NAS 1.26:195484) Avail: CASI HC A03/MF A01

The design specification of the primary flight trainer are: must conform to F.A.R. 23, including the crashworthiness standards; is limited to two to four occupants; engine must be FAA certified; must comply with FAA standards for VFR and allow for upgrade to IFR flights; must be at least utility category with good spin recovery characteristics; must have a structural lifetime of at least 10,000 flight hours; capable of either of two training missions: climb to 5,000 ft., cruise 500 Nm. plus reserve, land, or climb to 1,000 ft. and descend ten cycles for landing practice, climb to 3,000 ft., maneuver at two g's for 15 minutes, cruise 100 Nm. and land; must have a cruise speed of at least 120 knots; must take-off or land on a runway no longer than 3,000 ft; and has a cost goal of $50,000, not including avionics, for production of 1,000 airplanes over a five year period. Derived from text

N94-25052 Department of the Navy, Washington, DC.
GENERIC DRONE CONTROL SYSTEM Patent
DAVID M. ELBAND, inventor (to Navy) and LYNN R. KERN, inventor (to Navy) 31 Aug. 1993 11 p Filed 3 Aug. 1992
(AD-D015993; US-PATENT-5,240,207;
US-PATENT-APPL-SN-923867; US-PATENT-CLASS-244-190)
Avail: US Patent and Trademark Office

The disclosed invention is a generic Drone Control System or alternatively a method to remotely pilot an air vehicle. The present invention essentially comprises a converted aircraft or other air vehicle and a ground station from where the drone is remotely controlled. Also disclosed as part of the Drone Control System are a plurality of means to transfer information and data between the ground station and the drone. DTIC

N94-25069 Boeing Co., Seattle, WA.
HIGH-ORDER TECHNOLOGY: APPLYING TECHNICAL EXCELLENCE TO NEW AIRPLANE DEVELOPMENT
ALBERTUS D. WELLIVER *In* National Academy of Engineering, The Future of Aerospace: Proceedings of a Symposium Held in Honor of Alexander H. Flax p 37-44 1993
Copyright Avail: Issuing Activity

There is a misconception today about what technology really is. Technology has now come to mean specific things: fault-tolerant computers, portable satellite phones, featherweight composite materials. But these individual items, however important they may be, are not examples of the true meaning of the word technology. Instead, these are examples of technical excellence. A higher form of technology is at work behind these specific pieces of equipment: the technology based on human experience, wisdom, and judgment. In aviation, the ultimate technology means listening to the customer and adding value to the airplane. In Boeing's design process, every new technology development must earn its way onto an airplane by adding value in one of three ways: increased safety, improved operational efficiency and economic utility, and greater customer satisfaction. Higher-order technology, the technology of knowing how to apply examples of technical excellence, is now shaping the development of two exciting classes of airplane. One is the development of large subsonic transports, including the potential for new airplanes larger than any current commercial transports. The other is the prospect of a high-speed civil transport (HSCT). Although these two categories of airplane are very different, they do have one thing in common: A successful design will depend on how technical excellence is applied to the satisfaction of the customer. By themselves, individual examples of technical excellence will not produce a winning design. A good airplane is the result of good decisions, not just good components. Derived from text

N94-25070 Army Aviation Systems Command, Moffett Field, CA. Advanced Systems Research and Analysis Office.
THE FUTURE OF ROTARY-WING AIRCRAFT
RICHARD M. CARLSON *In* National Academy of Engineering, The Future of Aerospace: Proceedings of a Symposium Held in Honor of Alexander H. Flax p 45-63 1993
Copyright Avail: Issuing Activity

Advances in rotary wing aircraft technology will improve performance of future helicopters in three broad mission segments, defined as vertical takeoff and landing, horizontal flight, and hovering flight. This paper addresses technologies associated with these three mission segments in the areas of propulsion, rotary-wing aerodynamics, and materials and structures. The paper also examines the economic outlook for rotary wing aircraft in future commercial and military markets. CASI

N94-25109*# Joint Inst. for Advancement of Flight Sciences, Hampton, VA. Aircraft Guidance and Controls Branch.
X-31 AERODYNAMIC CHARACTERISTICS DETERMINED FROM FLIGHT DATA
ALEX KOKOLIOS *In* NASA. Langley Research Center, NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 373-387 Dec. 1993
Avail: CASI HC A03/MF A04

The lateral aerodynamic characteristics of the X-31 were determined at angles of attack ranging from 20 to 45 deg. Estimates of the lateral stability and control parameters were obtained by applying two parameter estimation techniques, linear regression, and the extended Kalman filter to flight test data. An attempt to apply maximum likelihood to extract parameters from the flight data was also made but failed for the reasons presented. An overview of the System Identification process is given. The overview includes a listing of the more important properties of all three estimation techniques that were applied to the data. A comparison is given of results obtained from flight test data and wind tunnel data for four important lateral parameters. Finally, future research to be conducted in this area is discussed. Author (revised)

N94-25113*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF AEROELASTIC-PROPULSIVE INTERACTIONS ON FLIGHT DYNAMICS OF A HYPERSONIC VEHICLE
DAVID L. RANEY, JOHN D. MCMINN, ANTHONY S. POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA.), and CHRISTINE L. WOOLEY (Cincinnati Univ., OH.) *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 459-472 Dec. 1993
Avail: CASI HC A03/MF A04

The desire to achieve orbit-on-demand access to space with rapid turn-around capability and aircraft-like processing operations has given rise to numerous hypersonic aerospace plane design concepts which would take off horizontally from a conventional runway and employ air-breathing scramjet propulsion systems for acceleration to orbital speeds. Most of these air-breathing hypersonic vehicle concepts incorporate an elongated fuselage forebody to act as the aerodynamic compression surface for a scramjet combustor module. This type of airframe-integrated scramjet propulsion system tends to be highly sensitive to inlet conditions and angle-of-attack perturbations. Furthermore, the basic configuration of the fuselage, with its elongated and tapered forebody, produces relatively low frequency elastic modes which will cause perturbations in the combustor inlet conditions due to the oscillation of the forebody compression surface. The flexibility of the forebody compression surface, together with sensitivity of scramjet propulsion systems to inlet conditions, creates the potential for an unprecedented form of aeroelastic-propulsive interaction in which deflections of the vehicle fuselage give rise to propulsion transients, producing force and moment variations that may adversely impact the longitudinal flight dynamics and/or excite the elastic modes. These propulsive force and moment variations may have an appreciable impact on the performance, guidance, and control of a hypersonic aerospace plane. The objectives of this research are to quantify the magnitudes of propulsive force and moment perturbations resulting from elastic deformation of a representative hypersonic vehicle, and to assess the potential impact of these perturbations on the vehicle's longitudinal flight dynamics. Derived from text

N94-25152# General Accounting Office, Washington, DC. National Security and International Affairs Div.
B-2 BOMBER: ASSESSMENT OF DOD'S RESPONSE TO MANDATED CERTIFICATIONS AND REPORTS
3 Nov. 1993 6 p
(AD-A273179; GAO/NSIAD-94-75) Avail: CASI HC A02/MF A01

Department of Defense Authorization Acts for fiscal years 1990, 1992, and 1993 required the Secretary of Defense to deliver to the Congress, certain certifications and reports concerning the B-2 bomber program. The Congress restricted the Air Force's use of about $2.3 billion appropriated in fiscal years 1992 and 1993 for procurement of B-2 Aircraft until those certifications and reports are delivered and an act of the Congress is passed authorizing release of the funds. The authorization acts also call for our office to report to the Congress concerning the certifications and reports submitted by the Secretary. This is an interim report in response to that legislation. A detailed classified report will be issued shortly. DTIC

N94-25268*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
HIGH LIFT AERODYNAMICS
JOHN SULLIVAN, STEVE SCHNEIDER, BRYAN CAMPBELL, GREG BUCCI, ROD BOONE (Shaw Univ., Raleigh, NC.), SHAD TORGERSON, RICK ERAUSQUIN, and CHAD KNAUER 8 Mar. 1994 46 p
(Contract NAG2-854)
(NASA-CR-195183; NAS 1.26:195183) Avail: CASI HC A03/MF A01

The current program is aimed at providing a physical picture of the flow physics and quantitative turbulence data of the interaction of a high Reynolds number wake with a flap element. The impact of high lift on aircraft performance is studied for a 150 passenger transport aircraft with the goal of designing optimum high lift systems with minimum complexity. Derived from text

N94-25301 Institut Franco-Allemand de Recherches, Saint-Louis (France).
THE ISL ROTOR BENCH [LE BANC ROTOR DE L'ISL]
C. JOHE, J. HAERTIG, P. GNEMMI, and F. VINCENT 18 May 1992 29 p In FRENCH
(ISL-R-108/92; ETN-94-95120) Avail: Issuing Activity (Fachinformationszentrum Karlsruhe, Eggenstein-Leopoldschafen 2, 7014 Karlsruhe, Germany)

The rotor test bench of the ISL (French acronym for Saint-Louis Institute) is described. The test facility was designed for aeroacoustic experiments of helicopter rotors. Special attention is given to noise at high speeds. The test bench mechanical systems and the operation procedures are described. The measurement and control electronic equipment and the applied software tools, developed for surveying tasks and data acquisition, are presented. The rotor acoustic signatures measured at low and at transonic speeds are discussed. ESA

N94-25440# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.
AIRCRAFT MANEUVERS FOR THE EVALUATION OF FLYING QUALITIES AND AGILITY. VOLUME 2: MANEUVER DESCRIPTIONS AND SECTION GUIDE Final Report, Sep. 1990 - Jun. 1993
DAVID J. WILSON, DAVID R. RILEY, and KEVIN D. CITURS Aug. 1993 92 p
(Contract F33615-90-C-3600)
(AD-A273685; WL-TR-93-3082-VOL-2) Avail: CASI HC A05/MF A01

A set of aircraft maneuvers was developed to augment evaluation maneuvers used currently by the flying qualities and flight test communities. These maneuvers extend evaluation to full aircraft dynamics throughout the aircraft flight envelope. As a result, a tie was established between operational use and design parameters without losing control of the aircraft evaluation process. Twenty maneuvers are described as an initial set to examine primarily high-angle-of-attack conditions. Perhaps as important as the maneuvers themselves is the method used to select them. These maneuvers will allow direct measurement of flying qualities throughout the flight envelope instead of merely comparing parameters to specification values. DTIC

N94-25590# McDonnell-Douglas Astronautics Co., Saint Louis, MO.
AIRCRAFT MANEUVERS FOR THE EVALUATION OF FLYING QUALITIES AND AGILITY. VOLUME 1: MANEUVER DEVELOPMENT PROCESS AND INITIAL MANEUVER SET Final Report, 1 Sep. 1990 - 1 Jun. 1993
DAVID J. WILSON, DAVID R. RILEY, and KEVIN D. CITURS Aug. 1993 165 p
(Contract F33615-90-C-3600)
(AD-A273913; WL-TR-93-3081) Avail: CASI HC A08/MF A02

A set of aircraft maneuvers has been developed to augment evaluation maneuvers used currently by the flying qualities and flight test communities. These maneuvers extend evaluation to full aircraft dynamics throughout the aircraft flight envelope. As a result, a tie has been established between operational use and design parameters without losing control of the aircraft evaluation process. Twenty maneuvers are described as an initial set to examine primarily high angle of attack conditions. Perhaps as important as the maneuvers themselves is the method used to select them. These maneuvers will allow direct measurement of flying qualities throughout the flight envelope instead of merely comparing parameters to specification values. DTIC

N94-25695*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Mechanical Engineering, Aerospace Engineering, and Mechanics.
THE LIGHTCRAFT PROJECT: FLIGHT TECHNOLOGY FOR A HYPERSONIC MASS TRANSIT SYSTEM Abstract Only
LEIK MYRABO and KENNETH BOUCHARD *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 250 1992
Avail: CASI HC A01/MF A04

Rensselaer Polytechnic Institute has been developing transatmospheric 'Lightcraft' technology aimed at creating an efficient, economically affordable, hypersonic mass transportation system. The system utilizes laser-energized airbreathing engines to accelerate minimum-volume passenger capsules. The system gains a high level of reliability by using remote 'centralized' space power sources, e.g., satellite solar power stations. The most critical portion of the Lightcraft's acceleration trajectory involves flight propulsion at hypersonic velocities within the Earth's atmosphere, using a 'Magneto-Hydro-Dynamic (MHD) Fanjet' mode. Of all the propulsion modes proposed for the Lightcraft's combined-cycle engine, the MHD-Fanjet mode has received the least critical inquiry, largely because of its complexity. During the 1991-1992 academic year, Rensselaer's ADP teams produced a detailed conceptual design for the MHD-Fanjet engine, including the specific details of its integration with the other three propulsive modes. To facilitate this process, students built a full-scale mockup of a 1/12th section of this annular engine, complete with a working model of the shroud translation system. The class also made preliminary design calculations for the double-dipole, 'cuspfield' superconducting magnets that provide the external magnetic field needed by the MHD air accelerator, as well as for an onboard microwave power system to enhance the electrical conductivity of the air plasma working fluid. In addition, a large hypersonic model of the MHD accelerator was designed for future tests in RPI's Hypersonic Shock Tunnel in order to validate present analytical performance models. Another group continued design work on a full-sized prototype of a one-person 'Mercury Lightcraft' (a transatmospheric flight simulator), with major emphasis on the detailed design of the major structure, robotic landing gear, and exterior aeroshell. Author (revised)

N94-25708*# Auburn Univ., AL. Dept. of Aerospace Engineering.
DESIGN OF THE ADVANCED REGIONAL AIRCRAFT, THE DART-75
STEVE ELLIOT, JASON GISLASON, MARK HUFFSTETLER, JON MANN, ASHLEY WITHERS, and MARK ZIMMERMAN *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 367-373 1992
Avail: CASI HC A02/MF A04

The need for regional aircraft stems from the problem of hub airport congestion. Regional travel will allow a passenger to commute from one spoke city to another spoke city without entering the congested hub airport. In addition, those people traveling longer routes may begin the flight at home instead of traveling to the hub airport. At this time, there is no American aerospace company that produces a regional transport for under 100 passengers. The intention of the Developmental Advanced Regional Transport (DART-75) is to fill this void with a modern, efficient regional aircraft. This design achieves the efficiency through a number of advanced features including three lifting surfaces, partial composite construction, and an advanced engine design. Efficiency is not the only consideration. Structural integrity, fatigue life, ease of maintenance, passenger comfort and convenience, and environmental aspects must all be considered. These factors force the design team to face many tradeoffs that are studied to find the best solution. The final consideration that cannot be overlooked is that of cost. The DART-75 is a 75-passenger medium-range regional transport intended for spoke-to-spoke, spoke-to-hub, and some hub-to-hub operations. Included are the general descriptions of the structures, weight and balance, stability and control, performance, and engine design. Derived from text

N94-25709*# Auburn Univ., AL. Dept. of Aerospace Engineering.
EAGLE RTS: A DESIGN OF A REGIONAL TRANSPORT
PAUL BRYER, JON BUCKLES, PAUL LEMKE, and KIRK PEAKE *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 373-378 1992
Avail: CASI HC A02/MF A04

The Eagle RTS (Regional Transport System) is a 66-passenger aircraft designed to satisfy the need for accessible and economical regional travel. The first design objective for the Eagle RTS is safety. Safety results primarily from avoidance of the hub airport air traffic, implementation of anti-stall characteristics by tailoring the canard, and proper positioning of the engines for blade shedding. To provide the most economical aircraft, the Eagle RTS will use existing technology to lower production and maintenance costs by decreasing the amount of new training required. In selecting the propulsion system, the effects on the environment were a main consideration. Two advantages of turbo-prop engines are the high fuel efficiency and low noise levels produced by this type of engine. This ensures the aircraft's usage during times of rising fuel costs and growing aircraft noise restrictions. The design of the Eagle RTS is for spoke-to-spoke transportation. It must be capable of landing on shorter runways and have speeds comparable to that of the larger aircraft to make its service beneficial to the airlines. With the use of turbo-prop engines and high lift devices, the Eagle RTS is highly adaptable to regional airports. The design topics discussed include: aerodynamics, stability, structures and materials, propulsion, and cost. Author

N94-25710*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
PRELIMINARY DESIGN OF NINE HIGH SPEED CIVIL TRANSPORTS
DORAL SANDLIN, ROBERT VANTRIET, DANI SOBAN, and TY HOANG *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 379-390 1992
Avail: CASI HC A03/MF A04

Sixty senior design students at Cal Poly, SLO have completed a year-long project to design the next generation of High Speed Civil Transports (HSCT). The design process was divided up into three distinct phases. The first third of the project was devoted entirely to research into the special problems associated with an HSCT. These included economic viability, airport compatibility, high speed aerodynamics, sonic boom minimization, environmental impact, and structures and materials. The result of this research was the development of nine separate Requests for Proposal (RFP) that outlined reasonable yet challenging design criteria for the aircraft. All were designed to be technically feasible in the year 2015. The next phase of the project divided the sixty students into nine design groups. Each group, with its own RFP, completed a Class 1 preliminary design of an HSCT. The nine configurations varied from conventional double deltas to variable geometry wings to a pivoting oblique wing design. The final phase of the project included a more detailed Class 2 sizing as well as performance and stability and control analysis. Cal Poly, San Luis Obispo presents nine unique solutions to the same problem: that of designing an economically viable, environmentally acceptable, safe and comfortable supersonic transport. Author

N94-25711*# California State Polytechnic Univ., Pomona. Dept. of Aerospace Engineering.
SUPERCRUISER ARROW HS-8
PAUL LORD, EDWARD KAO, JOEY B. ABOBO, TODD A. COLLINS, LEONG MA, ADNAN MURAD, HITESH NARAN, THUAN P. NGUYEN, TIMITHY I. NUON, and DIMITRI D. THOMAS *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 391-405 1992
Avail: CASI HC A03/MF A04

Technology in aeronautics has advanced dramatically since the last design of a production High Speed Civil Transport (HSCT) aircraft. Newly projected requirements call for a new High Speed Civil Transport aircraft with a range of approximately 550 nm and at least 275 passenger capacity. The aircraft must be affordable and marketable. The new HSCT must be able to sustain long-duration flights and to absorb the abuse of daily operation. The new aircraft must be safe and simple to fly and require a minimum amount of maintenance. This aircraft must meet FAA certification criteria of FAR Part 25 and environmental constraints. Several design configurations were examined and two designs were selected for further investigation. The first design employs the delta planform wings and conventional empennage layout. The other design uses a swing wing layout and conventional empennage. Other engineering challenges, including materials and propulsion are also discussed. At a cruise flight speed between Mach 2.2 and Mach 3.0, no current generation of materials can endure the thermal loading of supersonic flight and satisfy the stringent weight requirements. A new generation of lightweight composite materials must be developed for the HSCT. With the enforcement of stage 3 noise restrictions, these new engines must be able to propel the aircraft and satisfy the noise limit. The engine with the most promise is the variable cycle engine. At low subsonic speeds the engine operates like a turbofan engine, providing the most efficient performance. At higher speeds the variable cycle engine operates as a turbojet power plant. The two large engine manufacturers, General Electric and Pratt & Whitney in the United States, are combining forces to make the variable cycle engine a reality. Author (revised)

N94-25713*# Case Western Reserve Univ., Cleveland, OH. Dept. of Mechanical and Aerospace Engineering.
TESSERACT SUPERSONIC BUSINESS TRANSPORT
ELI RESHOTKO, GARY GARBINSKI, JAMES FELLENSTEIN, MARY BOTTING, JOAN HOOPER, MICHAEL RYAN, PETER STRUK, BEN TAGGART, MAGGIE TAILLON, and GARY WARZYNSKI *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 413-424 1992
Avail: CASI HC A03/MF A04

This year, the senior level Aerospace Design class at Case Western Reserve University developed a conceptual design of a supersonic business transport. Due to the growing trade between Asia and the United States, a transpacific range was chosen for the aircraft. A Mach number of 2.2 was chosen, too, because it provides reasonable block times and allows the use of a large range of materials without a need for active cooling. A payload of 2,500 lbs. was assumed corresponding to a complement of nine passengers and crew, plus some light cargo. With these general requirements set, the class was broken down into three groups. The aerodynamics of the aircraft were the responsibility of the first group. The second developed the propulsion system. The efforts of both the aerodynamics and propulsion groups were monitored and reviewed for weight considerations and structural feasibility by the third group. Integration of the design required

considerable interaction between the groups in the final stages. The fuselage length of the final conceptual design was 107.0 ft, while the diameter of the fuselage was 7.6 ft. The delta wing design consisted of an aspect ratio of 1.9 with a wing span of 47.75 ft and mid-chord length of 61.0 ft. A SNECMA MCV 99 variable-cycle engine design was chosen for this aircraft.
Author (revised)

N94-25714*# Kansas Univ., Lawrence. Dept. of Aerospace Engineering.
A REVOLUTIONARY APPROACH TO COMPOSITE CONSTRUCTION AND FLIGHT MANAGEMENT SYSTEMS FOR SMALL, GENERAL AVIATION AIRPLANES
JAN ROSKAM and ED WENNINGER *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 425-436 1992
Avail: CASI HC A03/MF A04

The design studies for two composite general aviation airplanes are presented. The main consideration for both of the designs was to avoid the typical 'metal replacement' philosophy that has hindered the widespread use of composites in general aviation aircraft. The first design is for a low wing aircraft based on the Smith Aircraft Corporation GT-3 Global Trainer. The second aircraft is a composite version of the Cessna 152. The project was conducted as a graduate level design class under the auspices of the KU/NASA/USRA Advanced Design Program in aeronautics. The results obtained from the Fall semester of 1991 and the Spring semester of 1992 are presented. Author (revised)

N94-25715*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
DESIGN STUDY TO SIMULATE THE DEVELOPMENT OF A COMMERCIAL FREIGHT TRANSPORTATION SYSTEM
STEPHEN M. BATILL, KEVIN COSTELLO, and JIM PINKELMAN *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 437-452 1992
Avail: CASI HC A03/MF A04

The Notre Dame Aerospace Engineering senior class was divided into six design teams. A request for proposals (RFP) asking for the design of a remotely piloted vehicle (RPV) was given to the class, and each design team was responsible for designing, developing, producing, and presenting an RPV concept. The RFP called for the design of commercial freight transport RPV. The RFP provided a description of a fictitious world called 'Aeroworld'. Aeroworld's characteristics were scaled to provide the same types of challenges for RPV design that the real world market provides for the design of commercial aircraft. Fuel efficiency, range and payload capabilities, production and maintenance costs, and profitability are a few of the challenges that were addressed in this course. Each design team completed their project over the course of a semester by designing and flight testing a prototype, freight-carrying remotely piloted vehicle. Author

N94-25716*# Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.
THE DESIGN OF FOUR HYPERSONIC RECONNAISSANCE AIRCRAFT
G. M. GREGOREK and D. T. DETWILER *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 453-462 1992
Avail: CASI HC A02/MF A04

Four different hypersonic reconnaissance aircraft were designed by separate student teams. These aircraft were designed to provide the U.S. with a system to acquire aerial tactical reconnaissance when satellite reconnaissance proved unobtainable or ineffective. The design requirements given for this project stated that these aircraft must carry a 7500 lb, 250 cu ft payload of electronic and photographic intelligence gathering equipment over a target area at speeds between Mach 4-7 and at altitudes above 80,000 ft. Two of the aircraft were required to be manned by a crew of two and have a range of 12,000 nmi. One of these was to use airborne refueling to complete its mission while the other was not to use any refueling. The other two aircraft were required to be unmanned with a range of 6,000 nmi. One of these was to take off from another aircraft. The final details of all four aircraft designs along with an overview of the design process is provided.
Author (revised)

N94-25717*# Ecole Polytechnique Feminine, Sceaux (France).
DESIGN OF A REFUELING TANKER DELIVERING LIQUID HYDROGEN
DANIEL LOURME, CAROLINE BARNIER, SABINE FAURE, MARIE-HELENE POMPEI, and KARINE PRUNIAUX *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 463-466 1992
Avail: CASI HC A01/MF A04

A refueling tanker that could deliver 155,000 lb of liquid hydrogen to a hypersonic tanker in 15 min was designed. A flying boom system was chosen to fit strict delivery criteria. Tank design and material specification were also addressed. To assure the flow required, it was important to cancel the pressure drop phenomenon. Geometry, aerodynamics, weight considerations, propulsion, stability, and performance for the tanker were also considered. Finally, the cost of developing three prototypes was estimated. Author

N94-25718*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
THE DESIGN OF A LONG-RANGE MEGATRANSPORT AIRCRAFT
TERRENCE A. WEISSHAAR and CARL L. ALLEN *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 467-476 1992
Avail: CASI HC A02/MF A04

Aircraft manufacturers are examining the market and feasibility of long-range passenger aircraft carrying more than 600 passengers. These aircraft would carry travelers at reduced cost and, at the same time, reduce congestion around major airports. The design of a large, long-range transport involves broad issues such as: the integration of airport terminal facilities; passenger loading and unloading; trade-offs between aircraft size and the cost to reconfigure these existing facilities; and, defeating the 'square-cube' law. Thirteen Purdue design teams generated RFP's that defined passenger capability and range, based upon team perception of market needs and infrastructure constraints. Turbofan engines were designed by each group to power these aircraft. The design problem and the variety of solutions developed are reviewed. Author (revised)

N94-25719*# Worcester Polytechnic Inst., MA. Dept. of Mechanical Engineering.
SOLAR POWERED MULTIPURPOSE REMOTELY POWERED AIRCRAFT
A. N. ALEXANDROU, W. W. DURGIN, R. F. COHN, D. J. OLINGER, CHARLOTTE K. CODY, AGNES CHAN, KWOK-HUNG CHEUNG, KRISTIN CONLEY, PAUL M. CRIVELLI, CHRISTIAN T. JAVORSKI et al. *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 477-489 1992
Avail: CASI HC A03/MF A04

Increase in energy demands coupled with rapid depletion of natural energy resources have deemed solar energy as an attractive alternative source of power. The focus was to design and construct a solar powered, remotely piloted vehicle to demonstrate the feasibility of solar energy as an effective, alternate source of power. The final design included minimizing the power requirements and maximizing the strength-to-weight and lift-to-drag ratios. Given the design constraints, Surya (the code-name given to the aircraft), is a lightweight aircraft primarily built using composite materials and capable of achieving level flight powered entirely by solar energy.
Author

N94-25905# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EVALUATION OF MODERATE ANGLE OF ATTACK ROLL OF A DUAL ENGINE, THRUST VECTORING AIRCRAFT USING QUANTITATIVE FEEDBACK THEORY M.S. Thesis
KEVIN E. BOYUM Dec. 1993 207 p
(AD-A274118; AFIT/GE/ENG/93D-01) Avail: CASI HC A10/MF A03

This thesis develops an innovative approach to the design of a flight control system for performing the large-amplitude velocity vector roll maneuver at high angles of attack (AOA's). A six degree of freedom aircraft model is developed from the fundamental nine-state equations of motion using a modified linearization technique. The MIMO (multiple-input multiple-output) Quantitative Feedback Theory (QFT) robust control design technique is then used to jointly address the system nonlinearities present in this maneuver and the changes in the system parameters due to changes in flight condition, treating them as structured uncertainty in the design of a three-axis rate-commanded control system. The development of a weighting matrix, based on the fundamentals of the aileron-rudder interconnect, aids in this design process. Nonlinear six degree-of-freedom closed-loop control system simulations demonstrate the accuracy of the developed models, the validity of the QFT designed compensator and prefilter, and the successful initiation and arrest of the velocity vector roll maneuver. DTIC

N94-25961# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.
AIRCRAFT MANEUVERS FOR THE EVALUATION OF FLYING QUALITIES AND AGILITY. VOLUME 3: SIMULATION DATA Final Report, Sep. 1990 - Jun. 1993
DAVID J. WILSON, DAVID R. RILEY, and KEVIN D. CITURS Aug. 1993 536 p
(Contract F33615-90-C-3600)
(AD-A273814; WL-TR-93-3083-VOL-3) Avail: CASI HC A23/MF A04

A set of aircraft maneuvers was developed to augment evaluation maneuvers used currently by the flying qualities and flight test communities. These maneuvers extend evaluation to full aircraft dynamics throughout the aircraft flight envelope. As a result, a tie was established between operational use and design parameters without losing control of the aircraft evaluation process. Twenty maneuvers are described as an initial set to examine primarily high-angle-of attack conditions. Perhaps as important as the maneuvers themselves is the method used to select them. These maneuvers will allow direct measurement of flying qualities throughout the flight envelope instead of merely comparing parameters to specification values. DTIC

N94-26091*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EGADS: A MICROCOMPUTER PROGRAM FOR ESTIMATING THE AERODYNAMIC PERFORMANCE OF GENERAL AVIATION AIRCRAFT
JOHN E. MELTON Jan. 1994 57 p
(Contract RTOP 505-59-53)
(NASA-TM-104013; A-93066; NAS 1.15:104013) Avail: CASI HC A04/MF A01

EGADS is a comprehensive preliminary design tool for estimating the performance of light, single-engine general aviation aircraft. The software runs on the Apple Macintosh series of personal computers and assists amateur designers and aeronautical engineering students in performing the many repetitive calculations required in the aircraft design process. The program makes full use of the mouse and standard Macintosh interface techniques to simplify the input of various design parameters. Extensive graphics, plotting, and text output capabilities are also included. Author (revised)

N94-26151*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DESIGN OPTIMIZATION OF HIGH-SPEED PROPROTOR AIRCRAFT
DAVID R. SCHLEICHER, JAMES D. PHILLIPS, and KEVIN B. CARBAJAL Apr. 1993 40 p
(Contract RTOP 505-69-36)
(NASA-TM-103988; A-93010; NAS 1.15:103988) Avail: CASI HC A03/MF A01

NASA's high-speed rotorcraft (HSRC) studies have the objective of investigating technology for vehicles that have both low downwash velocities and forward flight speed capability of up to 450 knots. This paper investigates a tilt rotor, a tilt wing, and a folding tilt rotor designed for a civil transport mission. Baseline aircraft models using current technology are developed for each configuration using a vertical/short takeoff and landing (V/STOL) aircraft design synthesis computer program to generate converged vehicle designs. Sensitivity studies and numerical optimization are used to illustrate each configuration's key design tradeoffs and constraints. Minimization of the gross takeoff weight is used as the optimization objective function. Several advanced technologies are chosen, and their relative impact on future configurational development is discussed. Finally, the impact of maximum cruise speed on vehicle figures of merit (gross weight, productivity, and direct operating cost) is analyzed. The three most important conclusions from the study are payload ratios for these aircraft will be commensurate with current fixed-wing commuter aircraft; future tilt rotors and tilt wings will be significantly lighter, more productive, and cheaper than competing folding tilt rotors; and the most promising technologies are an advanced-technology proprotor for both tilt rotor and tilt wing and advanced structural materials for the folding tilt rotor. Author (revised)

N94-26182# Naval Postgraduate School, Monterey, CA.
AN ANALYSIS OF MULTIPLE SENSOR SYSTEM PAYLOADS FOR UNMANNED AERIAL VEHICLES M.S. Thesis
JOHN F. KEANE Sep. 1993 101 p
(AD-A274905) Avail: CASI HC A06/MF A02

Unmanned aerial vehicles (UAV's) presently under consideration by the Program Executive Officer for Cruise Missile Projects and Unmanned Aerial Vehicles (PEOCNPUAV) will be equipped solely with electrooptical (EO) sensors. This thesis provides a comparative analysis of the mission effectiveness between UAV's equipped with EO sensors and those equipped with a multiple sensor system payload. A historical review of UAV development and employment is provided so that the reader may gain some insight into past UAV shortcomings in the hopes that they might be prevented in future systems. A typical reconnaissance, surveillance, and target acquisition (RSTA) mission scenario is defined and a comparison made between UAV's equipped with EO sensors and those equipped with multiple sensor system payloads. The measure of effectiveness used for this comparison is the time required by the UAV to search 100 percent of an assigned area. The physical and operating characteristics of available sensor systems are discussed in detail. An optimization model is developed for selecting multiple sensor payloads from those sensor systems described. The model considers the sensor's physical characteristics, unit cost, identification capability, and false alarm rate when determining the optimum payload. The optimum sensor system payloads are selected and the best alternatives to EO sensors for performing RSTA missions in a hostile environment are recommended under a range of budgets. DTIC

N94-26235*# California Polytechnic State Univ., San Luis Obispo. Aeronautical Engineering.
ANALYSIS AND OPTIMIZATION OF PRELIMINARY AIRCRAFT CONFIGURATIONS IN RELATIONSHIP TO EMERGING AGILITY METRICS Final Report, 15 Sep. 1991 - 14 Sep. 1993
DORAL R. SANDLIN and BRENT ALAN BAUER Dec. 1993 133 p
(Contract NAG2-743)
(NASA-CR-195228; NAS 1.26:195228) Avail: CASI HC A07/MF A02

This paper discusses the development of a FORTRAN computer code to perform agility analysis on aircraft configurations. This code is to be part of the NASA-Ames ACSYNT (AirCraft SYNThesis) design code. This paper begins with a discussion of contemporary agility research in the aircraft industry and a survey of a few agility metrics. The methodology, techniques and models developed for the code are then presented. Finally, example trade studies using the agility module along with ACSYNT are illustrated. These trade studies were conducted using a Northrop F-20 Tigershark aircraft model. The studies show that the agility module is effective in analyzing the influence of common parameters such as thrust-to-weight ratio and wing loading on agility criteria. The module can compare the agility potential between different configurations. In addition one study illustrates the module's ability to optimize a configuration's agility performance. Author

N94-26488# Galaxy Scientific Corp., Pleasantville, NJ.
EFFECTS OF PLASTIC MEDIA BLASTING ON AIRCRAFT SKIN Final Report
CHARLES C. CHEN, MARK MULLER, and JOHN W. REINHARDT Nov. 1993 113 p
(Contract DTFA03-89-C-00043)
(AD-A274817; DOT/FAA/CT-91/27) Avail: CASI HC A06/MF A02

The use of methylene chloride chemical solvents in aviation paint removal is becoming increasingly unacceptable in view of restrictive Environmental Protection Agency (EPA) regulations. A readily available alternative, plastic media blasting (PMB), must be examined for its effects on the thin aluminum used as skin material in civilian aircraft. This study examines the effects of plastic media blasting or the crack propagation rates of 2024-T3 aluminum in alclad of 0.032, 0.040, 0.050 inch thickness, and in anodized of 0.032, 0.040, and 0.050 inch thickness. A technical search was performed for the following topics: (1) fatigue crack growth (FCG) rate comparison between PMB and chemical stripping, (2) effects of heavy particulate contamination on the fatigue life of aircraft skin, (3) acceptable level of contamination in the plastic media, (4) effects of multiple strippings on FCG, (5) maximum number of strippings allowed, and (6) specifications of controlled parameters to safely operate a PMB system. Fatigue crack propagation tests, Almen strip tests, Scanning Electron Microscope (SEM) photography, and surface toughness measurements were conducted. The results of the technical search and the tests performed are presented, as well as supplementary Almen strip arc height data. This study also presents an overview of nine alternative aviation paint stripping methods in terms of paint stripping effectiveness, substrate damage, environmental impact, health impact, and cost. DTIC

N94-26531# Naval Postgraduate School, Monterey, CA.
COMPUTER CODE FOR INTERACTIVE ROTORCRAFT PRELIMINARY DESIGN USING A HARMONIC BALANCE METHOD FOR ROTOR TRIM M.S. Thesis
ROBERT K. NICHOLSON, JR. 23 Sep. 1993 91 p
(AD-A274924) Avail: CASI HC A05/MF A01

The Joint Army/Navy Rotorcraft Analysis and Design (JANRAD) computer program was developed to aid in the analysis of helicopter rotor performance, stability and control, and rotor dynamics. JANRAD is an interactive, user friendly program, capable of accurately and quickly solving helicopter design problems at the preliminary design level. The program was written as a collection of MATLAB script and function files (M-files) using the 386-MATLAB version 3.5 programming language. The M-file janrad.in invokes the user interface routines and calls various analysis modules (M-files) which contain the appropriate analysis and output routines. Each of these modules use a common routine, trim.m, which employs blade element theory and a harmonic balance method for rotor trim. The program is limited to conditions of steady flight with no winds and is accurate at a hover and for forward airspeeds greater than or equal to 50 knots. DTIC

N94-26604*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENTAL INVESTIGATION OF ADVANCED HUB AND PYLON FAIRING CONFIGURATIONS TO REDUCE HELICOPTER DRAG
D. M. MARTIN (Sterling Software, Inc., Palo Alto, CA.), R. W. MORT (Bell Helicopter Co., Fort Worth, TX.), L. A. YOUNG, and P. K. SQUIRES (Bell Helicopter Co., Fort Worth, TX.) Sep. 1993 93 p
(Contract RTOP 505-59-36)
(NASA-TM-4540; A-93079; NAS 1.15:4540) Avail: CASI HC A05/MF A01

New hub and pylon fairing designs were tested on a one-fifth scale Bell Helicopter Textron Model 222 helicopter with a bearingless main rotor hub. The blades were not installed for this test. The fairings were designed by NASA and Bell Helicopter Textron under a joint program and tested in the Ames Research Center 7-by 10-Foot Wind Tunnel. All six aircraft forces and moments were measured using the tunnel scales system. Previous research has identified the integrated hub and pylon fairing approach as the most efficient in reducing helicopter drag. Three hub fairings and three pylon fairings were tested (in various combinations) resulting in a total of 16 different configurations, including the baseline helicopter model without fairings. The geometry of the new fairings is described in detail. Test results are presented in the form of plots of the six model forces and moments. The data show that model drag can be reduced by as much as 20 percent by combining a small hub fairing (that has a circular arc upper surface and a flat lower surface) integrated with a nontapered pylon fairing. To minimize drag, the gap between the lower surface of the hub and upper surface of the pylon fairing must be kept to a minimum. Results show that the aerodynamic effects of the fairings on static longitudinal and directional stability can also be important. Author (revised)

N94-26606*# Lockheed Engineering and Sciences Co., Hampton, VA.
A TECHNIQUE FOR INTEGRATING ENGINE CYCLE AND AIRCRAFT CONFIGURATION OPTIMIZATION Final Report
KARL A. GEISELHART Feb. 1994 77 p
(Contract NAS1-19000; RTOP 505-69-50-01)
(NASA-CR-191602; NAS 1.26:191602) Avail: CASI HC A05/MF A01

A method for conceptual aircraft design that incorporates the optimization of major engine design variables for a variety of cycle types was developed. The methodology should improve the lengthy screening process currently involved in selecting an appropriate engine cycle for a given application or mission. The new capability will allow environmental concerns such as airport noise and emissions to be addressed early in the design process. The ability to rapidly perform optimization and parametric variations using both engine cycle and aircraft design variables, and to see the impact on the aircraft, should provide insight and guidance for more detailed studies. A brief description of the aircraft performance and mission analysis program and the engine cycle analysis program that were used is given. A new method of predicting propulsion system weight and dimensions using thermodynamic cycle data, preliminary design, and semi-empirical techniques is introduced. Propulsion system performance and weights data generated by the program are compared with industry data and data generated using well established codes. The ability of the optimization techniques to locate an optimum is demonstrated and some of the problems that had to be solved to accomplish this are illustrated. Results from the application of the program to the analysis of three supersonic transport concepts installed with mixed flow turbofans are presented. The results from the application to a Mach 2.4, 5000 n.mi. transport indicate that the optimum bypass ratio is near 0.45 with less than 1 percent variation in minimum gross weight for bypass ratios ranging from 0.3 to 0.6. In the final application of the program, a low sonic boom fix a takeoff gross weight concept that would fly at Mach 2.0 overwater and at Mach 1.6 overland is compared with a baseline concept of the same takeoff gross weight that would fly Mach 2.4 overwater and subsonically overland. The results indicate that for the design mission, the low boom concept has a 5 percent total range penalty relative to the baseline. Additional cycles were optimized for various design overland distances and the effect of flying off-design overland distances is illustrated. Author (revised)

N94-26608*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TESTS OF HIGHLY LOADED SKIDS ON A CONCRETE RUNWAY
SANDY M. STUBBS and ROBERT H. DAUGHERTY Mar. 1994 19 p
(Contract RTOP 505-63-10-02)
(NASA-TP-3435; L-17324; NAS 1.60:3435) Avail: CASI HC A03/MF A01

Skids have been used at various times for aircraft landing gear ever since the Wright Flyer appeared in the early 1900's. Typically, skids have been employed as aircraft landing gear either at low speeds or at low bearing pressures. Tests were conducted to examine the friction and wear characteristics of various metals sliding on a rough, grooved concrete runway. The metals represented potential materials for an overload protection skid for the Space Shuttle orbiter. Data from tests of six skid specimens conducted at higher speeds and bearing pressures than those of previous tests in the open literature are presented. Skids constructed of tungsten with embedded carbide chips exhibited the lowest wear, whereas a skid constructed of Inconel 718 exhibited high wear rates. Friction coefficients for all the skid specimens were moderate and would provide adequate stopping performance on a long runway. Because of its low wear rate, a skid constructed of tungsten with embedded carbide chips is considered to be a likely candidate for an aircraft skid or overload protection skid. Author (revised)

N94-26864 Materials Research Labs., Ascot Vale (Australia).
DEVELOPMENT AND EVALUATION OF A NEAR INFRARED REFLECTING AND LOW VISIBILITY PAINT SCHEME FOR RAAF P-3C ORION AIRCRAFT
L. V. WAKE Oct. 1993 18 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A274881; MRL-TR-93-35; DODA-AR-008-565) Avail: CASI HC A03

In this report, the development and trialling of a tactical, low visibility paint scheme (LVPS) for RAAF P-3C Orion aircraft is discussed. The LVPS was formulated in grey colors using solar heat reflecting pigments to reduce overheating problems which had resulted in the abandonment of an earlier camouflage trial. The paint scheme, which is one of several schemes under consideration by RAAF, employs strict countershading principles with pale grey underneath the aircraft, light grey on the fuselage sides and vertical flight control surfaces and mid-grey on top of the fuselage and upper flight control surfaces. Evaluation of the paint scheme was carried out at RAAF Edinburgh under summertime conditions and showed that the increase in heat load by use of the solar heat reflecting paint scheme (SHR)-LVPS on the Environmental Control System (ECS) of the aircraft was 0.53 kW compared with the existing paint scheme. This compares favorably with the reported heat load increase of 1.7 kW for counter-shaded aircraft using conventionally formulated grey paints. It is concluded that the use of the SHR-LVPS would have essentially no effect on P-3C operational temperatures except under severe environmental conditions where an increase in temperatures of 0.3 C in the cabin and 1.3 C at the flight stations could be expected. DTIC

N94-26906 National Academy of Engineering, Washington, DC.
FUTURE OF AEROSPACE
1993 89 p Conference held in Honor of Alexander H. Flax on February 28, 1992 Sponsored by National Academy of Sciences, Washington, DC Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-120185; ISBN-0-309-04881-8) Copyright Avail: CASI HC A05

Contents: Alexander H. Flax: Highlights of an Engineering Career; Defense Aerospace and the New World Order; The Future of Manned Spaceflight; Aviation--The Timeless Industry; Higher-Order Technology--Applying Technical Excellence to New Airplane Development; and The Future of Rotary-Wing Aircraft. NTIS

N94-26954 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
EXPERIMENTAL STUDY OF THE ANGLED CRACK IN GLARE 3
K. J. J. M. ZAAL 1994 66 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-126554; M-667) Avail: Issuing Activity (National Technical Information Service (NTIS))

The aim of the present investigation is to perform both an experimental and a theoretical study of the behavior of cracks in GLARE loaded under a combined mode I and mode II loading, using the angled crack problem. Cracks originating from impact damage in aircraft fuselages can experience a mixed mode I and II load at the start of their life. For GLARE, the more fibrous nature of GLARE compared to aluminum may change the propagation. The experiments were performed on specimens made of GLARE-3, with the main material directions aligned with the specimen axis. As reference materials, both aluminum 2024-T3 and 7075-T6 are used. For angled cracks, the propagation direction has been predicted by Erdogan and Sih, Williams and Ewing and Theocaris et al. NTIS

N94-26969# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
DEVELOPMENT OF FIBRE-METAL LAMINATES, ARALL AND GLARE, NEW FATIGUE RESISTANT MATERIALS
J. SCHIJVE Jan. 1993 25 p Presented at the 1993 FATIGUE, Montreal, Ontario, 3-7 May 1993 See also N90-26368 and PB92-133412
(PB94-126471; LR-715) Avail: CASI HC A03/MF A01

Research on adhesive-bonded sheet metal laminates (such as ARALL and GLARE) is described as a predecessor of a new class of materials, the fiber-metal laminates. It is explained why fiber-metal laminates have such a high fatigue resistance, especially against fatigue crack growth. Additional advantages of the barrier function of the fiber layers are indicated. Applications are discussed. Comments are made on developing a material for practical applications. NTIS

N94-27105# Naval Air Warfare Center, Warminster, PA. Aircraft Div.
METHODS FOR EXPERIMENTALLY DETERMINING COMMERCIAL JET AIRCRAFT LANDING PARAMETERS FROM VIDEO IMAGE DATA Final Report
RICHARD P. MICKLOS and THOMAS DEFIORE Aug. 1993 60 p
(Contract DTFA03-92-Z-0029)
(AD-A274207; DOT/FAA/CT-93/7) Avail: CASI HC A04/MF A01

As part of its Aging Aircraft Research Program, the Federal Aviation Administration is establishing a passive system of measuring aircraft landing contact parameters at commercial airports. This research involves the broader application of recent US NAVY technology used to measure landing contact conditions of Navy carrier aircraft and develop/assess Navy landing loads design criteria. This technique is based on digitizing and analyzing high resolution video images recorded by cameras strategically stationed along the runway apron, and it does not require the installation of any instrumentation on the aircraft or changes to normal aircraft operating procedures. This report describes the application of the Navy's latest procedures for precisely determining the kinematics of typical commercial aircraft landings and provides the results of a demonstration survey conducted at the Federal Aviation Administration (FAA) Technical Center in June 1992. In addition, the proposed runway camera configuration for a production landing survey at a high volume airport is presented. DTIC

N94-27273 Boeing Commercial Airplane Co., Seattle, WA.
COMPOSITE LEADING EDGE/SPAR MEMBER FOR AN AIRCRAFT CONTROL SURFACE Patent
RUDOLF BRAUN, inventor (to Boeing) and RICHARD JENSEN, inventor (to Boeing) 4 Jan. 1994 24 p
(CA-PATENT-1-325-765; INT-PATENT-CLASS-B32B-031/24; CTN-94-61094) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A one-piece composite leading edge/spar member for an aircraft control surface is provided which is of a lighter and stronger construction offering dimensional stability. An efficient method for manufacturing the member is also disclosed. The member of the invention includes a forward leading edge portion and an aft spar portion, which are connected together as a continuous one-piece tubular member of composite material. The forward leading edge portion may be rounded, and the aft spar portion may include an aft web portion and first and second rebate portions. The rebate portions connect the web portion to the rounded forward leading edge portion, and provide surfaces for the attachment of skin surface members. In a preferred mode of fabricating the member, a composite material is applied or wrapped around a mandrel, with the material perimetrically surrounding and covering the rounded leading edge and the spar forming portions of the mandrel. A forming pressure may then be applied to the composite material to shape and mold the material into the same shape as the rounded leading edge and spar forming portions. This method permits the composite material to be filament wound around the mandrel instead of being wrapped on a layer by layer basis. Filament winding would be particularly well suited for mass production of leading edge/spar members of the invention. Author (CISTI)

N94-27439*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PROCEEDINGS OF THE NON-LINEAR AERO PREDICTION REQUIREMENTS WORKSHOP
MICHAEL J. LOGAN, ed. Mar. 1994 163 p Workshop held in Hampton, VA, 8-9 Dec. 1993 Sponsored by NASA, Washington
(Contract RTOP 505-68-70-09)
(NASA-CP-10138; NAS 1.55:10138) Avail: CASI HC A08/MF A02

The purpose of the Non-Linear Aero Prediction Requirements Workshop, held at NASA Langley Research Center on 8-9 Dec. 1993, was to identify and articulate requirements for non-linear aero prediction capabilities during conceptual/preliminary design. The attendees included engineers from industry, government, and academia in a variety of aerospace disciplines, such as advanced design, aerodynamic performance analysis, aero methods development, flight controls, and experimental and theoretical aerodynamics. Presentations by industry and government organizations were followed by panel discussions. This report contains copies of the presentations and the results of the panel discussions. Author (revised)

N94-27666 Defence Research Establishment Pacific, Victoria (British Columbia). Research and Development Branch.
THE DEVELOPMENT OF AN IN-MOTION RADIOGRAPHY SYSTEM FOR LARGE AREA AIRCRAFT SCANNING
RICHARD D. FINLAYSON, JOHN K. CORNES, DAN S. LIESCH, and WILLIAM R. STURROCK Jul. 1993 22 p
(DREP-TM-93-53; DSIS-94-00099; CTN-94-61118) Avail: CASI HC A03/MF A01

An in-motion radiography system (IMRS) includes a portable x-ray unit, adapted for the requirements of in-motion radiography, and an x-y scanning arrangement to allow large area scanning. Two separate IMRS experiments were performed, each with a different slit length set on a focusing collimator. A long slit length allowed a fast scan that exposed the film in one pass of the x-ray tube, creating a low resolution radiograph. A shorter slit length was set to allow for exposure of the film in several strips, thus eliminating the parallax error caused by the cone-shaped radiation field and creating a higher resolution radiograph. The results show that an IMRS is a fast and reliable means for inspecting large aircraft surfaces. Inspection of helicopter rotor blades for water ingress in honeycomb is seen as one possible use for the IMRS, expecially for very large blades. In-motion radiography is simple and based on standard radiographic procedures, with some slight modifications in exposure settings. Almost any radiography system could be adapted to use in-motion radiography if the tube or the part is able to move in the desired scanning motion. In-house testing of the IMRS is complete and ready for an on-aircraft trial. Author (CISTI)

N94-27796 National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
INVESTIGATION OF THE BOND STRENGTH OF A DISCRETE SKIN-STIFFENER INTERFACE
H. G. S. J. THUIS and J. F. M. WIGGENRAAD 24 Apr. 1992 14 p Presented at the AGARD/SMP Specialists Meeting on Debonding/Delamination of Composites, Patras, Greece, 25-27 May 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(NLR-TP-92183-U; ETN-94-95446) Avail: CASI HC A03

The results of an experimental study on the effects of several design parameters on the strength of a skin-stiffener interface are presented. Design parameters considered are skin and stiffener laminate properties and the width of the bond layer. Test specimens consisting of a blade type stiffener secondarily bonded to skin laminate were fabricated. The specimens were tested by lateral tension tests, four point bending tests, and pull-off tests. Calculations were made with the numerical program BONDST. The test results are compared with each other and with the calculated results. Conclusions are drawn and design guidelines are provided. ESA

N94-27917*# Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
WING DESIGN FOR A CIVIL TILTROTOR TRANSPORT AIRCRAFT: A PRELIMINARY STUDY
MASOUD RAIS-ROHANI *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 147-148 Dec. 1993
Avail: CASI HC A01/MF A03

A preliminary study was conducted on the design of the wing-box structure for a civil tiltrotor transport aircraft. The wing structural weight is to be minimized subject to structural and aeroelastic constraints. The composite wing-box structure is composed of skin, stringers, ribs, and spars. The design variables include skin ply thicknesses and orientations and spar cap and stringer cross-sectional areas. With the total task defined, an initial study was conducted to learn more about the intricate dynamic and aeroelastic characteristics of the tiltrotor aircraft and their roles in the wing design. Also, some work was done on the wing finite-element modeling (via PATRAN) which would be used in structural analysis and optimization. Initial studies indicate that in order to limit the wing/rotor aeroelastic and dynamic interactions in the preliminary design, the cruise speed, rotor system, and wing geometric attributes must all be held fixed. Author (revised)

N94-28017# British Aerospace Defense Ltd., Farnborough (England).
EXPERIMENTS INTO THE SCALING PARAMETERS REQUIRED FOR EXHAUST GAS INGESTION TESTING OF VERTICAL LANDING AIRCRAFT
P. CURTIS and P. J. BRADLEY *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 9 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

The phenomenon of Hot Gas Recirculation for vertical landing jet aircraft and the effect of exhaust gas ingestion on aircraft performance is described. Additionally, our experience with experimental modelling of HGR for aircraft configurations and the scaling of the important parameters is presented. The conflict between scaling the buoyancy of the flowfield and correct modelling of the pressure field is explored, and a number of fundamental experiments addressing this problem are related. It is shown that in the region close to the jets and when the aircraft is very close

to the ground that there are quite large differences between the two scaling criteria; the near-field region requires full scale pressures for accurate representation. Away from this region, the Nozzle Pressure Ratio does not greatly affect the flowfield. Testing of a generic aircraft model with a number of different configurations shows that once near-field flowpaths have been eliminated the ingestion levels are underpredicted if the flow-field buoyancy is below full scale. Absolute levels of ingestion are not greatly different between the two scaling criteria, particularly with the large scatter in results which is endemic to the phenomenon. However, it is concluded that for practical configurations, i.e., those with low levels of ingestion, scaling of flowfield buoyancy is more correct than scaling of the pressure field. This method of scaling is appropriate for use in achieving a low ingestion configuration.
Author (revised)

N94-28033*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NUMERICAL SIMULATION OF A POWERED-LIFT LANDING
KALPANA CHAWLA (MCAT Inst., Moffett Field, CA.) and WILLIAM R. VANDALSEM *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

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

N94-28034# Wright Lab., Wright-Patterson AFB, OH.
A STUDY OF JET EFFECT AND GROUND EFFECT INTERFERENCE ON A STOL FIGHTER
DAVID J. MOORHOUSE, JAMES G. REINSBERG (McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.), and FRANK J. SHIRK (McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.) *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

The STOL and Maneuver Technology Demonstrator (S/MTD) program was structured to investigate, develop and validate through analysis, experiment and flight test, four specific technologies related to providing current and future high performance fighters with both STOL capability and enhanced combat mission performance. The four technologies are: (1) Two-dimensional thrust vectoring and reversing exhaust nozzle, (2) Integrated Flight/Propulsion Control (IFPC) System, (3) Advanced Pilot Vehicle Interface, and (4) Rough/soft field landing gear. In addition to the required technologies, all-moving canard surfaces were also incorporated into the baseline F-15B. As stated previously, the intent of the demonstration program was to validate specific technologies, it was neither a prototype nor an explicit research program. Starting with an existing aircraft, many wind tunnel tests were performed to define the incremental effects of the specific technology items. Thrust reversing was achieved by blocking the nozzle exit area and exhausting the flow through vane packs on top and bottom of the engine. In the Short Landing (SLAND) mode the engines were at full military RPM and all exhaust flow was diverted through final approach with the reverse vanes pointed aft to provide forward thrust. At touchdown, the vanes quickly swing forward to orient the exhaust flow to provide reverse thrust for the rollout. A significant amount of wind tunnel testing was devoted to measuring jet effects at all conditions but definition of jet effects in ground effect received particular emphasis. Reference 1 documented the development of the S/MTD configuration with details on the wind tunnel data and control laws. Data was presented on the jet effects in ground effect that were predicted. Special control logic was defined to mitigate strong nose-up pitching moments as thrust reversing was initiated after touchdown. A special ground-handling mode was also incorporated for the rollout phase. The flight testing produced some surprising results. The object of the present paper is to document that experience. Data will be summarized briefly for completeness. Pertinent flight test experience will be presented, with results of an innovative analysis technique developed by the contractor. Lastly, future requirements will be discussed.
Author

N94-28035*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TRANSITIONAL FLIGHT CHARACTERISTICS OF A GEOMETRICALLY SIMPLIFIED STOVL MODEL
KARLIN R. ROTH *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

The transitional flight characteristics of a geometrically simplified Short Take-Off Vertical Landing (STOVL) aircraft configuration were measured in the NASA Ames 7- by 10-Foot Wind Tunnel. The experiment was designed to provide detailed data for evaluating the capability of computational fluid dynamics methods to predict the important powered lift flow parameters. The model consists of a 60 deg cropped delta wing planform; a blended fuselage; and tandem, circular, high pressure air jets that exit perpendicular to the flat lower surface. Freestream Mach number is limited to a maximum 0.2. Model angle of attack ranges from -10 deg to +20 deg. The nozzle pressure ratios of both jets are varied between 1 and 3, and the jet exit temperatures are maintained at near ambient conditions. Detailed surface pressure measurements show that suction pressure peaks located on the upper surface of the wing during conventional wingborne flight for angles of attack greater than 5 deg move to the wing lower surface at angles of attack less than 0 deg. A reduction in these suction pressure peaks is observed when the lift jets are operating. With sonic jet exit conditions, a freestream Mach number of 0.14, and 0 deg angle of attack, the jet-induced suckdown is equivalent to a 3.7 deg reduction in angle of attack. Schlieren, laser light sheet flow visualization and total pressure measurements in the jet plumes provide a description of the three-dimensional jet efflux flowfield.
Author

N94-28092 ESDU International Ltd., London (England).
EXAMPLES OF FLIGHT PATH OPTIMISATION USING A MULTIVARIATE GRADIENT-SEARCH METHOD
Dec. 1993 24 p
(ISSN 0141-4054)
(ESDU-93021; ISBN-0-85679-874-6) Avail: ESDU

ESDU 93021 deals with one method of optimization of a complete sortie, applied as an example to a subsonic transport and used to demonstrate the penalties incurred by constraints imposed by design and operational considerations. It requires an appropriate numerical optimization technique able to solve constrained multivariate problems. That used here is RQPMIN developed at the then Royal Aircraft Establishment. The examples were to minimize block fuel for given range, maximize range for given ramp mass, minimize time for given range, and minimize direct operating costs (in this case a linear combination of time and block fuel) for given range. Each case is initially run with no constraints other than those to ensure flight is possible (for example, thrust at the appropriate rating must exceed drag). Progressive constraints are then introduced relating speed to minimum drag speed, providing a given margin to buffet onset, limiting rates of climb and descent by rates of cabin pressure change and by a maximum cabin differential pressure, and limiting cabin attitude for passenger comfort. The results are discussed. A comparison is also made of results for optimum climb paths of a transport aircraft with results obtained for the same cases in ESDU 90012 using energy height methods.
ESDU

N94-28094 ESDU International Ltd., London (England).
EXAMPLE OF STATISTICAL TECHNIQUES APPLIED TO ANALYSIS OF EFFECTS OF SMALL CHANGES
Nov. 1993 6 p

(ISSN 0141-4054)
(ESDU-93023; ISBN-0-85679-876-2) Avail: ESDU

ESDU 93023 uses second segment climb measurements to provide simple examples of statistical significance testing and confidence levels. Certification trials of a twin turbo-prop aircraft established that second segment climb gradient exceeded scheduled by a mean margin of 0.09 percent with a standard deviation of 0.35 percent. The comprehensive nature of the tests allowed the values to be taken as applying to the population. Two sets of ten points were then obtained, each set with a variant of the aircraft differing from the basic design by small aerodynamic changes. Use of Fisher's Variance Ratio F test established that the standard deviations (variances) of both sets did not differ significantly from that of the population. The means of both samples were then compared with that of the population using the normal cumulative distribution function to establish the confidence that the differences arose by chance. In one case the difference is seen to be significant and the performance had to be rescheduled. The necessary changes are calculated, and the probability that any single test point might fall below the new scheduled level is established. ESDU

N94-28250# Deutsche Lufthansa A.G., Frankfurt am Main (Germany).
A SYMBOL OF RELIABILITY: JU 52 [SYMBOL DER ZUVERLAESSIGKEIT: DIE JU 52]
RALF NOLTING *In its* Lufthansa Yearbook 1992 p 186-191 Oct. 1992 In GERMAN
Copyright Avail: CASI HC A02/MF A03

The story of Junker 52 (Ju 52) aircraft is presented. Lufthansa possessed 78 machines of this type in 1940 and in 1985 wished to find at least one JU 52 as a symbol of aviation tradition, German knowhow as pioneer aircraft. A Ju 52 was found in Florida and sent to Germany. The old aircraft was restored during sixteen months and its structure and turbines were totally overhauled; the cabin was equipped with new seats and the cockpit with modern navigation instruments. The renewed aircraft flew for eight months over the U.S. and ended its trip by a formation flight with a Boeing 737 aircraft above Seattle. The turbine engines were modified for noise reduction. ESA

N94-28322 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario). Aerodynanics Technology.
EXPERIMENTAL AND THEORETICAL STUDIES OF T-TAIL CONFIGURATIONS FOR COMMUTER AIRCRAFT APPLICATIONS
J. B. COLL, S. W. COSBY, and A. B. PAIGE *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 25-28 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

The design of a horizontal tail leading edge for a commuter aircraft is discussed relative to the existing production standard and an experimental comparison is made between them. Three fin cap fairing definitions are shown and an assessment of their respective performance in light of wind tunnel test results is offered. Three objectives were set for the modification of the existing production standard horizontal tail section: reduction of high speed buffet due to shock waves near the leading edge; retention of the existing low speed characteristics of the airfoil section; and minimization of structural modifications to the existing aircraft layout. Analysis of the standard and modified tails was restricted to two-dimensional sections and was performed using the potential method of Bauer et al (1977) with viscous corrections and a Boeing Euler code with coupled boundary layer (Choupani and Om, 1987). The modified leading edge was shown to have similar lift characteristics to the standard leading edge but a significantly reduced buffet level. The two modified fin cap fairings produced significantly lower drag than the production standard version. The extended fore and aft fairing had an impressive reduction in buffet level at high Mach and Reynolds numbers. Author (CISTI)

N94-28324 Bombardier, Inc., Montreal (Quebec). Canadair Group.
APPLICATION OF THE MBTEC EULER CODE TO THE CHALLENGER AND THE CF-18 COMPLETE AIRCRAFT CONFIGURATIONS
F. KAFYEKE and P. PIPERNI *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 33-36 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

The Canadair Multiblock Transonic Euler Code (MBTEC) has been extended to handle the geometry of complete aircraft configurations. Application of MBTEC to the Canadair CL-601 and CF-18 aircraft configurations is illustrated. MBTEC uses a system of Euler equations written in conservative form and is discretized on a structured body-fitted grid, using a finite volume technique. The scheme employs central differencing for the spatial operators. The resulting ordinary differential equations are integrated in time using a five-stage Runge-Kutta method. Artificial viscosity is added to stabilize the scheme and various convergence acceleration techniques are used including residual averaging and enthalpy damping. The code also has modified boundary condition formulations including additional boundary conditions for turbofan inlets and exhausts. The CL-601 grids use 30-600 blocks. Results have been used to indicate the effects of the winglet and of the interference between the nacelle and the wing. The CF-18 grids use 108 blocks and results have been obtained for a cruise condition at Mach 0.95 and a high angle of incidence condition at Mach 0.6, in comparison with wind tunnel data. Author (CISTI)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N94-26028# Galaxy Scientific Corp., Pleasantville, NJ.
DIGITAL SYSTEMS VALIDATION BOOK PLAN. VOLUME 3: HANDBOOK Final Report
JOAN JANOWITZ Jul. 1993 17 p
(Contract DTFA03-89-C-00043)
(AD-A274099; DOT/FAA/CT-93/16-VOL-3) Avail: CASI HC A03/MF A01

The Digital Systems Validation Handbook is a tutorial series designed to provide certification engineers information on current topics related to digital avionics. The book plan lays the foundation for volume three of this series. The purpose of the handbook book plan is to identify technology and related issues that certification engineers are likely to encounter. Volume three of the handbook series will consist of approximately 20 chapters. Sixteen chapters are described in the book plan. Four were reserved for technologies or issues that might emerge during the course of the volume three life cycle. A list of potential handbook topics was derived from a survey of the literature, conference and seminar attendance, results of an informal questionnaire, and interviews with Federal Aviation Administration (FAA) National Resource Specialists, experts in the field of certification and digital avionics, National Aeronautics and Space Administration (NASA) officials, and persons in private industry. From this input, the list of potential topics was developed and refined into handbook chapters. In addition to the chapter list and descriptions, the handbook purpose, scope, and use is discussed. The unabridged list of topics is included in the book plan appendix. DTIC

N94-26030# Federal Aviation Administration, Atlantic City, NJ.
DIGITAL ALTIMETER SETTING INDICATOR (DASI) OPERATIONAL TEST AND EVALUATION (OT/E) OPERATIONAL TEST PROCEDURES
MICHAEL GRECO, PAUL BIAGI, and ERIC HOOVER Dec. 1993

35 p
(AD-A274100; DOT/FAA/CT-TN93/44) Avail: CASI HC A03/MF A01

The Digital Altimeter Setting Indicator (DASI) is a system which measures the atmospheric pressure and converts the measured pressure value into the actual sea level pressure based on the United States (U.S.) Standard Atmospheric Table. The value then computed is known as the altimeter setting indicator (ASI) value and is presented to an air traffic controller, in a digital format, e.g., 29.50 inches of mercury. The ASI value is then transmitted by the air traffic controller to an aircraft pilot for use in setting the altimeter in the aircraft. If a perfectly calibrated altimeter is set to the ASI value existing at any given station whose elevation is designated as Hp, the pointer of the altimeter instrument will indicate an altitude of Hp when the instrument is at the altitude of the sensor in the DASI system. Hp is an elevation in geopotential meters above mean sea level of the altimeter setting indicator pressure sensor. The purpose of this operational test and evaluation (OT&E) test procedure is to describe the test and evaluation activities which will ensure the DASI system meets all the requirements of the DASI Specification, FAA-E-2569B, and integrates properly into the National Airspace System (NAS). The OT&E procedure includes the test cases, responsibilities, test support hardware and software, and test conduct associated with the testing of the DASI. The DASI test is developed and executed in accordance with the current FAA Test and Evaluation Policy Order, FAA Order 1810.4B. DTIC

N94-26340# David Sarnoff Research Center, Princeton, NJ.
COLOR HEAD DOWN DISPLAY PROGRAM Final Report, 1 Sep. 1988 - 1 Mar. 1993
D. L. JOSE, A. C. IPRI, and R. G. STEWART Apr. 1993 66 p
(Contract F33615-88-C-1825)
(AD-A274807; WL-TR-93-1103) Avail: CASI HC A04/MF A01

The purpose of the CHDD program was to develop a large-area AMLCD for cockpit applications. A 4- x 8-in. polysilicon AMLCD with 320,000 display cells was designed with integrated scanners and fabricated. A support electronics system was constructed that accepted multisource RGB video. This system reformatted the video information to drive the display at 180 fields/second and synchronized the display to a color sequential backlight. Moving the color information into the temporal domain, maintained the color pixel density identical to the cell density. A 192 x 192 pixel active matrix circuit with integrated drive and scan functions was fabricated in thin-film single-crystal silicon, using standard IC processing, and subsequently placed on glass to form a transmissive AMLCD. The first assembled 2.5- x 2.5-in. monochrome display shows greater than 85 percent pixel functionality. The speed, low leakage current, and high drive capability of single-crystal silicon devices should allow the fabrication of displays with integrated system-level peripheral circuitry, high pixel density, and improved contrast and optical aperture ratios. DTIC

N94-26989# Krug Life Sciences, Inc., San Antonio, TX. San Antonio Div.
STANDARDIZATION OF AIRCRAFT CONTROL AND PERFORMANCE SYMBOLOGY ON THE USAF HEAD-UP DISPLAY Final Report, Jan. 1990 - 1993
LISA F. WEINSTEIN, WILLIAM R. ERCOLINE, IAN MCKENZIE, D. F. BITTON, and KENT K. GILLINGHAM Nov. 1993 81 p
(Contract F33615-92-C-0018)
(AD-A274283; AL/CF-TR-1993-0088) Avail: CASI HC A05/MF A01

Researchers and pilots throughout the world continue to examine and debate the utility of the head-up display (HUD) for presenting instrument flight information. Although initially intended for the presentation of landing and weapons delivery information, the HUD has evolved into a flight instrument that researchers and pilots claim is successfully replacing many of the traditional panel instruments. Since the Attitude Awareness Workshop of 1985, the United States Air Force (USAF) has conducted numerous research projects to determine the most effective way to integrate the HUD with the other mission-essential instrument displays. The requirement to use the HUD for instrument flight, as well as a need to determine the optimal configuration of the HUD symbols, prompted a significant portion of that research. The research efforts conducted by scientists in the Visual Orientation Laboratory (VOL) and the Flight Motion Effects Branch of the Armstrong Laboratory (AL/CFTF) are summarized. Suggested standardization guidelines based on empirical findings are discussed, including the use of: counter-pointers for airspeed and altitude indicators, vertical and horizontal asymmetry for pitch-ladder configurations, a ghost horizon, analog information for vertical velocity, energy management symbology, and quickening for climb/dive markers. DTIC

N94-27286*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
A GRAPHICAL WORKSTATION BASED PART-TASK FLIGHT SIMULATOR FOR PRELIMINARY RAPID EVALUATION OF ADVANCED DISPLAYS
CRAIG WANKE, JAMES KUCHAR, EDWARD HAHN, A. PRITCHETT, and R. JOHN HANSMAN *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research, 1992-1993 p 9-15 Feb. 1994 See also A94-11991 Submitted for publication
(Contract NAG2-12; NAG2-716; NAG1-690; NGL-22-009-640; DTRS57-88-C-0078TD39; NSF MSS-85-52702; BARR-10-119)
Avail: CASI HC A02/MF A02

Advances in avionics and display technology are significantly changing the cockpit environment in current transport aircraft. The MIT Aeronautical Systems Lab (ASL) developed a part-task flight simulator specifically to study the effects of these new technologies on flight crew situational awareness and performance. The simulator is based on a commercially-available graphics workstation, and can be rapidly reconfigured to meet the varying demands of experimental studies. The simulator was successfully used to evaluate graphical microbursts alerting displays, electronic instrument approach plates, terrain awareness and alerting displays, and ATC routing amendment delivery through digital datalinks. Author (revised)

N94-27864*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF HISTORICAL AND PREDICTIVE INFORMATION ON ABILITY OF TRANSPORT PILOT TO PREDICT AN ALERT
ANNA C. TRUJILLO Mar. 1994 25 p
(Contract RTOP 505-64-13)
(NASA-TM-4547; L-17305; NAS 1.15:4547) Avail: CASI HC A03/MF A01

In the aviation community, the early detection of the development of a possible subsystem problem during a flight is potentially useful for increasing the safety of the flight. Commercial airlines are currently using twin-engine aircraft for extended transport operations over water, and the early detection of a possible problem might increase the flight crew's options for safely landing the aircraft. One method for decreasing the severity of a developing problem is to predict the behavior of the problem so that appropriate corrective actions can be taken. To investigate the pilots' ability to predict long-term events, a computer workstation experiment was conducted in which 18 airline pilots predicted the alert time (the time to an alert) using 3 different dial displays and 3 different parameter behavior complexity levels. The three dial displays were as follows: standard (resembling current aircraft round dial presentations); history (indicating the current value plus the value of the parameter 5 sec in the past); and predictive (indicating the current value plus the value of the parameter 5 sec into the future). The time profiles describing the behavior of the parameter consisted of constant rate-of-change profiles, decelerating profiles, and accelerating-then-decelerating profiles. Although the pilots indicated that they preferred the near term predictive dial, the objective data did not support its use. The objective data did show that the time profiles had the most significant effect on performance in estimating the time to an alert. Author (revised)

N94-27882*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF EXPECTED-VALUE INFORMATION AND DISPLAY FORMAT ON RECOGNITION OF AIRCRAFT SUBSYSTEM ABNORMALITIES
MICHAEL T. PALMER and KATHY H. ABBOTT Mar. 1994 76 p
(Contract RTOP 505-64-13-22)
(NASA-TP-3395; L-17262; NAS 1.60:3395) Avail: CASI HC A05/MF A01

This study identifies improved methods to present system parameter information for detecting abnormal conditions and to identify system status. Two workstation experiments were conducted. The first experiment determined if including expected-value-range information in traditional parameter display formats affected subject performance. The second experiment determined if using a nontraditional parameter display format, which presented relative deviation from expected value, was better than traditional formats with expected-value ranges included. The inclusion of expected-value-range information onto traditional parameter formats was found to have essentially no effect. However, subjective results indicated support for including this information. The nontraditional column deviation parameter display format resulted in significantly fewer errors compared with traditional formats with expected-value-ranges included. In addition, error rates for the column deviation parameter display format remained stable as the scenario complexity increased, whereas error rates for the traditional parameter display formats with expected-value ranges increased. Subjective results also indicated that the subjects preferred this new format and thought that their performance was better with it. The column deviation parameter display format is recommended for display applications that require rapid recognition of out-of-tolerance conditions, especially for a large number of parameters. Author

07

AIRCRAFT PROPULSION AND POWER

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

N94-25085*# Ohio State Univ., Columbus.
A CONCEPTUAL DESIGN OF AN UNMANNED TEST VEHICLE USING AN AIRBREATHING PROPULSION SYSTEM
1992 60 p
(Contract NASW-4435)
(NASA-CR-195550; NAS 1.26:195550) Avail: CASI HC A04/MF A01

According to Aviation Week and Space Technology (Nov. 16, 1992), without a redefined approach to the problem of achieving single stage-to-orbit flight, the X-30 program is virtually assured of cancellation. One of the significant design goals of the X-30 program is to achieve single stage to low-earth orbit using airbreathing propulsion systems. In an attempt to avoid cancellation, the NASP Program has decided to design a test vehicle to achieve these goals. This report recommends a conceptual design of an unmanned test vehicle using an airbreathing propulsion system. Author (revised)

N94-25185*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TWO-DIMENSIONAL CFD MODELING OF WAVE ROTOR FLOW DYNAMICS
GERARD E. WELCH and RODRICK V. CHIMA Feb. 1994 16 p Presented at the 11th Computational Fluid Dynamics Conference, Orlando, FL, 6-9 Jul. 1993; sponsored by AIAA See also A93-45014
(Contract RTOP 505-62-10)
(NASA-TM-106261; E-8404; NAS 1.15:106261) Avail: CASI HC A03/MF A01

A two-dimensional Navier-Stokes solver developed for detailed study of wave rotor flow dynamics is described. The CFD model is helping characterize important loss mechanisms within the wave rotor. The wave rotor stationary ports and the moving rotor passages are resolved on multiple computational grid blocks. The finite-volume form of the thin-layer Navier-Stokes equations with laminar viscosity are integrated in time using a four-stage Runge-Kutta scheme. Roe's approximate Riemann solution scheme or the computationally less expensive advection upstream splitting method (AUSM) flux-splitting scheme is used to effect upwind-differencing of the inviscid flux terms, using cell interface primitive variables set by MUSCL-type interpolation. The diffusion terms are central-differenced. The solver is validated using a steady shock/laminar boundary layer interaction problem and an unsteady, inviscid wave rotor passage gradual opening problem. A model inlet port/passage charging problem is simulated and key features of the unsteady wave rotor flow field are identified. Lastly, the medium pressure inlet port and high pressure outlet port portion of the NASA Lewis Research Center experimental divider cycle is simulated and computed results are compared with experimental measurements. The model accurately predicts the wave timing within the rotor passages and the distribution of flow variables in the stationary inlet port region. Author (revised)

N94-25200*# Sverdrup Technology, Inc., Brook Park, OH.
EFFECT OF POWER SYSTEM TECHNOLOGY AND MISSION REQUIREMENTS ON HIGH ALTITUDE LONG ENDURANCE AIRCRAFT Final Report
ANTHONY J. COLOZZA Feb. 1994 22 p
(Contract NAS3-25266; RTOP 537-10-20)
(NASA-CR-194455; E-8408; NAS 1.26:194455) Avail: CASI HC A03/MF A01

An analysis was performed to determine how various power system components and mission requirements affect the sizing of a solar powered long endurance aircraft. The aircraft power system consists of photovoltaic cells and a regenerative fuel cell. Various characteristics of these components, such as PV cell type, PV cell mass, PV cell efficiency, fuel cell efficiency, and fuel cell specific mass, were varied to determine what effect they had on the aircraft sizing for a given mission. Mission parameters, such as time of year, flight altitude, flight latitude, and payload mass and power, were also altered to determine how mission constraints affect the aircraft sizing. An aircraft analysis method which determines the aircraft configuration, aspect ratio, wing area, and total mass, for maximum endurance or minimum required power based on the stated power system and mission parameters is presented. The results indicate that, for the power system, the greatest benefit can be gained by increasing the fuel cell specific energy. Mission requirements also substantially affect the aircraft size. By limiting the time of year the aircraft is required to fly at high northern or southern latitudes, a significant reduction in aircraft size or increase in payload capacity can be achieved. Author (revised)

N94-25617# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
DEVELOPMENT AND IMPLEMENTATION OF A SCRAMJET CYCLE ANALYSIS CODE WITH A FINITE-RATE-CHEMISTRY COMBUSTION MODEL FOR USE ON A PERSONAL COMPUTER M.S. Thesis
CLARENCE F. CHENAULT Dec. 1993 254 p
(AD-A273834; AFIT/GAE/ENY/93D-7) Avail: CASI HC A12/MF A03

This study compared the performance of an equilibrium combustion model to a finite-rate-chemistry combustion model for a fixed geometry scramjet flying at the flight conditions of Mach 12, 15, and 18 with a constant dynamic pressure of 50,000 Pa. An integrated PC-based code, developed specifically for this study, models the combustor as an equilibrium combustion process or as finite-rate-chemistry combustion process. This integrated program is based on two existing programs, Ramjet Performance Analysis (RJPA) and 3 STREAM. The effects of mixing schedule, combustor length, and combustor exit area were investigated. The results of this study indicate that inefficient mixing is the primary cause of Scramjet performance loss regardless of the flight speed. Combustor length and combustor exit area also had a strong impact on performance. DTIC

N94-26176# Science Applications International Corp., San Antonio, TX. Logistics Technology Div.
AIRCRAFT TURBINE ENGINE RELIABILITY AND INSPECTION INVESTIGATIONS Final Report
BRUCE A. RICHTER, MARGARET RIDENOUR-BENDER, and MIKE TSAO Oct. 1993 120 p Sponsored by FAA
(AD-A274860; SAIC-67-6733; DOT/FAA/CT-92/29) Avail: CASI HC A06/MF A02

This study of JT9D, CF6, and PT6 aircraft engine reliability represents a follow-on effort to the JT8D engine study which was published in the Federal Aviation Administration (FAA) Technical Center Final Report DOT/FAA/CT-91/10. As with the JT8D engine study, this study trended in-flight shutdowns and unscheduled removal rates of JT9D, CF6, and PT6 turbine aircraft engines for a thirty-six-month period covering February 1988 through January 1991. As in the previous report, the methodology was to review which air carriers consistently exceeded the standard deviation norm for in-flight shutdowns and unscheduled engine removals on a monthly basis and then examine the engine component failures reported by those carriers. Engine component failures were grouped as follows: bearings, airfoils, cases, controls and accessories, fuel/oil systems, and others (not trended). For this study of the JT9D, CF6, and PT6 engines, controls and accessories typically produced the largest number of in-flight flameouts, compressor stalls, and engine shutdowns. In addition to the actuarial analysis and component failure mode trending performed on the JT9D, CF6, and PT6 engines, application of an inspection procedure developed for the JT8D engine was made on the JT9D and CF6 engine cases. DTIC

N94-26345# Wright Lab., Wright-Patterson AFB, OH.
AN INVESTIGATION OF THE SURGE BEHAVIOR OF A HIGH-SPEED TEN-STAGE AXIAL FLOW COMPRESSOR Final Report, Aug. 1990 - Aug. 1992
PATRICK RUSSLER May 1993 162 p
(Contract AF PROJ. 3066)
(AD-A274910; WL-TR-93-2076) Avail: CASI HC A08/MF A02

During a ten-stage compressor rig test conducted at Wright-Patterson AFB, several instances of compressor surge were observed. While surge is known to occur in high-speed multi-stage compressors, very little transient data pertaining to such events exists in the open literature, exclusive of engine data. In an attempt to make more data of this type available to researchers, surge data from this test are presented in this report. The predictions of a computer-based transient compressor model are compared to the data for study. Furthermore, an unexplained instability phenomenon is investigated: a constant surge/rotating stall boundary. During the test, it was found that the speed boundary between surge and rotating stall occurred between 80% and 81% rotor speed. This boundary did not change when the compressor discharge volume was changed. This seemed to contradict accepted theory, which predicts a shift in the surge/rotating stall boundary. An investigation into the possible causes of this phenomenon is conducted as part of this report. Several theories are explored, including the possibility of excess volume communicating with the compressor during instability. Although the excess volume theory is not proven, it remains the most likely cause of the unusual surge/rotating stall boundary behavior.
DTIC

N94-26573*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FOCUSED SCHLIEREN FLOW VISUALIZATION STUDIES OF MULTIPLE VENTURI FUEL INJECTORS IN A HIGH PRESSURE COMBUSTOR
K. S. CHUN, R. J. LOCKE (Sverdrup Technology, Inc., Brook Park, OH.), C. M. LEE, and W. J. RATVASKY Jan. 1994 19 p
Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA Original contains color illustrations
(Contract NAS3-25266; RTOP 537-02-20)
(NASA-TM-106479; E-8409; NAS 1.15:106479; AIAA PAPER 94-0280) Avail: CASI HC A03/MF A01; 4 functional color pages

Multiple venturi fuel injectors were used to obtain uniform fuel distributions, better atomization and vaporization in the premixing/prevaporizing section of a lean premixed/prevaporized flame tube combustor. A focused Schlieren system was used to investigate the fuel/air mixing effectiveness of various fuel injection configurations. The Schlieren system was focused to a plane within the flow field of a test section equipped with optical windows. The focused image plane was parallel to the axial direction of the flow and normal to the optical axis. Images from that focused plane, formed by refracted light due to density gradients within the flow field, were filmed with a high-speed movie camera at framing rates of 8,000 frames per second (fps). Three fuel injection concepts were investigated by taking high-speed movies of the mixture flows at various operating conditions. The inlet air temperature was varied from 600 F to 1000 F, and inlet pressures from 80 psia to 150 psia. Jet-A fuel was used typically at an equivalence ratio of 0.5. The intensity variations of the digitized Schlieren images were analytically correlated to spatial density gradients of the mixture flows. Qualitative measurements for degree of mixedness, intensity of mixing, and mixing completion time are shown. Various mixing performance patterns are presented with different configurations of fuel injection points and operating conditions. Author (revised)

N94-26588*# Pratt and Whitney Aircraft, East Hartford, CT.
PROGRAM TO DEVELOP A PERFORMANCE AND HEAT LOAD PREDICTION SYSTEM FOR MULTISTAGE TURBINES Technical Progress Report No. 44, 1-31 Jan. 1994
OM SHARMA 28 Feb. 1994 6 p
(Contract NAS3-25804)
(NASA-CR-195223; NAS 1.26:195223; PWA-6228-47) Avail: CASI HC A02/MF A01

Flows in low-aspect ratio turbines, such as the SSME fuel turbine, are three dimensional and highly unsteady due to the relative motion of adjacent airfoil rows and the circumferential and spanwise gradients in total pressure and temperature, The systems used to design these machines, however, are based on the assumption that the flow is steady. The codes utilized in these design systems are calibrated against turbine rig and engine data through the use of empirical correlations and experience factors. For high aspect ratio turbines, these codes yield reasonably accurate estimates of flow and temperature distributions. However, future design trends will see lower aspect ratio (reduced number of parts) and higher inlet temperature which will result in increased three dimensionality and flow unsteadiness in turbines. Analysis of recently acquired data indicate that temperature streaks and secondary flows generated in combustors and up-stream airfoils can have a large impact on the time-averaged temperature and angle distributions in downstream airfoil rows. Derived from text

N94-26673 Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
SIMULATING INDIRECT THRUST MEASUREMENT METHODS AS USED ON MODERN HIGH-BYPASS TURBOFANS M.S. Thesis
JONATHAN DAVID STEVENSON Dec. 1992 143 p
(ISBN-0-315-84123-0; CTN-94-61059) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

As yet, there is no known reliable method for directly measuring the thrust of a turbofan in flight. Manufacturers of civil turbofans use various indirect thrust measurements to indicate performance of an engine to the flight deck. Included among these are engine pressure ratio (EPR), integrated engine pressure ratio (IEPR), fan mechanical speed as a percentage of its design speed (N1), and various turbine gas temperatures. Of key concern is whether these thrust indicators give an accurate account of the actual engine thrust. A study was undertaken to determine the effect of advanced engine cycles on typical values of the most popular thrust setting parameters, using a generic computer model of a twin-spool high bypass ratio turbofan. A preliminary investigation was conducted to determine the effects of various kinds of engine deterioration on the engine performance and the indirect thrust indicators. The results show very little difference between the most popular thrust indicator methods used. EPR and IEPR have the unique advantage of being self-correcting to a wide range of ambient takeoff temperatures, but are affected by changes in altitude, forward speed, and engine cycle. N1 appears to exhibit different behavior at takeoff and cruise operation, but has the advantage of being intuitive to pilots. Author (CISTI)

N94-27432*# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO. New Aircraft and Missile Products Div.
DESIGN AND FLIGHT TEST OF THE PROPULSION CONTROLLED AIRCRAFT (PCA) FLIGHT CONTROL SYSTEM ON THE NASA F-15 TEST AIRCRAFT
EDWARD A. WELLS and JAMES M. URNES, SR. Feb. 1994 42 p
(Contract NAS2-13312; RTOP 533-02-36)
(NASA-CR-186028; H-1965; NAS 1.26:186028; REPT-94B0005) Avail: CASI HC A03/MF A01

This report describes the design, development and flight testing of the Propulsion Controlled Aircraft (PCA) flight control system performed at McDonnell Douglas Aerospace (MDA), St. Louis, Missouri and at the NASA Dryden Flight Research Facility, Edwards Air Force Base, California. This research and development program was conducted by MDA and directed by NASA through the Dryden Flight Research Facility for the period beginning January 1991 and ending December 1993. A propulsion steering backup to the aircraft conventional flight control system has been developed and flight demonstrated on a NASA F-15 test aircraft. The Propulsion Controlled Aircraft (PCA) flight system utilizes collective and differential thrust changes to steer an aircraft that experiences partial or complete failure of the hydraulically actuated control surfaces. The PCA flight control research has shown that propulsion steering is a viable backup flight control mode and can assist the pilot in safe landing recovery of a fighter aircraft that has damage to or loss of the flight control surfaces. NASA, USAF and Navy evaluation test pilots stated that the F-15 PCA design provided the control necessary to land the aircraft. Moreover, the feasibility study showed that PCA technology can be directly applied to transport aircraft and provide a major improvement in the survivability of passengers and crew of controls damaged aircraft. Author

N94-27593# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. Antriebsintegration.
EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE INFLUENCE OF THE JET ON THE FLOW AROUND A BYPASS-ENGINE [EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNGEN UEBER DEN STRAHLEINFLUSS BEI DER UMSTROEMUNG EINES BYPASS-TRIEBWERKES]
ANDREAS KORUS Dec. 1992 130 p In GERMAN
(ISSN 0939-2963)
(DLR-FB-93-17; ETN-94-95495) Avail: CASI HC A07/MF A02

The characteristics of jet flows and their interference with boat tails are described, and experimental investigations with a 'hot jet simulator' of the bypass engine CF6-50 on the 'jet simulation tunnel' are described. The influences of the nozzle pressure ratios and the free stream Mach number on the pressure distributions of the engine contours and the jet behavior, as well as the mutual effects on the fan and core jet are investigated, due to measurements with a cold core jet. Subsequently, the results of the jets on the flow around the bypass engine carried out theoretically using the coupled STC (Stream Tube Curvature)-GENMIX code. An Euler code was used to examine the influence of the shape of the jet profile on the pressure distribution of the core cowl contour. The results received from the measurements and the calculations were compared. ESA

N94-27608# National Aerospace Lab., Kakuda (Japan).
A STUDY ON HEAT TRANSFER IN A SCRAMJET LEADING EDGE MODEL
SHUICHI UEDA, NOBORU SAKURANAKA, TOSHIHITO SAITO, KATSUHIRO ITO, YOSHIO WAKAMATSU, and KIWAMU IMAI Dec. 1992 15 p Original contains color illustrations
(ISSN 0389-4010)
(NAL-TR-1187T; JTN-94-80615) Avail: CASI HC A03/MF A01

Heating tests and analysis of a cooling panel that simulates the leading edge of a scramjet engine inlet or strut were performed using a crossflow type water-cooled panel with a circular leading edge. The cooling panel was fabricated by nickel electroforming and heated by supersonic hot gas. An NTO (Nitrogen TetraOxide) and MMH (MonoMethyl Hydrazine) rectangular chamber was used as the gas generator. The free stream Mach number at the nozzle exit was about 2.67. Water was used as the coolant, and heat flux distribution was measured based on the temperature increase. Thermal analyses were performed using a two-dimensional CFD (Computational Fluid Dynamics) code and a finite element code. The results of the analysis were compared with the experimental data. Author (NASDA)

N94-27654*# Duke Univ., Durham, NC. Dept. of Mechanical Engineering and Materials Science.
PREDICTION OF UNDSTEADY FLOWS IN TURBOMACHINERY USING THE LINEARIZED EULER EQUATIONS ON DEFORMING GRIDS Final Report
WILLIAM S. CLARK and KENNETH C. HALL Mar. 1994 111 p
(Contract NAG3-1192; RTOP 505-62-10)
(NASA-CR-195285; E-8630; NAS 1.26:195285) Avail: CASI HC A06/MF A02

A linearized Euler solver for calculating unsteady flows in turbomachinery blade rows due to both incident gusts and blade motion is presented. The model accounts for blade loading, blade geometry, shock motion, and wake motion. Assuming that the unsteadiness in the flow is small relative to the nonlinear mean solution, the unsteady Euler equations can be linearized about the mean flow. This yields a set of linear variable coefficient equations that describe the small amplitude harmonic motion of the fluid. These linear equations are then discretized on a computational grid and solved using standard numerical techniques. For transonic flows, however, one must use a linear discretization which is a conservative linearization of the non-linear discretized Euler equations to ensure that shock impulse loads are accurately captured. Other important features of this analysis include a continuously deforming grid which eliminates extrapolation errors and hence, increases accuracy, and a new numerically exact, nonreflecting far-field boundary condition treatment based on an eigenanalysis of the discretized equations. Computational results are presented which demonstrate the computational accuracy and efficiency of the method and demonstrate the effectiveness of the deforming grid, far-field nonreflecting boundary conditions, and shock capturing techniques. A comparison of the present unsteady flow predictions to other numerical, semi-analytical, and experimental methods shows excellent agreement. In addition, the linearized Euler method presented requires one or two orders-of-magnitude less computational time than traditional time marching techniques making the present method a viable design tool for aeroelastic analyses. Author

N94-27739# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. Antriebsintegration.
THE DESIGN OF A COUNTER ROTATING ULTRA-HIGH-BYPASS FAN SIMULATOR FOR WINDTUNNEL INVESTIGATION [AUSLEGUNG EINES COUNTER ROTATING ULTRA-HIGH-BYPASS FAN SIMULATORS FUER WINDKANALUNTERSUCHUNGEN]
HEINZ HOHEISEL Mar. 1993 84 p Original contains color

illustrations
(ISSN 0939-2963)
(DLR-FB-93-20; ETN-94-95497) Avail: CASI HC A05/MF A01

The procedure and special aspects that had to be taken into account during the design of an engine simulator to be used for simulating the integration of airframes and engines with ultra high bypass ratios are described. The simulator should be able to simulate the aerodynamics and acoustics of the real engine. For this reason, the simulator was designed with a counter rotating fan. The counter rotation of the fan was generated by a reverse gearbox, similar to the real engine where a gearbox is necessary to maintain a good LP turbine efficiency. ESA

N94-27778*# United Technologies Corp., East Hartford, CT. Pratt and Whitney Div.
COUPLED 2-DIMENSIONAL CASCADE THEORY FOR NOISE AN D UNSTEADY AERODYNAMICS OF BLADE ROW INTERACTION IN TURBOFANS. VOLUME 2: DOCUMENTATION FOR COMPUTER CODE CUP2D
DONALD B. HANSON Washington Jan. 1994 42 p
(Contract NAS3-25952; RTOP 535-03-10)
(NASA-CR-4506-VOL-2; E-7766; NAS 1.26:4506-VOL-2) Avail: CASI HC A03/MF A01

A two dimensional linear aeroacoustic theory for rotor/stator interaction with unsteady coupling was derived and explored in Volume 1 of this report. Computer program CUP2D has been written in FORTRAN embodying the theoretical equations. This volume (Volume 2) describes the structure of the code, installation and running, preparation of the input file, and interpretation of the output. A sample case is provided with printouts of the input and output. The source code is included with comments linking it closely to the theoretical equations in Volume 1. Author (revised)

N94-28018# Rolls-Royce Ltd., Bristol (England). Powerplant Technology.
INFLUENCE OF HEADWIND ON HOT GAS REINGESTION AND CONSIDERATION OF PRESSURE RATIO SCALING
C. J. PENROSE *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 9 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

A major concern affecting the operation of Advanced Short Take-Off and Vertical Landing (ASTOVL) aircraft close to the ground is ingestion by the aircraft intakes of engine hot exhaust gas. This hot gas reingestion (HGR) can produce loss of engine thrust and erode engine stability margins. A prime source of HGR is the flow occupying the region in the 'near' and 'mid' fields around the aircraft. The 'near-field' flow can be controlled by aircraft-mounted anti-HGR devices but these are likely to be less effective in containing the mid-field flow which is greatly influenced by headwind. Near and mid-field ingestion on Harrier-type configurations has, for many years, been studied by means of model-scale experiments. In most cases in the United Kingdom, the experiments have been set up observing scaling procedures which include consideration of the buoyant action of the hot gas and imply tests at low jet velocities with dynamic head similarity maintained. It can be argued that low velocities may not be appropriate for currently-conceived ASTOVL aircraft employing high pressure-ratio supersonic exhausts, and it may be more appropriate to test at full-scale nozzle pressure ratios. This paper reviews the effects of headwind on HGR for Harrier-type configurations during landing maneuvers with tests carried out both at low jet velocities consistent with buoyancy scaling (NPR(sub F) = 1. 07) and at velocities representative of full-scale nozzle pressure ratios (NPR(sub f) = 2.46). The HGR results are examined in relation to expectations of the forward-flowing gas cloud height and penetration distance for the engine exhaust streams while under the influence of headwinds. Author (revised)

N94-28019# Rolls-Royce Ltd., Bristol (England). Powerplant Technology.
UNSTEADY ASPECTS OF HOT GAS REINGESTION AND STATISTICAL ANALYSIS
R. BEASLEY *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 6 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

The ingestion of engine exhaust gases into an aircraft intake during jet-lift Advanced Short Take-off and Vertical Lift (ASTOVL) aircraft operation close to the ground is an area of considerable concern and has been the subject of much experimental study. The recirculatory flows follow complex paths which are strongly influenced by interference with the ground, aircraft structures, adjacent jet streams, and by the action of an oncoming headwind. The flows are turbulent at a large scale and unsteady with 'streaks' of hot gas entering the intake in a random manner. This Hot Gas Reingestion (HGR) can erode engine stability margins in a region of aircraft operation where reliable engine performance is critical. To ensure engine stability, sophisticated analysis techniques are required to enable prediction of worst-case destabilizing temperature distortion levels for chosen aircraft/engine combination. This paper describes the development and application of statistical analysis techniques designed to examine results of model experiments. These techniques enable quantitative conclusions to be reached as an extension to qualitative examination of trends from observed data. Due to the nature of the flow and distortion parameter, observed HGR data distributions are frequently not normal (Gaussian), and standard statistical techniques cannot be used. Author (revised)

N94-28037# Karlsruhe Univ. (Germany).
ANALYSIS OF COOLING JETS NEAR THE LEADING EDGE OF TURBINE BLADES
E. BENZ, S. WITTIG, A. BEECK (ABB Power Generation, Inc., Baden, Switzerland.), and L. FOTTNER (Universitaet der Bundeswehr Muenchen, Neubiberg, Germany.) *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 12 p Nov. 1993
Copyright Avail: CASI HC A03/MF A04

Film-cooling air ejection affects the aerodynamics of turbine blades by the mixing of the coolant with the mainstream as well as by the interaction between the jet and the boundary layer. In the present paper, these effects are studied experimentally and numerically. The results show that the flow in the coolant channel is strongly affected by the main flow around the blade, leading to significant deflection of the coolant air jets. To account for these interactions between the cooling jet and the main flow in the numerical predictions, a multi-block technique is applied. With this technique very complex but structured geometries can be modelled by simply attaching grids of the different sub-domains. For the present investigations, these sub-domains are the two coolant channels at the leading edge and the main flow around the blade. For adaption to the curved geometry of such a turbine blade, a non-orthogonal body fitted grid is used for solving the time average two- or three-dimensional compressible Navier-Stokes equations by a finite volume method. The turbulence is taken into account by the standard k-epsilon model. For discretization of the convective terms the Monotonized-Linear-Upwind scheme (MLU) is used. The pressure-velocity coupling is achieved by the SIMPLEC-algorithm for compressible flows. The calculated results are compared with experimental investigation performed with a L2F-system at a large scaled turbine blade. Three typical blowing ratios are presented. Due to the simultaneous calculation of the coolant flow and the main flow, good agreement was obtained. Author

N94-28319 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario).
PROPELLER OFF-AXIS LOADS DUE TO THRUST AXIS INCIDENCE AND NACELLE MAGNUS FORCE
P. VYRIOTES, J. PETZKE, and D. BARBER *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 13-16 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Propeller and nacelle loads for various configurations were measured in a series of wind tunnel tests. Wind tunnel data for four- and six-blade research propellers demonstrated the influence

of blade angle, advance ratio, and model incidence on propeller shaft loads and nacelle force. Complementary theoretical estimates of the off-axis hub loads were performed using panel and lifting line theories. Favorable correlation between experimental and theoretical data was demonstrated. The test data showed that when the propeller was yawed, the swirl induced nacelle force was comparable in magnitude, but perpendicular to, the propeller shaft side force. The effect of an inlet on the propeller shaft loads was also examined. For an axisymmetric nacelle, the normal force and yawing moment acting on the propeller shaft remained approximately zero. The presence of a pitot inlet nacelle immediately behind the propeller induced an additional normal force and yawing moment on the propeller shaft which was independent of the nacelle yaw angle. If the propeller and nacelle were then pitched, the intake induced loads would contribute to the shaft loads. If the propeller and nacelle were yawed, the intake induced force would act in the same sense as the nacelle force.
Author (CISTI)

N94-28320 Carleton Univ., Ottawa (Ontario).
EFFECT OF SURFACE FINISH ON TURBINE AIRFOIL CASCADE LOSSES
RAMA RADMARD, PETER J. TURYK (Pratt and Whitney Aircraft of Canada Ltd., Mississauga, Ontario.), and WILLIAM E. CARSCALLEN (National Research Council of Canada, Ottawa, Ontario.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 17-20 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

The importance of surface finish on airfoil pressure loss measurement was investigated in a four-passage transonic cascade at nominal exit Mach numbers of 0.7, 0.9, and 1.1. Stagnation pressure and flow angles were measured one quarter chord downstream of the airfoil row using a yawing wedge probe. Three airfoil profiles were used: a baseline airfoil typical of a midsection of a high pressure turbine first vane, plus two thicker airfoils of 27 percent and 48 percent maximum thickness to true chord ratio. The thicker airfoils exhibit lower total pressure loss than the baseline at all three exit conditions. Flow visualization runs showed separation was consistently occurring at the locations of what seemed to be surface defects on each of the airfoil profiles. The airfoils were manually refinished to remove the surface discontinuities and reinstalled. Tests were performed at Mach number 0.7 and results show that the full span pressure losses were reduced with the refinished airfoils. The reduction in total losses decreased as the airfoil thickness increased. The trend of loss with airfoil thickness remained the same as in the original tests.
Author (CISTI)

N94-28321 Atomic Energy of Canada Ltd., Pinawa (Manitoba). Containment Analysis Branch.
THE EFFECT OF AXIAL VELOCITY RATIO, TURBULENCE INTENSITY, INCIDENCE, AND LEADING EDGE GEOMETRY ON THE MIDSPAN PERFORMANCE OF A TURBINE CASCADE
D. R. WHITEHOUSE, S. H. MOUSTAPHA (Pratt and Whitney Aircraft of Canada Ltd., Longueuil, Quebec.), and S. A. SJOLANDER (Carleton Univ., Ottawa, Ontario.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 21-24 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Tests were carried out in a low-speed large-scale planar cascade test section to investigate the effect of axial velocity ratio (AVR), incidence, and turbulence intensity (TI) on the midspan performance of a turbine blade. The effect of leading edge geometry was investigated by comparing the results with those of Rodger (1992). Flow measurements were made with three-hole pressure probes mounted in planes upstream and downstream of the cascade. Measurements included midspan total pressure loss and flow performance. As the positive incidence increases, the overspeed increases, creating a strong adverse pressure gradient near the blade leading edge. Flow visualization confirmed the presence of boundary layer separation at +20 deg incidence. The strong adverse pressure gradient caused by the endplates (used to establish two-dimensional flow) appears to be the dominating influence on the boundary layer. An observed sensitivity of blade losses to AVR at high positive incidence highlights the importance of comparing loss measurements at AVR=1.0. Losses rose very quickly as AVR was reduced below 1.0. Turbulence intensity and changes in leading edge geometry had little or no effect on blade off-design losses for the AVR range studied.
Author (CISTI)

N94-28336 Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
A NEW APPROACH TO TURBOPROP FORWARD NACELLE DESIGN
I. ADARE, I. FEJTEK (De Havilland Aircraft Co. of Canada Ltd., Downsview, Ontario.), S. BEDI, and J. COLL (De Havilland Aircraft Co. of Canada Ltd., Downsview, Ontario.) *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 82-85 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

An innovative nacelle design capability was developed that significantly reduces the time for turboprop forward nacelle design and simplifies the effort required to generate nacelle shapes. The approach is an extension of the surface modeling methodologies developed by Bedi et al, in which the forward nacelle is viewed as being a blended surface joining, at the front end, a circular shape representing the spinner opening and another elongated shape representing the inlet opening, and at the aft end, a near-rectangular shape. By providing control over the manner in which the blending is performed, a variety of nacelle shapes can be generated which are smooth and which meet various geometric constraints imposed by engine and gearbox locations. The blending technique used in the modeling is based on the Bernstein basis functions. Once the surface is created using the above blending method, it is automatically divided into a network of quadrilateral panels. The output is in a surface panel format suitable for input to the aerodynamics computer program VSAERO. The interactive computer algebra package MAPLE is an integral part of the method. The entire design process comprising nacelle surface blending, surface grid generation, and VSAERO analysis can take under an hour of elapsed time on a workstation. Further refinements of the method are planned.
Author (CISTI)

08

AIRCRAFT STABILITY AND CONTROL

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

N94-24804*# West Virginia Univ., Morgantown.
DETERMINATION OF THE STABILITY AND CONTROL DERIVATIVES OF THE NASA F/A-18 HARV USING FLIGHT DATA Contractor Report, 15 May - 15 Dec. 1993
MARCELLO R. NAPOLITANO and JOELLE M. SPAGNUOLO 15 Dec. 1993 123 p
(Contract NCC2-759)
(NASA-CR-194838; NAS 1.26:194838) Avail: CASI HC A06/MF A02

This report documents the research conducted for the NASA-Ames Cooperative Agreement No. NCC 2-759 with West Virginia University. A complete set of the stability and control derivatives for varying angles of attack from 10 deg to 60 deg were estimated from flight data of the NASA F/A-18 HARV. The data were analyzed with the use of the pEst software which implements the output-error method of parameter estimation. Discussions of the aircraft equations of motion, parameter estimation process, design of flight test maneuvers, and formulation of the mathematical model are presented. The added effects of the thrust vectoring and single surface excitation systems are also addressed. The results of the longitudinal and lateral directional derivative estimates at varying angles of attack are presented and compared to results from previous analyses. The results indicate a significant improvement due to the independent control surface deflections induced by the single surface excitation system, and at the same time, a need for additional flight data especially at higher angles of attack. Author (revised)

N94-24957*# Embry-Riddle Aeronautical Univ., Daytona Beach, FL.
COCKPIT CONTROL SYSTEM
DAVID LESNEWSKI, RUSS M. SNOW, DAVE PAUFLER, GEORGE SCHNIEDER, ROXANNE ATHOUSAKE, and LISA COMBS 12 Mar. 1993 67 p
(Contract NASW-4435)
(NASA-CR-195488; NAS 1.26:195488) Avail: CASI HC A04/MF A01

The purpose of this project is to provide a detail design for the cockpit control system of the Viper PFT. The statement of work for this project requires provisions for control of the ailerons, elevator, rudder, and elevator trim. The system should provide adjustment for pilot stature, rigging, and maintenance. MIL-STD-1472 is used as a model for human factors criterion. The system is designed to the pilot limit loading outlined in FAR part 23.397. The general philosophy behind this design is to provide a simple, reliable control system which will withstand the daily abuse that is experienced in the training environment without excessive cost or weight penalties. Author (revised)

N94-25099*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGHLY-RELIABLE FLY-BY-LIGHT/POWER-BY-WIRE TECHNOLOGY
FELIX L. PITTS *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 85-95 Dec. 1993
Avail: CASI HC A03/MF A04

This paper presents in viewgraph format an overview of the program at NASA Langley Research Center to develop fly-by-light/power-by-wire (FBL/PBW) technology. Benefits of FBL/PBW include intrinsic electromagnetic interference (EMI) immunity and lifetime immunity to signal EMI of optics; simplified certification; the elimination of hydraulics, engine bleed air, and variable speed, constant frequency drive; and weight and volume reduction. The paper summarizes a study on the electromagnetic environmental effects on FBL/PBW systems. The paper concludes with FY 1993 plans. CASI

N94-25103*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PARAMETRIC UNCERTAINTY MODELING FOR APPLICATION TO ROBUST CONTROL
CHRISTINE M. BELCASTRO, B.-C. CHANG (Drexel Univ., Philadelphia, PA.), and ROBERT FISCHL (Drexel Univ., Philadelphia, PA.) *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 177-192 Dec. 1993
Avail: CASI HC A03/MF A04

Viewgraphs and a paper on parametric uncertainty modeling for application to robust control are included. Advanced robust control system analysis and design is based on the availability of an uncertainty description which separates the uncertain system elements from the nominal system. Although this modeling structure is relatively straightforward to obtain for multiple unstructured uncertainties modeled throughout the system, it is difficult to formulate for many problems involving real parameter variations. Furthermore, it is difficult to ensure that the uncertainty model is formulated such that the dimension of the resulting model is minimal. A procedure for obtaining an uncertainty model for real uncertain parameter problems in which the uncertain parameters can be represented in a multilinear form is presented. Furthermore, the procedure is formulated such that the resulting uncertainty model is minimal (or near minimal) relative to a given state space realization of the system. The approach is demonstrated for a multivariable third-order example problem having four uncertain parameters. Author (revised)

N94-25104*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC VEHICLE CONTROL LAW DEVELOPMENT USING H(INFINITY) AND MICRON-SYNTHESIS
IRENE M. GREGORY, JOHN D. MCMINN, JOHN D. SHAUGHNESSY, and RAJIV S. CHOWDHRY (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 193-208 Dec. 1993
Avail: CASI HC A03/MF A04

Hypersonic vehicle control law development using H(infinity) and mu-synthesis is discussed. Airbreathing SSTO vehicles has a mutli-faceted mission that includes orbital operations, as well as re-entry and descent culminating in horizontal landing. However, the most challenging part of the operations is the ascent to orbit. The airbreathing propulsion requires lengthy atmospheric flight that may last as long as 30 minutes and take the vehicle half way around the globe. The vehicles's ascent is characterized by tight payload to orbit margins which translate into minimum fuel orbit as the performance criteria. Issues discussed include: SSTO airbreathing vehicle issues; control system performance requirements; robust control law framework; H(infinity) controller frequency analysis; and mu controller frequency analysis. Author (revised)

N94-25105*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON-LINE EVALUATION OF MULTILOOP DIGITAL CONTROLLER PERFORMANCE
CAROL D. WIESEMAN *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 209-220 Dec. 1993
Avail: CASI HC A03/MF A04

The purpose of this presentation is to inform the Guidance and Control community of capabilities which were developed by the Aeroservoelasticity Branch to evaluate the performance of multivariable control laws, on-line, during wind-tunnel testing. The capabilities are generic enough to be useful for all kinds of on-line analyses involving multivariable control in experimental testing. Consequently, it was decided to present this material at this workshop even though it has been presented elsewhere. Topics covered include: essential on-line analysis requirements; on-line analysis capabilities; on-line analysis software; frequency domain procedures; controller performance evaluation frequency-domain flutter suppression; and plant determination. Author (revised)

N94-25106*# Air Force Materials Lab., Wright-Patterson AFB, OH. Directorate of Engineering and Technical Management.
AIRCRAFT DIGITAL FLIGHT CONTROL TECHNICAL REVIEW
OTHA B. DAVENPORT and DAVID B. LEGGETT (Wright Lab., Wright-Patterson AFB, OH.) *In* NASA. Langley Research Center, NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 243-250 Dec. 1993
Avail: CASI HC A02/MF A04

The Aircraft Digital Flight Control Technical Review was initiated by two pilot induced oscillation (PIO) incidents in the spring and summer of 1992. Maj. Gen. Franklin (PEO) wondered why the Air Force development process for digital flight control systems was not preventing PIO problems. Consequently, a technical review team was formed to examine the development process and determine why PIO problems continued to occur. The team was also to identify the 'best practices' used in the various programs. The charter of the team was to focus on the PIO problem, assess the current development process, and document the 'best practices.' The team reviewed all major USAF aircraft programs with digital flight controls, specifically, the F-15E, F-16C/D, F-22, F-111, C-17, and B-2. The team interviewed contractor, System

Program Office (SPO), and Combined Test Force (CTF) personnel on these programs. The team also went to NAS Patuxent River to interview USN personnel about the F/A-18 program. The team also reviewed experimental USAF and NASA systems with digital flight control systems: X-29, X-31, F-15 STOL and Maneuver Technology Demonstrator (SMTD), and the Variable In-Flight Stability Test Aircraft (VISTA). The team also discussed the problem with other experts in the field including Ralph Smith and personnel from Calspan. The major conclusions and recommendations from the review are presented. Author (revised)

N94-25107*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF HIGH-ANGLE-OF-ATTACK NOSE-DOWN PITCH CONTROL MARGIN DESIGN GUIDELINES FOR COMBAT AIRCRAFT
MARILYN E. OGBURN and JOHN V. FOSTER *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 293-322 Dec. 1993
Avail: CASI HC A03/MF A04

A broad research program to identify maneuvering requirements for advanced fighters and the corresponding design criteria to aid in making critical design tradeoffs is being conducted under the NASA High-Angle-of-Attack Technology Program (HATP). As part of this activity, NASA and the U.S. Navy are conducting cooperative research to develop high-angle-of-attack control margin requirements. This paper will summarize the status of this program. Following some background information, the simulation study conducted to develop a set of preliminary guidelines for nose-down pitch control is reviewed, and the results of some very limited flight tests are described. Author (revised)

N94-25108*# Wright Lab., Wright-Patterson AFB, OH.
ROBUST, NONLINEAR, HIGH ANGLE-OF-ATTACK CONTROL DESIGN FOR A SUPERMANEUVERABLE VEHICLE
RICHARD J. ADAMS *In* NASA. Langley Research Center, NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 323-371 Dec. 1993
Avail: CASI HC A03/MF A04

High angle-of-attack flight control laws are developed for a supermaneuverable fighter aircraft. The methods of dynamic inversion and structured singular value synthesis are combined into an approach which addresses both the nonlinearity and robustness problems of flight at extreme operating conditions. The primary purpose of the dynamic inversion control elements is to linearize the vehicle response across the flight envelope. Structured singular value synthesis is used to design a dynamic controller which provides robust tracking to pilot commands. The resulting control system achieves desired flying qualities and guarantees a large margin of robustness to uncertainties for high angle-of-attack flight conditions. The results of linear simulation and structured singular value stability analysis are presented to demonstrate satisfaction of the design criteria. High fidelity nonlinear simulation results show that the combined dynamics inversion/structured singular value synthesis control law achieves a high level of performance in a realistic environment. Author (revised)

N94-25111*# Vigyan Research Associates, Inc., Hampton, VA.
A STUDY OF ROLL ATTRACTOR AND WING ROCK OF DELTA WINGS AT HIGH ANGLES OF ATTACK
T. NIRANJANA, D. M. RAO, and BANDU N. PAMADI *In* NASA. Langley Research Center, NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 401-430 Dec. 1993
Avail: CASI HC A03/MF A04

Wing rock is a high angle of attack dynamic phenomenon of limited cycle motion predominantly in roll. The wing rock is one of the limitations to combat effectiveness of the fighter aircraft. Roll Attractor is the steady state or equilibrium trim angle (phi(sub trim)) attained by the free-to-roll model, held at some angle of attack, and released form rest at a given initial roll (bank) angle (phi(sub O)). Multiple roll attractors are attained at different trim angles depending on initial roll angle. The test facility (Vigyan's low speed wind tunnel) and experimental work is presented here along with mathematical modelling of roll attractor phenomenon and analysis and comparison of predictions with experimental data. Derived from text

N94-25112*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MODELING TRANSONIC AERODYNAMIC RESPONSE USING NONLINEAR SYSTEMS THEORY FOR USE WITH MODERN CONTROL THEORY
WALTER A. SILVA *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 431-457 Dec. 1993
Avail: CASI HC A03/MF A04

The presentation begins with a brief description of the motivation and approach that has been taken for this research. This will be followed by a description of the Volterra Theory of Nonlinear Systems and the CAP-TSD code which is an aeroelastic, transonic CFD (Computational Fluid Dynamics) code. The application of the Volterra theory to a CFD model and, more specifically, to a CAP-TSD model of a rectangular wing with a NACA 0012 airfoil section will be presented. Author

N94-25176*# Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.
FEEDBACK CONTROL LAWS FOR HIGHLY MANEUVERABLE AIRCRAFT Annual Report, 1 Feb. 1993 - 31 Jan. 1994
WILLIAM L. GARRARD and GARY J. BALAS 10 Mar. 1994 7 p
(Contract NAG1-1380)
(NASA-CR-195195; NAS 1.26:195195) Avail: CASI HC A02/MF A01

During the first half of the year, the investigators concentrated their efforts on completing the design of control laws for the longitudinal axis of the HARV. During the second half of the year they concentrated on the synthesis of control laws for the lateral-directional axes. The longitudinal control law design efforts can be briefly summarized as follows. Longitudinal control laws were developed for the HARV using mu synthesis design techniques coupled with dynamic inversion. An inner loop dynamic inversion controller was used to simplify the system dynamics by eliminating the aerodynamic nonlinearities and inertial cross coupling. Models of the errors resulting from uncertainties in the principal longitudinal aerodynamic terms were developed and included in the model of the HARV with the inner loop dynamic inversion controller. This resulted in an inner loop transfer function model which was an integrator with the modeling errors characterized as uncertainties in gain and phase. Outer loop controllers were then designed using mu synthesis to provide robustness to these modeling errors and give desired response to pilot inputs. Both pitch rate and angle of attack command following systems were designed. The following tasks have been accomplished for the lateral-directional controllers: inner and outer loop dynamic inversion controllers have been designed; an error model based on a linearized perturbation model of the inner loop system was derived; controllers for the inner loop system have been designed, using classical techniques, that control roll rate and Dutch roll response; the inner loop dynamic inversion and classical controllers have been implemented on the six degree of freedom simulation; and lateral-directional control allocation scheme has been developed based on minimizing required control effort. Derived from text

N94-25516# Organization for Industrial Research, TNO, The Hague (Netherlands). Phyiscs and Electronics Lab.
REMOTE VIBRATION MEASUREMENTS AT A SUD AVIATION ALOUETTE 3 HELICOPTER WITH A CW CO2-LASER SYSTEM
H. E. BOETZ 28 Sep. 1993 51 p
(AD-A273818; FEL-93-A183; TDCK-TD93-2777) Avail: CASI HC A04/MF A01

This report describes an experiment with a helicopter to quantify the performance of our experimental multifunctional CO2-laser heterodyne detection system as a vibration detection instrument.

The laser system emitted a beam with a diameter of 35 mm with a divergence of 0.5 mrad and a continuous output of 0.4 Watt. The purpose of our measurements was to measure the vibration spectra of a helicopter from the Dutch Air Force at distances between 0.5 to 6 km at various aspect angles. Vibration detection with the help of lasers might prove important for classification of targets. Especially helicopters are of interest because of the typical constant rotor speeds and fixed speed-ratio's between the tail-and main rotor (T/R-ratio) and other characteristics of the spectra. The obtained spectral components are compared with maintenance (rotortuning) frequency measurements done at the airbase with accelerometers. The results are in accordance with each other. The rotor frequencies were determined at all positions of the helicopter. Depending on the place where the laser beam hits the target, the amplitudes of the spikes in the frequency spectrum may vary significantly. With an Advantest R9211C FFT spectrum analyzer, a measurement will take at least one second, yielding a recognizable spectrum at distances of the helicopter up to 4 km.
DTIC

N94-25525 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
FLIGHT CONTROLLER DESIGN USING MIXED H2/H INFINITY OPTIMIZATION WITH A SINGULAR H INFINITY CONSTRAINT M.S. Thesis
JAMES P. LUKE Dec. 1993 135 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A273831; AFIT/GAE/ENY/93D-21) Avail: CASI HC A07

This thesis explores the effectiveness of mixed H2/H Infinity optimal control design applied to a realistic flight control problem. The application used by this thesis is a single input single output problem dealing with a normal acceleration command following model of the AFTI F-16. The mixed H2/H Infinity control problem is broken into its component H2 and H Infinity parts; the H2 part is formulated as an LQG problem, and a weight is applied to system sensitivity in the H Infinity problem to obtain tracking performance. The sensitivity weight in the underlying H Infinity part results in a singular constraint on the mixed problem. A newly-developed numerical technique is applied and solutions are obtained for controllers of order equal to, first, the order of the underlying H2 problem and, second, the order of the underlying H Infinity problem. Performance characteristics of these controllers are compared to controllers designed using the more-conventional LQG/LTR design method. The results indicate the potential for controllers obtained through mixed H2/H Infinity optimization to provide excellent performance and robustness characteristics at orders less than those obtained through LQG/LTR. Since this conclusion grows in significance when applied to multiple input multiple output (MIMO) problems, a three input, five output example is introduced and the underlying H2 and H Infinity problems for two solution approaches are formulated. DTIC

N94-25640# Cranfield Inst. of Tech., Bedford (England). Flight Dynamics Group.
THE APPLICATION OF A C(STAR) FLIGHT CONTROL LAW TO LARGE CIVIL TRANSPORT AIRCRAFT Ph.D. Thesis
EDMUND FIELD Mar. 1993 45 p Sponsored by United Kingdom Science and Engineering Research Council
(CRANFIELD-AERO-9303; ISBN-1-871564-58-1; ETN-94-95222)
Avail: CASI HC A03/MF A01

The aim of the program is to design flight control laws to give fly by wire civil transport aircraft excellent flying qualities at all flight conditions. The most critical flight phase of a civil transport is the landing approach. An analysis of the C(star) parameter is presented. The C(star) criterion was one of the first handling qualities criteria designed to take account of advanced aerodynamic designs of modern aircraft and higher order systems introduced by flight control systems. Several aircraft have since employed control laws based around the C(star) parameter. A proportional feedback C(star) controller was applied to a Boeing 747-100 in landing approach configuration, and assessed against the C(star) criterion. ESA

N94-25653# Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
REPORT ON A VISIT TO THE ARVIN/CALSPAN CORPORATION, BUFFALO, NEW YORK, USA, SEPTEMBER 1992
EDMUND FIELD Apr. 1993 61 p Sponsored by Eric Beverley Memorial Trust
(CRANFIELD-AERO-9305; NFP-9202; ISBN-1-871564-59-X; ETN-94-95277) Avail: CASI HC A04/MF A01

A literature search of reports related to flying and handling qualities of advanced fly by wire aircraft was performed. An engineering test flight in a variable stability Learjet in-flight simulator was carried out to demonstrate features of modern flight control systems designs. Recent developments in the field were discussed with the personnel. Contact was also made with the stability, control, simulation, and flight qualities group which was conducting total in flight simulation (TIFS). ESA

N94-25771# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DESIGN OF A SUBSONIC ENVELOPE FLIGHT CONTROL SYSTEM FOR THE VISTA F-16 USING QUANTITATIVE FEEDBACK THEORY M.S. Thesis
ODELL R. REYNOLDS Dec. 1993 180 p
(AD-A274057; AFIT/GE/ENG/93D-34) Avail: CASI HC A09/MF A02

A controlled plant's characteristics can vary widely throughout its operational envelope. This is a major problem in nominal plant-based control system design. Hence, gain scheduling is often used for full envelop design. In this paper, it is proposed to address the plant's variability using robust control design concepts. In particular, the frequency domain based Quantitative Feedback Theory Multiple-Input Multiple-Output robust control design method is employed for the synthesis of a full envelop flight control system for an F-16 derivative. Compensators for the aircraft's pitch and lateral directional channels are designed, and the designs are validated using linear simulations. DTIC

N94-25785# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
NEURAL NETWORKS FOR DYNAMIC FLIGHT CONTROL M.S. Thesis
RONALD E. SETZER Dec. 1993 140 p
(AD-A274089; AFIT/GE/ENG/93D-36) Avail: CASI HC A07/MF A02

This thesis examines the application of artificial neural networks (NN's) to the problem of dynamic flight control. The specific application is the control of a flying model helicopter. The control interface is provided through a hardware and software test bed called the Fast Adaptive Maneuvering Experiment (FAME). The NN design approach uses two NN's: one trained as an emulator of the plant and the other trained to control the emulator. The emulator neural network is designed to reproduce the flight dynamics of the experimental plant. The controller is then designed to produce the appropriate control inputs to drive the emulator to a desired final state. Previous research in the area of NN's for controls has almost exclusively been applied to simulations. To develop a controller for a real plant, a neural network must be created which will accurately recreate the dynamics of the plant. This thesis demonstrates the ability of a neural network to emulate a real, dynamic, nonlinear plant. DTIC

N94-25833# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DESIGN OF A FLIGHT CONTROLLER FOR AN UNMANNED RESEARCH VEHICLE WITH CONTROL SURFACE FAILURES USING QUANTITATIVE FEEDBACK THEORY M.S. Thesis
MARK S. KEATING Dec. 1993 163 p
(AD-A274049; AFIT/GE/ENG/93D-18) Avail: CASI HC A08/MF A02

This thesis describes the application of the multiple-input multiple-output (MIMO) Quantitative Feedback Theory (QFT) design technique to the design of a digital flight control system for the

Lambda Unmanned Research Vehicle (URV). The QFT technique allows the synthesis of a control system which is robust in the presence of structured plant uncertainties. Uncertainties considered in this design are the aircraft's plant variation within the flight envelope and the effects of damage to aircraft control surfaces. Mathematical models of control surface failure effects on aircraft dynamics are derived and used to modify an existing small perturbation model of the Lambda. The QFT technique is applied to design a control system utilizing aircraft pitch rate, roll rate and sideslip angle as feedback variables. The inherent cross-coupling rejection qualities of QFT and an aileron-rudder interconnect are utilized to design a control system which results in a coordinated flight. An outer-loop autopilot is then designed around the QFT controller to further assist turn coordination. Sensor noise effects on aircraft states are also analyzed. DTIC

N94-25998# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DISCOVERY LEARNING IN AUTONOMOUS AGENTS USING GENETIC ALGORITHMS M.S. Thesis
EDWARD O. GORDON Dec. 1993 209 p
(AD-A274083; AFIT/GE-93D-10) Avail: CASI HC A10/MF A03

As the new Distributed Interactive Simulation (DIS) draft standard evolves into a useful document and distributed simulations begin to emerge that implement parts of the standard, there is renewed interest in available methods to effectively control autonomous aircraft agents in such a simulated environment. This investigation examines the use of a genetics-based classifier system for agent control. These are robust learning systems that use the adaptive search mechanisms of genetic algorithms to guide the learning system in forming new concepts (decision rules) about its environment. By allowing the rule base to evolve, it adapts agent behavior to environmental changes. Addressed are the learning needs of autonomous aircraft agents, showing how multiple learning strategies are possible and that the best approach is a coherent combination of these. A design is described for a control system using a distributed filtering architecture and a genetics-based classifier system modified to support a phasing-rule niching system based on phase tags. Finally, a prototype system called the Phased Pilot Learning System (PPLS) is implemented based on this design and tested within a limited simulation environment. Results from empirical tests show that this approach is a viable alternative to other control methods. DTIC

N94-26192# Naval Postgraduate School, Monterey, CA.
LINEAR MODELING OF ROTORCRAFT FOR STABILITY ANALYSIS AND PRELIMINARY DESIGN M.S. Thesis
WALTER M. WIRTH, JR. Sep. 1993 188 p
(AD-A274869) Avail: CASI HC A09/MF A02

This thesis investigates linear state space modeling of single main rotor helicopters culminating in a computer program that can be used for stability and control analysis for any single main rotor helicopter or preliminary design of a helicopter. The trim solution for a flight condition is found, the aircraft is perturbed about the nominal point, and the stability and control derivatives are determined. State space models and analysis tools are provided by the program. A notional attack helicopter designed for the 1993 American Helicopter Society Design Competition and a notional utility helicopter are used as examples. DTIC

N94-26593*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE RELATIONSHIP OF AN INTEGRAL WIND SHEAR HAZARD TO AIRCRAFT PERFORMANCE LIMITATIONS
M. S. LEWIS, P. A. ROBINSON, D. A. HINTON, and R. L. BOWLES Feb. 1994 18 p
(Contract RTOP 505-64-12-01)
(NASA-TM-109080; NAS 1.15:109080) Avail: CASI HC A03/MF A01

The development and certification of airborne forward-looking wind shear detection systems has required a hazard definition stated in terms of sensor observable wind field characteristics. This paper outlines the definition of the F-factor wind shear hazard index and an average F-factor quantity, calculated over a specified averaging interval, which may be used to judge an aircraft's potential performance loss due to a given wind shear field. A technique for estimating airplane energy changes during a wind shear encounter is presented and used to determine the wind shear intensity, as a function of the averaging interval, that presents significant hazard to transport category airplanes. The wind shear hazard levels are compared to averaged F-factor values at various averaging intervals for four actual wind shear encounters. Results indicate that averaging intervals of about one kilometer could be used in a simple method to discern hazardous shears.
Author (revised)

N94-26710# Institute for Aerospace Research, Ottawa (Ontario).
THE EFFECTS OF TAILWINDS AND CONTROL CROSS COUPLING ON ROTORCRAFT HANDLING QUALITIES FOR STEEP, DECELERATING INSTRUMENT APPROACHES AND MISSED APPROACHES
S. W. BAILLIE, S. KERELIUK, and J. M. MORGAN Sep. 1993 72 p
(IAR-AN-77; NRC-32159; CTN-94-61007) Avail: CASI HC A04/MF A01

The expansion of the rotorcraft instrument flight envelope to allow steep, decelerating approaches to low speeds and altitudes will profoundly improve the utility of those vehicles. As a supplement to previously published investigations, a research program was conducted using the Bell 205 Airborne Simulator, whose results provide a data base on which rotorcraft instrument flight certification standards can be formulated for rotorcraft operations equivalent to Category III A. The research was conducted to document the effect of conducting steep, decelerating approaches in the presence of tailwinds. The handling qualities factors of terminating the approach with one of three missed approach procedures were investigated, and the height loss at the initiation of a missed approach procedure was documented. The handling qualities degradation induced by inter-axis control cross coupling was also assessed. The handling qualities and performance were found to be acceptable at speeds down to 10 knots when approaches were performed with a tailwind present. The initiation of missed approach procedures resulted in minimum altitudes that approached 20 feet in some cases. Increased levels of inter-axis control cross coupling had little effect on handling qualities on approach.
CISTI

N94-26821*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
RESEARCH IN ROBUST CONTROL FOR HYPERSONIC AIRCRAFT Progress Report No. 3, 1 Sep. 1993 - 28 Feb. 1994
A. J. CALISE Mar. 1994 27 p
(Contract NAG1-1451)
(NASA-CR-195250; NAS 1.26:195250) Avail: CASI HC A03/MF A01

The research during the third reporting period focused on fixed order robust control design for hypersonic vehicles. A new technique was developed to synthesize fixed order H(sub infinity) controllers. A controller canonical form is imposed on the compensator structure and a homotopy algorithm is employed to perform the controller design. Various reduced order controllers are designed for a simplified version of the hypersonic vehicle model used in our previous studies to demonstrate the capabilities of the code. However, further work is needed to investigate the issue of numerical ill-conditioning for large order systems and to make the numerical approach more reliable. Author (revised)

N94-27112# Department of the Navy, Washington, DC.
FLUID DYNAMIC LINEAR ACCELEROMETER Patent Application
DAVID E. KEYSER, inventor (to Navy) 17 May 1993 16 p
(AD-D016042; US-PATENT-APPL-SN-063844) Avail: CASI HC A03/MF A01

A linear acceleration sensing device operates through a fluid medium. A fluid signal output represents a differential pressure from the elastic deformation of a fluid-filled diaphragm or bellows assembly. A pair of fluid proximity sensors operate differentially in a fluid control network and detect the elastic deformation of the diaphragm assembly caused by increased hydrostatic pressure resulting from a change in acceleration, or g-force. DTIC

N94-27132# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AUTOMATION OF FORMATION FLIGHT CONTROL M.S. Thesis
VINCENT P. REYNA 1994 193 p
(AD-A274137; AFIT/GE/ENG/94M-01) Avail: CASI HC A09/MF A03

The research contained in this thesis explores the concepts of Automated Formation Flight Control documented in three previous AFIT theses. The generic formation analyzed consists of a Leader and Wingman, with the Wingman referencing its maneuvers off of Leader maneuvers. Specifically, planar formation flight control concerning only heading and velocity changes is considered. Next, the vertical separation constraint is relaxed to allow wing maneuvers outside of the flight plane of the lead in order to minimize the energy expended by the wing in a maneuver. Analysis of the two forms of formation flight control investigated in this thesis reveals the close relationship between formation geometry, aircraft time constants, controller gains, formation performance, and control system stability. Integral control action is determined to be necessary for formation flight control. Nonlinear simulations are accomplished on a digital computer to validate the analysis of the automated formation flight control system. Comparisons are made between the two forms of formation flight control considered, and a third, energy conserving maneuvers, in order to determine which is best for each phase of flight. DTIC

N94-27206# National Aerospace Lab., Tokyo (Japan). Flight Research Div.
OPTIMAL CONTROL OF HELICOPTERS FOLLOWING POWER FAILURE [HERIKOPUTA NO ENJIN KOSHOJI NO SAITEKI HIKO SEIGYO]
YOSHINORI OKUNO Jan. 1993 49 p In JAPANESE
(ISSN 0389-4010)
(NAL-TR-1190; JTN-94-80617) Avail: CASI HC A03/MF A01

Helicopter control procedures following power failure were theoretically investigated by applying nonlinear optimal control theory to the following four optimization problems: (1) Minimization of the touchdown speed following power failure. Comparisons between the calculated optimal solutions and the empirical flight test results showed that the pilots used nonoptimal controls, especially in the timing and amplitude of the collective flare before touchdown; (2) Prediction of the Height-Velocity (H-V) boundaries. The optimization problems were formulated to minimize the unsafe region under the condition that the touchdown speed is within the landing gear capacity. The calculated H-V boundaries showed good correlation with the flight test results. In addition, parameters such as the flight-path angle at the moment of power failure, collective control delay, collective setting during descent, landing site location and its available field length, and wind speed were found to have significant effects on the success of the emergency landing; (3) Optimization of the takeoff procedure for Category A STOL operation. The results show that the required takeoff distance using the normal takeoff procedure can be significantly reduced if the takeoff path and the critical decision point are specifically optimized for a given set of operating conditions, e.g., gross weight, ambient conditions, and heliport configuration; (4) Evaluation of the take-off performance for Category A VTOL operation. The calculated maximum weight when assuming the normal takeoff procedure showed good agreement with the certificated takeoff weight. Additionally, optimization of the takeoff path was shown to allow the payload to be increased. Author (NASDA)

N94-27395 National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
THE DETERMINISTIC POWER-SPECTRAL-DENSITY METHOD
R. NOBACK 17 Mar. 1992 63 p Presented at Gust Specialists Meeting, Dallas, TX, 15 Apr. 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract OV/RLD-132)
(AD-B175894; ETN-94-95443; NLR-TP-92114-U) Avail: CASI HC A04

The Deterministic Power Spectral Density (DPSD) method was derived directly from the continuous PSD method. It can be regarded as a 'translation' from the frequency domain to the space or time domain. The critical gust profile, giving maximum response, is obtained directly. The method was compared with the matched filter theory and with simulation. The DPSD method gives the same results as the continuous PSD method, for linear systems. The DPSD method was applied to a nonlinear system, using equivalent gain to obtain the critical gust profile. Results were compared with those obtained with simulation. ESA

N94-27414*# Akron Univ., OH.
COMPUTER CODE FOR CONTROLLER PARTITIONING WITH IFPC APPLICATION: A USER'S MANUAL Final Report
PHILLIP H. SCHMIDT and ASIM YARKHAN Mar. 1994 76 p
(Contract NAG3-11467; RTOP 505-62-50)
(NASA-CR-195291; E-8654; NAS 1.26:195291) Avail: CASI HC A05/MF A01

A user's manual for the computer code for partitioning a centralized controller into decentralized subcontrollers with applicability to Integrated Flight/Propulsion Control (IFPC) is presented. Partitioning of a centralized controller into two subcontrollers is described and the algorithm on which the code is based is discussed. The algorithm uses parameter optimization of a cost function which is described. The major data structures and functions are described. Specific instructions are given. The user is led through an example of an IFCP application. Author (revised)

N94-27648 Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
CONTROLLED OSCILLATION OF FOREBODY VORTICES BY NOZZLE JET BLOWING M.S. Thesis
KARIM ALEXAN Dec. 1992 166 p
(ISBN-0-315-84134-6; CTN-94-61064) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

The flowfield surrounding an ogive-cylinder type model immersed in a free stream fluid as its angle of attack is increased is discussed and the most promising methods of forebody vortex manipulation are reviewed. A scheme for controlling the behavior of forebody vortices at high angles of attack is experimentally investigated in a water tunnel at low speed. A detailed log of the repair work and modifications done to the water tunnel, a summary of operating procedures, and recommendations for its continued operation are provided. The use of port and starboard positioned, forward blowing nozzles located near the forebody apex is investigated. The ability of blowing to alter the orientation of asymmetrically positioned streamwise vortices is assessed and the possibility of using relatively rapid port-starboard oscillatory blowing to obtain a desired time-averaged side force and yaw moment is explored. The dynamic response of an F-18 aircraft to rapid oscillatory blowing at high angles of attack is approximated. The resulting amplitudes of oscillation indicate that this motion would likely be felt by the pilot but suggestions are made for improved performance of this oscillatory blowing system and for future research into oscillatory blowing for forebody vortex manipulation. Author (CISTI)

N94-27660*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TECHNIQUES TO IMPROVE MANEUVER STABILITY CHARACTERISTICS OF A NONLINEAR WIDE-BODY TRANSPORT AIRPLANE IN CRUISE FLIGHT
WILLIAM D. GRANTHAM, LEE H. PERSON, JR., MELVIN L. BAILEY (Lockheed Engineering and Sciences Co., Hampton, VA.), and STEPHEN A. TINGAS (Lockheed Aeronautical Systems Co., Marietta, GA.) Mar. 1994 66 p

(Contract RTOP 505-64-52-01)
(NASA-TM-4521; L-17205; NAS 1.15:4521) Avail: CASI HC A04/MF A01

The maneuver control stability characteristics of an aircraft are a flying qualities parameter of critical importance, to ensure structural protection as well as adequate predictability to the pilot. Currently, however, maneuver stability characteristics are not uniquely addressed in the Federal Aviation Regulations (FAR) Part 25, for transport aircraft. In past transport category certification programs, the Federal Aviation Administration (FAA) has used a combination of requirements (longitudinal control, vibration and buffeting, high-speed characteristics, and out-of-trim characteristics) to ensure safe and controllable maneuver stability characteristics over a range of flight conditions and airplane configurations. Controversies exist regarding each of these regulations, however, and considerable expenditures in terms of design studies and testing time have resulted from the requirements. It is also recognized that additional engineering guidance is needed for identifying acceptable nonlinear maneuver stability characteristics, particularly as they relate to relaxed stability, highly augmented transport configurations. The current trend in large aircraft design is toward relaxed, or even negative, static margins for improved fuel efficiency. The advanced flight control systems developed for these aircraft, in many instances, have rendered current aforementioned maneuver stability criteria either too stringent or of little practical use. Current design requirements do not account for these advanced designs. The objective was to evaluate a broad spectrum of linear and nonlinear longitudinal stability characteristics to generate data for defining satisfactory and unacceptable maneuver characteristics, as defined by pilot opinion. Primary emphasis was placed on two techniques of varying column force per normal acceleration. This study was a joint venture with four pilots participating; one from NASA, one from the FAA, and two from industry. Author (revised)

N94-27798 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

UNDERSTANDING AND DEVELOPMENT OF A PREDICTION METHOD OF TRANSONIC LIMIT CYCLE OSCILLATION CHARACTERISTICS OF FIGHTER AIRCRAFT

JOS J. MEIJER and ATLEE M. CUNNINGHAM, JR. 31 May 1992 17 p Presented at the 18th ICAS Congress, Beijing, China, 21-25 Sep. 1992; and AIAA Atmospheric Flight Mechanics Conference, Hilton Head, SC, 10-12 Aug. 1992 Sponsored by AF, General Dynamics Fort Worth, TX; Ministry of Defence, The Hague, Netherlands; and National Aerospace Lab., Amsterdam, Netherlands Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract NIVR-07801N)
(NLR-TP-92210-U; ETN-94-95448) Avail: CASI HC A03

An analysis of steady wind tunnel data, obtained for a fighter type aircraft, has indicated that shock induced and trailing edge separation play a dominant role in the development of limit cycle oscillations (LCO) at transonic speeds. On the basis of these data, a semiempirical LCO prediction method is being developed. Its preliminary version was applied to several configurations and correctly identified those which have encountered LCO. It has already shown the potential for application early in the design process of new aircraft to determine and understand the nonlinear aeroelastic characteristics. An upgraded form is described and results of the latest predictions are used to further assess various parametric effects. The ultimate refinements are expected from unsteady wind tunnel force and pressure measurements for which preliminary results are presented. ESA

N94-28028# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.

PNEUMATIC MANAGEMENT OF BLUNTED-FOREBODY FLOW ASYMMETRY FOR HIGH-ANGLE-OF-ATTACK DIRECTIONAL CONTROL

FREDERICK W. ROOS, CHARLES L. MAGNESS, and DANIEL V. BROWN *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 6 p Nov. 1993
Copyright Avail: CASI HC A02/MF A04

Low-speed experiments have been conducted to explore the effectiveness of combining nose bluntness, which suppresses the tendency toward flowfield asymmetry, and pneumatic flow-separation control, which triggers flow asymmetry, into a system of pneumatic side-force control for a slender forebody shape at high angles of attack (alpha). The basic forebody shape studied, a 20%-blunted, 3.5-caliber tangent ogive, developed no side force over the range 0 less than or = alpha less than or = 60 degrees. Slight blowing through either or two symmetrically positioned orifices at the blunt nose of the forebody produced a degree of flow asymmetry (and a corresponding side force) that depended on jet massflow rate within limits that varied with alpha, the specific jet configuration, and laminar vs. turbulent boundary-layer separation. Forward-blowing jets were found to be generally more effective that nets normal to the forebody surface in producing pneumatic side-force control. Derived from text

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RESEARCH AND SUPPORT FACILITIES (AIR)

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

N94-24785 FMT International Trade A.B. (Sweden).

SYSTEM FOR AUTOMATIC TRANSPORTATION OF AIRCRAFT ON THE GROUND Patent

NILS-ERIC ANDERBERG, inventor (to Micromedia Ltd.) 21 Sep. 1993 16 p
(CA-PATENT-1-322-361; INT-PATENT-CLASS-B64F-001/22; CTN-94-60933) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

A system is provided for automatically transporting aircraft on the ground to a precise parking position. The system of the invention satisfies the requirements of environmental friendliness, reliability, flexibility, security, and accuracy of positioning, and can be adapted to all types of aircraft arriving at civil airports. The system is operated by remote means, such as by radio signals, with only minor assistance of ground personnel. The system can be preprogrammed so that it can park a heavy airliner with an accuracy down to one mm adjacent to, for example, a passenger loading device or in the position outside the gate from which the aircraft is to taxi by means of its own engines. The system of the invention consists of a carriage which catches and locks at least one wheel of the aircraft, preferably the nose wheel, and which is drivable back and forth along a guide means arranged on or in the ground. Each end of the guide means is provided with a capstan and a towing rope runs between both capstans. A computer control and monitoring system ensures that start and stop operations are performed properly and smoothly so as to put minimum strain on the landing gear of the aircraft. CISTI

N94-25101*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FUTURE DIRECTIONS IN FLIGHT SIMULATION: A USER PERSPECTIVE

BRUCE JACKSON *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 115-135 Dec. 1993
Avail: CASI HC A03/MF A04

Langley Research Center was an early leader in simulation technology, including a special emphasis in space vehicle simulations such as the rendezvous and docking simulator for the Gemini program and the lunar landing simulator used before Apollo. In more recent times, Langley operated the first synergistic six degree of freedom motion platform (the Visual Motion Simulator, or VMS) and developed the first dual-dome air combat simulator, the Differential Maneuvering Simulator (DMS). Each Langley simulator was developed more or less independently from one another with different programming support. At present time, the various simulation cockpits, while supported by the same host computer system, run dissimilar software. The majority of recent investments in Langley's simulation facilities have been hardware procurements: host processors, visual systems, and most recently, an improved motion system. Investments in software improvements, however, have not been of the same order. Author

N94-25184*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TEMPERATURE MEASUREMENT USING INFRARED IMAGING SYSTEMS DURING TURBINE ENGINE ALTITUDE TESTING
MAUREEN E. BURNS Feb. 1994 23 p
(Contract RTOP 505-62-84)
(NASA-TM-105871; E-7336; NAS 1.15:105871) Avail: CASI HC A03/MF A01

This report details the use of infrared imaging for temperature measurement and thermal pattern determination during simulated altitude engine testing in the NASA Lewis Propulsion Systems Laboratory. Three identical argon-cooled imaging systems were installed in the facility exhaust collector behind sapphire windows to look at engine internal surfaces. The report describes the components of each system, presents the specifics of the complicated installation, and explains the operation of the systems during engine testing. During the program, several problems emerged, such as argon contamination system, component overheating, cracked sapphire windows, and other unexplained effects. This report includes a summary of the difficulties as well as the solutions developed. The systems performed well, considering they were in an unusually harsh exhaust environment. Both video and digital data were recorded, and the information provided valuable material for the engineers and designers to quickly make any necessary design changes to the engine hardware cooling system. The knowledge and experience gained during this program greatly simplified the installation and use of the systems during later test programs in the facility. The infrared imaging systems have significantly enhanced the measurement capabilities of the facility, and have become an outstanding and versatile testing resource in the Propulsion Systems Laboratory. Author (revised)

N94-25522 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
AUTOMATIC PRESSURE CONTROL SYSTEM FOR THE WRIGHT LABORATORY COMPRESSOR RESEARCH FACILITY M.S. Thesis
BRIAN J. HULL Dec. 1993 96 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A273827; AFIT/GAE/ENY/93D-19) Avail: CASI HC A05

This thesis presents the design of a pressure control system for the Compressor Research Facility (CRF). Using a fluid dynamics model of the CRF, a controller was designed to track commanded test chamber pressure while the test compressor operated at varying speeds. This was accomplished by adjusting CRF inlet valves first with a coarse open-loop gain schedule, then closing the loop with a digital dynamic compensator for fine adjustments. The design was simulated on a digital computer and coded for incorporation into the CRF's current control algorithm. DTIC

N94-25586# National Research Inst. for Metals, Tokyo (Japan).
STUDY ON UTILIZATION OF SUPER CLEAN, HIGH VACUUM SPACE [CHOSEIJO SHINKU KUKAN NO RIYO NI KANSURU CHOSA KENKYU]
KAZUHIRO YOSHIHARA, YOSHIO SAKKA, HARUKI SHIRAISHI, TETSUJI NODA, JOSEI NAGAKAWA, RYOSUKE HASEGAWA, TOSHIYUKI HIRANO, TSUYOSHI OZAKI, KEIKICHI NAKAMURA, KAZUO SAITO et al. *In its* Bulletin of National Research Institute for Metals in Fiscal Year 1993, no. 14 p 393-401 29 Jan. 1993 In JAPANESE
Avail: CASI HC A02/MF A04

Creation of new materials is entering a new phase with recent development in control and analysis technologies. Nowadays, it is becoming possible to freely control individual atoms, ions, electrons, and photons. However, technologies in metallic materials are not yet ready for super high vacuum environment unlike those in semiconductors. A new field in metallurgy will start with the creation of new materials by dealing with super pure material atoms individually on clean surfaces and interfaces in special research institutions. Such institutions should provide super clean, high vacuum environment to allow a series of processes from refinement, synthesis, and processing to evaluation. For this purpose, it is important to establish a transportation system where equipment relevant to material creation is all connected in super clean, high vacuum so that samples can be transported between equipment to minimize changes in material quality. These institutions are likely to be used for joint researches, and the first issue to arise will be management and administration of this transportation system in high vacuum. Secondly, there is an issue of the parties to be responsible for administration/management of main equipment on each line. Researchers that may utilize these institutions must be considered as well. Author (NASDA)

N94-25740# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
DYNAMIC RESPONSE OF A COMPRESSOR RESEARCH FACILITY M.S. Thesis
JANET W. GRONDIN Dec. 1993 226 p
(AD-A273836; AFIT/GAE/ENY/93D-16) Avail: CASI HC A11/MF A03

The response of the Wright Laboratory Compressor Research Facility to a small amplitude, acoustic, sinusoidal disturbance was investigated. The fluid transmission line equations for laminar, one-dimensional flow in a circular duct were solved and verified through a laboratory experiment using a scale model of the facility. The resonant frequencies of the facility were determined for a variety of flow conditions. Techniques for analytically modeling end impedance and flow straightening elements were also studied. The fundamental frequency of the facility was determined to be between 5.5 and 6.5 Hz depending on the flow conditions and geometry configurations specified. DTIC

N94-25773# Dayton Univ. Research Inst., OH.
IMAGE QUALITY AND THE DISPLAY MODULATION TRANSFER FUNCTION: EXPERIMENTAL FINDINGS Final Report, Jan. 1991 - Mar. 1992
RONALD J. EVANS Sep. 1993 89 p
(Contract F33615-90-C-0005)
(AD-A274061; AL/HR-TR-1993-0131) Avail: CASI HC A05/MF A01

Image quality metrics represent an attempt to quantify differences in the quality of the transmission and display of visual information. This report focuses on the components in the image transfer process which contribute to image quality as well as tasks through which image quality may be empirically defined. The components consist of the content of the original image, display device characteristics, and observer characteristics. Special attention within these three components is given to the display Modulation Transfer Function (MTF) which has traditionally been the major contributor to image quality metrics. Ambiguities exist in the definition and measurement of display MTF's and these problems are discussed as they pertain to image quality. Additional discussion includes the use of threshold versus suprathreshold tasks as empirical measures of image quality and the use of the Contract Sensitivity Function (CSF) versus the MTF of the eye in image quality metrics. An argument is presented which questions the use of either the CSF or MTF for suprathreshold tasks. In order to test the use of display MTF's in metrics, a methodology is described for digitally filtering images with filter representing hypothetical display MTF's. Although this method permits a subset of display MTF's to be compared, further efforts are requiredto compare MTF's which exhibit a crossover effect in the spatial frequency domain. Finally, empirical observations suggest that other display parameters (e.g., luminance) must be weighted more heavily in image quality metrics. DTIC

N94-26141*# Sverdrup Technology, Inc., Brook Park, OH.
NASA LEWIS RESEARCH CENTER LEAN-, RICH-BURN MATERIALS TEST BURNER RIG Final Report
C. A. STEARNS and R. C. ROBINSON Feb. 1994 58 p
(Contract NAS3-25266; RTOP 537-04-20)
(NASA-CR-194437; E-8285; NAS 1.26:194437) Avail: CASI HC A04/MF A01

The lean-, rich-burn materials test burner rig at NASA LeRC is used to evaluate the high temperature environmental durability of aerospace materials. The rig burns jet fuel and pressurized air, and sample materials can be subjected to both lean-burn and rich-burn environments. As part of NASA's Enabling Propulsion Materials (EPM) program, an existing rig was adapted to simulate the rich-burn quick-quench lean-burn (RQL) combustor concept which is being considered for the HSCT (high speed civil transport) aircraft. RQL materials requirements exceed that of current superalloys, thus ceramic matrix composites (CMC's) emerged as the leading candidate materials. The performance of these materials in the quasi reducing environment of the rich-burn section of the RQL is of fundamental importance to materials development. This rig was developed to conduct such studies, and its operation and capabilities are described. Author (revised)

N94-26196 Massachusetts Inst. of Tech., Lexington.
MACHINE INTELLIGENT GUST FRONT ALGORITHM
RICHARD L. DELANOY and SETH W. TROXEL 4 Nov. 1993 95 p Sponsored in part by AF Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DTFA01-93-Z-02012; F19628-90-C-0002)
(AD-A273695; ATC-196; DOT/FAA/RD-93/1) Avail: CASI HC A05

The Federal Aviation Administration has sponsored research and development of algorithms for automatic gust front detection as part of a suite of hazardous weather detection capabilities for airports. These algorithms are intended for use with Doppler radar systems, specifically the Terminal Doppler Weather Radar (TDWR) and the Airport Surveillance Radar enhanced with a Wind Shear Processor (ASR-9 WSP). Although gust fronts are observable with fairly reliable signatures in TDWR data existing gust front detection algorithms have achieved only modest levels of detection performance. For smaller airports not slated to receive a dedicated TDWR, the ASR-9 WSP will provide a less expensive wind shear detection capability. Gust front detection in ASR-9 SP data is an even more difficult problem, given the reduced sensitivity and less reliable Doppler measurements of this radar. A Machine Intelligent Gust Front Algorithm (MIGFA) has been constructed at Lincoln Laboratory. MIGFA is a radical departure from previous design strategies. Incorporating knowledge-based, signal-processing techniques initially developed at Lincoln Laboratory for automatic target recognition, MIGFA uses meteorological knowledge, spatial and temporal context, conditional data fusion, delayed thresholding, and pixel-level fusion of evidence to improve gust front detection performance significantly. In tests comparing MIGFA with an existing state-of-the-art algorithm applied to ASR-9 WSP data, MIGFA has substantially outperformed the older algorithm. DTIC

N94-26200# Wichita State Univ., KS. National Inst. for Aviation Research.
THE DEVELOPMENT OF A HORIZONTAL IMPACT SLED FACILITY AND SUBSEQUENT CRASHWORTHINESS EXPERIMENTS Final Report
WALTER D. BERNHART, JOSEPH A. MITCHELL, KARL W. PETZOLD, and JUAN C. RODRIGUEZ Jun. 1993 208 p
(NIAR-93-15; DOT/FAA/TN93/42) Avail: CASI HC A10/MF A03

The goal of this program was to develop a horizontal impact sled test laboratory for the National Institute for Aviation Research (NIAR) at Wichita State University to effectively serve the aviation industry relative to seat performance as well as other aircraft components. The fundamental goal was achieved in the fall of 1992 and the ensuing period has been spent in testing programs with at least five commercial clients, three of which were FAA observed certification tests. Author

N94-26202# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
SOFT GROUND ARRESTING SYSTEM FOR AIRPORTS Final Report
JAMES C. WHITE, SATISH K. AGRAWAL, and ROBERT E. COOK (Comrise Technologies, Inc.) Dec. 1993 75 p
(DOT/FAA/CT-93/80) Avail: CASI HC A04/MF A01

Aircraft can and do overrun the ends of runways, sometimes with disastrous consequences. Safety overrun areas are designed to provide an additional 1,000 feet of length for stopping overrunning aircraft. At many airports, however, the additional 1,000-foot safety area is not available. At these locations, soft ground arresting systems can be employed to decelerate or stop an overrunning aircraft. A mathematical model representing the interface between the aircraft and the soft ground was developed. This model was used to predict aircraft gear loads, deceleration, and stopping distance within the soft ground system. The validity of the mathematical model was confirmed by eight tests with the use of an instrumented Boeing 727 aircraft. A phenolic foam bed 680 feet long by 48 feet wide and 18 inches deep was used to demonstrate the effectiveness of safely stopping a Boeing 727 aircraft entering the bed at 50 knots and 60 knots: at 50 knots the aircraft came to a complete stop in 420 feet and at 60 knots in 540 feet. The aircraft was successfully extracted from the bed, the foam was successfully repaired, and airport rescue and fire fighting equipment and personnel were able to maneuver without difficulty on the foam. Author

N94-26305 Norwegian Defence Research Establishment, Kjeller.
SAFETY STANDARDS FOR AIRCRAFT SHELTER [SIKRINGSAVSTAND FOR FLYBUNKER]
JENS BRANDSTORP 27 Mar. 1992 69 p In NORWEGIAN Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(FFI-92/4003; ETN-94-94957) Avail: CASI HC A04

A reexamination of papers concerning Hardened Aircraft Shelter (HAS) explosion tests is presented. Of special interest is the physical background of all the phenomena which occur during or after the internal blast loading on the concrete walls. It is believed that a better physical understanding will benefit the analysis of practical explosion tests. A simulation model which systemizes the physical correlations and thereby predicts the Quantity-Distance (QD) for the debris from aircraft shelters was developed. When the test program of the U.S./Norwegian aircraft shelters in New Mexico (U.S.) are finished during 1992, these results will be compared with those of the simulation model. During the analysis of the earlier tests, a substantial difference in the break up mechanism was proved. This effect causes the size of the model debris to become greater than the full scale debris. A theory concerning this matter is developed. A major difference is also seen between frontside debris and rearside debris QD results. ESA

N94-26603*# Lockheed Engineering and Sciences Co., Hampton, VA.
PROPAGATION OF EXPERIMENTAL UNCERTAINTIES FROM THE TUNNEL TO THE BODY COORDINATE SYSTEM IN 3-D LDV FLOW FIELD STUDIES
DAN H. NEUHART Mar. 1994 46 p
(Contract NAS1-19000; RTOP 505-59-30-04)
(NASA-CR-191607; NAS 1.26:191607) Avail: CASI HC A03/MF A01

An analysis of experimental laser Doppler velocimetry (LDV) data uncertainties that propagate from measurements in the tunnel coordinate system to results in the model system are provided. Calculations of uncertainties as functions of the variables that comprise the final result requires assessment of the contribution each variable makes. Such an analysis enables and necessitates the experimentalists to identify and address the contributing error

sources in the experimental measurement system. This provides an opportunity to improve the quality of data derived from experimental systems. This is especially important in experiments where small changes in test conditions are expected to produce small, detectable changes in results. In addition, the need for high-quality experimental data for CFD method validation demands a thorough assessment of experimental uncertainty. Transforming from one Cartesian coordinate system to another by three sequential rotations, equations were developed to transform the variables initially obtained in the original coordinates into variables in the final coordinate system. Based on the transformation equations, propagation equations for errors in the experimentally-derived flow quantities were derived for a model at angle of attack. Experimental uncertainties were then propagated from the tunnel coordinate system into the model system.
Author (revised)

N94-26684*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESEARCH AND TEST FACILITIES
1993 102 p
(NASA-TM-109685; NAS 1.15:109685) Avail: CASI HC A06/MF A02

A description is given of each of the following Langley research and test facilities: 0.3-Meter Transonic Cryogenic Tunnel, 7-by 10-Foot High Speed Tunnel, 8-Foot Transonic Pressure Tunnel, 13-Inch Magnetic Suspension & Balance System, 14-by 22-Foot Subsonic Tunnel, 16-Foot Transonic Tunnel, 16-by 24-Inch Water Tunnel, 20-Foot Vertical Spin Tunnel, 30-by 60-Foot Wind Tunnel, Advanced Civil Transport Simulator (ACTS), Advanced Technology Research Laboratory, Aerospace Controls Research Laboratory (ACRL), Aerothermal Loads Complex, Aircraft Landing Dynamics Facility (ALDF), Avionics Integration Research Laboratory, Basic Aerodynamics Research Tunnel (BART), Compact Range Test Facility, Differential Maneuvering Simulator (DMS), Enhanced/Synthetic Vision & Spatial Displays Laboratory, Experimental Test Range (ETR) Flight Research Facility, General Aviation Simulator (GAS), High Intensity Radiated Fields Facility, Human Engineering Methods Laboratory, Hypersonic Facilities Complex, Impact Dynamics Research Facility, Jet Noise Laboratory & Anechoic Jet Facility, Light Alloy Laboratory, Low Frequency Antenna Test Facility, Low Turbulence Pressure Tunnel, Mechanics of Metals Laboratory, National Transonic Facility (NTF), NDE Research Laboratory, Polymers & Composites Laboratory, Pyrotechnic Test Facility, Quiet Flow Facility, Robotics Facilities, Scientific Visualization System, Scramjet Test Complex, Space Materials Research Laboratory, Space Simulation & Environmental Test Complex, Structural Dynamics Research Laboratory, Structural Dynamics Test Beds, Structures & Materials Research Laboratory, Supersonic Low Disturbance Pilot Tunnel, Thermal Acoustic Fatigue Apparatus (TAFA), Transonic Dynamics Tunnel (TDT), Transport Systems Research Vehicle, Unitary Plan Wind Tunnel, and the Visual Motion Simulator (VMS).
CASI

N94-26815# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
EXPERIMENTAL INVESTIGATION OF THE FLOW QUALITY IN THE GLT20 SUBSONIC-TRANSONIC BOUNDARY LAYER WIND TUNNEL
F. MOTALLEBI Apr. 1993 136 p
(PB94-126539; LR-720) Avail: CASI HC A07/MF A02

The design of modern subsonic civil aircrafts requires a detailed knowledge of boundary layer behavior over the aircraft. Wind tunnel experiments are needed to obtain the necessary design information and to provide test data for numerical validations. The primary purpose of the present work was to gather experimental data over the quality of the boundary layer flow developing on the bottom wall of a newly built wind tunnel in order to assess its suitability as an experimental tool for fundamental research on the structure of turbulent boundary layer flows in both subsonic and transonic flow regimes.
NTIS

N94-27113# Department of the Navy, Washington, DC.
RECONFIGURABLE AIRCRAFT STICK CONTROL Patent Application
THOMAS M. KELSO, inventor (to Navy), JOHN K. KOTCH, inventor (to Navy), DAMON BOYLE, inventor (to Navy), DAVID H. MEISER, inventor (to Navy), and WILLIAM FLAHERTY, inventor (to Navy) 29 Sep. 1993 19 p
(AD-D016043; US-PATENT-APPL-SN-129729) Avail: CASI HC A03/MF A01

A reconfigurable aircraft stick control for an aircraft simulator that enables pitch and roll to be simulated is presented. It includes a generic base that has mounting means that are adapted to be connected to a stick control of the type having a standard production grip as well as a stick control that uses a yoke. The control sticks include linkages that are easily connected to the mounting means on the base so that control sticks can be exchanged with minimum expenditure of time and effort to thereby simulate the control sticks on aircraft that are being simulated. Torque motors can be connected to the simulator to detect the speed and displacement of the control stick and to provide resistance to movement of the control sticks so as to simulate actual flying conditions.
DTIC

N94-27247# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.
THE RENEWING OF THE TEST SECTION OF THE NAL TRANSONIC WIND TUNNEL. PART 1: RECONSTRUCTION OF THE 1ST CORNER TURNING VANES AND AERODYNAMIC STRESS MEASUREMENT [KOGIKEN SENONSOKU FUDO SOKUTEI DO KAISHU. SONO 1: DAIICHI KUKKYOKUBU HENRYUYOKU KAISHU TO ORYOKU SOKUTEI]
AKIRA KOIKE, NOBUYUKI HOSOE, YASUO OGUNI, KOICHI SUZUKI, and HITOSHI MIWA Dec. 1992 27 p In JAPANESE
(ISSN 0452-29822)
(NAL-TM-651; JTN-94-80619) Avail: CASI HC A03/MF A01

National Aerospace Laboratory (NAL) transonic wind tunnel was constructed in 1960, and in-depth repairs of its superannuated parts was begun in 1985. The newly reconstructed turning vanes are described. The thickness of the turning vanes was 6 mm at first and it was increased to 9 mm in 1968 to prevent cracks caused by fatigue from developing. Despite this increase in thickness, cracks were observed again. With the present reconstruction, the thickness was increased to 12 mm. Tests designed to measure the stresses within the vanes by aerodynamic force and pressure fluctuations of incoming flow were conducted before and after reconstruction. Results from the measurements are presented including a correlation analysis between the stress and the pressure fluctuation.
Author (NASDA)

N94-27425*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESCRIPTION OF THE EXPERIMENTAL AVIONICS SYSTEMS INTEGRATION LABORATORY (EASILY)
BRUCE K. E. OUTLAW Jan. 1994 17 p
(Contract RTOP 505-64-13-11)
(NASA-TM-109072; NAS 1.15:109072) Avail: CASI HC A03/MF A01

The Experimental Avionics Systems Integration Laboratory (EASILY) is a comprehensive facility used for development, integration, and preflight validation of hardware and software systems for the Terminal Area Productivity (TAP) Program's Transport Systems Research Vehicle (TSRV) experimental transport aircraft. This report describes the history, capabilities, and subsystems of EASILY. A functional description of the many subsystems is provided to give potential users the necessary knowledge of the capabilities of this facility.
Author

N94-27587# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Abt. Kryo-Kanal Koeln.
THE CRYOGENIC TUNNEL COLOGNE AT DLR Progress Report, 1992 [DER KRYO-KANAL KOELN (KKK) DER DLR (STAND 1992)]
GUENTER VIEHWEGER, RUEDIGER REBSTOCK, BERNHARD

STAHL, KARL WICHMANN, WILHELM BECKER, ROLF KRONEN, and DIETER DISTELRATH Mar. 1992 78 p In GERMAN
(ISSN 0939-298X)
(DLR-MITT-93-10; ETN-94-95489) Avail: CASI HC A05/MF A01

Information for users of the cryogenic wind tunnel is provided. This wind tunnel is a facility with a closed circuit test section. The cross section is 2.4 by 2.4 m. With a drive power of 1 MW, a maximum speed of 115 m/s can be achieved. Dry, gaseous nitrogen is used as the test gas. The test gas can be cooled down to 100 K by injecting liquid nitrogen. By cooling down the test gas, the maximum Reynolds number can be increased by a factor of 5.5 to 9.5 Mio. The independent variation of the test parameters allows the separation of the influence of Mach and Reynolds numbers and dynamic pressure (deformation) on the results. This report provides customers with the information required for the preliminary planning of test programs and for the preliminary layout of models for intended tests. ESA

N94-27594 Institute for Aerospace Research, Ottawa (Ontario).
INSTALLATION OF MODELS IN THE 2 M X 3 M LOW SPEED WIND TUNNEL
K. HANSEN Mar. 1991 57 p
(LTR-LA-286; CTN-94-61011) Avail: CASI HC A04/MF A01

Details are provided for installing models in the 2 by 3 meter low speed wind tunnel located in the Building M-2 aeronautical research facilities in the Applied Aerodynamics Laboratory of the Canadian Institute for Aerospace Research. Drawings are included which provide enough information to permit wind tunnel users to prepare models and instrumentation for attachment in the facility. Only the components which interface between models or instrumentation and permanent wind tunnel hardware are detailed, and usually, only the relevant attachment interface details of the component are presented. A hardware selection guide assists wind tunnel users in selecting appropriate model attachment components. A pictorial review of model installations illustrates the variety of tests performed and demonstrates the adaptability of the wind tunnel facility. Author (CISTI)

N94-27879 Toronto Univ. (Ontario). Inst. for Aerospace Studies.
A SIMULATOR INVESTIGATION OF HELICOPTER FLIGHT CONTROL SYSTEM MODE TRANSITIONS
L. D. REID, P. RAJAGOPAL, and W. O. GRAF Jan. 1994 141 p
(Contract W2207-0-AF10) (ISSN 0082-5255)
(UTIAS-348) Copyright Avail: Issuing Activity

The UTIAS Flight Research Simulator was modified to represent a fly-by-wire helicopter with a digital flight control system (FCS) and a side-arm controller. A smooth FCS mode selection algorithm was developed and successfully tested. The pilot/helicopter response to mode transitions was studied for formation flying and precision hover. Both normal and failure-induced transitions were investigated by a group of 9 evaluation pilots. The results were obtained in the form of Cooper/Harper handling qualities ratings (HQR) and station-keeping performance measurements. It was found that for the present mode selection algorithm, the type of mode transition did not significantly influence the experimental results. However, the mode pair (initial mode combined with final mode) was found to influence both HQR's and performance. The mode with the poorest handling qualities was involved in most of the significant effects. In some instances the mode in place before transition influenced the HQR's and performance after transition. Tests were also carried out to study the influence of simulator configuration on the experimental results. In addition to the standard configuration, one with no motion and one using a stereoscopic visual display system were employed. In general no significant effects were found except in one instance when there was a significant difference between the no-motion and stereoscopic configurations. Author

N94-27903*# Wilkes Coll., Wilkes-Barre, PA. Dept. of Mechanical and Material Engineering.
MICROSPHERES FOR LASER VELOCIMETRY IN HIGH TEMPERATURE WIND TUNNEL
ANTHONY GHORIESHI *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 91-99 Dec. 1993
Avail: CASI HC A02/MF A03

The introduction of non-intrusive measurement techniques in wind tunnel experimentation has been a turning point in error free data acquisition. Laser velocimetry has been progressively implemented and utilized in various wind tunnels; e.g. subsonic, transonic, and supersonic. The success of the laser velocimeter technique is based on an accurate measurement of scattered light by seeding particles introduced into the flow stream in the wind tunnel. Therefore, application of appropriate seeding particles will affect, to a large extent the acquired data. The seeding material used depends on the type of experiment being run. Among the seeding material for subsonic tunnel are kerosene, Kaolin, and polystyrene. Polystyrene is known to be the best because of being solid particles, having high index of refraction, capable of being made both spherical and monodisperse. However for high temperature wind tunnel testing seeding material must have an additional characteristic that is high melting point. Typically metal oxide powders such as Al2O3 with melting point 3660 F are used. The metal oxides are, however polydispersed, have a high density, and a tendency to form large agglomerate that does not closely follow the flow velocity. The addition of flame phase silica to metal oxide helps to break up the agglomerates, yet still results in a narrow band of polydispersed seeding. The less desirable utility of metal oxide in high temperature wind tunnels necessitates the search for a better alternative particle seeding which this paper addresses. The Laser Velocimetry (LV) characteristic of polystyrene makes it a prime candidate as a base material in achieving the high temperature particle seeding inexpensively. While polystyrene monodisperse seeding particle reported has been successful in a subsonic wind tunnel, it lacks the high melting point and thus is not practically usable in a high temperature wind tunnel. It is well known that rise in melting point of polystyrene can be achieved by a cross-linking technique. Since polystyrene already possesses all the desired characteristics for LV, to circumvent the low melting point, a cross-linking technique was investigated. Author

N94-27905*# Drexel Univ., Philadelphia, PA. Dept. of Electrical and Computer Engineering.
NEURAL CONTROL OF MAGNETIC SUSPENSION SYSTEMS
W. STEVEN GRAY *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 102-103 Dec. 1993
Avail: CASI HC A01/MF A03

The purpose of this research program is to design, build and test (in cooperation with NASA personnel from the NASA Langley Research Center) neural controllers for two different small air-gap magnetic suspension systems. The general objective of the program is to study neural network architectures for the purpose of control in an experimental setting and to demonstrate the feasibility of the concept. The specific objectives of the research program are: (1) to demonstrate through simulation and experimentation the feasibility of using neural controllers to stabilize a nonlinear magnetic suspension system; (2) to investigate through simulation and experimentation the performance of neural controllers designs under various types of parametric and nonparametric uncertainty; (3) to investigate through simulation and experimentation various types of neural architectures for real-time control with respect to performance and complexity; and (4) to benchmark in an experimental setting the performance of neural controllers against other types of existing linear and nonlinear compensator designs. To date, the first one-dimensional, small air-gap magnetic suspension system has been built, tested and delivered to the NASA Langley Research Center. The device is currently being stabilized with a digital linear phase-lead controller. The neural controller hardware is under construction. Two different neural network paradigms are under consideration, one based on hidden layer feedforward networks trained via back propagation and one based on using Gaussian radial basis functions trained by analytical methods related to stability conditions. Some advanced nonlinear control algorithms using feedback linearization and sliding mode control are in simulation studies. Author (revised)

N94-27908*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering.
SYSTEM IDENTIFICATION OF THE LARGE-ANGLE MAGNETIC SUSPENSION TEST FACILITY (LAMSTF)
JEN-KUANG HUANG *In its* The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 114-115 Dec. 1993
Avail: CASI HC A01/MF A03

The Large-Angle Magnetic Suspension Test Facility (LAMSTF), a laboratory-scale research project to demonstrate the magnetic suspension of objects over wide ranges of attitudes, has been developed. This system represents a scaled model of a planned Large-Gap Magnetic Suspension System (LGMSS). The LAMSTF system consists of a planar array of five copper electromagnets which actively suspend a small cylindrical permanent magnet. The cylinder is a rigid body and can be controlled to move in five independent degrees of freedom. Five position variables are sensed indirectly by using infra-red light-emitting diodes and light-receiving phototransistors. The motion of the suspended cylinder is in general nonlinear and hence only the linear, time-invariant perturbed motion about an equilibrium state is considered. One of the main challenges in this project is the control of the suspended element over a wide range of orientations. An accurate dynamic model plans an essential role in controller design. The analytical model of the LAMSTF system includes highly unstable real poles (about 10 Hz) and low-frequency flexible modes (about 0.16 Hz). Projection filters are proposed to identify the state space model from closed-loop test data in time domain. A canonical transformation matrix is also derived to transform the identified state space model into the physical coordinate. The LAMSTF system is stabilized by using a linear quadratic regulator (LQR) feedback controller. The rate information is obtained by calculating the back difference of the sensed position signals. The reference inputs contain five uncorrelated random signals. This control input and the system reponse are recorded as input/output data to identify the system directly from the projection filters. The sampling time is 4 ms and the model is fairly accurate in predicting the step responses for different controllers while the analytical model has a deficiency in the pitch axis. Author

N94-27912*# Old Dominion Univ., Norfolk, VA. Dept. of Engineering Technology.
EXPERIMENTAL APPARATUS FOR OPTIMIZATION OF FLAP POSITION FOR A THREE-ELEMENT AIRFOIL MODEL
DREW LANDMAN *In its* The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 126-128 Dec. 1993
Avail: CASI HC A01/MF A03

It is proposed to design and build a wind tunnel model comprising a Douglas Aircraft Company three-element high-lift airfoil with internal actuators to move the flap vertically and horizontally under computer control. The model will be used to find the optimum flap location for a fixed angle of attack, slat position and flap deflection angle. The model will span the full tunnel width and lift will be measured by integration of pressure readings taken from midspan taps. It is proposed to conduct experiments in the NASA Langley EFPB 2' x 3' low speed wind tunnel. This report serves as a project overview and a review of work completed to date through funding by the 1993 NASA/ASEE Summer Faculty Fellowship Program. Author

N94-27997# Sandia National Labs., Albuquerque, NM.
SIMULATING HIGH-FREQUENCY WIND FOR LONG DURATIONS
ANDREW MCFARLANE (Cherry Creek High School, Englewood, CO.), PAUL VEERS, and LARRY SCHLUTER 1993 11 p
Presented at the 13th Energy-Sources Technology Conference and Exhibition (ETCE) on Wind Energy, New Orleans, LA, 23-26 Jan. 1994
(Contract DE-AC04-94AL-85000)
(DE94-002739; SAND-93-1584C; CONF-940113-4) Avail: CASI HC A03/MF A01 (US Sales Only)

A wind simulator that can provide high-frequency synthetic wind data indefinitely was developed to numerically test various aspects of wind turbine control systems. The wind simulator builds synthetic wind data in two basic steps. First, using an auto-regressive method, the simulator creates low-frequency wind speeds at a small number of time steps for each one-hour interval. This low-frequency part of the wind has a Weibull distribution and an exponential auto correlation. Second, it creates high-frequency data and superimposes it on top of the low-frequency wind speed data. The high-frequency part has zero mean, Gaussian distribution and frequency content selected from a library of turbulence pads. The low- and high-frequency parts are summed to produce the final result. This process repeats itself for as many one-hour intervals as the user desires and lends itself to the eventual addition of diurnal and seasonal effects. DOE

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ASTRONAUTICS

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

N94-24860*# Michigan Univ., Ann Arbor.
DESIGN OF AN AIRBORNE LAUNCH VEHICLE FOR AN AIR LAUNCHED SPACE BOOSTER
CHIN CHAO, RICH CHOI, SCOTT COHEN, BRIAN DUMONT, MAURICIUS GIBIN, ROB JORDEN, and STEFAN POTH 1993 184 p
(Contract NASW-4435)
(NASA-CR-195534; NAS 1.26:195534) Avail: CASI HC A09/MF A02

A conceptual design is presented for a carrier vehicle for an air launched space booster. This airplane is capable of carrying a 500,000 pound satellite launch system to an altitude over 40,000 feet for launch. The airplane features a twin fuselage configuration for improved payload and landing gear integration, a high aspect ratio wing for maneuverability at altitude, and is powered by six General Electric GE-90 engines. The analysis methods used and the systems employed in the airplane are discussed. Launch costs are expected to be competitive with existing launch systems. Author

N94-25098*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FUTURE SPACE TRANSPORTATION SYSTEM ARCHITECTURE AVIONICS REQUIREMENTS
HOWARD STONE and WALT ENGELUND *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 55-83 Dec. 1993
Avail: CASI HC A03/MF A04

NASA began a multi-center study in January 1993 to examine options for providing the most cost effective space transportation system in the future. The key advanced avionics requirements for these vehicle concepts are envisioned to provide significantly improved operational efficiency and effectiveness. It is very desirable to have adaptive guidance, navigation, and control approaches that will allow launch and return in almost any weather condition. The vehicles must be able to accommodate atmospheric density variations and winds without software changes. The flight operations must become much more autonomous in all flight regimes like an aircraft, and preflight checkout should make use of the onboard systems. When the vehicle returns to the launch site, subsystem health must be known and maintenance tasks scheduled accordingly. Ground testing of most subsystems must be eliminated. Also, the health monitoring system must be designed to enhance the ability to abort the mission significantly and save the crew and the vehicle. The displays and controls must be much less complex than current systems and must significantly reduce pilot work load. It is important to have low power, light weight displays and controls. Rendezvous and docking and all flight phases must have autopilot capability to reduce pilot work load for routine operations and in abort situations. The vehicles must have the demonstrated ability to return to the launch site. Abort from all mission phases can put additional demands on the communications system. Derived from text

N94-26613*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HANDBOOK FOR HANDLING AND STORAGE OF NICKEL-CADMIUM BATTERIES: LESSONS LEARNED
FLOYD E. FORD (Swales and Associates, Beltsville, MD.), GOPALAKRISHNA M. RAO, and THOMAS Y. YI Feb. 1994 77 p
(Contract NAS5-30375)
(NASA-RP-1326; NAS 1.61:1326; REPT-94B00027) Avail: CASI HC A05/MF A01

The handbook provides guidelines for the handling and storage of conventional NiCd flight batteries. The guidelines are based on many years of experience with ground and in-flight handling of batteries. The overall goal is to minimize the deterioration and irreversible effects of improper handling of NiCd flight batteries on flight performance. A secondary goal is to provide the reader with an understanding, in nonanalytical terms, of the degradation mechanisms of NiCd cells and how these mechanisms are affected by improper ground handling of flight hardware. Section 2 provides the reader with a brief introduction to NiCd cells. The effects of the environment on NiCd batteries are discussed in Section 3, and Section 4 contains 12 guidelines for battery handling and storage with supporting rationale for each guideline. The appendix provides a synopsis of NiCd cell design and evolution over 30 years of space flight on Goddard Space Flight Center (GSFC) satellites, along with a chronological review of key events that influenced the design of NiCd cells being flown today. Author

N94-27789*# Maryland Univ., College Park. Dept. of Aerospace Engineering.
A PARAMETRIC SENSITIVITY STUDY FOR SINGLE-STAGE-TO-ORBIT HYPERSONIC VEHICLES USING TRAJECTORY OPTIMIZATION
T. ALAN LOVELL and D. K. SCHMIDT 21 Mar. 1994 38 p
(Contract NAG1-1540)
(NASA-CR-195703; NAS 1.26:195703) Avail: CASI HC A03/MF A01

The class of hypersonic vehicle configurations with single stage-to-orbit (SSTO) capability reflect highly integrated airframe and propulsion systems. These designs are also known to exhibit a large degree of interaction between the airframe and engine dynamics. Consequently, even simplified hypersonic models are characterized by tightly coupled nonlinear equations of motion. In addition, hypersonic SSTO vehicles present a major system design challenge; the vehicle's overall mission performance is a function of its subsystem efficiencies including structural, aerodynamic, propulsive, and operational. Further, all subsystem efficiencies are interrelated, hence, independent optimization of the subsystems is not likely to lead to an optimum design. Thus, it is desired to know the effect of various subsystem efficiencies on overall mission performance. For the purposes of this analysis, mission performance will be measured in terms of the payload weight inserted into orbit. In this report, a trajectory optimization problem is formulated for a generic hypersonic lifting body for a specified orbit-injection mission. A solution method is outlined, and results are detailed for the generic vehicle, referred to as the baseline model. After evaluating the performance of the baseline model, a sensitivity study is presented to determine the effect of various subsystem efficiencies on mission performance. This consists of performing a parametric analysis of the basic design parameters, generating a matrix of configurations, and determining the mission performance of each configuration. Also, the performance loss due to constraining the total head load experienced by the vehicle is evaluated. The key results from this analysis include the formulation of the sizing problem for this vehicle class using trajectory optimization, characteristics of the optimal trajectories, and the subsystem design sensitivities. Author (revised)

N94-27868*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
MULTIDISCIPLINARY AEROELASTIC ANALYSIS OF A GENERIC HYPERSONIC VEHICLE
K. K. GUPTA and K. L. PETERSEN Washington Oct. 1993 13 p Presented at the AIAA 5th International Aerospace Planes Conference, Munich, Germany, 30 Nov. - 3 Dec. 1993
(Contract RTOP 505-70-00)
(NASA-TM-4544; H-1956; NAS 1.15:4544; AIAA PAPER 93-5028) Avail: CASI HC A03/MF A01

This paper presents details of a flutter and stability analysis of aerospace structures such as hypersonic vehicles. Both structural and aerodynamic domains are discretized by the common finite element technique. A vibration analysis is first performed by the STARS code employing a block Lanczos solution scheme. This is followed by the generation of a linear aerodynamic grid for subsequent linear flutter analysis within subsonic and supersonic regimes of the flight envelope; the doublet lattice and constant pressure techniques are employed to generate the unsteady aerodynamic forces. Flutter analysis is then performed for several representative flight points. The nonlinear flutter solution is effected by first implementing a CFD solution of the entire vehicle. Thus, a 3-D unstructured grid for the entire flow domain is generated by a moving front technique. A finite element Euler solution is then implemented employing a quasi-implicit as well as an explicit solution scheme. A novel multidisciplinary analysis is next effected that employs modal and aerodynamic data to yield aerodynamic damping characteristics. Such analyses are performed for a number of flight points to yield a large set of pertinent data that define flight flutter characteristics of the vehicle. This paper outlines the finite-element-based integrated analysis procedures in detail, which is followed by the results of numerical analyses of flight flutter simulation. Author

N94-27956*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
DEBRIS/ICE/TPS ASSESSMENT AND INTEGRATED PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-60 Final Report, 1-14 Feb. 1994
GREGORY N. KATNIK, BARRY C. BOWEN, J. BRADLEY DAVIS, JORGE E. RIVERA, and ROBERT F. SPEECE Mar. 1994 110 p Original contains color illustrations
(NASA-TM-109193; NAS 1.15:109193) Avail: CASI HC A06/MF A02; 44 functional color pages

A debris/ice/thermal protection system (TPS) assessment and integrated photographic analysis was conducted for Shuttle mission STS-60. Debris inspections of the flight elements and launch pad were performed before and after launch. Icing conditions on the External Tank were assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle followed by on-pad visual inspection. High speed photography of the launch was analyzed to identify ice/debris sources and evaluate potential vehicle damage and/or in-flight anomalies. This report documents the ice/debris/TPS conditions and integrated photographic analysis of Shuttle mission STS-60, and the resulting effect on the Space Shuttle Program. Author

N94-28020# Laboratoire d'Aerothermique du CNRS, Meudon (France).
CONTROL JETS IN INTERACTION WITH HYPERSONIC RAREFIED FLOW [JETS TRANSVERSAUX EN INTERACTION AVEC DES ECOULEMENTS HYPERSONIQUES RAREFIES]

J. ALLEGRE and M. RAFFIN *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 9 p Nov. 1993 In FRENCH Sponsored by ESA
Copyright Avail: CASI HC A02/MF A04

Control jets are used on space vehicles in order to replace or complement mechanical aerodynamic controls at high altitudes. As a matter of fact, the efficiency of mechanical controls decreases drastically with higher rarefaction levels of external flow. Control jets were experimentally investigated in wind-tunnels. The jets interact with external hypersonic rarefied flows. Jet efficiency and associated interaction mechanisms were analyzed for two types of configurations. The first configuration is a delta wing with transverse control jets issuing from sonic nozzles located close to the trailing edge. Tests are performed with an external hypersonic air flow characterized by a Mach number of about 8, a Reynolds number of 11,000, and a rarefaction parameter V = 0.077. The second configuration is a corner flow interacting with a transverse jet issuing from one hypersonic nozzle. This nozzle is inserted in one of the two walls which make up the corner model. Tests are made under external hypersonic nitrogen flows characterized by a Mach number of about 20 and dynamic pressures ranging from 20 Pa to 620 Pa covering rarefaction levels associated with reentry conditions. Author (revised)

N94-28032# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Inst. for Experimental Fluid Mechanics.
FIRST EXPERIMENTAL ASSESSMENT OF RCS PLUME-FLOW FIELD INTERACTION ON HERMES LEADING EDGE THRUSTER CONFIGURATION
T. POERTNER *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 13 p Nov. 1993
Copyright Avail: CASI HC A03/MF A04

Glow discharge flow visualization experiments are demonstrated which have been performed to enable a first assessment of the HERMES 1.0 leading edge thruster configuration concerning interference between the thruster plumes of the reaction control system (RCS) and the surrounding flow field. The results of the flow visualization tests are presented in exemplary selected photographs. Additional Pitot pressure measurements support assumptions concerning interference induced pressure changes that may result from the observed significant flow field disturbances. Author

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CHEMISTRY AND MATERIALS

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

N94-24788 Dayton Univ., OH. Research Inst.
ULTRASONIC PROCESS FOR CURING ADHESIVES Interim Report, Jun. 1992 - Feb. 1993
NAGA SENAPATI and RON MOULDER Mar. 1993 40 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract F33615-89-C-5643)
(AD-A273175; WL-TR-93-4037) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The objective of this program was to demonstrate in the laboratory the feasibility of using ultrasonic energy to cure a structural adhesive used to bond two pieces of 2024-T3 aluminum. A process was developed that demonstrated that American Cyanamid FM-73 adhesive could be cured using ultrasonic energy at a power level of less than 25 watts/sq. inch of adhesive area. The bonds produced using ultrasonic energy were just as strong as the bonds produced using a thermal process. A styrene butadiene rubber was found to be an excellent material to couple the ultrasonic energy to the adhesive through the aluminum substrate. The required coupling pressure ranged from 10 to 15 psi. Ultrasonic energy is absorbed by the adhesive and is converted to heat. Fine thermocouples embedded in the adhesive showed that the temperature of the adhesive increased from room temperature (70 F) to 250 F in less than 10 minutes. The method currently used to cure the epoxy adhesive bonding a composite repair patch to an aircraft structure employs a heating blanket over the patch and the surrounding aircraft structure. This method is inefficient and requires the area surrounding a patch to be heated to the same temperature required to cure the adhesive. Since ultrasonic energy is absorbed directly by the adhesive, very little energy is wasted heating up the area surrounding the patch. Thus, an ultrasonic heating process is more efficient than the heating blanket method. The ultrasonic process has the potential to be used for repairing aging aircraft structures with bonded composite patches. DTIC

N94-24942# Materials Sciences Corp., Blue Bell, PA.
TEST METHODS FOR COMPOSITES: A STATUS REPORT. VOLUME 1: TENSION TEST METHODS Final Report, Sep. 1990 - May 1993
S. CHATERJEE, D. ADAMS, and D. W. OPLINGER Jun. 1993 93 p
(Contract DTFA03-88-A-0029; DAAL04-89-C-0023)
(AD-A273501; DOT/FAA/CT-93/17-VOL-1) Avail: CASI HC A05/MF A01

This document provides an evaluation of current test methods for tension properties of composite materials consisting of high modules, high strength fibers in organic matrix materials. Mechanical testing is an important step in the 'building block' approach to design of composite aircraft structures. The document provides a source of information by which the current test methods can be evaluated and from which test methods which appear to give good-quality test data can be selected. Problems with current test methods are also addressed as a means of providing recommendations for future research. DTIC

N94-25072# Naval Postgraduate School, Monterey, CA.
AN X RAY DIFFRACTION INVESTIGATION OF ALPHA-AL2O2 ADDITION TO YTTRIA STABILIZED ZIRCONIA (YSZ) THERMAL BARRIER COATINGS SUBJECT TO DESTABILIZING VANADIUM PENTOXIDE (V2O5) EXPOSURE M.S. Thesis
DEAN M. KRESTOS Sep. 1993 79 p
(AD-A273403) Avail: CASI HC A05/MF A01

Since the mid 1970's the U.S. Navy has used yttria-stabilized zirconia (YSZ) as thermal barrier coatings for hot stage gas turbine components. Use of low cost, high contaminant, fuels has led to shortened component life from failure of YSZ coatings due to corrosive attack by vanadium and other combustion oxides. The object of this investigation was to determine the reactivity of adding alpha-Al2O3 to Current YSZ ceramics for creation of a ceramic composite which could improve mechanical properties and show improved durability to corrosive chemical attack. Ten powder samples of Zro2(8)Mol%YzO3, alpha-Al2O3, and V2Os5 of varying compositions were annealed at 900 C for 100 hours. X-ray diffraction analysis utilizing a standard 'search and match' method was used to determine the phases present in the reacted powder samples. Peak intensity comparisons between reacted and un-reacted samples allowed for a quantitative determination for the reactivity of a-A12O3 with the YSZ system exposed to V2O3. This investigation indicated that alpha-Al2O3 is non-reactive in all YSZ samples exposed to V2O5 at 900 C. DTIC

N94-25163 Materials Sciences Corp., Blue Bell, PA.
TEST METHODS FOR COMPOSITES: A STATUS REPORT. VOLUME 3: SHEAR TEST METHODS Final Report, Sep. 1990 - May 1993
S. CHATERJEE, D. ADAMS, and D. W. OPLINGER Jun. 1993 188 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract DTFA03-88-A-0029; DAAL04-89-C-0023)
(AD-A273561; DOT/FAA/CT-93/17-VOL-3) Avail: CASI HC A09

This document provides an evaluation of current test methods for shear properties of composite materials consisting of high modulus, high strength fibers in organic matrix materials. Mechanical testing is an important step in the 'building block' approach to design of composite aircraft structures. This document provides a source of information by which the current shear test methods can be evaluated and from which test methods which appear to give good-quality test data can be selected. Problems with the available shear test methods are also addressed as a means of providing recommendations for future research. DTIC

N94-25406# National Association of Corrosion Engineers, Houston, TX.

PROCEEDINGS OF THE 12TH INTERNATIONAL CONGRESS: CORROSION CONTROL FOR LOW-COST RELIABILITY. VOLUME 5A: CORROSION: GENERAL ISSUES

24 Sep. 1993 493 p Congress held in Houston, TX, 19-24 Sep. 1993
(AD-A273666; ISBN-1-877914-65-7) Avail: CASI HC A21/MF A04; NACE International, PO Box 218340, Houston, TX 77218-8340 HC

Proceedings from the 12th International corrosion Congress, Volume 5A Corrosion: General Issues are included. Topics covered include: (1) The role of corrosion in aging aircraft; (2) Hidden corrosion - needs and requirements; (3) Corrosion control as a necessary treatment; (4) Computer assisted aircraft paint stripping technology; (5) Reducing aircraft corrosion with desiccant dehumidifiers; (6) Corrosion contribution to environmental cracking failures of critical aircraft parts; (7) Designing metallic surface coatings for improved corrosion resistance; (8) Development of chromium based composite coatings; (9) In-situ analysis of corrosion in the crevice of automotive body by A.C. impedance measurement; (10) Designing a reinforced concrete against corrosion in chloride containing environments; (11) Carbonation of flyash-containing concrete electrochemical studies; (12) Evaluation of concrete corrosion inhibitors; (13) Cathodic protection of new steel reinforced concrete structure; (14) Reliability and corrosion testing of electronic components and assemblies; (15) Corrosion study of polymer-on-metal systems modified by processing conditions; (16) How to formulate corrosion knowledge for expert systems; and (17) Corrosion prediction from laboratory tests using artificial neural networks. DTIC

N94-26205*# Eloret Corp., Palo Alto, CA.

THEORETICAL DETERMINATION OF CHEMICAL RATE CONSTANTS USING NOVEL TIME-DEPENDENT METHODS Final Technical Report, 1 Jan. 1991 - 31 Jan. 1994

CHRISTOPHER E. DATEO 12 Mar. 1994 7 p
(Contract NCC2-737)
(NASA-CR-195221; NAS 1.26:195221) Avail: CASI HC A02/MF A01

The work completed within the grant period 10/1/91 through 12/31/93 falls primarily in the area of reaction dynamics using both quantum and classical mechanical methodologies. Essentially four projects have been completed and have been or are in preparation of being published. The majority of time was spent in the determination of reaction rate coefficients in the area of hydrocarbon fuel combustion reactions which are relevant to NASA's High Speed Research Program (HSRP). These reaction coefficients are important in the design of novel jet engines with low NOx emissions, which through a series of catalytic reactions contribute to the deterioration of the earth's ozone layer. A second area of research studied concerned the control of chemical reactivity using ultrashort (femtosecond) laser pulses. Recent advances in pulsed-laser technologies have opened up a vast new field to be investigated both experimentally and theoretically. The photodissociation of molecules adsorbed on surfaces using novel time-independent quantum mechanical methods was a third project. And finally, using state-of-the-art, high level ab initio electronic structure methods in conjunction with accurate quantum dynamical methods, the rovibrational energy levels of a triatomic molecule with two nonhydrogen atoms (HCN) were calculated to unprecedented levels of agreement between theory and experiment. Author

N94-26796# Sandia National Labs., Albuquerque, NM.

A CONSTITUTIVE MODEL FOR LAYERED WIRE MESH AND ARAMID CLOTH FABRIC

M. K. NEILSEN, J. D. PIERCE, and R. D. KRIEG (Tennessee Univ., Knoxville.) Sep. 1993 65 p
(Contract DE-AC04-94AL-85000)
(DE94-003275; SAND-91-2850; TTC-1251) Avail: CASI HC A04/MF A01

A new package for the air transport of hazardous materials is currently being developed in the Transportation Systems Department at Sandia National Laboratories. The baseline design has a unique impact limiter which uses layers of aluminum screen wire and aramid cloth fabric. A primary motivation for selecting this unusual combination of materials is the need for the impact limiter to not only limit the amount of load transmitted to the primary container but also to remain in place during impact events so that it provides a thermal barrier during a subsequent fire. A series of uniaxial and confined compression tests indicated that the layered material does not behave like other well characterized materials. No existing constitutive models were able to satisfactorily capture the behavior of the layered material; thus, a new plasticity model was developed. The new material model was then used to characterize the response of air transport packages with layered impact limiters to hypothetical accidental impact events. Responses predicted by these analyses compared favorably with experiments at Sandia's rocket sled test facility in which a one-fourth scale package was subjected to side and end impacts at velocities of 428 and 650 fps, respectively. DOE

N94-26978# Dynamet Technology, Inc., Burlington, MA.

MATERIAL OPTIMIZATION AND MANUFACTURING DEVELOPMENT OF REDUCED COST POWDER METAL TITANIUM ALLOY COMPONENTS FOR GAS TURBINE ENGINE APPLICATION, PHASE 2 Final Report, Oct. 1991 - May 1993

STANLEY ABKOWITZ, ROBERT DJINGHEUZIAN, SUSAN M. ABKOWITZ, HAROLD HEUSSI, and PAUL WEIHRAUCH Nov. 1993 114 p
(Contract DAAL04-91-C-0046)
(AD-A274410; ARL-CR-110) Avail: CASI HC A06/MF A02

This Small Business Innovation Research (SBIR) program has demonstrated the economic benefits of cold-hot isostatic pressing (CHIP) powder metallurgy (P/M) materials and manufacturing technology to produce lightweight titanium alloy components. The tooling was developed, and a turbine engine bearing housing preform and a tank track pin were produced. The study also established a data base of the static and dynamic mechanical properties as a function of the chloride impurity level of the commercially available elemental titanium powders and their associated costs. DTIC

N94-27201# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.

IMPACT TESTS ON FIBRE METAL LAMINATES UNDER A TENSILE LOAD

A. VLOT Mar. 1993 34 p
(PB94-126570; LR-714) Avail: CASI HC A03/MF A01

The well-known sensitivity of conventional composites to incidental damage, such as impact, has slowed their widespread application to thin, damage tolerance-critical primary structures such as fuselage pressure cabin skins. Therefore, impact tests were performed to determine the impact characteristics of fiber metal laminates (GLARE and ARALL). Comparative low and high velocity impact tests were performed on monolithic aluminum, fiber metal laminates, and carbon thermoplastic composites. Additional impact tests were performed on monolithic aluminum and ARALL specimens under tensile loading. NTIS

N94-27352*# California Univ., San Diego, La Jolla. Dept. of *Applied Mechanics and Engineering Sciences.*
THE EXPERIMENTAL BEHAVIOR OF SPINNING PRETWISTED LAMINATED COMPOSITE PLATES Final Technical Report, 1 May 1990 - 30 Sep. 1993
JOHN B. KOSMATKA and ALEX J. LAPID 1993 219 p
(Contract NCC3-173)
(NASA-CR-195220; NAS 1.26:195220; SSRP-93/10) Avail: CASI HC A10/MF A03

The purpose of the research is to gain an understanding of the material and geometric couplings present in advanced composite turbo-propellers. Twelve pre-twisted laminated composite plates are tested. Three different ply lay-ups (2 symmetric and 1 asymmetric) and four different geometries (flat and 30x pre-twist about the mid-chord, quarter-chord, and leading edge) distinguish each plate from one another. Four rotating and non-rotating tests are employed to isolate the material and geometric couplings of an advanced turbo propeller. The first series of tests consist of non-rotating static displacement, strain, and vibrations. These tests examine the effects of ply lay-up and geometry. The second series of tests consist of rotating displacement, strain, and vibrations with various pitch and sweep settings. These tests utilize the Dynamic Spin Rig Facility at the NASA Lewis Research Center. The rig allows the spin testing of the plates in a near vacuum environment. The tests examine how the material and plate geometry interact with the pitch and sweep geometry of an advanced turbo-propeller. Author (revised)

N94-27854*# Pratt and Whitney Aircraft, East Hartford, CT. Commercial Engine Business.
BROAD SPECIFICATION FUELS COMBUSTION TECHNOLOGY PROGRAM, PHASE 2 Final Report
R. P. LOHMANN, R. A. JEROSZKO, and J. B. KENNEDY Oct. 1990 235 p
(Contract NAS3-23269)
(NASA-CR-191066; NAS 1.26:191066) Avail: CASI HC A11/MF A03

An experimental evaluation of two advanced technology combustor concepts was conducted to evolve and assess their capability for operation on broadened properties fuels. The concepts were based on the results of Phase 1 of the Broad Specification Fuel Combustor Technology Program which indicated that combustors with variable geometry or staged combustion zones had a flexibility of operation that could facilitate operation on these fuels. Emphasis in defining these concepts included the use of single pipe as opposed to duplex or staged fuels systems to avoid the risk of coking associated with the reduction in thermal stability expected in broadened properties fuels. The first concept was a variable geometry combustor in which the airflow into the primary zone could be altered through valves on the front while the second was an outgrowth of the staged Vorbix combustor, evolved under the NASA/P&W ECCP and EEE programs incorporating simplified fuel and air introduction. The results of the investigation, which involved the use of Experimental Referee Broad Specification (ERBS) fuel, indicated that in the form initially conceived, both of these combustor concepts were deficient in performance relative to many of the program goals for performance emissions. However, variations of both combustors were evaluated that incorporated features to simulate conceptual enhancement to demonstrate the long range potential of the combustor. In both cases, significant improvements relative to the program goals were observed. Author (revised)

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ENGINEERING

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

N94-24839*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMIC ANALYSIS OF PRETWISTED ELASTICALLY-COUPLED ROTOR BLADES
MARK W. NIXON and HOWARD E. HINNANT Jan. 1994 19 p
Presented at the 1992 ASME Winter Annual Meeting, Anaheim, CA, 8-13 Nov. 1992 See also A93-21125
(Contract RTOP 505-63-50-15)
(NASA-TM-109070; NAS 1.15:109070) Avail: CASI HC A03/MF A01

The accuracy of using a one-dimensional analysis to predict frequencies of elastically-coupled highly-twisted rotor blades is addressed. Degrees of freedom associated with shear deformation are statically condensed from the formulation, so the analysis uses only those degrees of freedom associated with classical beam theory. The effects of cross section deformation (warping) are considered, and are shown to become significant for some types of elastic coupling. Improved results are demonstrated for highly-coupled blade structures through account of warping in a local cross section analysis, without explicit inclusion of these effects in the beam analysis. A convergence study is also provided which investigates the potential for improving efficiency of elastically-coupled beam analysis through implementation of a p-version beam finite element. Author (revised)

N94-24858*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
NUMERICAL SOLUTIONS OF THE COMPLETE NAVIER-STOKES EQUATIONS Progress Report No. 24, 1 Jul. - 31 Dec. 1993
H. A. HASSAN 31 Dec. 1993 10 p
(Contract NAG1-244)
(NASA-CR-194780; NAS 1.26:194780) Avail: CASI HC A02/MF A01

The objective of this study is to compare the use of assumed pdf (probability density function) approaches for modeling supersonic turbulent reacting flowfields with the more elaborate approach where the pdf evolution equation is solved. Assumed pdf approaches for averaging the chemical source terms require modest increases in CPU time typically of the order of 20 percent above treating the source terms as 'laminar.' However, it is difficult to assume a form for these pdf's a priori that correctly mimics the behavior of the actual pdf governing the flow. Solving the evolution equation for the pdf is a theoretically sound approach, but because of the large dimensionality of this function, its solution requires a Monte Carlo method which is computationally expensive and slow to coverage. Preliminary results show both pdf approaches to yield similar solutions for the mean flow variables. Author (revised)

N94-25140# Naval Command, Control and Ocean Surveillance Center, San Diego, CA. Research, Development, Technology and Evaluation Div.
ACTIVE CONTROL OF OSCILLATORY LIFT FORCES ON A CIRCULAR CYLINDER Professional Paper
D. M. LADD, D. S. PARK, E. W. HENDRICKS, and N. S. NOSSEIR Aug. 1993 8 p
(AD-A273243) Avail: CASI HC A02/MF A01

The results of a computational and experimental study of feedback control of Karman vortex shedding behind a circular cylinder are presented. The experiments were performed in a nominally two dimensional flow around a 12.7 mm cylinder at

Reynolds numbers up to 10,000. The computations utilized the two-dimensional Navier-Stokes equations at Reynolds numbers up to 100. In both experimental and numerical studies blowing and suction slots were used to control the vortex shedding. In the numerical study complete suppression of vortex shedding is achieved up to a Reynolds number Re = 80 (about 70% above the onset Reynolds number for vortex shedding). In the experimental study using the fluctuating lift force as feedback, about 50% suppression of the rms fluctuations has been achieved at a Reynolds number of approximately 10,000. DTIC

N94-25181*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NASA/ARMY ROTORCRAFT TRANSMISSION RESEARCH, A REVIEW OF RECENT SIGNIFICANT ACCOMPLISHMENTS

TIMOTHY L. KRANTZ (Army Research Lab., Cleveland, OH.) Mar. 1994 16 p Proposed for presentation at the American Helicopter Society 50th Annual Forum and Technology Display, Washington, DC, 11-13 May 1994; sponsored by the American Helicopter Society
(Contract RTOP 505-62-36; DA PROJ. 1L1-62211-A-47-A)
(NASA-TM-106508; E-8616; NAS 1.15:106508; ARL-MR-138) Copyright Avail: CASI HC A03/MF A01

A joint helicopter transmission research program between NASA Lewis Research Center and the U.S. Army Research Lab has existed since 1970. Research goals are to reduce weight and noise while increasing life, reliability, and safety. These research goals are achieved by the NASA/Army Mechanical Systems Technology Branch through both in-house research and cooperative research projects with university and industry partners. Some recent significant technical accomplishments produced by this cooperative research are reviewed. The following research projects are reviewed: oil-off survivability of tapered roller bearings, design and evaluation of high contact ratio gearing, finite element analysis of spiral bevel gears, computer numerical control grinding of spiral bevel gears, gear dynamics code validation, computer program for life and reliability of helicopter transmissions, planetary gear train efficiency study, and the Advanced Rotorcraft Transmission (ART) program. Author (revised)

N94-25188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PROBABILISTIC ASSESSMENT OF SMART COMPOSITE STRUCTURES

CHRISTOS C. CHAMIS and MICHAEL C. SHIAO (Sverdrup Technology, Inc., Brook Park, OH.) Jan. 1994 21 p Presented at the 38th International SAMPE Symposium and Exhibit, Anaheim, CA, 10-13 May 1993; sponsored by the Society for the Advancement of Materials and Process Engineering
(Contract RTOP 510-02-12)
(NASA-TM-106358; E-8145; NAS 1.15:106358) Avail: CASI HC A03/MF A01

A composite wing with spars and bulkheads is used to demonstrate the effectiveness of probabilistic assessment of smart composite structures to control uncertainties in distortions and stresses. Results show that a smart composite wing can be controlled to minimize distortions and to have specified stress levels in the presence of defects. Structural responses such as changes in angle of attack, vertical displacements, and stress in the control and controlled plies are probabilistically assessed to quantify their respective uncertainties. Sensitivity factors are evaluated to identify those parameters that have the greatest influence on a specific structural response. Results show that smart composite structures can be configured to control both distortions and ply stresses to satisfy specified design requirements. Author

N94-25193*# Lockheed Sanders, Inc., Nashua, NH. Advanced Engineering and Technology Div.

NEW TECHNOLOGIES FOR SPACE AVIONICS, 1993 Final Report

DAVID W. AIBEL, DAVID R. HARRIS, DAVE BARTLETT (New Hampshire Univ., Durham.), STEVE BLACK (Lockheed Space Operations Co., Cocoa Beach, FL.), DAVE CAMPAGNA, NANCY FERNALD, and RAY GARBOS Dec. 1993 77 p
(Contract NAS9-18873)
(NASA-CR-188272; NAS 1.26:188272) Avail: CASI HC A05/MF A01

The report reviews a 1993 effort that investigated issues associated with the development of requirements, with the practice of concurrent engineering and with rapid prototyping, in the development of a next-generation Reaction Jet Drive Controller. This report details lessons learned, the current status of the prototype, and suggestions for future work. The report concludes with a discussion of the vision of future avionics architectures based on the principles associated with open architectures and integrated vehicle health management.

N94-25194*# Lockheed Sanders, Inc., Nashua, NH.

APPENDIX A: PROPOSED STATEMENT OF WORK, 1994

In its New Technologies for Space Avionics, 1993 5 p Dec. 1993
Avail: CASI HC A01/MF A01

This NRA effort is devoted to developing new techniques and methodologies which utilize and/or provide support to Integrated Vehicle Health Management (IVHM) concepts and techniques, modern design processes, and open architectures to realize an avionics system architecture that relieves the flight control system (FCS) of the requirement of maintaining intimate knowledge and control of the vehicle subsystems (for instance, the reaction control system (RCS)). The benefit of this architecture is that future upgrades and enhancements to the system(s) or to individual components within the system(s) are greatly simplified. This approach also allows a much more straightforward treatment of failure analysis, system diagnosis, and the design of fault containment domains. This NRA effort is also devoted to realizing capabilities to provide an available avionics system (and subsystem(s)) at minimum operational cost. This thrust provides a direct benefit to NASA in that it seeks to accelerate the design cycle to allow state of the art components and designs to actually appear in the fielded system rather than merely in the initial design. To achieve this, this effort is intended to benefit from efforts already underway at Lockheed and other major contractors. For instance, Lockheed Sanders is currently engaged in a major DoD funded development program which has the goal of cutting design cycle time of high performance electronics by a factor of four while simultaneously improving quality also by a factor of four. The early work on this program was used to enable the rapid prototyping of the Reaction Jet Drive Controller which was accomplished in 1993. Similarly, maximum leverage will be derived from recent NASA and DoD efforts to increase the content of high quality commercial grade electronic components in systems for aerospace applications. Both of these goals result in a system with enhanced cost effectiveness, increased reliability, and greatly increased performance compared to a system developed using a more conventional approach. *Derived from text*

N94-25463# Institut Franco-Allemand de Recherches, Saint-Louis (France).

STUDY OF THE BLADE/VORTEX INTERACTION: ACOUSTICS, AERODYNAMICS AND MODELS Final Report [ETUDE DE L'INTERACTION PALE/TOURBILLON: ACOUSTIQUE, AERODYNAMIQUE, MODELISATIONS]

P. GNEMMI, J. HAERTIG, C. JOHE, and M. SCHAFFAR 7 Apr. 1992 76 p In FRENCH Original contains color illustrations
(Contract DRET-88-214)
(ISL-R-104/92; ETN-94-95119) Avail: CASI HC A05/MF A01

A program for calculating the load noise of a helicopter rotor was developed. The method, which requires the knowledge of the local blade load values, was extended to calculate the two dimensional flow around a foil in a field of vortices. A three dimensional method based on the lifting surface theory was developed to simulate the turbulent field developed by a pitch oscillating foil and interacting with another foil placed downstream. The calculated and the measured lift evolution values were compared. The flow velocity was measured by laser velocimetry and the configuration of the rotational flow field was obtained. ESA

N94-25503*# Westinghouse Electric Corp., Sunnyvale, CA.
RADAR E-O IMAGE FUSION
WILLIAM F. ONEIL *In* NASA. Ames Research Center, Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 225-232 Dec. 1993
Avail: CASI HC A02/MF A04

The fusion of radar and electro-optic (E-O) sensor images presents unique challenges. The two sensors measure different properties of the real three-dimensional (3-D) world. Forming the sensor outputs into a common format does not mask these differences. In this paper, the conditions under which fusion of the two sensor signals is possible are explored. The program currently planned to investigate this problem is briefly discussed. Author

N94-25534# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
OFF-DESIGN PERFORMANCE OF CRENULATED BLADES IN A LINEAR COMPRESSOR CASCADE M.S. Thesis
MICHAEL J. COSTELLO 1 Dec. 1993 133 p
(AD-A273744; AFIT/GAE/ENY/93D-9) Avail: CASI HC A07/MF A02

The effects of using compressor blades with a crenulated (notched) trailing edge in a low aspect ratio (AR = 1) linear compressor cascade at four incidence angles (-1.08 deg, +4.49 deg, +9.32 deg and +12.44 deg) were investigated. Blade performance and wake mixing characteristics for crenulated blades were compared with similar data for blades with a straight trailing edge. A seven-bladed cascade was operated with a flow Mach number of 0.4 and a blade chord Reynolds number of 4.1 x 10(exp 5). The diffusion factor ranged from 0.22 to 0.42 and strong three-dimensional flow effects were present. Total pressure losses were measured with a total pressure rake. Velocities and flow angles were measured using hot-film anemometry. Crenulated blades were found to enhance wake mixing from 20 to 50 percent depending on blade loading and downstream location. Crenulated blades were also found to reduce flow deflection by 1.9 deg at the lowest incidence and by 3.7 deg at the highest incidence. At the highest blade loading, crenulations were found to reduce total pressure losses by 20 percent and inhibit large scale flow degradation and vortex breakdown. At mild blade loadings, negligible differences in losses were observed. DTIC

N94-25654# Ecole Centrale de Lyon (France). Lab. de Mecanique des Fluides.
EXPERIMENTAL CONTRIBUTION TO THE STUDY OF SECONDARY FLOWS IN CENTRIFUGAL TURBOPUMP STATOR COMPONENTS Ph.D. Thesis [CONTRIBUTION EXPERIMENTALE A L'ETUDE DES ECOULEMENTS SECONDAIRES DANS LES ORGANES STATORIQUES DES TURBOPOMPES CENTRIFUGES]
SAHRAOUI BOUZIANE 1992 232 p In FRENCH Sponsored by SEP, France, and CNES Original contains color illustrations
(ECL-92-35; ETN-94-95279) Avail: CASI HC A11/MF A03

The flow characteristics in centrifugal turbomachines is investigated. Particular attention is given to the turbomachine stator components. The purposes of the study were: to validate the flow model for centrifugal turbopumps; to perform flow measurements on a test bed model in order to acquire accurate stator and U-bend pipe flow data; and to acquire local flow data for future numerical flow characterizations. The validity of the quasi three dimensional hypothesis is investigated. The characteristics of the low energy fluid accumulation zone are discussed. The effect of the stability of the blade root on the accumulation zone vortices is studied. The stator configuration choice is explained. The method applied for simulating the inducer's flow is described. The results of the flow visualization measurements showed that the outlet flow can be improved. ESA

N94-25732# Army Test and Evaluation Command, Aberdeen Proving Ground, MD.
FR/GE/UK/US INTERNATIONAL TEST OPERATIONS PROCEDURE (ITOP) 1-1-050 DEVELOPMENT OF LABORATORY VIBRATION TEST SCHEDULES Final Report
14 May 1993 87 p
(AD-A273887; ITOP-1-1-050) Avail: CASI HC A05/MF A01

This ITOP presents the considerations and techniques involved in developing laboratory vibration schedules simulate the field transportation vibration environment associated with tactical vehicles. DTIC

N94-25757# Northwestern Univ., Evanston, IL. Dept. of Electrical Engineering and Computer Science.
EXTENSION OF ON-SURFACE RADIATION CONDITION (OSRC) THEORY TO FULL-VECTOR ELECTROMAGNETIC WAVE SCATTERING BY THREE-DIMENSIONAL CONDUCTING, DIELECTRIC, AND COATED TARGETS Final Report, 1 Jul. 1988 - 27 Aug. 1993
ALLEN TAFLOVE and KORADA R. UMASHANKAR 27 Aug. 1993 253 p
(Contract N00014-88-K-0475)
(AD-A274023) Avail: CASI HC A12/MF A03

This project introduced radiation boundary condition (RBC) and absorbing boundary condition (ABC) theory to the engineering electromagnetics community. An approximate method for obtaining the scattering of 2-D and 3-D bodies, the on-surface radiation condition (OSRC) method, was formulated and validated. RBC's and ABC's were shown to work well at points closer to scatterers than anyone had expected. Finite-difference time domain (FD-TD) methods exploiting these ABC's were pursued for applications in scattering, radiation, penetration, biomedical studies, and nonlinear optics. Multiprocessing supercomputer software was developed for FD-TD, leading to the largest scale detailed electromagnetic wave interaction models ever conducted, including entire jet fighter aircraft modeled for radar cross section (RCS) at UHF frequencies up to 500 MHz. DTIC

N94-25862# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EFFECTS OF CRENULATIONS ON THREE DIMENSIONAL LOSSES IN A LINEAR COMPRESSOR CASCADE M.S. Thesis
WILLIAM L. SPACY, II Dec. 1993 196 p
(AD-A273778; AFIT/GAE/ENY/93D-26) Avail: CASI HC A09/MF A03

An experimental investigation into the effect of compressor blade trailing edge geometry on three dimensional flows in a linear cascade was conducted at the AFIT linear cascade test facility. Hot-wire/hot-film anemometry along with total pressure instrumentation was used to analyze crenulation generated vortices and their interaction with the three dimensional flows in the cascade. The effects of this interaction on the performance parameters associated with the cascade were quantified. The results indicate that wake mixing is better for crenulated trailing edges and that the precise geometry of the crenulations is critical to performance. One crenulation geometry was found to increase wake mixing while slightly reducing the total pressure losses. DTIC

N94-25991# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A NUMERICAL DETERMINATION OF BIFURCATION POINTS FOR LOW REYNOLDS NUMBER CONICAL FLOWS M.S. Thesis
LARRY K. WATERS Dec. 1993 78 p
(AD-A273984; AFIT/GAE/ENY/93D-29) Avail: CASI HC A05/MF A01

It has long been established that supersonic flow over axisymmetric conical bodies at high angles of attack tend to develop a side force due to vortical asymmetry. One of the proposed reasons for the asymmetry is a bifurcation point in the solution of the Navier-Stokes equations. This study investigated the possible existence of a bifurcation point in the Navier-Stokes equations for subsonic flow. Newton's method, with gauss elimination, was used-to solve the steady-state, viscous, compressible Navier-Stokes equations in spherical coordinates assuming conical similarity. DTIC

N94-26011# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague (Netherlands). Physics and Electronics Lab.

ZERNIKE MOMENTS AND ROTATION INVARIANT OBJECT RECOGNITION. A NEURAL NETWORK ORIENTED CASE STUDY Final Report

P. F. KREKEL Dec. 1992 88 p

(AD-A273749; FEL-92-A394; TDCK-TD-92-3840) Avail: CASI HC A05/MF A01

This report presents the results of the feasibility study investigating the characteristics of complex Zernike moments and their application in translation-, scale-, and rotation-invariant object recognition problems. The complex Zernike moments are used as characterizing features in a neural network based target recognition approach for the classification of objects in images recorded by sensors mounted on an airborne platform. The complex Zernike moments are a transformation of the image by the projection of the image onto an extended set of orthogonal polynomials. The emphasis of this study is laid on the evaluation of the performances of Zernike moments in relation with the application of neural networks. Therefore, three types of classifiers are evaluated: a multi-layer perceptron (MLP) neural network, a Bayes statistical classifier and a nearest-neighbor classifier. Experiments are based on a set of binary images simulating military vehicles extracted from the natural background. From these experiments the conclusion can be drawn that complex Zernike moments are efficient and effective object characterizing features that are robust under rotation of the object in the image and to a certain extent under varying affine projections of the object onto the image plane. DTIC

N94-26117# Midwest Research Inst., Golden, CO.

THE IDENTIFICATION OF INFLOW FLUID DYNAMICS PARAMETERS THAT CAN BE USED TO SCALE FATIGUE LOADING SPECTRA OF WIND TURBINE STRUCTURAL COMPONENTS

N. D. KELLEY Nov. 1993 8 p Presented at the 13th Energy-sources Technology Conference and Exhibition (ETCE) on Wind Energy, New Orleans, LA, 23-26 Jan. 1994

(Contract DE-AC02-83CH-10093)

(DE94-000231; NREL/TP-442-6008; CONF-940113-5) Avail: CASI HC A02/MF A01

We have recently shown that the alternating load fatigue distributions measured at several locations on a wind turbine operating in a turbulent flow can be described by a mixture of at least three parametric statistical models. The rainflow cycle counting of the horizontal and vertical inflow components results in a similar mixture describing the cyclic content of the wind. We believe such a description highlights the degree of non-Gaussian characteristics of the flow. We present evidence that the severity of the low-cycle, high-amplitude alternating stress loads seen by wind turbine components are a direct consequence of the degree of departure from normality in the inflow. We have examined the details of the turbulent inflow associated with series large loading events that took place on two adjacent wind turbines installed in a large wind park in San Gorgonio Pass, California. In this paper, we describe what we believe to be the agents in the flow that induced such events. We also discuss the atmospheric mechanisms that influence the low-cycle, high-amplitude range loading seen by a number of critical wind turbine components. We further present results that can be used to scale the specific distribution shape as functions of measured inflow fluid dynamics parameters. DOE

N94-26186# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

DAMAGE TOLERANCE ASSESSMENT HANDBOOK. VOLUME 1: INTRODUCTION FRACTURE MECHANICS FATIGUE CRACK PROPAGATION Final Report, Jun. 1990 - Dec. 1992

Oct. 1993 164 p

(AD-A274777; DOT-VNTSC-FAA-93-13-VOL-1; DOT/FAA/CT-93/69-VOL-1; PB94-134335) Avail: CASI HC A08/MF A02

This 'Damage Tolerance Assessment Handbook' consists of two volumes: vol. 1 and vol. 2. Volume 1 introduces the damage tolerance concept with a historical perspective followed by the fundamentals of fracture mechanics and fatigue crack propagation. Various fracture criteria and crack growth rules are studied. Volume 2 exclusively treats the subject of damage tolerance evaluation of airframes. DTIC

N94-26357# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

DAMAGE TOLERANCE ASSESSMENT HANDBOOK. VOLUME 2: AIRCRAFT DAMAGE TOLERANCE EVALUATION Final Report, Jun. 1990 - Dec. 1992

Oct. 1993 198 p

(AD-A274778; DOT-VNTSC-FAA-93-13-VOL-2; DOT/FAA/CT-93/69-VOL-2) Avail: CASI HC A09/MF A03

This 'Damage Tolerance Assessment Handbook' consists of two volumes: Volume 1 introduces the damage tolerance concept with a historical perspective followed by the fundamentals of fracture mechanics and fatigue crack propagation. Various fracture criteria and crack growth rules are studied. Volume 2 treats exclusively the subject of damage tolerance evaluation of airframes. DTIC

N94-26498# Naval Postgraduate School, Monterey, CA.

LASER DOPPLER VELOCIMETRY IN A LOW SPEED MULTISTAGE COMPRESSOR M.S. Thesis

JOSEPH M. UTSCHIG 23 Sep. 1993 97 p

(AD-A274836) Avail: CASI HC A05/MF A02

Two-dimensional Laser Doppler Velocimetry (LDV) measurements were taken in the Low Speed Multistage Compressor (LSMSC) with data indexed to the rotor position. Laser measurements were conducted at two axial positions downstream of the second rotor and one axial position downstream of the second stator. The entire rotor periphery was measured at fixed radial displacements at each location and ensemble averaged. The survey downstream of the stator attempted to quantify the unsteady flow of the stator passage. Attempts were made to quantify the absolute flow angle behind both the rotor and the stator and compare them to pneumatic data collected at the same axial and circumferential positions, respectively. Absolute flow angles calculated from the laser measurements were in agreement with pneumatic probe data. In addition, the surveys were conducted in an attempt to quantify the velocity profile from the rotor passage. The laser surveys indicated distinct and repeatable patterns in both the axial and circumferential components of the rotor exit velocity. Data downstream of the stator proved inconclusive. DTIC

N94-26644# Institute for Aerospace Research, Ottawa (Ontario).

A COMPARISON OF PROBABILITY OF DETECTION (POD) DATA DETERMINED USING DIFFERENT STATISTICAL METHODS

A. FAHR, D. FORSYTH, and M. BULLOCK Dec. 1993 18 p

(LTR-ST-1947; CTN-94-61063) Avail: CASI HC A03/MF A01

Different statistical methods have been suggested for determining probability of detection (POD) data for nondestructive inspection (NDI) techniques. A comparative assessment of various methods of determining POD was conducted using results of three NDI methods obtained by inspecting actual aircraft engine compressor disks which contained service induced cracks. The study found that the POD and 95 percent confidence curves as a function of crack size as well as the 90/95 percent crack length

vary depending on the statistical method used and the type of data. The distribution function as well as the parameter estimation procedure used for determining POD and the confidence bound must be included when referencing information such as the 90/95 percent crack length. The POD curves and confidence bounds determined using the range interval method are very dependent on information that is not from the inspection data. The maximum likelihood estimators (MLE) method does not require such information and the POD results are more reasonable. The log-logistic function appears to model POD of hit/miss data relatively well and is easy to implement. The log-normal distribution using MLE provides more realistic POD results and is the preferred method. Although it is more complicated and slower to calculate, it can be implemented on a common spreadsheet program.
Author (CISTI)

N94-26671 Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
AN INVESTIGATION OF THE EFFECTS OF THE HIGH MAXIMUM-THICKNESS-TO-CHORD RATIO ON THE PERFORMANCE OF NOZZLE GUIDE VANES IN A TRANSONIC PLANAR CASCADE M.S. Thesis
RAMA RADMARD Mar. 1993 209 p
(ISBN-0-315-84107-9; CTN-94-61053) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

The performance of turbine airfoils is usually predicted by empirical correlations, which however are inadequate for the case of airfoils with maximum thickness to chord ratio (MTCR) higher than 25 percent. Studies were conducted to create a data base from which the performance of turbine airfoils with a MTCR higher than 25 percent could be predicted. A planar cascade consisting of four airfoils was constructed to allow the investigation of the effect of the MTCR on the airfoil performance. Three airfoil sets with MTCR of 15.2 percent (baseline), 26.6 percent, and 48.2 percent were used. Measurements included surface Mach number distributions for the baseline airfoil, total pressure loss coefficients, and deviation angles for isentropic exit Mach numbers of 0.7 (design), 0.9, and 1.1. The effect of varying the inlet boundary layer thickness and free-stream turbulence level was also examined. The results showed that the 26.6 percent airfoil produced lower losses as predicted by the Kacker and Okapuu (1982) correlation. The introduction of turbulence produced a significant redistribution of losses in the exit plane. The secondary loss decreased as the leading edge diameter was increased. Except for the baseline blade where high under-turning in exit flow angle was observed, the airfoils showed a decrease in over-turning with increasing exit Mach number, as predicted by Ainley and Mathieson (1951).
Author (CISTI)

N94-26691*# Physical Research, Inc., Torrance, CA.
OPTICAL SURFACE CONTOURING FOR NON-DESTRUCTIVE INSPECTION OF TURBOMACHINERY Status Report No. 1, 6 Dec. 1993 - 5 Feb. 1994
DARIUSH MODARRESS and DAVID F. SCHAACK 9 Mar. 1994 24 p
(Contract NAS3-27214)
(NASA-CR-195245; NAS 1.26:195245; PRI-200) Avail: CASI HC A03/MF A01

Detection of stress cracks and other surface defects during maintenance and in-service inspection of propulsion system components, including turbine blades and combustion compartments, is presently performed visually. There is a need for a non-contact, miniaturized, and fully fieldable instrument that may be used as an automated inspection tool for inspection of aircraft engines. During this SBIR Phase 1 program, the feasibility of a ruggedized optical probe for automatic and nondestructive inspection of complex shaped objects will be established. Through a careful analysis of the measurement requirements, geometrical and optical constraints, and consideration of issues such as manufacturability, compactness, simplicity, and cost, one or more conceptual optical designs will be developed. The proposed concept will be further developed and a prototype will be fabricated during Phase 2.
Derived from text

N94-26707*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF THE PROTOTYPE DUAL-AXIS WALL ATTITUDE MEASUREMENT SENSOR
DOUGLAS T. WONG Feb. 1994 46 p
(Contract RTOP 505-59-54-02)
(NASA-TM-109056; NAS 1.15:109056) Avail: CASI HC A03/MF A01

A prototype dual-axis electrolytic tilt sensor package for angular position measurements was built and evaluated in a laboratory environment. The objective was to investigate the use of this package for making wind tunnel wall attitude measurements for the National Transonic Facility (NTF) at NASA Langley Research Center (LaRC). The instrumentation may replace an existing, more costly, and less rugged servo accelerometer package (angle-of-attack package) currently in use. The dual-axis electrolytic tilt sensor package contains two commercial electrolytic tilt sensors thermally insulated with NTF foam, all housed within a stainless steel package. The package is actively heated and maintained at 160 F using foil heating elements. The laboratory evaluation consisted of a series of tests to characterize the linearity, repeatability, cross-axis interaction, lead wire effect, step response, thermal time constant, and rectification errors. Tests revealed that the total RMS errors for the x-axis sensor is 0.084 degree, and 0.182 degree for the y-axis sensor. The RMS errors are greater than the 0.01 degree specification required for NTF wall attitude measurements. It is therefore not a viable replacement for the angle-of-attack package in the NTF application. However, with some physical modifications, it can be used as an inexpensive 5-degree range dual-axis inclinometer with overall accuracy approaching 0.01 degree under less harsh environments. Also, the data obtained from the tests can be valuable for wind tunnel applications of most types of electrolytic tilt sensors.
Author (revised)

N94-26836# Scientech, Inc., Idaho Falls, ID.
S-76 HIGH INTENSITY RADIATED FIELDS, VOLUME 2 Final Report
JERRY BLAIR Oct. 1993 169 p
(AD-A274572; DOT/FAA/CT-93/5-VOL-2) Avail: CASI HC A08/MF A02

The Federal Aviation Administration (FAA) Technical Center sponsored a series of High Intensity Radiated Fields (HIRF) test on a Sikorsky S-76 rotorcraft. The project was conducted to evaluate the practically of performing aircraft level HIRF tests, determine the effects of HIRF on a specific rotorcraft with the potential to obtain information on rotorcraft in general, and evaluate the effects of exposure to real world HIRF emitters. HIRF ground and flight tests were conducted to achieve the objective of the project. Site calibration (SCAL) measurements were made in the test area to determine the levels at which the S-76 would be irradiated when placed in the test area. Ground tests consisted of Low Level Swept Coupling (LLSC) and Low Level Swept Fields (LLSF) tests. The flight tests were flown directly into the main beam of a variety of pulsed and continuous wave (CW) transmitters including the Over the Horizon Back Scatter (OTHB), PAVE PAWS, ASR-9, FPS-65, and FPS-16 radars. Results of the S-76 tests added credibility to the existence of HIRF as a flight safety hazard. In the evaluation of the emitters, the flight tests showed repeatable instances where exposure resulted in instrumentation disruptions. It should be noted that all the observed disruptions were of a non-critical nature.
DTIC

N94-26854# Scientech, Inc., Idaho Falls, ID.
S-76 HIGH INTENSITY RADIATED FIELDS, VOLUME 1 Final Report
JERRY BLAIR Oct. 1993 88 p
(AD-A274571; DOT/FAA/CT-93/5-VOL-1) Avail: CASI HC A05/MF A01

The Federal Aviation Administration (FAA) Technical Center sponsored a series of High Intensity Radiated Fields (HIRF) test on a Sikorsky S-76 rotorcraft. The project was conducted to evaluate the practicality of performing aircraft level HIRF tests, determine the effects of HIRF on a specific rotorcraft with the potential to obtain information on rotorcraft in general, and evaluate the effects of exposure to real world HIRF emitters. HIRF ground and flight tests were conducted to achieve the objective of the project. Site calibration (SCAL) measurements were made in the test area to determine the levels at which the S-76 would be irradiated when placed in the test area. Ground tests consisted of Low Level Swept Coupling (LLSC) and Low Level Swept Fields (LLSF) tests. The flight tests were flown directly into the main beam of a variety of pulsed and continuous wave (CW) transmitters including the Over the Horizon Back Scatter (OTHB), PAVE PAWS, ASR-9, FPS-65, and FPS-16 radars. Results of the S-76 tests added credibility to the existence of HIRF as a flight safety hazard. In the evaluation of the emitters, the flight tests showed repeatable instances where exposure resulted in instrumentation disruptions. It should be noted that all the observed disruptions were of a non-critical nature. DTIC

N94-26911 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
FORMULAE FOR THE BUCKLING OF SIMPLY-SUPPORTED CORRUGATED PANELS OF ORTHOTROPIC MATERIAL UNDER SHEAR LOAD
P. G. VANBLADEL Mar. 1993 28 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-126547; LR-716) Avail: Issuing Activity (National Technical Information Service (NTIS))

This report presents formulae for the shear buckling of corrugated panels made of orthotropic materials. The formulae developed are to be incorporated in COPANO, a computer program for corrugated panel analysis and optimization. The corrugated panels considered in COPANO can be made of composite material, with orthotropic properties. Both the buckling analysis and the optimization are then much more involved than if isotropic material was used. The buckling analysis then has to take into account more stiffness parameters. Also, the optimization necessitates simple buckling calculations without recourse to numerical iteration procedures, to limit the time consumed in the analysis. These characteristics determine to a large extent the type of buckling formulae developed here. NTIS

N94-26922# CSA Engineering, Inc., Palo Alto, CA.
PROCEEDINGS OF DAMPING 1993, VOLUME 1 Final Interim Report, 1-28 Feb. 1993
BONNIE L. PORTIS Jun. 1993 387 p Conference held in San Francisco, CA, 24-26 Feb. 1993
(Contract F33615-89-C-3201)
(AD-A274226; WL-TR-93-3103-VOL-1) Avail: CASI HC A17/MF A04

Presented are individual papers of Damping '93 held 24-26 February, 1993, in San Francisco. The subjects included: passive damping concepts; passive damping analysis and design techniques; optimization; damped control/structure interaction; viscoelastic material testing and characterization; highly damped materials; vibration suppression techniques; damping identification and dynamic testing; application to aircraft; space structures; marine structures; commercial products; defense applications; and payoffs of vibration suppression. DTIC

N94-26961# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
DESIGN AND TEST OF POSTBUCKLED STIFFENED CURVED PLATES: A LITERATURE SURVEY
J. L. VEROLME Feb. 1993 35 p
(PB94-126521; LR-711) Avail: CASI HC A03/MF A01

A designer's tool for compressive buckling of aircraft fuselage panels, currently being developed at the Structures and Materials Laboratory of the Faculty of Aerospace Engineering of Delft University of Technology, must be validated with experimental results. The tested materials will be either isotropic (metal), orthotropic (GLARE, a fiber-metal laminate), or anisotropic (fibre reinforced plastics). For the formulation of a test matrix, a literature survey concentrating on tests of flat and curved, stiffened and unstiffened plates is performed. At the same time, simple semi-empirical formulas are collected to construct a design procedure based on these formulas. The design procedure can be checked and validated with the results of the literature survey. NTIS

N94-26963 Massachusetts Inst. of Tech., Lexington.
ENCODING APPROACHES FOR DATA LINK TRANSMISSION OF WEATHER GRAPHICS
JEFFREY L. GERTZ and ROBERT D. GRAPPEL 10 Dec. 1993 21 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DTFA01-93-Z-02012; F19628-90-C-0002)
(AD-A274497; ATC-205; DOT/FAA/RD-93/33) Avail: CASI HC A03

To provide pilots with necessary information to make informed decisions on the avoidance of hazardous weather and to maintain situational awareness of the weather conditions, the FAA is actively developing the capability to provide real-time graphical weather information to aircraft through the use of bandwidth-limited data links such as Mode S. The information content of weather images and the restricted bandwidth of the transmission channel require that the images be extensively compressed. This paper provides the results of a study concerning the applicability of various data compression algorithms to the weather image problem. Its conclusion is that the Polygon-Ellipse Algorithm developed at Lincoln Laboratory provides the best combination of compression, computational efficiency, and image quality for the encoding of weather images over the Mode S data link or other similarly bit-limited data links. DTIC

N94-26976# Notre Dame Univ., IN. Dept. of Civil Engineering and Geological Sciences.
AIRCRAFT WHEEL LIFE ASSESSMENT Final Report, 1 Oct. 1991 - 1 Sep. 1992
B. F. SPENCER, JR., D. J. KIRKNER, E. E. SCHUDT, and S. KANDARPA Jul. 1993 62 p
(AD-A274378; WL-TR-93-3065) Avail: CASI HC A04/MF A01

The important part of wheel life assessment problems is the accurate determination of the tire/wheel interface pressure distribution under various loading conditions. A combined analytical/experimental methodology for obtaining this pressure distribution was developed. The principal analytical tool in this methodology is the finite element program ANTWILL (Analysis of Tire Wheel Interface Loads) which recovers the pressure distribution given a number of experimental strain measurements on the wheel. The major activity consisted of a study of the F-16 Block 30 and the Block 40 main landing gear wheels to determine the optimal number and location of the strain gages for subsequent experiments. Experiments to be conducted will record strains at the specified locations and this data will be used to determine tire/wheel interface pressures. DTIC

N94-26980# Scientech, Inc., Idaho Falls, ID.
S-76 HIGH INTENSITY RADIATED FIELDS, VOLUME 3 Final Report
JERRY BLAIR Oct. 1993 211 p Sponsored by FAA
(AD-A274416; DOT/FAA/CT-93/5-VOL-3) Avail: CASI HC A10/MF A03

The Federal Aviation Administration (FAA) Technical Center sponsored a series of High Intensity Radiated Fields (HIRF) tests on a Sikorsky S-76 rotorcraft. The project was conducted to evaluate the practically of performing aircraft level HIRF tests, determine the effects of HIRF on a specific rotorcraft with the potential to obtain information on rotorcraft in general, and evaluate the effects of exposure to 'real world' HIRF emitters. HIRF ground and flight tests were conducted to achieve the objective of the project. Site calibration (SCAL) measurements were made in the test area to determine the levels at which the S-76 would be irradiated when placed in the test area. Ground tests consisted of Low Level Swept Coupling (LLSC) and Low Level Swept Fields (LLSF) tests. The flight tests were flown directly into the main beam of a variety of pulsed and continuous wave (CW) transmitters including the Over the Horizon Back Scatter (OTHB), PAVE PAWS, ASR-9, FPS-65, and FPS-16 radars. Results of the S-76 tests added credibility to the existence of HIRF as a flight safety hazard. In the evaluation of the emitters, the flight tests showed repeatable instances where exposure resulted in instrumentation disruptions. It should however be noted that all the observed disruptions were of a non-critical nature. DTIC

N94-26986# Arnold Engineering Development Center, Arnold AFS, TN.
AN ALGORITHM FOR DETERMINATION OF BEARING HEALTH THROUGH AUTOMATED VIBRATION MONITORING Final Report, 1 Oct. 1992 - 30 Sep. 1993
SID W. HITE, III Dec. 1993 67 p
(AD-A274591; AEDC-TR-93-19) Avail: CASI HC A04/MF A01

This report investigates considerations involved in designing an expert system capable of real-time monitoring of turbine engine vibration data to detect rolling element bearing faults. Topics include development of the fundamental bearing fault frequencies, data analysis techniques, results of manual analysis, and considerations in bearing health criteria and monitoring. Methodologies are described for characterization of engine family vibration across the engine's envelope, and a bearing health monitoring algorithm is discussed in detail. Work reported will be extended and automated to encompass a complete vibration based turbine engine Health Monitoring System (HEMOS). When completely developed, HEMOS will likely augment the multifaceted capabilities of the Computer Assisted Dynamic Data Monitoring and Analysis System (CADDMAS) under development by the Directorate of Technology - Propulsion Division (DOTP) of Arnold Engineering Development Center (AEDC), Air Force Materiel Command (AFMC), Arnold AFB, TN. DTIC

N94-27026# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
NOMINALLY 2-DIMENSIONAL FLOW ABOUT A NORMAL FLAT PLATE Annual Report, 1 Oct. 1992 - 30 Sep. 1993
DEREK LISOSKI 1 Aug. 1993 104 p
(Contract N00014-90-J-1589)
(AD-A274472) Avail: CASI HC A06/MF A02

Towing tank and water channel experiments and a two-dimensional vortex element numerical model were used to study the forces experienced by a bluff flat plate set normal to a nominally two-dimensional flow. Intrinsic (small scale) and extrinsic (large scale) three-dimensional motions in the experimental flow were isolated and their separate and combined effects on forces and overall wake development were studied. Transient flow development starting from rest, as well as steady flow conditions, were investigated. A force balance was used to measure the unsteady lift and drag of vertically oriented models projecting through a free surface with various lower end conditions; simultaneous LIF flow visualizations imaged the structure of the vortices in the wake. Plate aspect ratio, lower end condition, and angle of attack were varied to effect changes in large scale three-dimensional motions, while changes in Reynolds number and Richardson number (flow stratification) modified the small scale three dimensionality intrinsic to the flow. DTIC

N94-27228*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
DESIGN AND EXPERIMENTAL PERFORMANCE OF A TWO STAGE PARTIAL ADMISSION TURBINE. TASK B.1/B.4 Final Report, Dec. 1984 - Jun. 1986
R. F. SUTTON, J. L. BOYNTON, R. A. AKIAN, DAN SHEA, EDMUND ROSCHAK, LOU ROJAS, LINSEY ORR, LINDA DAVIS, BRAD KING, BILL BUBEL et al. 14 Dec. 1992 168 p
(Contract NAS3-23773)
(NASA-CR-179548; NAS 1.26:179548; RI/RD92-214) Avail: CASI HC A08/MF A02

A three-inch mean diameter, two-stage turbine with partial admission in each stage was experimentally investigated over a range of admissions and angular orientations of admission arcs. Three configurations were tested in which first stage admission varied from 37.4 percent (10 of 29 passages open, 5 per side) to 6.9 percent (2 open, 1 per side). Corresponding second stage admissions were 45.2 percent (14 of 31 passages open, 7 per side) and 12.9 percent (4 open, 2 per side). Angular positions of the second stage admission arcs with respect to the first stage varied over a range of 70 degrees. Design and off-design efficiency and flow characteristics for the three configurations are presented. The results indicated that peak efficiency and the corresponding isentropic velocity ratio decreased as the arcs of admission were decreased. Both efficiency and flow characteristics were sensitive to the second stage nozzle orientation angles. Author (revised)

N94-27298*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
OPTICAL COMMUNICATIONS FOR TRANSPORT AIRCRAFT
ROBERT STENGEL *In* NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research , 1992-1993 p 141-145 Feb. 1994
Avail: CASI HC A01/MF A02

Optical communications for transport aircraft are discussed. The problem involves: increasing demand for radio-frequency bands from an enlarging pool of users (aircraft, ground and sea vehicles, fleet operators, traffic control centers, and commercial radio and television); desirability of providing high-bandwidth dedicated communications to and from every aircraft in the National Airspace System; need to support communications, navigation, and surveillance for a growing number of aircraft; and improved meteorological observations by use of probe aircraft. The solution involves: optical signal transmission support very high data rates; optical transmission of signals between aircraft, orbiting satellites, and ground stations, where unobstructed line-of-sight is available; conventional radio transmissions of signals between aircraft and ground stations, where optical line-of-sight is unavailable; and radio priority given to aircraft in weather. CASI

N94-27308 Concordia Univ., Montreal (Quebec). Dept. of Electrical and Computer Engineering.
DEVELOPMENTS IN THE APPLICATION OF THE GEOMETRICAL THEORY OF DIFFRACTION AND COMPUTER GRAPHICS TO AIRCRAFT INTER-ANTENNA COUPLING ANALYSIS M.S. Thesis
MICHAEL BOGUSZ Jan. 1993 189 p
(ISBN-0-315-84643-7; CTN-94-61083) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

The need for a systematic methodology for the analysis of aircraft electromagnetic compatibility (EMC) problems is examined. The available computer aids used in aircraft EMC analysis are assessed and a theoretical basis is established for the complex algorithms which identify and quantify electromagnetic interactions. An overview is presented of one particularly well established aircraft antenna to antenna EMC analysis code, the Aircraft Inter-Antenna Propagation with Graphics (AAPG) Version 07 software. The specific new algorithms created to compute cone geodesics and their associated path losses and to graph the physical coupling path are discussed. These algorithms are validated against basic principles. Loss computations apply the uniform geometrical theory of diffraction and are subsequently compared to measurement data. The increased modelling and analysis capabilities of the newly developed AAPG Version 09 are compared to those of Version 07. Several models of real aircraft, namely the Electronic Systems Trainer Challenger, are generated and provided as a basis for this preliminary comparative assessment. Issues such as software reliability, algorithm stability, and quality of hardcopy output are also discussed. Author (CISTI)

N94-27588# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. Numerische Stroemungsmechanik.
DIRECT SIMULATION MONTE-CARLO OF NEAR CONTINUUM HYPERSONIC FLOW WITH CHEMICAL REACTIONS Ph.D. Thesis - Stuttgart Univ. [DIREKTES MONTE-CARLO-SIMULATIONSVERFAHREN FUER KONTINUUMSNAHE HYPERSCHALLSTROEMUNGEN MIT CHEMISCHEN REAKTIONEN]
STEFAN DIETRICH Jan. 1993 73 p In GERMAN Original contains color illustrations
(ISSN 0939-2963)
(DLR-FB-93-01; ETN-94-95490) Avail: CASI HC A04/MF A01

Phenomenological models for use in the 'direct simulation Monte Carlo' method are studied. Emphasis is given to the modeling of chemical reactions. The use of these models is enhanced due to new computational techniques allowing, for example, a more efficient movement of particles in structured and unstructured grids. The drag of a cylinder in the transitional regime of cold hypersonic flows is calculated, and detailed comparisons to an experiment are made. The hypersonic flow with chemical reactions past a cylinder is simulated. Available nonequilibrium Navier-Stokes results for the same flow are used for comparison. The influence of chemical reactions on the wake structure behind the cylinder is also investigated. ESA

N94-27599*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF HYPERSONIC ENGINE SEALS: FLOW EFFECTS OF PRELOAD AND ENGINE PRESSURES
ZHONG CAI (Drexel Univ., Philadelphia, PA.), RAJAKKANNU MUTHARASAN (Drexel Univ., Philadelphia, PA.), FRANK K. KO (Drexel Univ., Philadelphia, PA.), and BRUCE M. STEINETZ Apr. 1993 13 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE
(Contract RTOP 763-22-41)
(NASA-TM-106333; E-7400; NAS 1.15:106333; AIAA PAPER 93-1998) Avail: CASI HC A03/MF A01

A new type of engine seal is being developed to meet the needs of advanced hypersonic engines. A seal braided of emerging high temperature ceramic fibers comprised of a sheath-core construction was selected for study based on its low leakage rates. Flexible, low-leakage, high temperature seals are required to seal the movable engine panels of advanced ramjet-scramjet engines either preventing potentially dangerous leakage into backside engine cavities or limiting the purge coolant flow rates through the seals. To predict the leakage through these flexible, porous seal structures as a function of preload and engine pressures, new analytical flow models are required. An empirical leakage resistance/preload model is proposed to characterize the observed decrease in leakage with increasing preload. Empirically determined compression modulus and preload factor are used to correlate experimental leakage data for a wide range of seal architectures. Good agreement between measured and predicted values are observed over a range of engine pressures and seal preloads. Author

N94-27657*# State Univ. of New York, Binghamton. Dept. of Mechanical and Industrial Engineering.
STUDY OF THE KINEMATIC AND DYNAMIC CHARACTERISTICS OF A WORMGEAR TRANSMISSION FOR HELICOPTER APPLICATIONS Final Report
D. C. SUN and QIN YUAN Mar. 1994 138 p
(Contract NAG3-1316; DA PROJ. 1L1-61102-AH-45; RTOP 505-62-0K-00)
(NASA-CR-195287; E-8633; NAS 1.26:195287; ARL-CR-78)
Avail: CASI HC A07/MF A02

The first phase of the study of the performance of a wormgear transmission is reported. In this phase the work included the selection of a double-enveloping wormgear type, and its dimensions, suitable for use in helicopter transmissions; the 3-D graphics representation of the selected wormgear using the I-DEAS software; the analysis of the kinematics of meshing; the analysis of load sharing among the meshing teeth; and the implementation of the analyses in a computer program. The report describes the analyses, their results, and the use of the computer programs. Author

N94-27776*# United Technologies Corp., East Hartford, CT.
THERMAL/STRUCTURAL TAILORING OF ENGINE BLADES (T/STAEBL): USER'S MANUAL Final Report
K. W. BROWN Mar. 1994 43 p
(Contract NAS3-22525; RTOP 505-63-5B)
(NASA-CR-194461; E-8494; NAS 1.26:194461) Avail: CASI HC A03/MF A01

The Thermal/Structural Tailoring of Engine Blades (T/STAEBL) system is a computer code that is able to perform numerical optimizations of cooled jet engine turbine blades and vanes. These optimizations seek an airfoil design of minimum operating cost that satisfies realistic design constraints. This report documents the organization of the T/STAEBL computer program, its design and analysis procedure, its optimization procedure, and provides an overview of the input required to run the program, as well as the computer resources required for its effective use. Additionally, usage of the program is demonstrated through a validation test case. Author

N94-27802*# Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
FLOWFIELD DYNAMICS IN BLUNT FIN-INDUCED SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTIONS Final Report, 13 Mar. 1989 - 9 Nov. 1993
DAVID S. DOLLING and LEON BRUSNIAK Jan. 1994 83 p
(Contract NAG3-1023)
(NASA-CR-195170; NAS 1.26:195170) Avail: CASI HC A05/MF A01

Fluctuating wall pressure measurements have been made on centerline upstream of a blunt fin in a Mach 5 turbulent boundary layer. By examining the ensemble averaged wall pressure distributions for different separation shock foot positions, it has been shown that local fluctuating wall pressure measurements are due to a distinct pressure distribution, Rho(sub i), which undergoes a stretching and flattening effect as its upstream boundary translates aperiodically between the upstream influence and separation lines. The locations of the maxima and minima in the wall pressure standard deviation can be accurately predicted using this distribution, providing quantitative confirmation of the model. This model also explains the observed cross-correlations and ensemble average measurements within the interaction. Using the Rho(sub i) model, wall pressure signals from under the separated flow region were used to reproduce the position-time history of the separation shock foot. Further, the negative time delay peak in the cross-correlation between the predicted and actual shock foot histories suggests that the separated region fluctuations precede shock foot motion. The unsteady behavior of the primary horseshoe vortex and its relation to the unsteady separation shock are described. Author (revised)

N94-27851*# Virginia Univ., Charlottesville. Dept. of Materials Science and Engineering.
NASA-UVA LIGHT AEROSPACE ALLOY AND STRUCTURES TECHNOLOGY PROGRAM (LA2ST) Progress Report, 1 Jul. - 31 Dec. 1993
RICHARD P. GANGLOFF, JOHN R. SCULLY, EDGAR A. STARKE, JR., GLENN E. STONER, EARL A. THORNTON, FRANKLIN E. WAWNER, JR., and JOHN A. WERT 15 Mar. 1994 218 p
(Contract NAG1-745)
(NASA-CR-195275; NAS 1.26:195275; UVA/528266/MSE94/114)
Avail: CASI HC A10/MF A03

The NASA-UVA Light Aerospace Alloy and Structures Technology (LA2ST) Program was initiated in 1986, and continues a high level of activity, with projects being conducted by graduate students and faculty advisors in the Departments of Materials Science and Engineering, and Mechanical and Aerospace Engineering at the University of Virginia. This work is funded by the NASA-Langley Research Center under Grant NAG-1-745. Here, we report on progress achieved between July 1 and December 31, 1993. The objective of the LA2ST Program is to conduct interdisciplinary graduate student research on the performance of next generation, light weight aerospace alloys, composites and thermal gradient structures in collaboration with NASA-Langley researchers. Specific technical objectives are presented for each research project. We generally aim to produce relevant data and basic understanding of material mechanical response, environmental/corrosion behavior, and microstructure; new monolithic and composite alloys; advanced processing methods; new solid and fluid mechanics analyses; measurement and modeling advances; and critically, a pool of educated graduate students for aerospace technologies. Derived from text

N94-27874# Solar Turbines, Inc. San Diego, CA. Research Dept.

GAS FIRED ADVANCED TURBINE SYSTEM

R. T. LECREN and D. J. WHITE 1993 9 p Presented at the Joint Contractors Meeting on Advanced Turbine Systems, Fuel Cells and Coal-Fired Heat, Morgantown, WV, 3-5 Aug. 1993
(Contract DE-AC21-86MC-23166)
(DE94-003193; DOE/MC-23166/94/C0236; CONF-930893-37)
Avail: CASI HC A02/MF A01

The basic concept thus derived from the Ericsson cycle is an intercooled, recuperated, and reheated gas turbine. Theoretical performance analyses, however, showed that reheat at high turbine rotor inlet temperatures (TRIT) did not provide significant efficiency gains and that the 50 percent efficiency goal could be met without reheat. Based upon these findings, the engine concept adopted as a starting point for the gas-fired advanced turbine system is an intercooled, recuperated (ICR) gas turbine. It was found that, at inlet temperatures greater than 2450 F, the thermal efficiency could be maintained above 50%, provided that the turbine cooling flows could be reduced to 7% of the main air flow or lower. This dual and conflicting requirement of increased temperatures and reduced cooling will probably force the abandonment of traditional air cooled turbine parts. Thus, the use of either ceramic materials or non-air cooling fluids has to be considered for the turbine nozzle guide vanes and turbine blades. The use of ceramic components for the proposed engine system is generally preferred because of the potential growth to higher temperatures that is available with such materials. DOE

N94-27894*# Arizona State Univ., Tempe. Dept. of Electrical Engineering.

HYBRID TECHNIQUES FOR COMPLEX AEROSPACE ELECTROMAGNETICS PROBLEMS

JIM ABERLE *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 65-67 Dec. 1993
Avail: CASI HC A01/MF A03

Important aerospace electromagnetics problems include the evaluation of antenna performance on aircraft and the prediction and control of the aircraft's electromagnetic signature. Due to the ever increasing complexity and expense of aircraft design, aerospace engineers have become increasingly dependent on computer solutions. Traditionally, computational electromagnetics (CEM) has relied primarily on four disparate techniques: the method of moments (MoM), the finite-difference time-domain (FDTD) technique, the finite element method (FEM), and high frequency asymptotic techniques (HFAT) such as ray tracing. Each of these techniques has distinct advantages and disadvantages, and no single technique is capable of accurately solving all problems of interest on computers that are available now or will be available in the foreseeable future. As a result, new approaches that overcome the deficiencies of traditional techniques are beginning to attract a great deal of interest in the CEM community. Among these new approaches are hybrid methods which combine two or more of these techniques into a coherent model. During the ASEE Summer Faculty Fellowship Program a hybrid FEM/MoM computer code was developed and applied to a geometry containing features found on many modern aircraft. Author (revised)

N94-27911*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.

A NUMERICAL STUDY OF MIXING AND COMBUSTION IN HYPERVELOCITY FLOWS THROUGH A SCRAMJET COMBUSTOR MODEL

RAMESH KRISHAMURTHY *In its* The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 123-125 Dec. 1993
Avail: CASI HC A01/MF A03

Interest in high speed, air-breathing propulsion systems such as scramjets has revived in recent years fueled to a large extent by the National Aerospace Plane (NASP) program. These vehicles are expected to fly trans-atmospheric and as a consequence, the Mach number level within the engine/combustor would be rather high (M greater than 5). Ground based testing of such scramjet engines requires a facility that can not only achieve the right Mach number, but also have the proper pressures and temperatures to simulate the combustion processes. At present, only pulse type facilities can provide such high enthalpy flows. The newest of these is the free-piston shock tunnel, T5 located at GALCIT. Recently, a generic combustor model was tested in T5, and the experimental data from that study is analyzed in the present report. The available experimental data from T5 are essentially the static pressures on the injection wall and the one opposite to it. Thus, a principal aim of the present study was to validate the available experimental data by using a proven CFD tool and then investigate the performance characteristics of the combustor model, such as, the mixing efficiency and combustion efficiency. For this purpose, in this study, the code GASP has been used. Author

N94-27920*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mechanical Engineering.

DEVELOPMENT OF METHODOLOGIES FOR THE ESTIMATION OF THERMAL PROPERTIES ASSOCIATED WITH AEROSPACE VEHICLES

ELAINE P. SCOTT *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 158-161 Dec. 1993
Avail: CASI HC A01/MF A03

Thermal stress analyses are an important aspect in the development of aerospace vehicles such as the National Aero-Space Plane (NASP) and the High-Speed Civil Transport (HSCT) at NASA-LaRC. These analyses require knowledge of the temperature within the structures which consequently necessitates the need for thermal property data. The initial goal of this research effort was to develop a methodology for the estimation of thermal properties of aerospace structural materials at room temperature and to develop a procedure to optimize the estimation process. The estimation procedure was implemented utilizing a general purpose finite element code. In addition, an optimization procedure was developed and implemented to determine critical experimental parameters to optimize the estimation procedure. Finally, preliminary experiments were conducted at the Aircraft Structures Branch (ASB) laboratory. Author (revised)

N94-27925*# Miami Univ., Coral Gables, FL. Electrical and Computer Engineering.

COMPARATIVE ANALYSIS OF DIFFERENT CONFIGURATIONS OF PLC-BASED SAFETY SYSTEMS FROM RELIABILITY POINT OF VIEW

MOIEZ A. TAPIA *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 187-188 Dec. 1993
Avail: CASI HC A01/MF A03

The study of a comparative analysis of distinct multiplex and fault-tolerant configurations for a PLC-based safety system from a reliability point of view is presented. It considers simplex, duplex and fault-tolerant triple redundancy configurations. The standby unit in case of a duplex configuration has a failure rate which is k times the failure rate of the standby unit, the value of k varying from 0 to 1. For distinct values of MTTR and MTTF of the main unit, MTBF and availability for these configurations are calculated. The effect of duplexing only the PLC module or only the sensors and the actuators module, on the MTBF of the configuration, is also presented. The results are summarized and merits and demerits of various configurations under distinct environments are discussed. Author (revised)

N94-27984*# Caterpillar Tractor Co., Peoria, IL.
DEVELOPMENT OF ADVANCED HIGH TEMPERATURE IN-CYLINDER COMPONENTS AND TRIBOLOGICAL SYSTEMS FOR LOW HEAT REJECTION DIESEL ENGINES, PHASE 1 Final Report
C. A. KROEGER and H. J. LARSON Mar. 1992 78 p
(Contract DEN3-374; DE-A101-91CE-50306)
(NASA-CR-187158; NAS 1.26:187158; DOE/NASA/0374-1)
Avail: CASI HC A05/MF A01

Analysis and concept design work completed in Phase 1 have identified a low heat rejection engine configuration with the potential to meet the Heavy Duty Transport Technology program specific fuel consumption goal of 152 g/kW-hr. The proposed engine configuration incorporates low heat rejection, in-cylinder components designed for operation at 24 MPa peak cylinder pressure. Water cooling is eliminated by selective oil cooling of the components. A high temperature lubricant will be required due to increased in-cylinder operating temperatures. A two-stage turbocharger air system with intercooling and aftercooling was selected to meet engine boost and BMEP requirements. A turbocompound turbine stage is incorporated for exhaust energy recovery. The concept engine cost was estimated to be 43 percent higher compared to a Caterpillar 3176 engine. The higher initial engine cost is predicted to be offset by reduced operating costs due the lower fuel consumption. Author (revised)

N94-28010# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
EXPERIMENTAL DATA FOR CFD VALIDATION OF IMPINGING JETS IN CROSSFLOW WITH APPLICATION TO ASTOVL FLOW PROBLEMS
P. BEHROUZI and J. J. MCGUIRK *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 11 p Nov. 1993 Sponsored by British Aerospace Public Ltd. Co.
Copyright Avail: CASI HC A03/MF A04

An experimental facility, used to gather validation data suitable for testing CFD model predictions of multijet ground impingement flows, is described. Water is used as the working medium and LDV measurements of twin impinging jets are reported, both with and without a cross-flowing stream. Emphasis is placed on the presentation of mean and rms velocity contours in the foundation formation region between the jets. The effect of jet splay angle has also been studied. For zero splay or 10 deg of splay-out, the fountain is observed to develop as an upwash flow spatially separated from the two jet flows (jet spacing at six jet diameters); for 10 deg splay-in, a noticeable fountain/jet interaction is observed. Splay-out reduces the strength of the fountain by around 50 percent whereas splay-in has an opposite, strengthening effect for the seven jet diameter impingement height studied here. The effect of a cross-flow (jet/cross-flow velocity ratio of 10) leads to a clear downwind shift of the fountain origin and inclination of the fountain rise. The results presented offer a sufficiently comprehensive mapping of the mean velocity and turbulence fields to form suitable test cases for the validation of CFD models for ground effect flows. Author (revised)

N94-28012# Nangia Associates, Bristol (England).
VECTORED JETS-INDUCED INTERFERENCE ON AIRCRAFT, PREDICTION AND VERIFICATION
R. K. NANGIA *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 14 p Nov. 1993 Sponsored by Defence Research Agency
Copyright Avail: CASI HC A03/MF A04

The prediction of vectored jet-induced effects on V/STOL configurations during transition phase and maneuvers constitutes an important aspect in the understanding, design, control, and operation of such aircraft. In this paper, a semiempirical modelling of the jet is used within the framework of subsonic singularity methods. Comparisons with experimental data on a wing-body configuration have been presented. In general, acceptable agreement has been demonstrated. Overall, the emphasis has been on predicting jet interference effects on practical configurations with multijet effects and forward and aft nozzles. Configuration effects include tails which operate in a much stronger jet downwash than the wing. Optimization studies can be enabled prior to experimental programs. This process will allow the design cycle to commence with a good idea of the relative effectiveness of the various controls and the changes needed in the flight control system to cope with partially jet-borne phases of flight. Therefore there is a significant potential for encouraging cost and time savings. Areas for further work and improvements of the model have been proposed. It is believed that these aspects will have a constructive impact on current and future practical VSTOL and ASTOVL developments. Author (revised)

N94-28013# Deutsche Aerospace A.G., Munich (Germany). Military Aircraft.
NUMERICAL INVESTIGATION OF THRUST VECTORING BY INJECTION OF SECONDARY AIR INTO NOZZLE FLOWS
T. BERENS *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 15 p Nov. 1993 Sponsored by DGLR
Copyright Avail: CASI HC A03/MF A04

Injection of secondary air into nozzle flows is an efficient method to control the thrust vector angle of an aircraft. A numerical investigation of thrust vectoring has been carried out for hypersonic aircraft in the transonic flight regime. In this speed range, single duct asymmetrical single expansion ramp nozzles operate far off design due to large nozzle exit areas required for optimal thrust coefficients at hypersonic cruise Mach numbers, thus producing large thrust components in the downward direction. Injecting secondary air into the nozzle flow in the critical transonic flight Mach number regime can lead to favorable gross thrust vector angles and thus improved thrust efficiency in flight direction. For a hypersonic aircraft's rectangular convergent-divergent nozzle configuration with a single expansion ramp, two dimensional Euler calculations of the complete afterbody flow field were carried out in the transonic flight regime, investigating subsonic as well as supersonic injection of the aircraft's forebody boundary layer air into the nozzle flow. Subsonic flow of the injected air along the expansion ramp produces a favorable pressure distribution on the ramp and results in advantageous thrust vectors with small force components normal to the flight direction and in best thrust efficiency. The interaction between the external flow, the jet plume flow, and the secondary air flow, as well as the behavior of the thrust vector, due to pressure and temperature variations of the injected forebody boundary layer air, are discussed. Also investigated was the impact of the aircraft's angle of attack on the complete nozzle flow field. Author (revised)

N94-28016*# Wright Lab., Wright-Patterson AFB, OH.
EXPERIMENTS ON THE GROUND VORTEX FORMED BY AN IMPINGING JET IN CROSS FLOW
WILLIAM B. BLAKE and VEARL R. STEWART (KSA Technology, Columbus, OH.) *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 13 p Nov. 1993 Sponsored by NASA. Langley Research Center and KSA Technology
(Contract F33615-89-C-3611)
Copyright Avail: CASI HC A03/MF A04

An inclined jet impinging on the ground creates a wall flow that spreads radially from the point of impingement. If a cross-flow is introduced, the upstream component of the wall flow will separate from the ground and create what has been termed the 'ground vortex.' The ground vortex has been shown to have a significant impact on aircraft aerodynamics and is one of the major contributors to hot gas ingestion. The paper discusses a recent study which included a generic wing-body configuration for assessing the impact of the ground vortex on configuration aerodynamics. Wind tunnel tests using fixed ground boards, moving ground belts, and moving model tests are discussed. The emphasis of the data is macroscopic, i.e. forward location of the vortex, effects of ground height, etc. Author (revised)

N94-28030# Science Applications International Corp., Fort Washington, PA. *Propulsive Sciences Div.*

RECENT DEVELOPMENTS IN THE SIMULATION OF STEADY AND TRANSIENT TRANSVERSE JET INTERACTIONS FOR MISSILE, ROTORCRAFT, AND PROPULSIVE APPLICATIONS

S. M. DASH, B. J. YORK, N. SINHA, R. A. LEE, A. HOSANGADI, and D. C. KENZAKOWSKI *In* AGARD, Computational and Experimental Assessment of Jets in Cross Flow 21 p Nov. 1993

Copyright Avail: CASI HC A03/MF A04

A review of recent activities focused on the simulation of transverse jet interaction problems using advanced time-asymptotic and time-accurate Navier-Stokes methodology is presented. Missile work has involved the simulation of short-duration control jets issued from solid rocket motor nozzles. For the simulation of time-accurate particle-laden flows, a new Eulerian-based upwind/implicit particle-solver was developed and coupled with the gas-phase solver. Rotorcraft work has involved simulating the interaction of the exhaust plumes with the rotor wake and body aerodynamic flow. Hybrid vortex tracking/Navier-stokes methodology has been implemented with gridding of this complex 3D interactive flow being an issue of primary concern. Propulsive work has emphasized turbulence modeling. For scramjet fuel-injection applications, compressible-dissipation extensions to the k-epsilon turbulence model which provided marked improvements in simulating fundamental high-speed shear layers, have proven to work quite well for transverse jet injection. Author

N94-28041# Korea Research Inst. of Standards and Science, Taejon (Republic of Korea).

A NEW METHOD FOR TORSIONAL CRITICAL SPEED CALCULATION OF PRACTICAL INDUSTRIAL ROTORS

OH-SUNG JUN and PAUL Y. KIM (National Research Council of Canada, Vancouver, British Columbia.) Jul. 1993 78 p

(IMR-T&M-TR-001; CTN-94-61010) Avail: CASI HC A05/MF A01

A new approach to calculating the torsional critical speed of rotors is presented. The governing equations for these speeds and the method of solutions differ from existing methods such as Holzer's, and the theory and numerical algorithm are straight forward, without any change in the field variables. The rotor studied has a distributed mass and rigid disks, and consists of many shaft segments of different diameters. The exact solution for undamped torsional motion of a uniform shaft segment is applied to a practical rotor-bearing system to generate the simultaneous governing equations for the torsional critical speeds. Within the framework of the theory, the set of governing equations is completely analytical and explicit, and it does not include any approximations, such as discretization of shaft mass and polynomial approximations. A computer program for the torsional critical speeds and the related mode shapes is developed by introducing a simple recurring numerical algorithm for a 3 by 4 submatrix in calculating the determinant generated by the simultaneous equations. The numerical algorithm essentially eliminates the necessity of constructing a huge matrix. The effectiveness of the new method is demonstrated in analyses of three rotors. Author (CISTI)

N94-28043# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

GAS TURBINE ENGINE TRANSIENT BEHAVIOUR

1993 227 p Lecture series held in Rhode-Saint-Genese, Belgium, 10-12 May 1993

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(VKI-LS-1993-06; ETN-94-95454) Copyright Avail: CASI HC A11/MF A03

Information and data that are intended to provide an in depth understanding of gas turbine engine transient behavior, the modeling methods that are applied to transient events, and the simulation technology that supports the transient analysis process are presented. The diverse nature of the disciplines that are applied to the study of transient behavior makes it necessary to examine the subject from at least three perspectives: the application of the underlying technology to specific design and development concerns; the development of the mathematical models that support the various applications; and the computer programs that implement the models and provide the analytical capability required by the different applications. ESA

N94-28044# Rolls-Royce Ltd., Derby (England).

GAS-TURBINE ENGINE STEADY-STATE BEHAVIOR

BARRY CURNOCK *In* VKI, Gas Turbine Engine Transient Behaviour 35 p 1993

Copyright Avail: CASI HC A03/MF A03

A set of graphics with explanations illustrating gas turbine engine steady state behavior are presented. Typical combinations of compressors and nozzles which occur in a gas turbine engine are shown. The basic effect of a nozzle is explained by considering a compressor on a test rig: typical compressor, fan, and turbine characteristics are illustrated. The following are discussed: the degrees of freedom of an aeroengine (the flow and the power); the 'working lines' of components (the locus of the off design steady state operating points of a component plotted on a chart of that components characteristics); bleed and whirl; offtakes; P1 effects (performance changes which modify the basic nondimensional behavior an engine (caused by the effect on Reynolds number levels and on engine mechanical configuration of basic engine inlet pressure level)), and T1 effects (performance changes which modify the basic nondimensional behavior of an engine and are caused by the effects of engine inlet temperature level on Reynolds number level, on engine mechanical configuration and on specific heat level); variable nozzles; and turbojet matching. ESA

N94-28045# Rolls-Royce Ltd., Derby (England).

TRANSIENT PERFORMANCE

BARRY CURNOCK *In* VKI, Gas Turbine Engine Transient Behaviour 32 p 1993

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Gas turbine engine transient behavior, that which is concerned with the changes in engine parameters during acceleration or decceleration of an engine from one steady state point to a different steady state point, is considered. An engine can also experience cyclic aerodynamic phenomena which occur at a nominally steady condition; examples are compressor rotator stall and intake or afterburner buzz. The following are discussed: certification requirements; mechanism of acceleration; compressor working lines and surge; and some important factors (pressure level, moment of inertia, heat soakage, clearances, measurement of transients, thrust reversal, and transient maneuvers which involve significant changes to the shaft speeds of the engine). A set of graphics illustrating transient performance is presented. ESA

N94-28046# Rolls-Royce Ltd., Derby (England).

COMPRESSOR STABILITY

BARRY CURNOCK *In* VKI, Gas Turbine Engine Transient Behaviour 29 p 1993

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Various operating modes and conditions of the gas turbine which may cause compressor stall are considered. The behavior of a compressor in stall is explained because the engineer, although designing to avoid stall, must consider the possibility of stall and what control measures must be taken to recover engine operability. A major cause of stall is inlet distortion, that is a nonuniform pressure and/or temperature profile at entry to the compressor. The causes and effects of distortion are discussed. A set of graphics illustrating the above is also presented. ESA

N94-28047# Rolls-Royce Ltd., Derby (England).

ENGINE STARTING AND STOPPING

BARRY CURNOCK *In* VKI, Gas Turbine Engine Transient

Behaviour 36 p 1993
Copyright Avail: CASI HC A03/MF A03
Different starter systems for jet engines are discussed: electric, cartridge, iso-propyl-nitrate, air, gas turbine, and hydraulic. The fuel system, ignition system, air flow control system, and actual starting mechanism of an air starter motor system are considered. The variation of engine parameters throughout a typical starting sequence are described, with reference to examples for an RB211-535 engine. Physical constraints on engine starting are considered: rotating stall, light up, the window between hang and stall, hang, compressor stall, and the effects of ambient conditions. The following are also discussed: contractual and airworthiness requirements; windmilling; inflight relighting; afterburning light up; combustion stability; and broken shafts. Graphics illustrating the above are presented. ESA

N94-28048# General Electric Co., Owensboro, KY. Engine Simulation Technology.
TRANSIENT MODEL APPLICATIONS. 1: COMPRESSOR HEAT SOAK/CLEARANCE EFFECTS MODELING
PETER W. MCDONALD *In* VKI, Gas Turbine Engine Transient Behaviour 16 p 1993
Copyright Avail: CASI HC A03/MF A03
One of the potentially many ways in which expanding the objectives, requirements, and capabilities of engine simulation might improve the cost and time effectiveness of the engineering process in aircraft engine design is examined. The engine simulation developed for the analysis of heat soak and clearance effects on compressor performance and stability required technology interactions between heat transfer, mechanical design, and compressor aerodynamics. The objective and requirements of the models provided by the interacting technical disciplines were limited to the objectives of determining the compressors internal flow path heat transfer rates and clearances and the effect of these on the compressor performance and stability. The compressor aerodynamics model computes the performance of each compressor stage both at the stall line and the operating line with and without the stage heat addition and clearance variation. Boundary conditions for the aerodynamics model are required from the engine model as well as from the heat transfer and clearance models. ESA

N94-28049# General Electric Co., Owensboro, KY. Engine Simulation Technology.
TRANSIENT MODEL APPLICATIONS. 2: COMPRESSOR STALL MODELING METHODS
PETER W. MCDONALD and J. L. MOULTON *In* VKI, Gas Turbine Engine Transient Behaviour 18 p 1993
Copyright Avail: CASI HC A03/MF A03
A series of stall capable models which support the engine operability design effort for variable cycle engines is discussed. These models were derived from existing transient simulations which included the control, sensor, and actuator models. The process of constructing the stall models was accomplished in two steps. The first step was the addition of volume dynamics elements throughout the engine simulation. The core and bypass flows were partitioned into several volumes and the compression components were defined as sources and sinks of mass, momentum and energy at boundaries of these volumes. The second step was the extension of compression component performance representations to include in-stall operation. The methods used to accomplish these steps are illustrated with a simple model of a compressor test rig. Graphs showing the variation of compressor power, compressor momentum capability and system response and inlet corrected speed during a repeatable surge cycle and simulation are presented. The compressor inlet and exit pressure, the air flow and the temperature response during surge cycle simulation are graphically illustrated. In-stall and unstalled performance and efficiency are graphically illustrated at 70 to 75% corrected speed, and at 50 and 60% corrected speed. The temperature and momentum variation during a nonrecoverable stall simulation are also graphically illustrated. All graphs are discussed. ESA

N94-28050# General Electric Co., Owensboro, KY. Engine Simulation Technology.
TRANSIENT MODEL APPLICATIONS. 3: TRANSIENT ENGINE SIMULATION AND ANALYSIS OF AN ICE INGESTION TEST
PETER W. MCDONALD *In* VKI, Gas Turbine Engine Transient Behaviour 15 p 1993
Copyright Avail: CASI HC A03/MF A03
A transient engine model capable of simulating the transient response of an aircraft engine ice ingestion is examined. This model is required to simulate a controlled test which would provide data with which the model could be verified. Ice ingestion testing is routinely conducted with the objective of demonstrating the ability of an aircraft engine to safely operate while an aircraft passes through a hail storm. The most critical test condition is at a flight idle power setting where the engine power is low (or the capability to melt ice and evaporate water is limited) and the concentration of hail relative to the engine inlet airflow is high. The ice ingestion test was accomplished with a set of ice guns which shot large quantities of uniformly distributed ice at the fan hub region (into the core of the engine). The ice was crushed and filtered to match the size of hail stones and fired at a velocity consistent with the air speed being represented by the test. The response of certain engine parameters, as predicted by the model, to the ice ingestion test, is graphically illustrated and discussed. Examples include fuel flow, fan speed, core speed, compressor discharge pressure, compressor discharge temperature. ESA

N94-28051# McLaughlin (Peter), Glastonbury, CT.
ENGINE SIMULATION TECHNOLOGY
PETER MCLAUGHLIN *In* VKI, Gas Turbine Engine Transient Behaviour 14 p 1993
Copyright Avail: CASI HC A03/MF A03
A discussion of engine simulation technology which is intended to provide an overview of the continuous system simulation process as it has been applied in the gas turbine engine industry is presented. The topics include: devices employed in simulation, numerical and programming methods used; high level languages, applications toward which the simulation process is directed, organizational requirements, and future trends predicted by the current practice. ESA

N94-28052# McLaughlin (Peter), Glastonbury, CT.
TRANSIENT ENGINE SIMULATION
PETER MCLAUGHLIN *In* VKI, Gas Turbine Engine Transient Behaviour 9 p 1993
Copyright Avail: CASI HC A02/MF A03
The specific steps that are taken in the creation of a transient engine simulation program are presented. The types of models used in transient engine simulation are discussed: linear methods such as linear simulation background and Laplace transforms, nonlinear methods, and finite element methods. The process by which the simulation is used to generate useful data is discussed. ESA

N94-28053# McLaughlin (Peter), Glastonbury, CT.
NONLINEAR SOLVERS
PETER MCLAUGHLIN *In* VKI, Gas Turbine Engine Transient Behaviour 10 p 1993
Copyright Avail: CASI HC A02/MF A03
A typical example of a nonlinear solver used in several different engine simulation programs is described, including its interaction with the dynamic and discontinuous aspects of the model. The model equations are solved using the Newton-Raphson technique augmented by a matrix update based on Broyden's method. This solver is applied in both transient and steady state cases and provides reliable convergence of the set of implicit relationships required by the model. Broyden's method provides efficient convergence on component based engine models operating in the normal power range. However, several computations in a quasi Newton Broyden solver utilizing normalized parameters become indeterminate when the iteration variables, for example rotor speeds and flows, approach zero during starting or shutdown. REPLICAS (Rational, Effective Procedures and Logic for the Implementation

of Computerized Analysis and Simulation), is a collection of algorithms that is intended to provide convergence properties that are independent of the magnitudes of the iteration variables. In REPLICAS, a unique algorithm is employed which automatically provides an additive bias on the iteration variable. This bias is chosen in such a way as to maintain the magnitudes of the matrix elements at relatively constant values, independent of the absolute magnitude of the actual iteration variables. ESA

N94-28054# McLaughlin (Peter), Glastonbury, CT.
ENGINE SIMULATION SYSTEMS
PETER MCLAUGHLIN *In* VKI, Gas Turbine Engine Transient Behaviour 7 p 1993
Copyright Avail: CASI HC A02/MF A03

The development and utilization of gas turbine engine simulation systems, which are important elements of the process that supports design, development and product support activities, are described. A wide range of program requirements are described including user interfaces, numerical methods, software quality assurance, model and problem definition, model validation, program architecture, training, portability, reliability, error detection and documentation. ESA

N94-28080# General Electric Co., Schenectady, NY.
DEVELOPMENT OF THE GAS TURBINE. PART 1: DESIGN PHILOSOPHY AND PERFORMANCE
LEROY O. TOMLINSON *In* VKI, Combined Cycles for Power Plants 65 p 1993
Copyright Avail: CASI HC A04/MF A04

The development of the gas turbine from its conception in the 1930's up until present day is outlined. Focus is on the industrial gas turbines which were designed specifically for large combined cycle power generation applications. The materials used, which have to be cost effective, reliable, and have a long life, are discussed. The gas turbine controls, which have almost universally developed to a computer based system to perform control logic sequencing and protective logic, are also considered. The information given includes development, in firing temperature, compressor pressure ratio, efficiency, NO(x) emission, and compressor air flow. ESA

N94-28085# Delaval-Stork V.O.F., Hengelo (Netherlands).
STEAM PLANT: STEAM TURBINES FOR COMBINED CYCLES
J. SCHRIEKEN *In* VKI, Combined Cycles for Power Plants 20 p 1993
Copyright Avail: CASI HC A03/MF A04

Parameters affecting steam turbines design are discussed and it is concluded that steam turbines for combined cycles are suitable for: powers between 1 and 250 MW; driving a generator, via a gearbox if necessary; drive through of powers which can be up to three times their own power; and ground level installation with up, side, or axial exhaust for condensing turbine applications. Parameters affecting the steam turbine performance are discussed: inlet conditions and flows, sliding inlet conditions, reheat cycles, fired and unfired heat recovery steam generators, cogeneration systems, and combined cycle for process steam supply. Aerodynamic design aspects of steam turbines for combined cycles are discussed. It is concluded that steam turbines for combined cycles have a large range of special requirements. Some typical aspects are: large exhaust annular areas and special exhaust arrangements for condensing steam turbines, drive through of the power of the gas turbines, high influence on the total cycle performance optimization, and a wide variety of extraction systems for cogeneration. ESA

N94-28095 ESDU International Ltd., London (England).
VORTEX GENERATORS FOR CONTROL OF SHOCK-INDUCED SEPARATION. PART 1: INTRODUCTION AND AERODYNAMICS
Dec. 1993 63 p
(ISSN 0141-4356)
(ESDU-93024-PT-1; ISBN-0-85679-877-0) Avail: ESDU

ESDU 93024 summarizes situations where vortex generators have been used to control shock-induced separation. It is suggested that their use should be considered at the design stage and not only as a fix for undesirable characteristics found post-flight. Types of vortex generators are reviewed and the aerodynamic principles of their operation considered. Attention is focused on vane types: co- or counter-rotating and biplane. By applying simplifying assumptions, the degree and range of mixing effectiveness, and the rate of vortex decay, are studied and offer some guidance on the streamwise extent of control, the lateral spacing and the height above the surface that are appropriate for both co- and counter-rotating types. The degree of control achievable on aerofoils is considered, and calculations also show the possible adverse effects on drag. The use of multiple arrays and the use of vortex generators to control shock-induced separation in corners are briefly discussed. The use of wind-tunnel tests to assess the effects of vortex generators is considered. ESDU

N94-28096 ESDU International Ltd., London (England).
VORTEX GENERATORS FOR CONTROL OF SHOCK-INDUCED SEPARATION. PART 3: EXAMPLES OF APPLICATIONS OF VORTEX GENERATORS TO AIRCRAFT
Dec. 1993 35 p
(ISSN 0141-4356)
(ESDU-93026-PT-3; ISBN-0-85679-879-7) Avail: ESDU

ESDU 93026 illustrates by case studies the use of the information in Parts 1 and 2 on the use of vortex generators to control shock-induced separation. The examples are the control of internal noise by the application of vortex generators on the forward cabin roof of a business aircraft (Gulfstream III), the control of separation associated with a three-shock pattern near the tip of a highly swept and tapered model wing in a wind-tunnel, and the improvement of the buffet maneuver boundary on a straight wing interceptor aircraft of the fifties. In each case the geometric details of the arrays of vortex generators tested are provided, the results obtained are described, and the aerodynamic principles involved that influence those results are assessed. ESDU

N94-28175 Southampton Univ. (England). Inst. of Sound and Vibration Research.
ON THE USE OF FEEDBACK TO CONTROL SOUND RADIATION FROM A PLATE EXCITED BY A TURBULENT BOUNDARY LAYER
D. R. THOMAS and P. A. NELSON Jan. 1994 60 p
(ISVR-TR-227) Copyright Avail: Issuing Activity (Inst. of Sound and Vibration Research, Univ. of Southampton, Southampton SO9 5NH, England)

It is shown that the problem of applying active control to simply supported plate excited by a turbulent boundary layer can be presented in a form which allows the application of optimal control theory. Linear regulator theory and stochastic linear regulator theory are briefly summarized and the application of the latter to sound radiation from a vibrating structure is illustrated by the simple example of a rigid piston excited by a random force. It is shown that the optimal control theory can be applied to such a problem if the sound power radiated by the structure is estimated from the vibration signal by means of a 'radiation filter'. A modal model for the vibration of an elastic structure is presented and the state space realization of the model is given. It is shown that a simple Corcos model of the turbulent boundary layer excitation can be modeled as a number of 'excitation filters'. The state space realization of these filters can be combined with the state space model of a vibrating plate to give a state space model of a turbulent boundary layer excited plate to which optimal control theory can be applied. In similar fashion the sound power radiated by the plate can be estimated by means of a 'radiation filter matrix'. A detailed account of the calculation of such a 'radiation filter matrix' is given. Hence, the state space forms of the 'excitation filters' and 'radiation filter matrix' can be combined with the state space model of the plate to give a system state space realization which can be used in the solution of a linear quadratic regulator problem. Once in such a form optimal control analysis is applied to the state equations and optimal reductions in the far field radiated power are obtained for various arrangements of control forces.

These results give insight into the possibilities for obtaining useful reductions in turbulent boundary layer induced noise in aircraft by the application of feedback control. They do not, however, enable the simple design of practical controllers. Author (revised)

N94-28181*# Colorado Univ., Boulder. Dept. of Aerospace Engineering Sciences and Center for Space Structures and Controls.
HIGH-PERFORMANCE PARALLEL ANALYSIS OF COUPLED PROBLEMS FOR AIRCRAFT PROPULSION Final Report
C. A. FELIPPA, C. FARHAT, S. LANTERI, U. GUMASTE, and M. RONAGHI Mar. 1994 38 p
(Contract NAG3-1273; RTOP 505-10-11)
(NASA-CR-195292; E-8658; NAS 1.26:195292; CU-CSSC-93-16)
Avail: CASI HC A03/MF A01

Applications are described of high-performance parallel, computation for the analysis of complete jet engines, considering its multi-discipline coupled problem. The coupled problem involves interaction of structures with gas dynamics, heat conduction and heat transfer in aircraft engines. The methodology issues addressed include: consistent discrete formulation of coupled problems with emphasis on coupling phenomena; effect of partitioning strategies, augmentation and temporal solution procedures; sensitivity of response to problem parameters; and methods for interfacing multiscale discretizations in different single fields. The computer implementation issues addressed include: parallel treatment of coupled systems; domain decomposition and mesh partitioning strategies; data representation in object-oriented form and mapping to hardware driven representation, and tradeoff studies between partitioning schemes and fully coupled treatment. Author

N94-28209# Northrop Corp., Pico Rivera, CA. B-2 Div.
ADVANCED METALLIC EXHAUST IMPINGED STRUCTURAL CONCEPTS DEMONSTRATION Interim Technical Report No. 2, 7 Nov. 1992 - 5 May 1993
J. W. BOHLEN, M. T. HAHN, and J. O. BUNCH Jun. 1993 110 p
(Contract F33615-92-C-3201)
Avail: CASI HC A06/MF A02

The goal of the program is to design, develop, and test an advanced metallic exhaust impinged structure. The technology developed will provide a generic solution that can be applied to future advanced aircraft. Phase 1 preliminary design was initiated for two film-cooled concepts using either slots or small holes (transpiration cooling). Both designs were based on the same loft lines, loading requirements, and thermal/pressure profiles (from computational fluid dynamics). Finite element, dynamic, and thermal analyses were begun for the designs and for an uncooled baseline design. The functionality and scalability of the designs were assessed. Preliminary design testing of the candidate structural materials was begun. Author (revised)

N94-28227*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A REVIEW OF RECENT AEROELASTIC ANALYSIS METHODS FOR PROPULSION AT NASA LEWIS RESEARCH CENTER
T. S. R. REDDY (Toledo Univ., OH.), MILIND A. BAKHLE (Toledo Univ., OH.), R. SRIVASTAVA (Toledo Univ., OH.), ORAL MEHMED, and GEORGE L. STEFKO Sep. 1993 25 p
(Contract NAG3-1137; NAG3-1234; NAG3-1230; RTOP 535-03-01; RTOP 505-63-5B)
(NASA-TP-3406; E-7535; NAS 1.60:3406) Avail: CASI HC A03/MF A01

This report reviews aeroelastic analyses for propulsion components (propfans, compressors and turbines) being developed and used at NASA LeRC. These aeroelastic analyses include both structural and aerodynamic models. The structural models include a typical section, a beam (with and without disk flexibility), and a finite-element blade model (with plate bending elements). The aerodynamic models are based on the solution of equations ranging from the two-dimensional linear potential equation to the three-dimensional Euler equations for multibladed configurations. Typical calculated results are presented for each aeroelastic model. Suggestions for further research are made. Many of the currently available aeroelastic models and analysis methods are being incorporated in a unified computer program, APPLE (Aeroelasticity Program for Propulsion at LEwis). Author (revised)

N94-28327 Ecole Polytechnique, Montreal (Quebec). Dept. of Mechnical Engineering.
TRANSITION FOR THREE-DIMENSIONAL, COMPRESSIBLE BOUNDARY LAYERS
R. MARTINUZZI, F. LAMARRE, and I. PARASCHIVOIU *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 45-48 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

The SCOLIC computer code was developed for three dimensional compressible boundary layers on airfoils operating in the transonic regime. The problem of estimating the location of the laminar to turbulent transition is solved using temporal stability theory, and the point of transition is estimated according to an amplification or N-factor criterion. The methodology used in the computer code is described and some results using SCOLIC are presented. Transition predictions obtained with SCOLIC were compared to experimental data for seven different airfoils and it was found that the results were generally satisfactory. Test results for the NAE airfoil series are typically represented by the NAE-80-060. The calculated N-values suggest that the profile design is very effective at suppressing instabilities. Eventually, an instability of frequency 11,456 Hz, with point of inception at about 10 percent chord, does lead to transition around 64 percent chord which agrees remarkably well with experimental observations. For the E-580 NLF airfoil, computed results indicate that instabilities at 162 Hz and 143 Hz lead to transition at about 60 percent chord, while the transition is experimentally observed to occur at 62.6 to 65 percent chord. SCOLIC reproduces the suppression of leading edge instabilities observed with this airfoil.
Author (CISTI)

N94-28350 Institute for Aerospace Research, Ottawa (Ontario).
EXPERIMENTAL INVESTIGATIONS INTO THE WALL INTERFERENCE AND SIDEWALL BOUNDARY LAYER EFFECTS IN THE NATIONAL RESEARCH COUNCIL/INST. FOR AEROSPACE RESEARCH HIGH REYNOLDS NUMBER 2-D TEST FACILITY
Y. NISHIMURA and K. A. SCHIPPERS *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 136-139 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

A wind tunnel was used to investigate the aerodynamic characteristics of a supercritical airfoil section. Tests were conducted in two different sized test sections. Comparisons of results from the two test sections are used to show the effects of the sidewall boundary layer. The investigations supported the present method of making the Mach number and incidence corrections for the ceiling/floor wall interference effects based on the classical concept of representing the model with a system of vortex, doublet, and source. The influence of the sidewall boundary layer effects result in not only a decrease in local freestream Mach number but also in an inducement of a spanwise Mach number gradient, which affects the spanwise distribution of the airfoil aerodynamic characteristics. Investigations on short-span models in the smaller of the two test sections show that the sidewall boundary layer effect in disturbing the two dimensionality of the test section flow leads to a spanwise nonuniformity of the drag distribution, especially near the flow conditions for the airfoil drag divergence where the drag levels are sensitive to even small Mach number differences across the span. Author (CISTI)

N94-28351 Institute for Aerospace Research, Ottawa (Ontario).
COMPUTATION OF WIND-TUNNEL SIDE-WALL INTERFERENCE USING 3D NAVIER-STOKES CODE
D. F. HAWKEN *In* Canadian Aeronautics and Space Inst.,

Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 140-143 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Progress is reported in the numerical modeling of wind tunnel sidewall interference using the ARC3D code. This code was originally configured to compute flows through a duct containing a center body, and was altered to compute flows about wings of constant cross section. ARC3D solves the Euler equations or the thin-layer Navier-Stokes equations transformed into the numerical cordinate system and converted into a conservative second order accurate central difference equation for flow evolution at each internal cell vertex. The residual at each internal cell vertex is updated by adding the fluxes through the walls of an equivalent cell surrounding each internal cell vertex. Second- and fourth-order artificial dissipation terms are added to the fluxes to prevent instability of the solution. The system of equations is iterated towards the steady state using an implicit approximate factorization time-stepping algorithm. Pressure profiles across the airfoils obtained using preliminary ARC3D calculations are illustrated. Various methods used to eliminate pressure spikes generated by the code are discussed. Author (CISTI)

N94-28352 Institute for Aerospace Research, Ottawa (Ontario). High Speed Aerodynamics Lab.

EVALUATION OF THE BUOYANCY DRAG ON AUTOMOBILE MODELS IN LOW SPEED WIND TUNNELS

MIROSLAV MOKRY *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 144-147 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Of the several sources of inaccuracy in interpreting wind tunnel data for automobile models, the most prominent is the blockage interference. Streamwise variation of the wall induced pressure gives, in addition, rise to buoyancy drag. Buoyancy drag is analyzed in closed, 3/4 open, and slotted wind tunnels. The disturbance velocity potential is represented by a simple layer distribution. A numerical solution is obtained by a first-order panel method, approximating the surface by an assembly of flat panels, with a piecewise constant source density. The increment of the pressure coefficient due to wall interference considers only the contributions of the wall panels. Examples of the calculated buoyancy drag are given for the generic car model of the Motor Industry Research Association. Judged by the magnitude of the buoyancy drag, experiments at high blockage ratios would be highly distorted if performed in a closed-wall test section. However, with 30 percent open area ratio slotted walls, the buoyancy drag is reduced to about the same magnitude as that for test sections with low blockage ratios. Author (CISTI)

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GEOSCIENCES

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

N94-24850 Massachusetts Inst. of Tech., Lexington. Lincoln Lab.

ASR-9 MICROBURST DETECTION ALGORITHM Project Report

O. J. NEWELL and J. A. CULLEN 22 Oct. 1993 68 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DTFA01-89-Z-0203)
(AD-A273591; ATC-197; DOT/FAA/NR-93/2) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The ASR-9 Wind Shear Processor (WSP) is intended as an economical alternative for those airports that have not been slated to receive a Terminal Doppler Weather Radar(TDWR) but have, or will be receiving, an ASR-9 radar. Lincoln Laboratory has developed a prototype ASR-9 WSP system which was demonstrated during the summer months of the past three years in Orlando, Florida. During the operational test period, microburst and gust front warnings, as well as storm motion indications, were provided to the Air Traffic Control in real time. The ASR-9 Microburst Detection Algorithm (AMDA) is based on the earlier TDWR Microburst Detection Algorithm, but has been substantially modified to better match the particular strengths and weaknesses of the ASR-9 rapid-scanning fan-beam radar. The most significant additions included a capability to detect overhead microbursts, a reflectivity processing step used to help detect velocity signatures that have been biased by overhanging precipitation, and a modification to some of the shear segment grouping and thresholding parameters to accommodate better the typical on-air siting of the ASR-9. In addition, the AMDA has been designed to be as efficient as possible to allow it to run at the radar's 4.8 seconds/scan antennas rotation rate on a single-board computer. A detailed description of AMDA, as well as the performance evaluation strategy and results, are presented in this report. DTIC

N94-25261# Technische Univ., Eindhoven (Netherlands).

WIND CLIMATE AND URBAN GEOMETRY Ph.D. Thesis

MARCEL BOTTEMA 1993 223 p
(ISBN-9-03-860132-8; ETN-94-95350) Copyright Avail: CASI HC A10/MF A03

A study to analyze and supplement existing knowledge of prediction of wind comfort, and to communicate the results to architects and town planners by means of either verbal or graphical design rules, is presented. This aim can be summarized with the words 'technology transfer'. Outdoor climate and its incorporation into the design process is discussed. Theories of boundary layer meteorology and obstacle aerodynamics are presented. Measuring and numerical simulation techniques are discussed. Wind climate at the considered site is mainly dependent on the wind amplification factor, with contribution on three different scale levels: surrounding terrain; building and building group; details of site. Each of these contributions are discussed. Distributions of discomfort probability around buildings are presented. An example of wind comfort evaluation is given. Development of a town plan at a windy location in Amsterdam (Netherlands) is described, as well as cooperation between the architect and the wind expert. Rules of thumb for design are presented. ESA

N94-25271*# Ensco, Inc., Melbourne, FL. Applied Meteorology Unit.

THE EVALUATION OF ASOS FOR THE KENNEDY SPACE CENTER'S SHUTTLE LANDING FACILITY Final Report

ANN YERSAVICH, MARK WHEELER, GREGORY TAYLOR, ROBIN SCHUMANN, and JOHN MANOBIANCO Mar. 1994 66 p
(Contract NAS10-11844)
(NASA-CR-195685; NAS 1.26:195685; REPT-94-001) Avail: CASI HC A04/MF A01

This report documents the Applied Meteorology Unit's (AMU) evaluation of the effectiveness and utility of the Automated Surface Observing System (ASOS) in terms of spaceflight operations and user requirements. In particular, the evaluation determines which of the Shuttle Landing Facility (SLF) observation requirements can be satisfied by ASOS. This report also includes a summary of ASOS' background, current configuration and specifications, system performance, and the possible concepts of operations for use of ASOS at the SLF. This evaluation stems from a desire by the Air Force to determine if ASOS units could be used to reduce the cost of SLF meteorological observations. Derived from text

N94-25755# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
ANALYSIS AND DEVELOPMENT OF AN F-5 POLLUTION PREVENTION MANAGEMENT PROGRAM WITH RECOMMENDATIONS FOR CREATION OF SIMILAR PROGRAMS FOR OTHER AIRCRAFT M.S. Thesis
JANICE M. GAVERN Sep. 1993 154 p
(AD-A274016; AFIT/GLM/LSY/93S-19) Avail: CASI HC A08/MF A02

A pollution prevention program for the F-5 aircraft was developed, and its utility and applicability as a generic framework for similar programs is described. A representative set of F-5 technical orders was analyzed by hand, and the identified chemicals, materials, and processes were loaded into a spreadsheet data base for additional analysis. The Environmental Protection Agency EPA 17 chemical list, and lists of ozone depleting chemicals (ODC's) were used as criteria to identify, for minimization, reduction, or elimination from use on the F-5, a hazardous material (hazmat) subset of those chemicals and materials which had already been identified. The identified hazmat substances were then 'rolled-up' into an F-5 Pollution Prevention Management Plan. Program management use and implementation of the information set out in such a plan were also described. Recommendations for additional research and development, and for required tools were included. Finally, actual examples of all of the material created were attached to the document. DTIC

N94-26016# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague (Netherlands). Physics and Electronics Lab.
AN OVERVIEW OF THE TNO CONTRIBUTION TO VAST 92
G. J. KUNZ and M. M. MOERMAN 2 Sep. 1993 42 p
(AD-A273751; FEL-93-A039; TDCK-TD-930480) Avail: CASI HC A03/MF A01

The 'Vertical Atmospheric Structure Trail' (VAST92) took place from September 28 to October 16, 1992 at the Wehr Technische Dienststelle (WTD 52), Oberjettenberg, Germany, in the framework of NATO working group AC/243 (Panel 4/RSG.8) on atmospheric propagation effects on electro-optical systems. The experiment was designed to quantify the influence of the atmospheric vertical structure variations on infrared propagation and imaging and on lidar means of remotely sensing the variations. The TNO-Physics and Electronics Laboratory participated with a lidar system, meteo and aerosol equipment. The lidar was stationed in the valley. An altimeter and meteo-equipment were mounted on the cable car. Aerosol spectrometers and meteorological equipment were used, including a sonic anemometer and a fast hygrometer to measure turbulence on the mountain. A large part of the data from these instruments is of crucial importance for the evaluation and interpretation of the data obtained by the other participants. In this report, we present an overview of the TNO instrumentation and experiments. A number of data sets have been processed to demonstrate the possibilities of the different instruments. Interpretation of the results is postponed to later reports. This report is also a guideline for processing the TNO data in conjunction with data from other participants. DTIC

N94-26700# Sandia National Labs., Albuquerque, NM.
ANALYSIS/TEST CORRELATION USING VAWT-SDS ON A STEP-RELAXATION TEST FOR THE ROTATING SANDIA 34 M TEST BED
J. G. ARGUEELLO, C. R. DOHRMANN, T. G. CARNE, and P. S. VEERS 1993 7 p Presented at the 13th Energy-sources Technology Conference and Exhibition (ETCE) on Wind Energy, New Orleans, LA, 23-26 Jan. 1994
(Contract DE-AC04-76DP-00789)
(DE94-002290; SAND-93-1656C; CONF-940113-3) Avail: CASI HC A02/MF A01

The combined analysis/test effort described compares predictions with measured data from a step-relaxation test in the absence of significant wind-driven aerodynamic loading. The process described is intended to illustrate a method for validation of time domain codes for structural analysis of wind turbine structures. Preliminary analyses were performed to investigate the transient dynamic response that the rotating Sandia 34 m Vertical Axis Wind Turbine (VAWT) would undergo when one of the two blades was excited by step-relaxation. The calculations served two purposes. The first was for pretest planning to evaluate the relative importance of the various forces that would be acting on the structure during the test and to determine if the applied force in the step-relaxation would be sufficient to produce an excitation that was distinguishable from that produced by the aerodynamic loads. The second was to provide predictions that could subsequently be compared to the data from the test. The test was carried out specifically to help in the validation of the time-domain structural dynamics code, VAWT-SDS, which predicts the dynamic response of VAWT's subject to transient events. Post-test comparisons with the data were performed and showed a qualitative agreement between pretest predictions and measured response. However, they also showed that there was significantly more damping in the measurements than included in the predictions. Efforts to resolve this difference, including post-test analyses, were undertaken and are reported. The overall effort described represents a major step in the process of arriving at a validated structural dynamics code. DOE

N94-26846# Army Research Lab., White Sands Missle Range, NM.
SURFACE ROUGHNESS LENGTHS Final Report
FRANK V. HANSEN Aug. 1993 34 p
(AD-A274550; ARL-TR-61) Avail: CASI HC A03/MF A01

The surface roughness length is the meteorological equivalent of an aerodynamic drag coefficient. The surface morphology and terrain relief contribute to the roughness, have a large effect upon surface drag, and influence the analysis of wind, temperature, and specific humidity profiles in the surface boundary layer, as well as the examination of the surface energy balance. Roughness lengths effectively determine the vertical wind shear just above the surface with atmospheric stability almost a direct function of shear and roughness. Experimentally, roughness lengths over many natural surfaces have been determined. Many summaries of estimated surface roughness have been prepared, with most listing only a few typical values. One comprehensive study tabulated all values according to the year the data were collected. In this current effort, an attempt has been made to list roughness as a function of five categories, that is, natural surfaces, including seasonal variations, agricultural lands, urban roughness, effective roughness, and land-use categories. DTIC

N94-26959# National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Technology Lab.
CLOUD LIQUID WATER CONTENT MEASUREMENT TESTS USING DUAL-WAVELENGTH RADAR Technical Memo
BROOKS E. MARTNER, ROBERT A. KROPFLI, L. EDWARD ASH (Colorado Univ., Boulder.), and JACK B. SNIDER Oct. 1993 53 p See also PB91-131839 and PB92-133800 Prepared in cooperation with Colorado Univ., Boulder
(PB94-125960; NOAA-TM-ERL-ETL-235) Avail: CASI HC A04/MF A01

The first field test of a dual-wavelength differential attenuation radar technique for providing range-resolved measurements of cloud liquid water content (LWC) was conducted in Colorado during and shortly after the 1991 Winter Icing and Storms Project (WISP91). A dual-wavelength system was improvised from existing radars of 3.2 cm and 0.87 cm wavelengths. The radar antennas were electronically slaved together and scanned in synchronization with each other and with a steerable microwave radiometer which was used for comparisons. The experiment had mixed results. LWC values computed by the radar technique for several cases during WISP91 were erratic and included negative values. These clouds were relatively dry, however, and did not provide a suitable sample for evaluating the technique's performance in the more hazardous aircraft icing conditions of high LWC. Radar measurements obtained alone shortly after the end of WISP91 yielded reasonable LWC values and patterns, but without independent data for verification. The analyses suggest the radar technique may work best for long path lengths through high-LWC clouds of small droplets that contain some moderately large ice crystals and for clouds containing large droplets up to drizzle sizes. NTIS

N94-27069# Army Topographic Engineering Center, Fort Belvoir, VA.

CONIFER TREE INFLUENCE ON DIGITAL TERRAIN ELEVATION DATA (DTED): A CASE STUDY AT DULLES INTERNATIONAL AIRPORT Final Report, Mar. - Aug. 1991

KEVIN R. SLOCUM Sep. 1993 27 p

(AD-A274213; TEC-0038) Avail: CASI HC A03/MF A01

Conifer tree influence on the collection and portrayal of Digital Terrain Elevation Data (DTED) is presented. Study sites are investigated which had dense conifer canopy closure. Two separate DTED collection techniques are examined in the context of studying conifer tree influence: (1) photo source auto-correlated, and (2) photo source operator assisted (floating dot). Field surveying is the mechanism used for collecting accurate, verifiable ground elevation data subsequently compared against the elevations of corresponding DTED positions. Estimated conifer tree stand heights (at the time of DTED photo source) are compared against the difference in value between DTED and field surveyed elevations. A close relationship between stand height and difference values demonstrates the potential for conifer tree height inclusion within DTED 'ground' elevations. Terrain modelling impacts caused by the addition of tree heights within the DTED are addressed. DTIC

N94-27973# *National Inst. of Polar Research, Tokyo (Japan).*

STATUS REPORT FOR THE DEVELOPMENT OF THE ANTARCTIC PENETRATOR: 1990-YEAR PROGRAM Report No. 2 [NANKYOKU JINKO JISHIN KANSOKUYO PENETORETA NO KAIHATSU: 1990 NENDO KEIKA HOKOKU]

KAZUO SHIBUYA, KATSUTADA KAMINUMA, MASAHIKO HAYAKAWA (Ministry of Education, Science and Culture, Sagamihara, Japan.), AKIO FUJIMURA (Ministry of Education, Science and Culture, Sagamihara, Japan.), SHIGEKI TSUKAMOTO (Ministry of Education, Science and Culture, Sagamihara, Japan.), HITOSHI MIZUTANI (Ministry of Education, Science and Culture, Sagamihara, Japan.), ISAO YAMADA, JUNJI KOYAMA, MINORU KASAHARA, KIYOSHI ITO et al. *In its* Antarctic Record, Vol. 36, No. 2 p 310-340 30 Jul. 1992 In JAPANESE Sponsored by Ministry of Education, Science and Culture, Tokyo, Japan

Avail: CASI HC A03/MF A02

GPS (Global Positioning System) differential positioning test on the Antarctic penetrator was made at the Aoyama Pasture in Hokkaido. The reference GPS receiving site was chosen at 200 km southwest of the Aoyama Pasture, taking the planned operation on the Soer Rondane Mountains 400 km profile in Antarctica into consideration. Three dummy penetrators were dropped twice by changing the release height in the range from 160 to 1,000 m above the ground. Six impact positions of the deployed penetrators were determined by a relative carrier phase measurement to an accuracy of 0.1 m, and the position results were compared with the post-processed GPS differential positions. When 10 to 20 sec duration GPS position data could be acquired at an interval of 1 sec before and after the release instance of the penetrator, the estimated impact position by tracing the falling trajectory was found to be within 30 m offset from the actual impact location determined by the relative carrier phase measurement. When the GPS hovering data could be acquired for at least 1 minute duration just above the impact crater, the calculated impact location via the hovering-helicopter GPS position data was found to be within 10 m offset from the actual impact location. The height accuracy of GPS differential positioning was +/- 10 m which is considered to degrade to +/- 20 m when the coordinates of the reference GPS receiving site were determined by the time-average of point-positioning results. Author (NASDA)

N94-28101*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SUMMARY OF NASA AEROSPACE FLIGHT BATTERY SYSTEMS PROGRAM ACTIVITIES

MICHELLE MANZO and PATRICIA ODONNELL *In* NASA. Marshall Space Flight Center, The 1993 NASA Aerospace Battery Workshop p 3-81 Feb. 1994

Avail: CASI HC A04/MF A10

A summary of NASA Aerospace Flight Battery Systems Program Activities is presented. The NASA Aerospace Flight Battery Systems Program represents a unified NASA wide effort with the overall objective of providing NASA with the policy and posture which will increase the safety, performance, and reliability of space power systems. The specific objectives of the program are to: enhance cell/battery safety and reliability; maintain current battery technology; increase fundamental understanding of primary and secondary cells; provide a means to bring forth advanced technology for flight use; assist flight programs in minimizing battery technology related flight risks; and ensure that safe, reliable batteries are available for NASA's future missions. Derived from text

N94-28117*# *Bell Telephone Labs., Inc., Cranbury, NJ.*

CHARGE EFFICIENCY OF NI/H2 CELLS DURING TRANSFER ORBIT OF TELSTAR 4 SATELLITES

W. C. FANG, DEAN W. MAURER, B. VYAS, and M. N. THOMAS *In* NASA. Marshall Space Flight Center, The 1993 NASA Aerospace Battery Workshop p 405-422 Feb. 1994

Avail: CASI HC A03/MF A10

The TELSTAR 4 communication satellites being manufactured by Martin Marietta Astro Space (Astro Space) for AT&T are three axis stabilized spacecraft scheduled to be launched on expendable vehicles such as the Atlas or Ariane rockets. Typically, these spacecraft consist of a box that holds the electronics and supports the antenna reflectors and the solar array wings. The wings and reflectors are folded against the sides of the box during launch and the spacecraft is spun for attitude control in that phase; they are then deployed after achieving the final orbit. The launch phase and transfer orbits required to achieve the final geosynchronous orbit typically take 4 to 5 days during which time the power required for command, telemetry, attitude control, heaters, etc., is provided by two 50 AH nickel hydrogen batteries augmented by the exposed outboard solar panels. In the past, this situation has presented no problem since there was a considerable excess of power available from the array. In the case of large high powered spacecraft such as TELSTAR 4, however, the design power levels in transfer orbit approach the time-averaged power available from the exposed surface area of the solar arrays, resulting in a very tight power margin. To compound the difficulty, the array output of the spinning spacecraft in transfer orbit is shaped like a full wave rectified sine function and provides very low charging rates to the batteries during portions of the rotation. In view of the typically low charging efficiency of alkaline nickel batteries at low rates, it was decided to measure the efficiency during a simulation of the TELSTAR 4 conditions at the expected power levels and temperatures on three nickel hydrogen cells of similar design. The unique feature of nickel hydrogen cells that makes the continuous measurement of efficiency possible is that hydrogen is one of the active materials and thus, cell pressure is a direct measure of the state of charge or available capacity. The pressure is measured with a calibrated strain gage mounted on the outside of the pressurized cell. Author

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

N94-25090*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
RESEARCH IN PROGRESS AND OTHER ACTIVITIES OF THE INSTITUTE FOR COMPUTER APPLICATIONS IN SCIENCE AND ENGINEERING Final Semiannual Report, 1 Apr. - 30 Sep. 1993
Dec. 1993 113 p
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191576; NAS 1.26:191576) Avail: CASI HC A06/MF A02

This report summarizes research conducted at the Institute for Computer Applications in Science and Engineering in applied mathematics and computer science during the period April 1, 1993 through September 30, 1993. The major categories of the current ICASE research program are: (1) applied and numerical mathematics, including numerical analysis and algorithm development; (2) theoretical and computational research in fluid mechanics in selected areas of interest to LaRC, including acoustic and combustion; (3) experimental research in transition and turbulence and aerodynamics involving LaRC facilities and scientists; and (4) computer science. Author

N94-25453# Dayton Univ., OH. Research Inst.
BIRDSTRIKE RESISTANT CREW ENCLOSURE PROGRAM Final Report, 1 Aug. 1984 - 1 Mar. 1992
GREGORY J. STENGER Aug. 1993 11 p
(Contract F33615-84-C-3404)
(AD-A273700; UDR-TR-92-87; WL-TR-93-3088) Avail: CASI HC A03/MF A01

This final report defines the program objectives, presents an abstract for each technical report generated, and lists the major papers and presentations resulting from the technical effort. Major program accomplishments, both generic and specific, are also enumerated. DTIC

N94-25454# Wright Lab., Wright-Patterson AFB, OH.
EXPERT SYSTEM RULE-BASE EVALUATION USING REAL-TIME PARALLEL PROCESSING Final Report, 1 Jun. - 1 Aug. 1993
JAMES L. NOYES Sep. 1993 35 p
(AD-A273701; WL-TR-93-3098) Avail: CASI HC A03/MF A01

A large rule-based expert system with each rule involving perhaps 10 out of 100,000 possible Boolean criteria, can require a significant amount of processing time to evaluate. This time can be reduced if all rules have a single consequent and have antecedents that contain only conjunctions of the Boolean criteria or their complements. If the consequences do not insert new facts into the rule-base, then parallel processing can be used with great efficiency. The value of a rule-based expert system to help solve a variety of diagnostic and advisory needs has been well-demonstrated over the last 2 decades. Parallel processing has become increasingly important for embedded systems in order to accelerate a variety of computations. This report discusses research connected to the development of a data structure and algorithm to perform parallel inferencing in rule-based systems. It also discusses a simulation technique for estimating the number of processors needed to evaluate a given number of rules and criteria within the required time. DTIC

N94-25992# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
MULTIPLE MODEL ADAPTIVE ESTIMATION APPLIED TO THE LAMBDA URV FOR FAILURE DETECTION AND IDENTIFICATION M.S. Thesis
DAVID W. LANE 2 Dec. 1993 237 p
(AD-A274078; AFIT/GE/ENG/93D-23) Avail: CASI HC A11/MF A03

Multiple Model Adaptive Estimation (MMAE) is a method of estimating unknown system parameters by modeling all possible parameter configurations in several models. The parameters for this research are failure status conditions associated with flight control actuators and sensors on the LAMBDA Unmanned Research Vehicle. The LAMBDA URV is an experimental aircraft operated by Wright Laboratory Flight Controls Division at Wright-Patterson Air Force Base, Ohio. Six actuator failures and eight sensor failures are modeled, along with the fully functional aircraft, in fifteen elemental Kalman filters. These filters propagate and update their own aircraft state estimates in real time. A probability computation representing the likelihood of each elemental filter's match to the true condition of the aircraft is used to generate relative probabilities for each filter's hypothesis. In this research, the MMAE algorithm is extended for the identification of dual failures through the use of a hierarchical structure of filter banks. The ability of the MMAE to identify dual failures in the face of wind gust uncertainty and sensor noise is investigated. Aircraft state excitation is required for effective MMAE performance. Therefore, the form of an optimal input dither signal is derived through extensive experimentation. Dither signals are applied to the command inputs of a Quantitative Feedback Theory flight control system which controls pitch rate, roll rate, and sideslip angle. In particular, the MMAE performance is studied as sinusoidal dither inputs are varied in frequency and magnitude. An analysis of tuning techniques for the elemental filters within the MMAE is presented. DTIC

N94-26009# Wright Lab., Wright-Patterson AFB, OH.
A VHDL REGISTER TRANSFER LEVEL MODEL OF THE LINEAR TOKEN PASSING MULTIPLEX DATA BUS PROTOCOL FOR THE HIGH SPEED DATA BUS Interim Report, 1 Jun. 1992 - 15 Jul. 1993
JERRY A. MYERS Sep. 1993 74 p
(Contract AF PROJ. 2003)
(AD-A273734; WL-TR-93-1125) Avail: CASI HC A04/MF A01

The research project abstract presented will describe the design process to develop a partial simulatable specification model written in VHDL at the register transfer level to describe the linear token passing multiplex data bus protocol ('PROTOCOL') specification. The PROTOCOL is a distributed token passing computer protocol which operates over a dual redundant bus. The PROTOCOL is used as the communications standard to implement the high speed data bus (HSDB) module specification. The PROTOCOL and HSDB specifications are two of the pave pillar avionics architecture bus specifications being developed for the F-22, LHX, and future military aircraft. While this model does not implement the entire HSDB protocol specification, it does implement enough of the referenced specifications to give credence to the concept of hardware simulation modeling of avionics specifications. This concept is applicable for both military and commercial applications written in the VHDL language at a specification level of detail. DTIC

N94-26289*# SET Group, Denver, CO.
TECHNOLOGY DRIVERS FOR FLIGHT TELEROBOTIC SYSTEM SOFTWARE
ROBERT LABAUGH *In* NASA. Langley Research Center, Selected Topics in Robotics for Space Exploration p 223-232 Dec. 1993
Avail: CASI HC A02/MF A03

Viewgraphs on technology drivers for flight telerobotic system software are included. Topics covered include: flight software lines of code; flight computer architecture; system safety; safety critical parameters; system safety - software functions. Author (revised)

N94-26725 Centre National d'Etudes Spatiales, Toulouse (France). Projet PRONAOS.
PRONAOS FLIGHT SOFTWARE: A REAL-TIME APPLICATION FOR A BALLOONBORNE SCIENTIFIC GONDOLA
ANDRE LAURENS *In its* Real-Time Embedded Processing for Space Applications p 153-168 Apr. 1993 In FRENCH
Copyright Avail: Issuing Activity (CEPADUES-Editions, 111, Rue Nicolas-Vauquelin, 31100 Toulouse, France)

The flight software for PRONAOS (French acronym for national program of submillimeter astronomy) is addressed. Space applications use more and more sophisticated (and expensive) onboard computers. The PRONAOS project (as well as other science projects) cannot afford such architectures and is to use only classical, almost old fashioned, solutions. The main effort is made on software and methodology, to realize the required functions with the required performance. PRONAOS scientific aims, environment, and global architecture are presented, and the main onboard software (called LV NAPS (NAPS (French acronym for PRONAOS stabilized balloon gondola))), the associated computer architecture, and its main algorithms, are described. The main methodological principles in use for the software development are presented, and how they helped to reach the project's goals is discussed. ESA

N94-26730 Alsys, Inc., Saint Cloud (France).
ADA MULTIPLE-PROGRAMMING FOR HARD REAL TIME APPLICATIONS IN SPACE SYSTEMS
MARC RICHARD-FOY *In* CNES, Real-Time Embedded Processing for Space Applications p 223-233 Apr. 1993 In FRENCH
Copyright Avail: Issuing Activity (CEPADUES-Editions, 111, Rue Nicolas-Vauquelin, 31100 Toulouse, France)

Ada implementation of the integrated modular avionics (IMA) is addressed. IMA puts the accent on three types of requirements found in avionic and space projects: hard real time, safety systems, and multiprogramming. The principal results of the formal method rate monotonic analysis (RMA) are outlined. In applying RMA to an Ada multiprogram system, a scheduling method simultaneously for programs and tasks satisfying IMA criteria must be developed. A multiprogram scheduling conforming to RMA analysis is proposed and a second model more appropriate to the IMA concept is described. The real time executive certification procedures and current and future standards of the IMA support concept and RMA with the Ada language are discussed. ESA

N94-26742 Sextant Avionique, Velizy-Villacoublay (France).
USE OF HOOD COUPLED TO REAL TIME MONITORS [UTILISATION DE HOOD COUPLEE A DES MONITEURS TEMPS REEL]
THIERRY GOHON and PHILIPPE GUEDOU *In* CNES, Real-Time Embedded Processing for Space Applications p 381-398 Apr. 1993 In FRENCH
Copyright Avail: Issuing Activity (CEPADUES-Editions, 111, Rue Nicolas-Vauquelin, 31100 Toulouse, France)

The Hierarchical Object Oriented Design (HOOD) method and Ada are both widely used for large embedded real time software. This design method is oriented toward Ada programming. It uses the Ada tasking to map the dynamical properties of objects. Some particular critical real time requirements may today be hardly compatible with the implementation of Ada tasking. A real time silicon executive RTO (Real Time Operation) providing real time services that can be called from the software was developed. The capability of using this microchip early in the HOOD design phase while keeping the high level of abstraction of the HOOD real time features is addressed. The RTO silicon executive is seen as an alternative to the Ada implementation of the HOOD. The use of HOOD with RTO to provide an efficient implementation of cyclic tasks is examined. The HOOD/RTO connection is seen as a step leading to validation of the use of HOOD with IMAGES (Integrated Modular Avionics General Executive Software). ESA

N94-27093# CSA Engineering, Inc., Palo Alto, CA.
SMART STRUCTURES, AN OVERVIEW Final Report, Sep. 1991 - Jul. 1993
KENNETH B. LAZARUS and KEVIN L. NAPOLITANO Sep. 1993 67 p
(Contract F33615-90-C-3211)
(AD-A274147; ASIAC-TR-93-9; WL-TR-93-3101) Avail: CASI HC A04/MF A01

This report assesses the current status and maturity of smart structures technology. The report contains sections on smart materials, neural networks, health monitoring, and smart structures component technologies such as actuators, sensory elements, control methodologies and algorithms, controller architecture and implementation hardware, and signal conditioning and power amplification. A strategic research and development plan is suggested for the Air Force. Eleven specific problems with Air Force aircraft structure and weapons systems are identified which have the potential for being alleviated or reduced by application of smart structures technologies. DTIC

N94-27120# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
GENETIC ALGORITHMS APPLIED TO A MISSION ROUTING PROBLEM M.S. Thesis
JAMES B. OLSAN Dec. 1993 125 p
(AD-A274130; AFIT/GCE/ENG/93-12) Avail: CASI HC A06/MF A02

This thesis applies genetic algorithms to a mission routing problem. The mission routing problem involves determining an aircraft's best route between a staging base and a target. The goal is to minimize the route distance and the exposure to radar. Potential routes are mapped to a 3-dimensional mesh where the nodes correspond to checkpoints in the route and the arcs correspond to partial paths of the route. Each arc is weighted with respect to distance and exposure to radar. A genetic algorithm is a probabilistic search technique loosely based on theories of biological evolution. Genetic crossover and survival of the fittest are the basis of a genetic algorithm's control structure and can be used for general problems. Encoding and evaluation of the data structure is problem specific. This thesis focuses on approaches to mapping the mission routing problem's mesh to a data structure which the genetic algorithm's control structure can effectively and efficiently manipulate. Three broad methods are proposed: Bounded Progress, Free Progress, and Restricted Progress. The Bounded Progress method uses a tightly-coupled mesh while the Free Progress method uses a loosely-coupled mesh. The Restricted Progress method is a hybrid of the other two methods. DTIC

N94-27121# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
USING DISCOVERY-BASED LEARNING TO PROVE THE BEHAVIOR OF AN AUTONOMOUS AGENT M.S. Thesis
DAVID N. MEZERA Dec. 1993 144 p
(AD-A274131; AFIT/GCE/ENG/93D-10) Avail: CASI HC A07/MF A02

Computer-generated autonomous agents in simulation often behave predictably and unrealistically. These characteristics make them easy to spot and exploit by human participants in the simulation, when we would prefer the behavior of the agent to be indistinguishable from human behavior. An improvement in behavior might be possible by enlarging the library of responses, giving the agent a richer assortment of tactics to employ during a combat scenario. Machine learning offers an exciting alternative to constructing additional responses by hand by instead allowing the system to improve its own performance with experience. This thesis presents NOSTRUM, a discovery-based learning (DBL) system designed to work in tandem with the MAXIM air combat simulator. Through a process of repeated experimentation modeled after the scientific method, NOSTRUM was able to discover many responses that were more appropriate than the single mode of agent control implemented in the original MAXIM program. NOSTRUM often found responses that dramatically improved the offensive position of the agent, and it sometimes placed the agent in position for an extended shot on the target when one was not available before. DTIC

N94-27913*# Missouri Univ., Columbia. Electrical and Computer Engineering.
AN OVERVIEW ON DEVELOPMENT OF NEURAL NETWORK TECHNOLOGY Abstract Only
CHUN-SHIN LIN *In* Old Dominion Univ., The 1993 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program p 129 Dec. 1993
Avail: CASI HC A01/MF A03

The study has been to obtain a bird's-eye view of the current neural network technology and the neural network research activities in NASA. The purpose was two fold. One was to provide a reference document for NASA researchers who want to apply neural network techniques to solve their problems. Another one was to report out survey results regarding NASA research activities and provide a view on what NASA is doing, what potential difficulty exists and what NASA can/should do. In a ten week study period, we interviewed ten neural network researchers in the Langley Research Center and sent out 36 survey forms to researchers at the Johnson Space Center, Lewis Research Center, Ames Research Center and Jet Propulsion Laboratory. We also sent out 60 similar forms to educators and corporation researchers to collect general opinions regarding this field. Twenty-eight survey forms, 11 from NASA researchers and 17 from outside, were returned. Survey results were reported in our final report. In the final report, we first provided an overview on the neural network technology. We reviewed ten neural network structures, discussed the applications in five major areas, and compared the analog, digital and hybrid electronic implementation of neural networks. In the second part, we summarized known NASA neural network research studies and reported the results of the questionnaire survey. Survey results show that most studies are still in the development and feasibility study stage. We compared the techniques, application areas, researchers' opinions on this technology, and many aspects between NASA and non-NASA groups. We also summarized their opinions on difficulties encountered. Applications are considered the top research priority by most researchers. Hardware development and learning algorithm improvement are the next. The lack of financial and management support is among the difficulties in research study. All researchers agree that the use of neural networks could result in cost saving. Fault tolerance has been claimed as one important feature of neural computing. However, the survey indicates that very few studies address this issue. Fault tolerance is important in space mission and aircraft control. We believe that it is worthy for NASA to devote more efforts into the utilization of this feature. Author

N94-28353# National Aerospace Lab., Amsterdam (Netherlands).
THE DETERMINISTIC POWER-SPECTRAL-DENSITY-METHOD FOR NONLINEAR SYSTEMS
R. NOBACK 25 Aug. 1992 58 p
(Contract OV/RLD-132)
(AD-B179687; NLR-TP-92342-U) Avail: CASI HC A04/MF A01

The deterministic power spectral density (P.S.D.) method can be derived from the design envelope analysis of the continuous P.S.D. method. It provides a method to determine a deterministic function that gives a maximum response equal to the P.S.D. design load for linear systems. The P.S.D. design load is undefined for nonlinear systems. In this report a 'reasonable extrapolation' of the deterministic P.S.D. method has been proposed for nonlinear systems. Design loads for a simple nonlinear aircraft model have been calculated. The results have been compared with results obtained with a 'reasonable extrapolation' of the P.S.D method using simulation. Author (revised)

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PHYSICS

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

N94-25026 National Physical Lab., Teddington (England).
EXERCISE KEEVIL: NOISE LEVELS OF SIX MILITARY HELICOPTERS
B. F. BERRY, A. L. HARRIS, R. J. WESTON (Royal Air Force, Halton, England.), and D. STEELE (Royal Air Force, Halton, England.) 1993 38 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB93-210722; NPL-RSA(EXT)0042) Copyright Avail: Issuing Activity (National Technical Information Service (NTIS))

For a number of years the National Physical Laboratory, supported by the Ministry of Defense, has been developing AIRNOISE, a mathematical model for computing aircraft noise contours. The model is now being extended to include helicopter operations. In order to provide basic source noise data for the model, a special noise trial - Exercise Keevil - has been conducted at RAF Keevil in Wiltshire. One helicopter of each of six types performed a variety of flight operations over an array of microphones. Information on aircraft position and speed were obtained by video tracking techniques. The report describes the trial and presents the results obtained. NTIS

N94-25172*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FAN NOISE RESEARCH AT NASA
JOHN F. GROENEWEG Feb. 1994 12 p Proposed for presentation at the 1994 National Conference on Noise Control Engineering, Fort Lauderdale, FL, 1-4 May 1994; sponsored by the Institute of Noise Control Engineering
(Contract RTOP 538-03-11)
(NASA-TM-106512; E-8623; NAS 1.15:106512) Avail: CASI HC A03/MF A01

Results of recent NASA research to reduce aircraft turbofan noise are described. As the bypass ratio of a turbofan engine increases from five to as much as 20, the dominant source of engine noise is the fan. A primary mechanism of tone noise generation is the rotor blade wakes interacting with downstream stator vanes. Methods of analyzing rotor stator tone noise generation are described and sample results are given. The role of an acoustic modal description is emphasized. Wind tunnel tests of model fans and nacelles are described including a novel rotating microphone technique for modal measurement. Sample far field results are given showing the effects of inlet length, and modal measurements are shown which point to a new generation mechanism. Concepts for active fan noise control at the source are addressed. Implications of the research which have general relevance to fan noise generation and control are discussed. Author (revised)

N94-25177*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering.
THE EFFECTS OF PROFILES ON SUPERSONIC JET NOISE Progress Report, period ending 31 Jan. 1994
S. N. TIWARI and T. R. S. BHAT Feb. 1994 39 p
(Contract NAG1-1581)
(NASA-CR-195184; NAS 1.26:195184) Avail: CASI HC A03/MF A01

The effect of velocity profiles on supersonic jet noise are studied by using stability calculations made for a shock-free coannular jet, with both the inner and outer flows supersonic. The Mach wave emission process is modeled as the noise generated by the large scale turbulent structures or the instability waves in the mixing region. Both the vortex-sheet and the realistic finite thickness shear layer models are considered. The stability calculations were performed for both inverted and normal velocity profiles. Comparisons are made with the results for an equivalent single jet, based on equal thrust, mass flow rate and exit area to that of the coannular jet. The advantages and disadvantages of these velocity profiles as far as noise radiation is concerned are discussed. It is shown that the Rayleigh's model prediction of the merits and demerits of different velocity profiles are in good agreement with the experimental data. Author (revised)

N94-25506*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VALIDATION OF VISION-BASED RANGE ESTIMATION ALGORITHMS USING HELICOPTER FLIGHT DATA
PHILLIP N. SMITH *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 293-311 Dec. 1993
Avail: CASI HC A03/MF A04

The objective of this research was to demonstrate the effectiveness of an optic flow method for passive range estimation using a Kalman-filter implementation with helicopter flight data. This paper is divided into the following areas: (1) ranging algorithm; (2) flight experiment; (3) analysis methodology; (4) results; and (5) concluding remarks. The discussion is presented in viewgraph format. Author (revised)

N94-25731# Federal Aviation Administration, Cambridge, MA.
INM, INTEGRATED NOISE MODEL. VERSION 4.11: USER'S GUIDE, SUPPLEMENT Final Report
GREGG G. FLEMING and JOHN R. DAPRILE Dec. 1993 85 p (AD-A273885; DOT-VNTSC-FAA-93-19; DOT/FAA/EE-93-03; PB94-134061) Avail: CASI HC A05/MF A01

The John A. Volpe National Transportation Systems Center (Volpe Center), in support of the Federal Aviation administration, Office of Environment and Energy, has developed Version 4.11 of the Integrated Noise Model (INM). The User's Guide for the Version 4.11 computer software is a supplement to INM, Version 3, User's Guide - Revision 1 for the Version 3.10 computer software released in June, 1992. The Version 4.11 supplement, prepared by the Volpe Center's Acoustics Facility, presents computer system requirements as well as installation procedures and enhancements. Specific enhancements discussed include: (1) the introduction of a takeoff profile generator; (2) the ability to account for terrain elevation around a specified airport; (3) the ability to compute the CNEL, WECPNL, LEQDAY, and LEQNIGHT noise metrics; (4) the ability to account for airplane runup operations; (5) the ability to account for displaced runway thresholds during approach operations; (6) an enhancement to the noise contour computations: (7) an increase in the number of takeoff profile segments; and (8) enhancements to the echo file. DTIC

N94-27283# Tokyo Inst. of Tech., Yokahama (Japan). Precision and Intelligence Lab.
SILENCE AMENITY ENGINEERING: PAST AND PRESENT
HAJIME FUJITA and YASUYUKI YOKONO *In its* Bulletin of Precision and Intelligence Laboratory, No. 68 p 1-7 Sep. 1993
Avail: CASI HC A02/MF A02

Recent historical development of the noise control engineering, from mere noise reduction to silence amenity engineering, is reviewed, with social and psychological backgrounds behind it. Philosophical view points for fundamental approach to the silence amenity engineering and examples of noise source control in vibration and aerodynamic noises are described. Author (NASDA)

N94-28195*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL STUDIES OF LOUDNESS AND ANNOYANCE RESPONSE TO SONIC BOOMS
BRENDA M. SULLIVAN (Lockheed Engineering and Sciences Co., Hampton, VA.) and JACK D. LEATHERWOOD *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 153-175 Feb. 1994
Avail: CASI HC A03/MF A03

The purpose of this paper is to summarize the most recent sonic boom laboratory studies performed at NASA-LaRC using the Sonic Boom Simulator. The first used synthesized idealized outdoor boom shapes which were filtered to represent booms heard inside a house. The test explored the efficacy of various metrics in assessing both loudness and annoyance responses to these booms. The second test investigated the effects of adding single reflections to idealized boom signatures, and the third compared booms recorded from real aircraft with idealized boom signatures to determine if subjects rated the real booms differently. In these studies, as in previous studies performed at NASA-LaRC, there was a continuing effort to evaluate metrics for predicting the subjective effects of sonic booms. Author (revised)

N94-28196*# Bolt, Beranek, and Newman, Inc., Canoga Park, CA. BBV Systems and Technologies.
COMPARISON OF METHODS OF PREDICTING COMMUNITY RESPONSE TO IMPULSIVE AND NONIMPULSIVE NOISE
SANFORD FIDELL and KARL S. PEARSONS *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 177-189 Feb. 1994
Avail: CASI HC A03/MF A03

Several scientific, regulatory, and policy-coordinating bodies have developed methods for predicting community response to sonic booms. The best known of these is the dosage-response relationship of Working Group 84 of the National Academy of Science's Committee on Hearing, Bioacoustics and Biomechanics. This dosage-response relationship between C-weighted DayNight Average Sound Level and the prevalence of annoyance with high energy impulsive sounds was derived from limited amounts of information about community response to regular, prolonged, and expected exposure to artillery and sonic booms. U.S. Army Regulation 201 adapts this approach to predictions of the acceptability of impulsive noise exposure in communities. This regulation infers equivalent degrees of effect with respect to a well known dosage-response relationship for general (nonimpulsive) transportation noise. Differences in prevalence of annoyance predicted by various relationships lead to different predictions of the compatibility of land uses with sonic boom exposure. An examination of these differences makes apparent several unresolved issues in current practice for predicting and interpreting the prevalence of annoyance due to sonic boom exposure.
Author (revised)

N94-28197*# McDonnell-Douglas Aerospace, Long Beach, CA. Transport Aircraft.
VARIABILITY OF MEASURED SONIC BOOM SIGNATURES
K. R. ELMER and M. C. JOSHI *In* NASA. Ames Research Center, High-Speed Research: Sonic Boom, Volume 1 p 191-218 Feb. 1994
(Contract NAS1-19060)
Avail: CASI HC A03/MF A03

The topics discussed include the following: atmospheric turbulence; BOOMFILE Database description; BOOMFILE flight conditions; XB-70 Database descriptions; analysis progression; extended database; prediction method; overpressure variability dependence on flight conditions; loudness variability on flight conditions; sonic boom variability in repeat flights; and statistical distributions. CASI

N94-28318 De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario). Structures Research and Development.
ASSESSING THE EFFECTS OF TUNED VIBRATION ABSORBERS (TVAS) ON INTERIOR CABIN NOISE LEVELS: A CORRELATION BETWEEN ANALYTICAL ACOUSTIC PREDICTIONS AND FLIGHT TEST MEASUREMENTS
RALPH GARCEA *In* Canadian Aeronautics and Space Inst., Abstracts of Papers Presented at the 4th CASI Aerodynamics Symposium p 9-12 1993
Avail: Issuing Activity (Canadian Aeronautics and Space Inst., 130 Slater Street, Suite 818, Ottawa, ON K1P 6E2 Canada)

Analytical predictions of interior noise levels were correlated with actual flight test data obtained during a program undertaken to develop the proper design and optimal distribution of tuned vibration absorbers for the Dash-8 Series 300 aircraft. The measured operational deflection shape data of the fuselage structure were used as boundary conditions for the interior noise predictions using a boundary element method model and finite element method modal analysis. The analytical modelling procedures used to represent the interior cavity, the underlying assumptions on which the predictions were based, and the correlations obtained are reported. The main assumptions were that the fuselage model was closed with rigid end caps (simulating cabin bulkheads) and that the interior acoustic field was solely due to the vibration of the fuselage skin. In addition, a panel acoustic power contribution analysis was performed to identify the most heavily radiating panels. For example, the skin panels between frames 271 and 290 contributed 62 percent of the total radiated output power at 60 Hz. The flight data and noise predictions correlated well, showing decreased sound pressure levels within the cabin interior due to the effects of the tuned vibration absorbers. Author (CISTI)

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

N94-25541*# RMS Associates, Linthicum Heights, MD.
NACA COLLECTIONS: A DIRECTORY OF SIGNIFICANT COLLECTIONS OF THE DOCUMENTS OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
RUTH S. SMITH Washington Mar. 1994 74 p Prepared for RMS Associates, Linthicum Heights, MD
(Contract NASW-4584)
(NASA-CR-195686; NAS 1.26:195686) Avail: CASI HC A04/MF A01

An alphabetical listing is given of 42 centers that hold National Advisory Committee for Aeronautics (NACA) documents. Information is given on the number of NACA holdings in paper copy, bound volumes, and microfiche. Additional information is given on the bibliographic records and availability. Author

N94-25665*# Universities Space Research Association, Houston, TX.
PROCEEDINGS OF THE 8TH ANNUAL SUMMER CONFERENCE: NASA/USRA ADVANCED DESIGN PROGRAM
1992 493 p Conference held in Washington, DC, 15-19 Jun. 1992
(Contract NASW-4435)
(NASA-CR-195118; NAS 1.26:195118) Avail: CASI HC A21/MF A04

Papers presented at the 8th Annual Summer Conference are categorized as Space Projects and Aeronautics projects. Topics covered include: Systematic Propulsion Optimization Tools (SPOT), Assured Crew Return Vehicle Post Landing Configuration Design and Test, Autonomous Support for Microorganism Research in Space, Bioregenerative System Components for Microgravity, The Extended Mission Rover (EMR), Planetary Surface Exploration MESUR/Autonomous Lunar Rover, Automation of Closed Environments in Space for Human Comfort and Safety, Walking Robot Design, Extraterrestrial Surface Propulsion Systems, The Design of Four Hypersonic Reconnaissance Aircraft, Design of a Refueling Tanker Delivering Liquid Hydrogen, The Design of a Long-Range Megatransport Aircraft, and Solar Powered Multipurpose Remotely Powered Aircraft.

N94-25796# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
A COST MODEL FOR USAF ACQUISITION OF COMMERCIAL AIRCRAFT FOR SERVICE IN THE SPECIAL AIR MISSION FLEET M.S. Thesis
C. G. MCVICKER, III and MICHAEL T. ROCHE 4 Jun. 1993 102 p
(AD-A274012; AFIT/GCA/LAS/93S-8) Avail: CASI HC A06/MF A02

The purpose of this research was to develop a cost estimating model which would allow cost estimators the ability to quickly and accurately estimate the acquisition of Air Force Special Air Mission fleet aircraft. The literature review revealed studies, government contracts, and trade publications which served as source data. This information was supplemented by interviews with acquisition specialists and contractors and incorporated into a database. Several estimating techniques were created and used to estimate the various cost elements. The Commercial Aircraft Integrated Cost Estimating Tool (CAICET) model was then developed to incorporate the estimating techniques with the database. This was accomplished by integrating dialog boxes to access the information and estimate the program acquisition. The CAICET model provides the analyst with the ability to estimate an acquisition program based on a few specific parameters concerning the missionization of the aircraft. These parameters include interior configuration, avionics, mission communications, and self-sufficiency items. Once this information is input, the CAICET model provides the analyst with a real-time estimate in standard AF Form 1537 format. DTIC

N94-27772*# National Aeronautics and Space Administration, Washington, DC.
NASA SBIR ABSTRACTS OF 1992, PHASE 1 PROJECTS
F. C. SCHWENK (Futron Corp., Bethesda, MD.), J. A. GILMAN (Futron Corp., Bethesda, MD.), J. B. PAIGE (Futron Corp., Bethesda, MD.), and S. M. SACKNOFF (Futron Corp., Bethesda, MD.) Washington Sep. 1993 148 p
(NASA-TM-109694; NAS 1.15:109694; SBIR-92-2) Avail: CASI HC A07/MF A02

The objectives of 346 projects placed under contract by the Small Business Innovation Research (SBIR) program of the National Aeronautics and Space Administration (NASA) are described. These projects were selected competitively from among proposals submitted to NASA in response to the 1992 SBIR Program Solicitation. The basic document consists of edited, non-proprietary abstracts of the winning proposals submitted by small businesses. The abstracts are presented under the 15 technical topics within which Phase 1 proposals were solicited. Each project was assigned a sequential identifying number from 001 to 346, in order of its appearance in the body of the report. Appendixes to provide additional information about the SBIR program and permit cross-reference of the 1992 Phase 1 projects by company name, location by state, principal investigator, NASA Field Center responsible for management of each project, and NASA contract number are included. Derived from text

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GENERAL

N94-25065 National Academy of Engineering, Washington, DC.
THE FUTURE OF AEROSPACE: PROCEEDINGS OF A SYMPOSIUM HELD IN HONOR OF ALEXANDER H. FLAX
1993 83 p Symposium was held in Washington, DC, 28 Feb. 1992
(LC-93-83945; ISBN-0-309-04881-8) Copyright Avail: Issuing Activity

This volume consists of papers and speakers' remarks presented during a symposium entitled 'The Future of Aerospace,' held Feb. 28, 1992. Topics covered include the defense industry and the new world order, the future of manned spaceflight, the current outlook for the aviation industry, applying technology to new airplane development, and the future of rotary wing aircraft.

N94-26155*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE EVOLUTION OF THE HIGH-SPEED CIVIL TRANSPORT
M. LEROY SPEARMAN Feb. 1994 48 p Presented at the AIAA Aircraft Design, Systems and Operations Meeting, Monterey, CA, 11-13 Aug. 1993
(Contract RTOP 505-69-20-01)
(NASA-TM-109089; NAS 1.15:109089) Avail: CASI HC A03/MF A01

Current research directed toward the technology requirements for a high-speed civil transport (HSCT) airplane is an outgrowth of many years of activity related to air transportation. The purpose was to review some of the events that provided the background upon which current research programs are built. The review will include the subsonic era of transport aircraft and some events of the supersonic era that are related to the development of commercial supersonic transport aircraft. These events include the early NASA in-house studies and industry evaluations, the U.S. Supersonic Transport (SST) Program, the follow-on NASA supersonic cruise research programs, and the issuance of the National Aeronautical Research and Development (R&D) goals. Observations are made concerning some of the factors, both technical and nontechnical, that have had an impact on HSCT studies. Author (revised)

N94-27431*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA LANGLEY RESEARCH CENTER SEVENTY-FIFTH ANNIVERSARY PUBLICATIONS, 1992
1992 205 p Original contains color illustrations
(NASA-TM-109691; NAS 1.15:109691; HHR-58) Avail: CASI HC A10/MF A03; 13 functional color pages

The following are presented: The National Advisory Committee for Aeronautics Charter; Exploring NASA's Roots, the History of NASA Langley Research Center; NASA Langley's National Historic Landmarks; The Mustang Story: Recollections of the XP-51; Testing the First Supersonic Aircraft: Memoirs of NACA Pilot Bob Champine; NASA Langley's Contributions to Spaceflight; The Rendezvous that was Almost Missed: Lunar Orbit Rendezvous and the Apollo Program; NASA Langley's Contributions to the Apollo Program; Scout Launch Vehicle Program; NASA Langley's Contributions to the Space Shuttle; 69 Months in Space: A History of the First LDEF; NACA TR No. 460: The Characteristics of 78 Related Airfoil Sections from Tests in the Variable-Density Wind Tunnel; NACA TR No. 755: Requirements for Satisfactory Flying Qualities of Airplanes; 'Happy Birthday Langley' NASA Magazine Summer 1992 Issue. CASI

N94-27764*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAS TECHNICAL SUMMARIES. NUMERICAL AERODYNAMIC SIMULATION PROGRAM, MARCH 1992 - FEBRUARY 1993
Mar. 1994 161 p Original contains color illustrations
(Contract RTOP 536-01-11)
(NASA-RP-1321; A-94015; NAS 1.61:1321) Avail: CASI HC A08/MF A02; 123 functional color pages

NASA created the Numerical Aerodynamic Simulation (NAS) Program in 1987 to focus resources on solving critical problems in aeroscience and related disciplines by utilizing the power of the most advanced supercomputers available. The NAS Program provides scientists with the necessary computing power to solve today's most demanding computational fluid dynamics problems and serves as a pathfinder in integrating leading-edge supercomputing technologies, thus benefitting other supercomputer centers in government and industry. The 1992-93 operational year concluded with 399 high-speed processor projects and 91 parallel projects representing NASA, the Department of Defense, other government agencies, private industry, and universities. This document provides a glimpse at some of the significant scientific results for the year. Author (revised)

Typical Subject Index Listing

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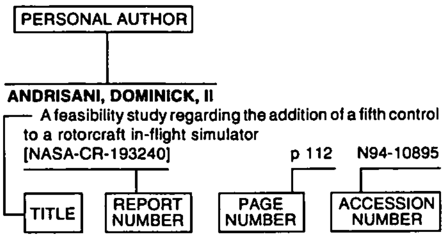

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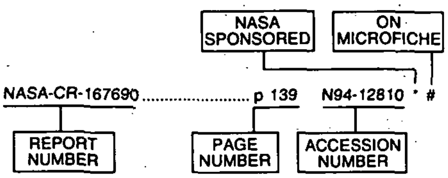

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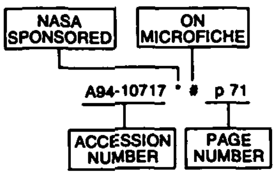

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