NASA SP-7037 (305)
June 1994

P-95

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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National Aeronautics and Space Administration
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INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 239 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)	N94-28399 — N94-30424
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.

TABLE OF CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT

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

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

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

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

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

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

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 305)

June 1994

01
AERONAUTICS (GENERAL)

N94-28666# Naval Aviation Logistics Center, Patuxent River, MD. Maintenance Office.
AIRCRAFT AGE IMPACTS ON MAINTENANCE REQUIREMENTS
JOHN JOHNSON Sep. 1993 21 p
(AD-A275701) Avail: CASI HC A03/MF A01

Under the current defense environment, decreasing economic resources limit new aircraft acquisition programs. As a consequence the Services will be forced to operate aging aircraft without replacement for many critical missions. The impact of this average age increase upon future Operating and Support (O&S) costs must be assessed properly if the Department of Defense decision makers are to make properly informed downsizing decisions. The Naval Aviation Maintenance Office, Logistics Engineering Department, Resource Analysis Division, has developed methodology, techniques and procedures for evaluating potential relationships between the age of in service aircraft and their O&S costs using existing data bases. The incidence of verified material failures (VF) and the Direct Maintenance Manhours (DMH) expended to correct them are correlated to the aircraft's age during its in-service operational life and are potential indicators of increased O&S Costs. The Naval Aviation Logistics Data Analysis (NALDA) data bases for Navy and Marine Corp aircraft contain historical operations and maintenance data which can serve as age indicators. DTIC

N94-28732# Naval Aviation Logistics Center, Patuxent River, MD. Maintenance Office.
AIRCRAFT AGE IMPACT ON INDIVIDUAL OPERATING AND SUPPORT COST ELEMENTS
LAURENCE STOLL and STAN DAVIS Sep. 1993 40 p
(AD-A275739) Avail: CASI HC A03/MF A01

This study develops methodology, techniques and procedures for evaluation of age related cost trends associated with major categories of Operating and Support cost. Data sources including Naval Aviation Logistics Data Analysis (NALDA) history, Chief of Naval Operations Flying Hour Projection System Budget Analysis Reports, Visibility and Management of Operating and Support Cost Maintenance Subsystem and Total Support System reports, and Naval Depot Production Performance Reports (PPR's) were used to evaluate cost trends over the most recent ten years of cost data. Detailed data was collected on ten major Type Model Series aircraft including the P-3C, S-3A, F/A- 18A/B, F-14A, CH-53E, SH-60B, E-2C, SH-3H, CH-46E and A-6E. Evaluations of age related trends and recommendations for changes in current estimating processes when appropriate have been developed for the following cost categories; (1) O&I Level Consumables/ Repair Parts (2) AVDLR's; (3) Aircraft Overhaul/Support; (4) Engine Overhaul/Support; (5) Petroleum, Oil, Lubricants (POL); (6) O and I level labor requirements. Results of this study clearly demonstrate age related trends of increasing costs linked to aircraft service life 'fleet age' for most of the categories under examination. DTIC

N94-28743# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Logistics and Acquisition Management.
DEMONSTRATION OF IMPROVED SOFTWARE SUPPORT LABOR ESTIMATION FOR AIR FORCE OPERATIONAL FLIGHT PROGRAMS THROUGH FUNCTIONAL ORIENTATION M.S. Thesis
RONALD R. WARNER, JR. and DARREL L. WRIGHT Dec. 1993 251 p
(AD-A275789; AFIT/GSS/LAS/93D-7) Avail: CASI HC A12/MF A03

This study demonstrated two approaches to improve current software support effort estimation models for aircraft software. Both approaches involved a functional orientation not used by existing models. The first approach demonstrated how to orient a model to reflect the block change cycle modification process and how to represent support effort changes over time in order to improve effort estimation accuracy. Current software models do not reflect the support environment or the temporal characteristics of aircraft software support. The second approach demonstrated how to calibrate a model by properly selecting source data in order to increase accuracy. Support calibration is not addressed by current models. A literature search affirmed the validity of both approaches and the methodology. In addition, a standard description of the block change cycle was developed and validated. A prototype estimation model was derived from the COCOMO model and included a unique support calibration. Data was obtained from Air Force Software Support Centers but was unusable, so data was generated from the prototype for the demonstration. A method that was developed to compare the prototype with current models demonstrated that the prototype is an acceptable model. DTIC

N94-29090 Aeronautical Research Labs., Melbourne (Australia).
FISHERMANS BEND: A CENTRE OF AUSTRALIAN AVIATION
J. L. KEPERT Sep. 1993 75 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A274981; ARL-GD-39; DODA-AR-008-377) Avail: CASI HC A04

Since 1919, Fishermens Bend, Victoria, has been a major center of Australian aviation. Many of Australia's great aviation achievements were born there. From its formation in 1939, the Aeronautical Research Laboratory, situated astride this activity at the Bend, has provided scientific and technical support to numerous aeronautical endeavors occurring in its surrounds. This report summarizes the many activities at the Bend from the first flight of an S11 Shorthorn from the Carey Airfield in 1919 to the production to the last indigenously built aircraft, the Nomad, in 1984. The aerodromes have long gone, the roar of aero-engines are contained within test cells, but the strong tradition of Australian aviation still lives on at the Bend today. DTIC

N94-29160 Sumitomo Heavy Industries Ltd., Tokyo (Japan).
STUDY OF BRIDGE DESIGN AND TECHNOLOGY
1993 89 p In JAPANESE
(PB94-137916) Copyright Avail: Issuing Activity (National Technical Information Service (NTIS))

Contents: Study of Super Long-span Bridge; ATMD System for Vibration Suppression on Bridge Tower; Effects of Turbulence Flow on Aerodynamic Characteristics of Box Girder Bridges; Aerodynamic Stability of Bridge Tower; Fabrication of 780N/mm2 Class High Tensile Steels Made Truss Member Chord; Structural Analysis System of Long

Span Bridge; Design of Akashikaikyo-ohashi Bridge; Design and Vibration Control of Tsurumi Fairway Bridge; Fabrication, Erection and Cable Vibration Control of Kemi 1-gousen Bridge; Repair Work of Girder on Hanshin Expressway Accidentally Damaged by Falling Heavy Load; *Countermeasure for Infra-sound and Erection of Dodairazawabashi* Bridge; Design, Fabrication, and Laying Down of 4A Steel Caisson for Kurushima-ohashi Bridge. NTIS

N94-29463# Aerospatiale, Paris (France).
A TIME REASONING SYSTEM BASED ON THE EVENT CALCULUS FOR SCHEDULING IN AERONAUTIC MAINTENANCE Ph.D. Thesis - Toulouse Univ. [UN SYSTEME DE RAISONNEMENT TEMPOREL BASE SUR LE CALCUL D'EVENEMENTS POUR L'ORDONNANCEMENT EN MAINTENANCE AERONAUTIQUE]
DENYS BERNARD 1993 214 p In FRENCH
(REPT-932-710-101; ETN-94-95487) Avail: CASI HC A10/MF A03

Problems specific to the planning and scheduling of aircraft maintenance work sites are addressed. Methods presently employed and their associated problems are considered. The event calculus of Kowaslki and Sergot is introduced. Its adaptation to the domain of aircraft maintenance is considered, together with the associated inference rules. This permits an appropriate representation of the whole of the actions which are treated in a particular problem. A description of all the axioms characterizing the different types of situation for which a plan is to be prescribed is given. This presupposes that the scheduling takes out or prevents intervention of 'bugs' which could constrain the time organization of the actions. The sequencing processed by the computer architecture is considered. The organization of the system is explained. The last program tested is presented. ESA

N94-29842# Lawrence Livermore National Lab., CA.
DUAL-BAND INFRARED (DBIR) IMAGING INSPECTIONS OF BOEING 737 AND KC-135 AIRCRAFT PANELS
N. K. DELGRANDE, K. W. DOLAN, P. F. DURBIN, M. R. GORVAD, and A. B. SHAPIRO 27 Aug. 1993 55 p
(Contract W-7405-ENG-48)
(DE94-005700; UCRL-CR-115237) Avail: CASI HC A04/MF A01

We apply dual-band infrared (DBIR) imaging as a dynamic thermal tomography tool for wide area inspection of a Boeing 737 aircraft and several Boeing KC-135 aircraft panels. Our analyses are discussed in this report. After flash-heating the aircraft skin, we record synchronized DBIR images every 40 ms, from onset to 8 seconds after the heat flash. We analyze selective DBIR image ratios which enhance surface temperature contrast and remove surface-emissivity clutter (from dirt, dents, tape, markings, ink, sealants, uneven paint, paint stripper, exposed metal, and roughness variations). The Boeing 737 and KC-135 aircraft fuselage panels have varying percent thickness losses from corrosion. We established the correlation of percent thickness loss with surface temperature rise (above ambient) for a partially corroded F-18 wing box structure and several aluminum reference panels. Based on this correlation, lap splice temperatures rise 1 C per 24 +/- 5 % material loss at 0.4 s after the heat flash. We show tables, charts and temperature maps of typical lap splice material losses for the riveted (and bonded) Boeing 737 and the riveted (but unbonded) Boeing KC-135. We map the fuselage composite thermal inertia, based on the (inverse) slope of the surface temperature versus inverse square root of time. Composite thermal inertia maps characterize shallow skin defects within the lap splice at early times (less than 0.3 s) and deeper skin defects within the lap splice at late times (greater than 0.4 s). Late time composite thermal inertia maps depict where corrosion-related thickness losses occur. Lap splice sites on a typical Boeing KC-135 panel with low composite thermal inertia values had high skin-thickness losses from corrosion. DOE

02 AERODYNAMICS

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

N94-28658*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STEADY PRESSURE MEASUREMENTS ON AN AEROELASTIC RESEARCH WING (ARW-2)
MAYNARD C. SANDFORD, DAVID A. SEIDEL, and CLINTON V. ECKSTROM Feb. 1994 537 p
(Contract RTOP 505-63-50-15)
(NASA-TM-109046; NAS 1.15:109046) Avail: CASI HC A23/MF A04

Transonic steady and unsteady pressure tests have been conducted in the Langley transonic dynamics tunnel on a large elastic wing known as the DAST ARW-2. The wing has a supercritical airfoil, an aspect ratio of 10.3, a leading-edge sweep back angle of 28.8 degrees, and two inboard and one outboard trailing-edge control surfaces. Only the outboard control surface was deflected to generate steady and unsteady flow over the wing during this study. Only the steady surface pressure, control-surface hinge moment, wing-tip deflection, and wing-root bending moment measurements are presented. The results from this elastic wing test are in tabulated form to assist in calibrating advanced computational fluid dynamics (CFD) algorithms.
Author (revised)

N94-28674# Naval Postgraduate School, Monterey, CA.
AERODYNAMIC DESIGN USING PARALLEL PROCESSORS Ph.D. Thesis
STEPHEN C. BRAWLEY Sep. 1993 152 p
(AD-A275470) Avail: CASI HC A08/MF A02

An airfoil design technique has been developed which decreases the computational processing time by more than an order of magnitude when optimizing aerodynamic performance. The practicality of airfoil design using parallel processors and Navier-Stokes flow solvers has been demonstrated. *Typically, an airfoil is designed to meet certain* criteria based upon its aerodynamic performance at set flight conditions. If an optimization technique is used for airfoil design, the shape of the airfoil is varied, and the aerodynamic performance of numerous airfoil geometries are evaluated using computational fluid dynamics. Multiple aerodynamic performance evaluations require the vast majority of computational processing time used in airfoil design optimization.
DTIC

N94-28899# Polytechnic Univ., Brooklyn, NY. Dept. of Aerospace Engineering.
EXPERIMENTAL INVESTIGATION OF THREE-DIMENSIONAL VORTEX-AIRFOIL INTERACTION IN A SUPERSONIC STREAM Final Report, 15 Oct. 1992 - 14 Oct. 1993
IRAJ M. KALKHORAN Dec. 1993 30 p
(Contract F49620-93-1-0009)
(AD-A275107; POLY-AE-93-8; AFOSR-94-0027TR) Avail: CASI HC A03/MF A01

An experimental study involving interaction between streamwise wing-tip vortices and a two-dimensional lifting surface in a supersonic stream was conducted. The experiments were designed to simulate interaction of supersonic vortices with aerodynamic surfaces of high-speed aircraft and missiles. The experimental scheme involves positioning an instrumented two-dimensional wedge downstream of a semi-span wing so that the trailing tip-vortex from the wing interacts with the aerodynamic surface. Experimental results indicate that the interaction strongly depends on the vortex strength and vortex proximity to the wedge leading edge. In their most organized form, distortion of streamwise vortices upon interacting with the wedge was found to result in formation of symmetric detached shock fronts far upstream of the wedge leading edge followed by an apparent slip surface separating a subsonic region from a supersonic zone. Interaction of vortices with

oblique shock wave over the wedge section indicates that interaction of a relatively weak vortex with a moderate strength oblique shock does not lead to significant changes in the vortex structure. On the other hand, interaction of a moderate strength vortex with a strong oblique shock results in the formation of a detached shock wave upstream of the oblique shock front. DTIC

N94-28946# National Aerospace Lab., Tokyo (Japan).
PROCEEDINGS OF THE 10TH NAL SYMPOSIUM ON AIRCRAFT COMPUTATIONAL AERODYNAMICS [DAI 10 KAI KOKUKI KEISAN KUKI RIKIGAKU SHINPOJIUM U RONBUNSHU]
Dec. 1992 268 p In ENGLISH and JAPANESE Symposium held in Tokyo, Japan, 10-12 Jun. 1992
(ISSN 0289-260X) (NAL-SP-19; JTN-94-80612) Avail: CASI HC A12/MF A03

The following topics were discussed: Monte Carlo simulation using variable soft sphere model, numerical simulation of shock wave, airfoil design using Navier-Stokes code, numerical analysis of supersonic flow, numerical simulation of three dimensional shear flow, and programming and interface for numerical wind tunnel.
Author (NASDA)

N94-28952# Kyushu Univ., Fukuoka (Japan). Dept. Aeronautics and Astronautics.
NUMERICAL SIMULATION OF UNSTEADY AERODYNAMIC HEATING INDUCED BY SHOCK REFLECTIONS [SHOGEKIHA NI YUKISARETA HITEIJO KURIKI KANETSU GENSHO NO SUCHI SHIMYURESHON]
SHIGERU ASO, KENICHI OHYAMA, and MASANORI HAYASHI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 27-32 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical simulations on unsteady shock reflections by a ramp have been conducted in order to investigate unsteady aerodynamic heating due to shock reflection processes at higher incident shock Mach number. The two-dimensional Navier-Stokes equations with thin layer approximation are solved numerically by a TVD (Total Variation Diminishing) scheme. The effect of mesh refinement to the calculated results is investigated carefully. The results show the smaller mesh size is necessary for calculating precise aerodynamic heating loads and capturing the fine structure of the shock reflection patterns.
Author (NASDA)

N94-28953# National Aerospace Lab., Kakuda (Japan).
NUMERICAL SIMULATION OF STEADY MACH REFLECTION BY SHOCK CAPTURING SCHEMES [SHOGEKIHA HOKAKUHO NIYORU TEIJO MAHHA HANSHA NO SUCHI SHIMYURESHON]
TAKESHI KANDA, KATSUHIRO ITO, KOUICHIRO TANI, and MASAHIRO TAKAHASHI In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 33-37 Dec. 1992 In JAPANESE
Avail: CASI HC A01/MF A03

Modern shock capturing schemes, i.e., solution adaptive interpolatory schemes, supply beautiful solutions, so they are used generally even in the industrial world. There is a problem in shock capturing schemes, however, when there are plural shocks within the grid points constructing a numerical flux. In order to stabilize a numerical solution in such a scheme, the accuracy must be degenerated. Such a situation can be often seen in two dimensional flow field, and steady Mach reflection is a typical example of the plural shock flow. An analytical solution of the steady Mach reflection was shown, and an investigation of shock capturing scheme performance by comparing it with present analysis was proposed. In this report, a newly developed scheme was also used to investigate the characteristics of the shock capturing schemes, and the performances of TVD (Total Variation Diminishing) scheme and of the new scheme were compared. Carbuncle phenomena and entropy layer on the wall were also discussed.
Author (NASDA)

N94-28954# Tohoku Univ., Sendai (Japan). Div. of Engineering.
HIGHER-ORDER ACCURATE NUMERICAL SIMULATION OF 3D SUPERSONIC MIXING LAYERS [SANJIGEN CHOONSOKU KONGOSO NO KOJI SEIDO SUCHI SHIMYURESHON]
KOICHI ISHIZAKA, SATORU YAMAMOTO, and HISAAKI DAIGUJI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 39-44 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

The purpose of the present paper is to perform direct numerical simulations of the time-developing subsonic and supersonic mixing layers. In order to simulate unsteady shock-vortex interactions accurately, a fourth-order accurate shock capturing scheme is used. This scheme is based on the third-order accurate upwind finite-difference scheme and the accuracy can be extended to fourth(fifth)-order by adopting additional compact terms into the schemes. The resolution is higher than the existing scheme and the algorithm is simpler than the ENO (Essentially Non-Oscillatory) scheme. Finally, some numerical results of subsonic and supersonic mixing layers are shown and the reliability is discussed in comparison with the ordinary numerical scheme. Author (NASDA)

N94-28955# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SIMULATION OF AEROTHERMODYNAMIC HEATING OF HYPERSONIC SPACE TRANSPORTATION VEHICLES [CHOKOSOKU HIKOTAI NO KURIKI KANETSU: CFD TO FUDOSHIKEN]
YUKIMITU YAMAMOTO In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 45-50 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical hypersonic aerodynamic studies of space planes, H-2 Orbiting Plane (HOPE). and OREX (Orbital Re-entry EXperiment) have been conducted for several years. In this paper, the analysis of the aerodynamic heating and real gas effects is described. Numerical results are compared with the heat transfer data obtained by various experimental techniques. Author (NASDA)

N94-28958# Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
NUMERICAL ANALYSIS OF AIRFOIL FOR HELICOPTER BLADE AT HIGH ANGLE OF ATTACK USING NAVIER-STOKES CODE [NABIE SUTOKUSU KAISEKI NIYORU HERI BUREDO YOKUGATA NO KOGYOKAKU TOKUSEI SUISAN NO KOKOROMI]
NAOHITO ADACHI, MITSUO ISHIGURO, MASAHIRO NAKAO, NAOKI HIROSE, and MAMORU SATOU In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 63-68 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical analysis using an Navier-Stokes code is conducted in order to develop a method to simulate flow fields around helicopter airfoils at high angle of attack. The results are compared with experimental data to investigate the subject for the simulation of the flow fields at high angle of attack. Based on the investigation, the effect of the grid system is examined. It is shown that the concentration of the grid at the trailing edge is important. Author (NASDA)

N94-28959# Fuji Heavy Industries Ltd., Tokyo (Japan).
NUMERICAL ANALYSIS OF SUPERSONIC TRANSPORT WINGS [CHOONSOKU YUSOKI SHUYOKU KEIJO NO SUCHI KAISEKI]
TETSUO YAMAZAKI and TAKASHI UCHIDA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 69-74 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical analysis of supersonic transport wings was carried out. The drag reduction obtained by using the warped wing design technique is from 0.0006 to 0.0010 in supersonic cruise condition. It is also clarified that the drag reduction by use of Euler analysis is less than that by the linear method, because the flow mechanism in supersonic region is essentially non-linear. Finally it is shown that the cranked arrow wing-

body configuration has the best lift to drag ratio in supersonic cruise condition in comparison with delta or ogee wing-body configuration.
Author (NASDA)

N94-28961# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
NUMERICAL SIMULATION OF SUPERSONIC FLOW AROUND SPACE PLANE WITH ENGINE INSTALLED [ENJIN TSUKI SUPESPUREN ZENKI KEIJO MAWARI NO NAGARE NO SUCHI SHIMYURESHON]
SHINICHI KURODA and KOZO FUJII In NAL, Proceedings of the 10th NAL *Symposium on Aircraft Computational Aerodynamics* p 81-86 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Airframe-engine integration is one of the most important problems in the area of supersonic inlet technologies. In the present paper the flow around an airframe-engine integration model is numerically simulated. Because of the geometrical complexity, the overlaid composite grid approach, based on the Fortified Solution Algorithm (FSA) concept, is used for the discretization strategy. In the present computation, the composite grid consists of four component grids. The primary grid is constructed with respect to the airframe, and the subsidiary grids are generated about the nacelle, duct, and diverter. The minor grids are used to resolve the features of the engine geometry and are overlaid on the main grid. The inviscid flow field is solved for this configuration at a Mach number of 2.75 and zero deg angle of attack. Although the overall flow features are successfully simulated by this preliminary computation, further improvement of the solution quality by grid enrichment and the discussion about the flow field are left as future work.
Author (NASDA)

N94-28962# Osaka Prefecture Univ., Sakai (Japan). Graduate School.
NUMERICAL ANALYSIS OF SONIC BOOM IN THE NEAR FIELD [KINOBA NIOKERU SONNIKKU BUMU NO SUCHI KAISEKI]
AKIHIKO YOSHIDA, KAZUHIRO NAKAHASHI, and SHOICHI FUJII In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 87-92 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical solutions of 3-D Euler equations are obtained for supersonic flows in order to investigate the sonic boom pressure signatures in the near field. The models used in the calculations are a body of revolution and two wing-body configurations. The results for the body of revolution indicate good agreement with the experimental data. A solution-adaptive-grid method which uses tension and torsion spring analogies is applied. The results show that this method improves the accuracy of solutions, and that sharper pressure signatures can be calculated than those in the initial grid. Author (NASDA)

N94-28963# Mitsubishi Electric Corp., Kamakura (Japan).
NUMERICAL ANALYSIS OF TWO DIMENSIONAL/ AXISYMMETRIC NON-EQUILIBRIUM HYPERSONIC FLOW [NIJIGEN/JIKU TAISHO GOKU CHOONSOKU HIHEIKORYU NO SUCHI KAISEKI]
TAKUJI KUROTAKI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 93-98 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical analysis of chemically and thermally non-equilibrium hypersonic flow around a sphere are carried out. Two-dimensional and axisymmetric full Navier-Stokes equations which have chemical and thermal non-equilibrium effects are considered by using Park's two-temperature model and the Landau-Teller vibrational relaxation model. An efficient numerical algorithm is constructed which consists of the combination of LU-SGS (Lower Upper-Symmetric Gauss-Seidel) schemes and the implicit diagonal method for a source Jacobian matrix for the time integration of an implicit finite difference method and MUSCL-type (Monotonic Upstream Centered Schemes for Conservation Laws) TVD (Total Variation Diminishing) scheme based on Roe-type flux splitting for convective terms. Shock location of both numerical results and experimental data are compared and good agreement is obtained in the wide range of Mach numbers up to M(sub infinity) = 16. Shock capturing capability is good enough to describe very strong discontinuity with no more than three grid points.
Author (NASDA)

N94-28965# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SOLUTION OF INVERSE PROBLEM IN AERODYNAMICS [KOKU RIKIGAKU NIOKERU GYAKUMONDAI TO SONO KAIHO]
SUSUMU TAKANASHI In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 105-108 Dec. 1992 In JAPANESE
Avail: CASI HC A01/MF A03

One of the most important inverse problems in aerodynamics is defined as the problem of finding the wing section contour given the desired surface pressure distribution for a fixed wing planform. This problem can be solved by the 'residual-correction' method based on the transonic integral equations. In this paper, some of the recent applications of the integral equation method using various analysis codes including Navier-Stokes codes are presented. Author (NASDA)

N94-28966# *Mitsubishi Heavy Industries Ltd., Tokyo (Japan).*
CODE DEVELOPMENT FOR HYPERSONIC REAL-GAS FLOW SIMULATIONS TOWARD THE DESIGN OF SPACE VEHICLES, PART 2 [KURIKI SEKKEI TSURU TOSHITE NO GOKU CHOONSOKURYU KEISANN KODO NO KAIHATSU. SONO 2]
MASAHIRO NAKAO and KOZO FUJII In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 109-114 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A hypersonic flow simulation system is under development. A flow analysis code, an adaptive grid generation code, and a computation code of equilibrium chemical composition as a post process routine have been developed. The flow analysis code that is based on 3-D upwind flux splitting scheme using the VEG (Variable Equivalent Gamma) method has been improved in order to simulate heat transfer distributions. Numerical simulations are conducted for flow fields around HOPE (H-2 Orbiting Plane). Flow conditions are Mach number of 15 and angle of attack of 30 degrees. Computed heat transfer ratio distributions are obtained. Results are compared with experimental data and good agreement is shown along a body symmetrical line of the lower surface. Author (NASDA)

N94-28967# Shimizu Corp. (Japan).
THREE DIMENSIONAL SIMULATION OF COMPRESSIBLE FLOW INDUCED BY A HIGH-SPEED TRAIN MOVING INTO A TUNNEL [TONNERU NI TOTSUNYUSURU KOSOKU SHARYO NIYOTTE YUKISARERU NAGAREBA NO SUCHI SHIMYURESHON]
TAKANOBU OGAWA, KOZO FUJII, and YOSHIAKI TAMURA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 115-120 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A three dimensional compressible flow induced by a practical high-speed train moving into a tunnel is numerically simulated. The flow field is decomposed with the zonal method and the Fortified Solution Algorithm (FSA) is used as an interface scheme. The result indicates that the algorithm is efficient to handle the moving boundary configurations which include a complicated geometry. The flow features, such as a compression wave and an expansion wave created by the train and an increment of drag force acting on the train are clarified.
Author (NASDA)

N94-28969# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
UNSTEADY AERODYNAMIC COMPUTATIONS AROUND NACA0012 AT HIGH ANGLES OF ATTACK [NACA0012 YOKUGATA MAWARI NO KOGYOKAKU NIOKERU HITEIJO KUKIRYOKU NO KEISAN]
KAZUHITO MIYATA, JIRO NAKAMICHI, and RINICHI MURAO In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 127-132 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

In the present study, periodic flows are simulated around NACA 0012 airfoil at high angle of attack to validate the unsteady Navier-Stokes code. Thin-layer approximated unsteady Navier-Stokes equations are integrated in a time-dependent manner with Baldwin-Lomax turbulence model. With Mach number, 0.3 and Reynolds number, 6 x 10(exp 6), characteristics of lift, drag and moment coefficients are investigated at a variety of angles of attack. The simulated flows are compared qualitatively with experimental results obtained by flow visualization conducted in a low-speed tunnel at higher angles of attack than that at which 'stall' occurs. The similar periodicity of the flows is found in the experimental result. Author (NASDA)

N94-28975# Tokyo Univ. (Japan). Graduate School.
STUDY ON MIXING AND INJECTION OF HYDROGEN INTO A SUPERSONIC FLOW [CHOONSOKURYU CHU ENO SUISO NO FUKIDASHI TO KONGO NIKANSURU KENKYU]
KAZUHIKO YOKOTA and SHOJIRO KAJI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 157-162 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

The effects of the injection methods on mixing of hydrogen in the free stream are investigated. The numerical simulations are performed by solving the full two-dimensional Navier-Stokes equations using the explicit symmetric total variation diminishing (TVD) scheme. As for the injection methods, single injection, tandem injection, and parallel injection are examined. The injected hydrogen mass flow is constant in all cases. Injection methods are evaluated by the correlation between the mixing efficiency and the mass flow averaged total pressure loss at the outlet boundary of the computational region. First, the injection angle is varied in case of single injection. The results show that the more forward the injection angle is leaned, the more deeply hydrogen penetrates into the free stream. Second case is tandem injection, and the distance between or mass flow ratio of two injections is varied. The results show that the upstream injection blocks the main stream, so the barrel shock of the downstream injection becomes larger and dominant in mixing in tandem injection. Last is parallel injection, and the distance from the wall to the injection is varied. The results show that parallel injected hydrogen can be mixed in the free stream in spite of the fact that it has no momentum perpendicular to the free stream. The correlations between the mixing efficiency and the total pressure loss in all cases show that the mixing efficiency in the parallel injection is two times as much as in other methods of injection.
Author (NASDA)

N94-29197 JAI Associates, Inc., Mountain View, CA.
A FREE-WAKE EULER AND NAVIER-STOKES CFD METHOD AND ITS APPLICATION TO HELICOPTER ROTORS INCLUDING DYNAMIC STALL Final Report, 1 May 1990 - 30 Sep. 1993
GANAPATHI R. SRINIVASAN Nov. 1993 127 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract DAAL03-90-C-0013)
(AD-A275416; TR-93-01; ARO-27752.8-EG-S) Avail: CASI HC A07

This report summarizes the results of the research in two parts. Part I describes the development and application of a free-wake Euler and Navier-Stokes computational fluid dynamics method, called 'TURNS', for helicopter applications. This finite-difference, implicit, upwind numerical method uses structured grids, and has been used for calculating the viscous, three-dimensional flow-fields of rotors in hover, forward flight, blade-vortex interactions, and high speed impulsive noise. The good agreement of numerical results with experiments for surface pressures, wake trajectory, thrust, power, Figure of Merit, and acoustic wave forms indicate the accuracy and suitability of the numerical method. It is demonstrated that both aerodynamics and acoustics information can be obtained in a single solution of the governing equations. In Part II, the unsteady flowfield results of a two-dimensional oscillating wing are presented for five widely used turbulence models and compared with experiments. The accuracy and suitability of turbulence models for unsteady separated flow are discussed. DTIC

N94-29306# Washington State Univ., Pullman.
AN EXPERIMENTAL STUDY OF WING TIP VORTEX IN THE NEAR WAKE OF A RECTANGULAR WING Interim Report, 1 Feb. 1991 - 31 May 1993
YOUXIN ZHENG and B. R. RAMAPRIAN Jun. 1993 209 p
(Contract DAAL03-91-G-0026)
(AD-A275389; MME-TF-93-1; ARO-28159.6-EG) Avail: CASI HC A10/MF A03

An experimental study of the tip vortex behind a NACA 0015 rectangular wing of aspect ratio 4 was carried out to understand the structure and evolution of the vortex in the near-wake region. The results of these experimental studies are presented in this report. These measurements were made nonintrusively using three-component laser-Doppler velocimetry (LDV). The experiments were carried out at a Reynolds number of about 180,000 in a low-speed wind tunnel. Two cases were studied, namely: (1) stationary wing, and (2) wing oscillating in pitch sinusoidally about its quarter-chord axis. The flow properties measured were the three components of the instantaneous velocity. These data were processed to obtain time-mean and phase-locked flow properties such as velocity, vorticity and turbulence. The data were obtained at several locations at 0.15 - 3.0 chord lengths downstream from the trailing edge. The typical distributions of mean velocity, vorticity, circulation and turbulent intensity in the near wake are presented and discussed for the stationary wing. In the case of the oscillating wing, the phase-locked velocity, vorticity and turbulence data show details of the evolution of the unsteady tip vortex downstream from the trailing edge. The results also show that the flow is strongly non-quasi-steady at the oscillation frequency studied. The results are fully archived on tape and are available to any interested reader. These can be used as database in the development of wake models for the finite wing, and in studies of three-dimensional wing aerodynamics.
DTIC

N94-29443*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A FLAT-PLATE PLANFORM MODEL OF AN ADVANCED FIGHTER CONFIGURATION
BRIAN E. MCGRATH (Lockheed Engineering and Sciences Co., Hampton, VA.), DAN H. NEUHART (Lockheed Engineering and Sciences Co., Hampton, VA.), GREGORY M. GATLIN, and PAT ONEIL Mar. 1994 36 p Original contains color illustrations
(Contract RTOP 505-68-70-05)
(NASA-TM-109045; NAS 1.15:109045) Avail: CASI HC A03/MF A01; 8 functional color pages

A flat-plate wind tunnel model of an advanced fighter configuration was tested in the NASA LaRC Subsonic Basic Research Tunnel and the 16- by 24-inch Water Tunnel. The test objectives were to obtain and evaluate the low-speed longitudinal aerodynamic characteristics of a candidate configuration for the integration of several new innovative wing designs. The flat plate test allowed for the initial evaluation of the candidate planform and was designated as the baseline planform for the innovative wing design study. Low-speed longitudinal aerodynamic data were obtained over a range of freestream dynamic pressures from 7.5 psf to 30 psf (M = 0.07 to M = 0.14) and angles-of-attack from 0 to 40 deg. The aerodynamic data are presented in coefficient form for the lift, induced drag, and pitching moment. Flow-visualization results obtained were photographs of the flow pattern over the flat plate model in the water tunnel for angles-of-attack from 10 to 40 deg. The force and

moment coefficients and the flow-visualization photographs showed the linear and nonlinear aerodynamic characteristics due to attached flow and vortical flow over the flat plate model. Comparison between experiment and linear theory showed good agreement for the lift and induced drag; however, the agreement was poor for the pitching moment. Author (revised)

N94-29473*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN EXPERIMENTAL AND THEORETICAL STUDY OF THE AERODYNAMIC CHARACTERISTICS OF SOME GENERIC MISSILE CONCEPTS AT MACH NUMBERS FROM 2 TO 6.8
M. LEROY SPEARMAN and DOROTHY O. BRASWELL Apr. 1994 31 p
(Contract RTOP 505-69-20-01)
(NASA-TM-109110; NAS 1.15:109110) Avail: CASI HC A03/MF A01

A study has been made of the experimental and theoretical aerodynamic characteristics for some generic high-speed missile concepts at Mach numbers from 2 to 6.8. The basic body for this study had a length-to-diameter ratio of 10 with the forward half being a modified blunted ogive and the rear half being a cylinder. Modifications made to the basic body included the addition of an after body flare, the addition of highly swept cruciform wings and the addition of highly swept aft tails. The effects of some controls were also investigated with all-moving wing controls on the flared body and trailing-edge flap controls on the winged body. The results indicated that the addition of a flare, wings, or tails to the basic body all provided static longitudinal stability with varying amounts of increased axial force. The control arrangements were effective in producing increments of normal-force and pitching-moment at the lower Mach numbers. At the highest Mach number, the flap control on the winged body was ineffective in producing normal-force or pitching-moment but the all-moving wing control on the flared body, while losing pitch effectiveness, still provided normal-force increments. Calculated results obtained through the use of hypersonic impact theory were in generally good agreement with experiment at the higher Mach numbers but were not accurate at the lower Mach numbers. Author (revised)

N94-29545*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL STUDIES OF TRANSONIC FLOW FIELD NEAR A LONGITUDINALLY SLOTTED WIND TUNNEL WALL Ph.D. Thesis - George Washington Univ., 1988
JOEL L. EVERHART and PERCY J. BOBBITT Apr. 1994 73 p
(Contract RTOP 506-40-41-01)
(NASA-TP-3392; L-16423; NAS 1.60:3392) Avail: CASI HC A04/MF A01

The results of detailed parametric experiments are presented for the near-wall flow field of a longitudinally slotted transonic wind tunnel. Existing data are reevaluated and new data obtained in the Langley 6- by 19-inch Transonic Wind Tunnel are presented and analyzed. In the experiments, researchers systematically investigate many pertinent wall-geometry variables such as the wall openness and the number of slots along with the free stream Mach number and model angle of attack. Flow field surveys on the plane passing through the centerline of the slot were conducted and are presented. The effects of viscosity on the slot flow are considered in the analysis. The present experiments, combined with those of previous investigations, give a more complete physical characterization of the flow near and through the slotted wall of a transonic wind tunnel. Author (revised)

N94-29674 Illinois Univ., Urbana-Champaign.
AN EXPERIMENTAL STUDY OF THE FLOWFIELD ON A SEMISPAN RECTANGULAR WING WITH A SIMULATED GLAZE ICE ACCRETION Ph.D. Thesis
ABDOLLAH KHODADOUST 1993 252 p
Avail: Univ. Microfilms Order No. DA9314893

The effect of a simulated glaze ice accretion on the flowfield of a semispan, reflection-plane, rectangular wing at Re = 1.5 million and M = 0.12 was investigated. A laser Doppler velocimeter was used to map the flowfield on the upper surface of the model in both the clean and iced configurations at alpha = 0, 4, and 8 degrees angle of attack. At low angles of attack, the massive separation bubble aft of the leading edge ice horn behaved in a manner similar to laminar separation bubbles. At alpha = 0 and 4 deg, the locations of transition and reattachment, as deduced from momentum thickness distributions, were in good agreement with transition and reattachment locations in laminar separation bubbles. These values at y/b = 0.470, the centerline measurement location, matched well with data obtained on a similar but two dimensional model. The measured velocity profiles on the iced wing compared reasonably with the predicted profiles from Navier-Stokes computations. The iced-induced separation bubble also had features similar to the recirculating region aft of rearward-facing steps. At alpha = 0 and 4 deg, reverse flow magnitudes and turbulence intensity levels were typical of those found in the recirculating region aft of rearward-facing steps. The calculated separation streamline aft of the ice horn at alpha = 4 deg, y/b = 0.470, coincided with the locus of the maximum Reynolds normal stress. The maximum Reynolds normal stress peaked at two locations along the separation streamline. The location of the first peak-value coincided with the transition location, as deduced from the momentum thickness distributions. The location of the second peak was just upstream of reattachment, in good agreement with measurements of flows over similar obstacles. The intermittency factor in the vicinity of reattachment at alpha = 4 deg, y/b = 0.470, revealed the time-dependent nature of the reattachment process. The size and extent of the separation bubble were a function of angle of attack and spanwise location. Three dimensional effects were strongest at alpha = 8 deg. The calculated separation and stagnation streamlines varied little with spanwise location at alpha = 0 deg. The calculated separation streamlines at alpha = 4 deg revealed that the bubble was largest near the centerline measurement plane, whereas the tip-induced vortex flow and the model root-tunnel wall boundary layer interaction reduced the size of the bubble. These effects were most dramatic at alpha = 8 deg. Dissert. Abstr.

N94-29760*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
NUMERICAL STUDY OF THE TRAILING VORTEX OF A WING WITH WING-TIP BLOWING
HOCK-BIN LIM Mar. 1994 136 p Sponsored by NASA. Ames Research Center
(NASA-CR-195803; NAS 1.26:195803; JIAA-TR-112) Avail: CASI HC A07/MF A02

Trailing vortices generated by lifting surfaces such as helicopter rotor blades, ship propellers, fixed wings, and canard control surfaces are known to be the source of noise, vibration, cavitation, degradation of performance, and other hazardous problems. Controlling these vortices is, therefore, of practical interest. The formation and behavior of the trailing vortices are studied in the present research. In addition, wing-tip blowing concepts employing axial blowing and spanwise blowing are studied to determine their effectiveness in controlling these vortices and their effects on the performance of the wing. The 3D, unsteady, thin-layer compressible Navier-Stokes equations are solved using a time-accurate, implicit, finite difference scheme that employs LU-ADI factorization. The wing-tip blowing is simulated using the actuator plane concept, thereby, not requiring resolution of the jet slot geometry. Furthermore, the solution blanking feature of the chimera scheme is used to simplify the parametric study procedure for the wing-tip blowing. Computed results are shown to compare favorably with experimental measurements. It is found that axial wing-tip blowing, although delaying the rolling-up of the trailing vortices and the near-field behavior of the flowfield, does not dissipate the circulation strength of the trailing vortex farther downstream. Spanwise wing-tip blowing has the effect of displacing the trailing vortices outboard and upward. The increased 'wing-span' due to the spanwise wing-tip blowing has the effect of lift augmentation on the wing and the strengthening of the

trailing vortices. Secondary trailing vortices are created at high spanwise wing-tip blowing intensities. Author (revised)

N94-29826 Maryland Univ., College Park.
AN ANALYTICAL STUDY OF UNSTEADY ROTOR/FUSELAGE INTERACTION IN HOVER AND FORWARD FLIGHT Ph.D. Thesis
GILBERT LEWIS CROUSE, JR. 1992 265 p
Avail: Univ. Microfilms Order No. DA9315626

An analytical study of the coupled rotor/fuselage aerodynamic environment is presented. Results from the analysis are used to help understand the nature of interactional phenomena on helicopters. Two analytical methods have been developed, and results from these models are compared with experimental measurements on a representative rotor/body model. The first method is a simplified analysis that treats the fuselage as a planar surface. This model is very computationally efficient, and is particularly useful for studying the pressure on the upper surface of the fuselage induced by the rotor and its wake. The second, and more comprehensive, model is the MURFI (Maryland Unsteady Rotor/Fuselage Interaction) model and consists of an unsteady source panel representation of the fuselage coupled with a lifting line rotor model and several different wake models. This analysis is more computationally expensive than the simplified model, but is capable of studying the entire coupled rotor/fuselage flowfield. In addition, the latter model is also used for the prediction of the effects of the fuselage on the rotor flowfield. A new helicopter free-wake methodology is also presented. The new model overcomes the well known instability of traditional free-wake methods in hover and in low-speed flight. In addition, the new method achieves this capability without an appreciable increase in computational effort. This model is particularly useful for interactional aerodynamics since the most severe wake/fuselage interactions occur in the hover and low-speed flight regime. Using these analytical models, results are shown that clearly demonstrate the capability of potential flow analyses to predict interactional effects, provided that all of the pertinent unsteady terms are included in the analysis. In particular, it is shown that the unsteady terms due to the time-rate-of-change of the surface source elements are very important to prediction of the surface pressure response. The analysis has also provided an improved understanding of the effects of the fuselage on the rotor loads and performance. Dissert. Abstr.

N94-29877 Purdue Univ., West Lafayette, IN.
TIME-MARCHING AEROELASTIC AND SPATIAL ADAPTATION PROCEDURES ON TRIANGULAR AND TETRAHEDRAL MESHES USING AN UNSTRUCTURED-GRID EULER METHOD Ph.D. Thesis
RUSS DAVID RAUSCH 1992 301 p
Avail: Univ. Microfilms Order No. DA9314067

Two- and three-dimensional, unstructured-grid, upwind-type Euler codes were modified to include time-marching aeroelastic and spatial adaptation procedures on triangular and tetrahedral meshes. The modifications for the time-marching aeroelastic procedures involve the addition of the structural equations of motion for their simultaneous time integration with the governing flow equations. A detailed description of the time-marching aeroelastic procedures is presented along with comparisons of computed results with experimental data to assess the accuracy of the capability. Flutter results are shown for both two and three-dimensional configurations including a NACA 0012 airfoil, an isolated 45 deg swept-back wing, and a supersonic transport configuration with a fuselage, clipped delta wing, and two identical rearward-mounted engine nacelles. The spatial adaptation procedures involve mesh enrichment and mesh coarsening to either add points in high gradient regions of the flow or remove points where they are not needed, respectively, in order to produce time-accurate solutions of high spatial accuracy at minimal computational cost. A detailed description of the enrichment and coarsening procedures is presented along with comparisons of computed results with experimental data to assess the accuracy of the capability. Steady results using the spatial adaptation procedures are shown for a NACA 0012 airfoil, an F-5 fighter wing, and an ONERA M6 wing. Unsteady results are shown for a NACA 0012 airfoil and a three dimensional simulation of a one-dimensional shock tube problem. The computed results are shown to be of high spatial accuracy, primarily in that shock waves are sharply captured. Dissert. Abstr.

N94-29879 Kansas Univ., Lawrence.
UNSTEADY TRANSONIC AERODYNAMICS IN FREQUENCY DOMAIN FOR FLUTTER ANALYSIS Ph.D. Thesis
TAI-HSING TOM SUN 1992 100 p
Avail: Univ. Microfilms Order No. DA9313180

A finite difference method for calculating the three dimensional nonlinear transonic flow in the frequency domain is presented for the solution of unsteady pressure distribution. The averaging technique is employed to separate the governing equation into the in-phase and the out-of-phase equations. These two equations are then solved simultaneously with the finite difference scheme adopted in an existing steady code. The modified code is verified by comparing the calculated results with experimental data and existing computational method for a uniform rectangular wing with NACA 64A010A airfoil, ONERA M6 wing, a uniform rectangular wing with symmetrical circular arc airfoil in pitching or structural bending oscillations. The results are shown in good agreement in most cases. The effects on the unsteady characteristics of grid number and convergence criterion are discussed. A new methodology for solving the nonlinear flutter condition is also discussed. The formulations using the Beecham-Titchner method shows that the flutter conditions can be easily determined. Dissert. Abstr.

N94-29893*# Eloret Corp., Palo Alto, CA.
PARTICLE KINETIC SIMULATION OF HIGH ALTITUDE HYPERVELOCITY FLIGHT Final Technical Report, 1 Jan. 1989 - 31 Jan. 1994
IAIN BOYD and BRIAN L. HAAS 19 Apr. 1994 17 p
(Contract NCC2-582)
(NASA-CR-194535; NAS 1.26:194535) Avail: CASI HC A03/MF A01

Rarefied flows about hypersonic vehicles entering the upper atmosphere or through nozzles expanding into a near vacuum may only be simulated accurately with a direct simulation Monte Carlo (DSMC) method. Under this grant, researchers enhanced the models employed in the DSMC method and performed simulations in support of existing NASA projects or missions. DSMC models were developed and validated for simulating rotational, vibrational, and chemical relaxation in high-temperature flows, including effects of quantized anharmonic oscillators and temperature-dependent relaxation rates. State-of-the-art advancements were made in simulating coupled vibration-dissociation recombination for post-shock flows. Models were also developed to compute vehicle surface temperatures directly in the code rather than requiring isothermal estimates. These codes were instrumental in simulating aerobraking of NASA's Magellan spacecraft during orbital maneuvers to assess heat transfer and aerodynamic properties of the delicate satellite. NASA also depended upon simulations of entry of the Galileo probe into the atmosphere of Jupiter to provide drag and flow field information essential for accurate interpretation of an onboard experiment. Finally, the codes have been used extensively to simulate expanding nozzle flows in low-power thrusters in support of propulsion activities at NASA-Lewis. Detailed comparisons between continuum calculations and DSMC results helped to quantify the limitations of continuum CFD codes in rarefied applications. Author

N94-29920*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
WALL PRESSURE FLUCTUATIONS IN THE REATTACHMENT REGION OF A SUPERSONIC FREE SHEAR LAYER Final Technical Report, 1 Jan. 1991 - 30 Jun. 1991
ALEXANDER J. SMITS 14 Apr. 1994 10 p
(Contract NAG1-1072)
(NASA-CR-195790; NAS 1.26:195790) Avail: CASI HC A02/MF A01

The primary aim of this research program was to investigate the mechanisms which cause the unsteady wall-pressure fluctuations in shock wave turbulent shear layer interactions. The secondary aim was to find means to reduce the magnitude of the fluctuating pressure loads by controlling the unsteady shock motion. The particular flow under

study is the unsteady shock wave interaction formed in the reattachment zone of a separated supersonic flow. Similar flows are encountered in many practical situations, and they are associated with high levels of fluctuating wall pressure. The free shear layer is formed by the flow over a backward facing step, using an existing model, with the base pressure on the step adjusted so that there is no pressure discontinuity at the lip. The shear layer therefore develops in a zero pressure gradient. The primary advantage of this flow configuration is that the reattachment process can be studied in the absence of a separation shock. The mean flow data, and some preliminary hot-wire measurements of the mass-flux fluctuations were made by Baca and Settles, Baca, Williams and Bogdonoff, who showed that the shear layer became self-similar at about 17 delta(sub 0) downstream of the lip, and that it grew at a rate typical of the observed Mach number difference (about 1/3rd the incompressible growth rate). The turbulence measurements were later extended by Hayakawa, Smits and Bogdon off under NASA Headquarters support. Derived from text

N94-29937*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC CHARACTERISTICS OF A PROPELLER-POWERED HIGH-LIFT SEMISPAN WING

GARL L. GENTRY, JR., M. A. TAKALLU, and ZACHARY T. APPLIN Apr. 1994 70 p

(Contract RTOP 535-03-10-02)

(NASA-TM-4541; L-17259; NAS 1.15:4541) Avail: CASI HC A04/MF A01

A small-scale semispan high-lift wing-flap system equipped under the wing with a turboprop engine assembly was tested in the LaRC 14- by 22-Foot Subsonic Tunnel. Experimental data were obtained for various propeller rotational speeds, nacelle locations, and nacelle inclinations. To isolate the effects of the high lift system, data were obtained with and without the flaps and leading-edge device. The effects of the propeller slipstream on the overall longitudinal aerodynamic characteristics of the wing-propeller assembly were examined. Test results indicated that the lift coefficient of the wing could be increased by the propeller slipstream when the rotational speed was increased and high-lift devices were deployed. Decreasing the nacelle inclination (increased pitch down) enhanced the lift performance of the system much more than varying the vertical or horizontal location of the nacelle. Furthermore, decreasing the nacelle inclination led to higher lift curve slope values, which indicated that the powered wing could sustain higher angles of attack near maximum lift performance. Any lift augmentation was accompanied by a drag penalty due to the increased wing lift. Author (revised)

N94-29973 Kansas Univ., Lawrence.

AIRCRAFT AERODYNAMICS WITH DEFLECTED JETS IN GROUND EFFECT Ph.D. Thesis

CHYUAN-HSYAN PAUL LIAW 1992 116 p

Avail: Univ. Microfilms Order No. DA9313133

A computational method by combining a potential flow approach with a Navier-Stokes solver is developed to analyze the flow field and predict the aerodynamics for three-dimensional configurations with deflected jet in ground effect. The potential flow method, PMARC/VSAERO, is a low-order panel code solving the potential flow over three-dimensional geometries. The Navier-Stokes code (NS3D) is based on the vorticity transport equation and the Poisson equation for the vector velocity potential in viscous, incompressible flow. Calculations for a rectangular flat plate and a wing-body combination with a single normal-deflected jet in ground effect with and without free stream are conducted. The computed results indicate that due to the induced velocity of a constant-thrust jet, the suck-down force (-L) is increased when the ground height (h) decreases. Calculated results for a 90 degree lifting jet issuing from a flat plate and for a wing-body configuration show good agreement in trend with available data. The computed moment coefficient versus ground height is also compared with data for the wing-body configuration. It also shows a good agreement in trend. However, the magnitude of the suck-down effect is under predicted. The discrepancy between the computational results and the experimental data is most likely due to a lack of an accurate simulation of turbulence effect, a fine enough grid system, an accurate specified vorticity distribution at the jet exit, or unknown experimental errors. The calculated flow field of roll-up jets is also presented. The flow patterns of a 90 degree jet impinging on the ground without the free stream effect has a stagnation point on the ground and symmetric with respect to the jet core. Due to the effect of the free stream, the stagnation point occurs ahead of the jet core, and the flow pattern is no longer symmetric. For deflected jets with any deflection angle other than 90 degrees, the vortex roll-up is stronger in the direction of the jet deflection, and the vortex shape is deformed. With a free stream combined with deflected jet, the flow pattern becomes more complicated. The jet core is deformed and the vortex roll-up is obvious. For lower ground height, the vortex becomes flatter. In summary, the flow patterns are affected by jet velocity, free stream velocity, deflected angles and ground height. Dissert. Abstr.

N94-30124*# Illinois Univ., Urbana-Champaign. Dept. of Aeronautical and Astronautical Engineering.

THE 3-D LDV MEASUREMENTS ON A 30-DEGREE SWEPT WING WITH A SIMULATED ICE ACCRETION Final Report

MICHAEL B. BRAGG and MICHAEL K. KERHO Apr. 1994 63 p

(Contract NAG3-1134; RTOP 505-68-10)

(NASA-CR-195327; E-8778; NAS 1.26:195327) Avail: CASI HC A04/MF A01

Three dimensional flowfield measurements have been obtained for a semispan 30-degree swept wing with a simulated glaze ice accretion. The model tested has a NACA 0012 section perpendicular to the leading edge. Measurements were made using a two-component laser Doppler velocimeter (LDV) system. Mean velocity measurements were obtained for all three velocity components. Streamwise turbulence intensities were also obtained. All measurements were taken in the University of Illinois 3 by 4 foot subsonic wind tunnel at a Reynolds number of 1 million and 8 degrees angle of attack. The data is presented in tabular form. Author (revised)

N94-30151*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPUTATION OF WIND TUNNEL WALL EFFECTS FOR COMPLEX MODELS USING A LOW-ORDER PANEL METHOD

DALE L. ASHBY and SCOTT H. HARRIS Feb. 1994 19 p

(Contract RTOP 505-59-53)

(NASA-TM-104019; A-93077; NAS 1.15:104019) Avail: CASI HC A03/MF A01

A technique for determining wind tunnel wall effects for complex models using the low-order, three dimensional panel method PMARC (Panel Method Ames Research Center) has been developed. Initial validation of the technique was performed using lift-coefficient data in the linear lift range from tests of a large-scale STOVL fighter model in the National Full-Scale Aerodynamics Complex (NFAC) facility. The data from these tests served as an ideal database for validating the technique because the same model was tested in two wind tunnel test sections with widely different dimensions. The lift-coefficient data obtained for the same model configuration in the two test sections were different, indicating a significant influence of the presence of the tunnel walls and mounting hardware on the lift coefficient in at least one of the two test sections. The wind tunnel wall effects were computed using PMARC and then subtracted from the measured data to yield corrected lift-coefficient versus angle-of-attack curves. The corrected lift-coefficient curves from the two wind tunnel test sections matched very well. Detailed pressure distributions computed by PMARC on the wing lower surface helped identify the source of large strut interference effects in one of the wind tunnel test sections. Extension of the technique to analysis of wind tunnel wall effects on the lift coefficient in the nonlinear

lift range and on drag coefficient will require the addition of boundary-layer and separated-flow models to PMARC. Author

N94-30152*# Illinois Univ., Urbana-Champaign. Dept. of Aeronautical and Astronautical Engineering.
AN EXPERIMENTAL STUDY OF THE AERODYNAMICS OF A SWEPT AND UNSWEPT SEMISPAN WING WITH A SIMULATED GLAZE ICE ACCRETION Final Report
MICHAEL B. BRAGG May 1994 232 p
(Contract NAG3-1134; NAG3-28; RTOP 505-68-10)
(NASA-CR-195330; E-8813; NAS 1.26:195330) Avail: CASI HC A11/MF A03

Two semispan wings, one with a rectangular planform and one with 30 degrees of leading edge sweep were tested. Both had a NACA 0012 airfoil section, and both were tested clean and with simulated glaze ice shapes on their leading edges. Several surface roughness were tested. Each model geometry is documented and each surface roughness is explained. Aerodynamic performance of the wing in the form of sectional lift and integrated three-dimensional lift is documented through pressure measurements obtained from rows of surface pressure taps placed at five span locations on the wing. For the rectangular wing, sectional drag near the midspan is obtained from wake total pressure profiles. The data is presented in tabular and graphical form and is also available on computer disk. Author

N94-30176*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
USER'S MANUAL FOR THE MODEL INTERFACE AND PLUGBOARD CABINETS IN THE 14- BY 22-FOOT SUBSONIC TUNNEL
ROBERT B. ASKEW and P. FRANK QUINTO Apr. 1994 55 p
(Contract RTOP 505-59-10-13)
(NASA-TM-109062; NAS 1.15:109062) Avail: CASI HC A04/MF A01

The primary method of connection between the wind tunnel model instrumentation and the data acquisition system in the 14- by 22-Foot Subsonic Tunnel is through the Model Interface (MIF) and Plugboard cabinets. The MIF and Plugboard cabinets allow versatility in the connection of the instrumentation to the different data systems in the facility. The User's Manual describes the components inside the MIF cabinet, the input and output of the MIF, and the MIF patchboard, and the Plugboard cabinets. There are examples of standard connections for most of the instrumentation used in the facility. Author (revised)

N94-30387 National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
THE DESIGN OF A SYSTEM OF CODES FOR INDUSTRIAL CALCULATIONS OF FLOWS AROUND AIRCRAFT AND OTHER COMPLEX AERODYNAMIC CONFIGURATIONS
J. W. BOERSTOEL (Technische Univ., Delft, Netherlands.), S. P. SPEKREIJSE, and P. L. VITAGLIANO 9 Apr. 1992 16 p Presented at the 10th AIAA Applied Aerodynamics Conference, Palo Alto, CA, 22-24 Jun. 1992 See also N92-45492 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract NIVR-01604N)
(PB94-125598; NLR-TP-92190-UP; AIAA PAPER 92-2619-CP; ALENIA-TR-57X92054; CIRA-DLC-EST-271; ETN-94-95581) Avail: CASI HC A03

For industrial calculations of three dimensional flows around transport aircraft, a system of Computational Fluid Dynamics (CFD) codes for flow calculations is developed. This system includes codes for aerodynamic geometry modeling in block decomposition work, multiblock grid generation, Euler and Navier-Stokes flow calculations, and flow visualization. The codes are tuned to each other. Two examples of this tuning are discussed. Analytic representations for geometric shapes of aerodynamic curves and surfaces are presented hat may be used for several tasks in CFD work (geometric modeling of surface, refacing of aerodynamic configuration surfaces). Multiblock grid generation is simplified by allowing grid lines to be only C(sup 0)- continuous over block faces. Block coupling algorithms for the flow solvers are discussed, that prevent accuracy loss due to the nonsmoothness of the grid over block faces. ESA

N94-30388 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics/Informatics Div.
NUMERICAL INVESTIGATION INTO HIGH-ANGLE-OF-ATTACK LEADING-EDGE VORTEX FLOW
J. I. VANDENBERG, H. W. M. HOEIJMAKERS, and H. A. SYTSMA 26 May 1992 29 p Presented at the AIAA 10th Applied Aerodynamics Conference, Palo Alto, CA, 22-24 Jun. 1992 See also N92-45477 Sponsored by Netherlands Agency for Aerospace Programs Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-125564; NLR-TP-92248-U; AIAA PAPER 92-2600-CP; ETN-94-95584) Avail: CASI HC A03

A Euler method is applied to the steady subsonic (M(infinity) = 0.50) leading edge vortex flow about a 65 deg sharp edged cropped delta wing at incidences close to the incidence at which vortex breakdown is observed in wind tunnel experiments. Above a critical value of the incidence the pseudo time dependent numerical procedure fails to attain a steady state solution. This occurrence of 'solution breakdown' indicates the limits of the domain of applicability of the steady flow Euler method for the case of subsonic leading edge vortex flow. Analysis of the converged solution at incidences just below the critical value reveals that above the aft part of the wing the velocity and vorticity distribution within the vortex core undergo a remarkable change. ESA

N94-30389 National Aerospace Lab., Emmeloord (Netherlands). Aerodynamics Div.
EXPERIMENTS AND THEORETICAL CONSIDERATIONS REGARDING THE ALLOWABLE ROUGHNESS HEIGHT IN LAMINAR FLOW
A. C. DEBRUIN 15 Jun. 1992 12 p Presented at the 1st European Forum on Laminar Flow Technology, Hamburg, Germany, 16-18 Mar. 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract NIVR-01506N)
(PB94-125556; NLR-TP-92252-U; ETN-94-95585) Avail: Issuing Activity (European Space Agency (ESA))

The results of detailed experiments with single cylindrical roughness elements in a favorable pressure gradient laminar boundary layer are described. Based on these results, the allowable roughness height is analyzed for a family of similarity type laminar boundary layers. Subsequently, the problem of optimum airfoil shape with maximum resistance against surface roughness is addressed. The scaling laws for allowable roughness height are also discussed from a more global viewpoint. ESA

N94-30401 National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.
CALCULUS OF VARIATIONS APPLIED TO 2D MULTI-POINT AIRFOIL DESIGN
T. E. LABRUJERE and J. VANDERVOOREN 1 Sep. 1992 32 p Presented at the 1st European Computational Fluid Dynamics Conference, Brussels, Belgium, 7-11 Sep. 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-125457; NLR-TP-92361-U; ETN-94-95594) Avail: CASI HC A03

Aspects of a residual correction method to solve the multipoint airfoil design problem for subsonic and transonic conditions are discussed. The method is based on full potential theory and minimizes a cost function weighting the deviations from specified target pressure distributions for each design condition in a least squares sense. Deviations from specified target pressure distributions (residuals) are translated into airfoil geometry corrections, using an approximate inverse method derived from solving an equivalent incompressible multipoint airfoil design problem using calculus of variations and numerical optimization. The feasibility of introducing the equivalent incompressible multipoint design problem is demonstrated for a two point reconstruction test case. First results of a two point example design are presented. ESA

03
AIR TRANSPORTATION AND SAFETY

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

N94-28799# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
CRASHWORTHINESS ANALYSIS OF COMMUTER AIRCRAFT SEATS Technical Note
DAVID H. LAANANEN Nov. 1993 20 p
(Contract DTFA03-90-P-00447)
(AD-A275889; CR-R-91012; DOT/FAA/CT-TN-91/28) Avail: CASI HC A03/MF A01

During the past several years, the Federal Aviation Regulations (FAR) were significantly modified with respect to seat/restraint system strength, attachment of seats to the aircraft structure, and the means by which they are to be evaluated. Aircraft accident data, human tolerance levels, and aircraft structural characteristics have been considered in the development of these new standards. Dynamic testing is now required for seats to be installed in general aviation aircraft, transport category aircraft, and rotorcraft. Performance criteria are similar to those specified by the Federal Motor Vehicle Safety Standards for automobiles but also include a limit on pelvic force, in order to prevent spinal injuries which may be caused by the vertical component of impact force. A category of aircraft that has not as yet been affected by the rule modifications is the commuter type aircraft, which seats 10 to 19 passengers. Since this airplane is closer in size to general aviation aircraft than to large transports, it is also covered by FAR Part 23. The Federal Aviation Administration is currently involved in the conduct of a test program addressing commuter aircraft occupant crash safety. In support of this effort, a research program the includes full-scale aircraft drop tests, sled tests of seats, and computer simulations is being conducted. This report describes the use of the SOM-LA (Seat/Occupant Model-Light Aircraft) program in modeling three commuter aircraft seats. The predicted response of the seats to a potential set of test conditions is described. DTIC

N94-29185 National Transportation Safety Board, Washington, DC.
NATIONAL TRANSPORTATION SAFETY BOARD ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA. US GENERAL AVIATION, 1990
17 Dec. 1993 84 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-126869; NTSB/ARG-93/02) Avail: CASI HC A05

The 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 report is divided into five sections: 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. NTIS

N94-29402# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT: IN-FLIGHT LOSS OF CONTROL, LEADING TO FORCED LANDING AND RUNWAY OVERRUN, CONTINENTAL EXPRESS, INC., N24706 EMBRAER EMB-120 RT, PINE BLUFF, ARKANSAS, 29 APRIL 1993
29 Apr. 1993 51 p
(PB94-910404; NTSB/AAR-94/02/SUM) Avail: CASI HC A04/MF A01

This report explains the in-flight loss of control of N24706, leading to a forced landing and runway overrun at Pine Bluff, Arkansas, on 29 April 1993. The safety issues discussed in the report are flight crew professionalism, inattentiveness, and fatigue. A recommendation concerning fatigue was made to the Federal Aviation Administration. Author (revised)

N94-29862# Systems Control Technology, Inc., Arlington, VA.
POTENTIAL HAZARDS OF MAGNETIC RESONANCE IMAGERS TO EMERGENCY MEDICAL SERVICE HELICOPTER OPERATIONS Final Report
ROBERT B. NEWMAN Jan. 1993 56 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/RD-92/15; SCT-92RR-14) Avail: CASI HC A04/MF A01

In recent years, there have been several incidents with helicopters where magnetic resonance imagers (MRI's) have interferred with the operation of magnetic sensors such as compasses and directional gyroscopes. The magnetic fields generated by the MRI magnet causes magnetic sensors to give aberrant readings. This report documents the characteristics of MIR's and how they operate. It discusses relevant federal regulations of MRI and all magnetic effects and hazards involved with operating helicopters in a strong static magnetic field for both personnel and equipment. Finally, the report makes recommendations for safe helicopter operations in and around MRI's. Author

N94-30144 Manitoba Univ., Winnipeg. Dept. of Actuarial and Management Science.
A CAPACITY PLANNING MODEL FOR CANADIAN MILITARY AIRLIFT REQUESTS M.S. Thesis
BARRY ANTHONY STANNARD Aug. 1993 150 p
(ISBN-0-315-86079-0; CTN-94-61178) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

The problem of the constrained assignment of n variable length tasks (missions), integrating many airlift requests from 13 users with eight priorities, to m parallel machines (CC130 Hercules airframes) is presented. A general mathematical model was developed which is suitable for assisting airlift planners in deciding which airlift mission requests to accept. The model can be implemented on a microcomputer and is essentially a computational subroutine for a larger decision support system. A high quality airlift capacity plan resulted from the application of a group of management science techniques. Analytic hierarchy process was used to quantify each mission request. A sequential linear programming model proved to be a computationally efficient approach for producing an automated planning aid to assist the airlift capacity planners. The model is flexible, computationally fast, and accurate. It handles linked missions, either as a pair or as a minimum out of an optimal number. User hour and fleet flying hour constraints are modelled and missions can be added, deleted, or modified. While the model was developed for the Canadian Forces, it can be adapted for other similar military and civilian situations. 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.

N94-28744# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Logistics and Acquisition Management.

EVALUATION OF ACCESS/NAVIGATIONAL FEATURES OF A GRAPHICAL-USER INTERFACE INSTALLED ON A PORTABLE MAINTENANCE AID M.S. Thesis

LISA A. CARNEY and ROGER A. QUINTO Sep. 1993 146 p

(AD-A275791; AFIT/GLM/LAL/93S-9) Avail: CASI HC A07/MF A02

Portable maintenance aids (PMA's) are being developed to access and store electronic technical information on the flightline. The prototype PMA designed by Armstrong Laboratory personnel has redundant access/navigational features. Redundancy increases software memory usage and adds unnecessary weight to the PMA. The purpose of this research was to determine the best access/navigational feature installed on the PMA. The best feature is the feature that provides the highest degree of user satisfaction. An experiment was conducted to evaluate the following features for screen and menu access and navigation, respectively: dedicated/hardware keys, programmable soft keys, and push button keys, and number keys, cursor control keys, and programmable soft keys. Modified computer screens from the prototype PMA were used on a laptop personal computer, which simulated the PMA, to evaluate each feature, one at a time. Twenty-eight maintenance technicians rated and ranked each access/navigational feature. The results indicated that the best feature for screen access and navigation was the dedicated/hardware keys and the best feature for menu access and navigation was the number keys. DTIC

N94-28914# Federal Aviation Administration, Atlantic City, NJ. Technical Center.

LOS ANGELES INTERNATIONAL AIRPORT INSTRUMENT LANDING SYSTEM APPROACH DATA COLLECTION AND REDUCTION, PHASE 1 Final Repoort, Nov. 1991 - Apr. 1992

J. THOMAS, D. TIMOTEO, and P. HOANG Nov. 1993 72 p

(AD-A275115; DOT/FAA/CT-TN93/12) Avail: CASI HC A04/MF A01

Position data on aircraft flying Instrument Landing System (ILS) approaches from 40 nautical miles (nmi) down to runway threshold were collected at Los Angeles International Airport (LAX) between November 26, 1991 and April 25, 1992. The purpose of the data collection was to provide an accurate database of navigational performance of aircraft flying ILS approaches at distances between 10 nmi and 32 nmi. Aircraft position data were collected using the in-place LAX surveillance primary and secondary radars. The data were reduced and analyzed at the Federal Aviation Administration (FAA) Technical Center by ACD-340 personnel. The discussion in this Final Report concerns the accuracy of the collected position data and possible sources of error in the data collection. DTIC

N94-29323# Wright Lab., Wright-Patterson AFB, OH.

OBJECT ORIENTED DESIGN OF THE AUTONOMOUS FIXTAKING MANAGEMENT SYSTEM

JOSEPH DIEMUNSCH and JOHN HANCOCK In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 14 p Nov. 1993

Copyright Avail: CASI HC A03/MF A03

The Air Force Avionics Laboratory has sponsored several efforts to increase the accuracy of aircraft navigation functions while decreasing crew workload through the application of intelligent systems. Two such efforts were the Adaptive Tactical Navigation (ATN) System and the Autonomous Fixtaking Management (AFM) system, which were both awarded to The Analytic Sciences Corporation (TASC). An intelligent system to aid the pilot with navigation functions was developed under the ATN program. This system incorporated real-time knowledge base software to manage the tactical navigation moding, fault tolerance, and pilot aiding to provide a robust navigation prototype for the next generation fighter aircraft. The ATN program highlighted the aircraft weapons officer's heavy workload associated with the location and identification of fixpoints to update and verify the accuracy of the navigation system. With this problem in mind, it was determined that an intelligent system was needed to automatically locate, image, and identify fixpoints and update the navigation solution. The AFM System was developed to prove the feasibility of automated navigation updates using tactical sensors and existing mission data processing systems. Several technologies developed under ATN were incorporated into the AFM system including a proven simulation of the navigation sensors, controllers, and mission planning and management software. Automation of human fix taking activity required integration of several emerging technologies including a real-time data fusion architecture, neural network and heuristic automatic recognition algorithms, and associative memories to retrieve fix points from on-board databases. Integration of these diverse technologies was simplified by the employment of an object-oriented software development approach and real-time control system. Derived from text

N94-29445# Federal Aviation Administration, Washington, DC.

THE 1993 FEDERAL AVIATION ADMINISTRATION AVIATION SYSTEM CAPITAL INVESTMENT PLAN

Dec. 1993 304 p

Avail: CASI HC A14/MF A03

Based on a total system approach, the Aviation System Capital Investment Plan (CIP) relates user community needs to technical opportunities, human factors, and operational considerations. The systematic implementation of the projects defined in this CIP will result in improved safety and efficiency, while accommodating spiraling demands at constrained cost. It supports a more complex system and creates a foundation for continued evolution that uses modern technologies and capabilities. The CIP also recognizes that continuing upgrades and enhancements are necessary to meet evolving national airspace system (NAS) user needs. It includes the following: Original NAS Plan (Chapter 2)—Preservation of the original NAS Plan projects; Growth (Chapter 3)—Projects that expand, relocate, or consolidate existing facilities/capabilities in response to changing demand on the system. Each potential metroplex control facility (MCF) is identified in this chapter; Infrastructure Replenishment (Chapter 4)—Projects identified since the original NAS Plan that refurbish structures, replace obsolete equipment, or relocate facilities to maintain service, improve effectiveness, and/or reduce cost; Supportability (Chapter 5)—Capital improvement projects that support logistics, provide spares, train personnel, and manage the human resource aspect of modernizing the NAS; and New Capabilities (Chapter 6)—Projects identified since the original NAS Plan which, if implemented, are expected to add significant new capabilities to the system. The new TRACON Automation System project is contained in this chapter. Author (revised)

N94-29558# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.

MACHINE INTELLIGENCE IN AIR TRAFFIC MANAGEMENT [L'INTELLIGENCE ARTIFICIELLE DANS LA GESTION DU TRAFIC AERIEN]

ANDRE BENOIT, ed. (European Organization for the Safety of Air Navigation, Brussels, Belgium.) Oct. 1993 400 p In ENGLISH and FRENCH The 56th Symposium was held in Berlin, Germany, 11-14 May 1993

(AGARD-CP-538; ISBN-92-835-0724-X) Copyright Avail: CASI

HC A17/MF A04

This volume contains the Technical Evaluation Report and the 30 papers, presented at the Guidance and Control Panel Symposium held in Berlin, Germany from 11th to 14th May 1993. The papers were presented covering the following headings: Air Traffic Processes; Novel Approaches; Transition to Operation; Human/Machine Relationship; Air/Ground Integration; PHARE; and Ground Movements Control.

N94-29559# Mitre Corp., McLean, VA. Center for Advanced Aviation Systems Development.

ADVANCES IN DEVELOPMENT CAPABILITIES FOR INTELLIGENT AIR TRAFFIC MANAGEMENT SYSTEMS

KERRY M. LEVIN and JOHN J. FEARNSIDES In AGARD, Machine Intelligence in Air Traffic Management 18 p Oct. 1993

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Visual presentation is a major source of information for air traffic control. Significant advances in computers, display technology, and the tools used by developers of intelligent air traffic management (ATM) systems pose challenges for the development of computer-human interfaces (CHI's) associated with the new automation. The CHI must be designed to be both usable and suitable. This paper reviews three capabilities available to developers of intelligent ATM systems: case-based reasoning system design, rule-based system design, and individually tailored CHI. It recommends that any intelligent ATM system be examined early in its development cycle in a laboratory environment, where it can be tested in concert with other elements of the ATM system. Author

N94-29560# CompEngServ Ltd., Ottawa (Ontario).

INTELLIGENT SYSTEMS FOR AIR SPACE CONTROL AND MANAGEMENT

DAVID BOWEN and ANDRZEJ HLIBOWICKI In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993 Sponsored by Transportation Development Centre

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Complete automation of an air traffic control system requires the identification of functions and their allocation to a distributed system, part of which is on the ground and part of which flies. The evolution of current systems appears to be taking place with ill-defined visions of what the final system will or should look like. In some cases this fuzzy view of the future is purposely carried because of the implications of proposing a view which antagonizes various groups or associations representing those already engaged in the process. Yet, each step along the way implies explicitly or implicitly some final target system. As each year goes by, we move toward a system which may be a long way from what is really desirable in the next century. It seems reasonable that some versions of the ideal future system should be understood within the community. At least one of these options should be what is technically feasible. From this, an acceptable system can be negotiated. The first step in this process is to determine the desired functionality *without regard to any other factors. From this, technical feasibility* can be determined and/or predicted; and finally, the allocation of the functions to humans or machines can be debated. The management of a dense cluttered air space requires a set of skills and capabilities on the part of an air traffic control team which, in some of their functions, cannot be represented algorithmically. Successful automated air traffic management systems will necessarily emulate the intuitive portions of the human management capability using various technologies drawn from the broad field of artificial intelligence. Indeed portions of the overall management system have been the subject of research and development efforts in many laboratories around the world. The integration of these fragments into an overall scheme is often left as an implicitly understood architecture. This paper begins by presenting CompEngServ (CES) Ltd.'s view of an automated airspace management system. The paper then presents an overview of the prototype of an advanced controller workstation developed by CES (under contract to Transport Canada) which prototypes various portions of this architecture for Airspace Management. This system represents the state of the art in Air Traffic Control (ATC) research. This prototype is also an example of multiple hardware and software technologies being harnessed to develop a solution to a problem initially thought to be too complex for automation. The paper then presents the future direction of research at CES and then closes with the issues which have been raised by our work that need addressing before an automated system will be practical. Author

N94-29561# Centre d'Etudes de la Navigation Aerienne, Toulouse (France).

USE OF ADVANCED TECHNOLOGIES IN ATM (AIR TRAFFIC MANAGEMENT) DOMAIN

P. PLANCHON and M. BONNARD In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993

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The CENA is in charge of studies related to Air Traffic Management and therefore to some of the communication, navigation, and surveillance means. The work is carried out to support French and European ATC (air traffic control) in an international cooperation. It encompasses studies and experimental development aiming at operational implementation within the CAUTRA 5 program. The different CENA projects are integrated in an experimental simulator frame named ADER. This test-bed will support one of the demonstrations within PHARE, a joint European experimental program. The CENA organization is based upon a technical directorate in charge of the horizontal projects as previously described and 10 divisions located either at Athis-Mons (near Paris) or in Toulouse. One of these divisions, called COA (Control Organization and Automation), deals mainly with studies aiming at providing ATM (air traffic management) operators with helpful decision tools, using advanced methods and technologies. In this paper, it can be found a short description of COA division activities and a more precise analysis of one of the projects, called GOETHE, aiming to provide ATFM (Air Traffic Flow Management) regulators with a more user-friendly tool. Derived from text

N94-29562# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

AIR TRAFFIC MANAGEMENT AS PRINCIPLED NEGOTIATION BETWEEN INTELLIGENT AGENTS

ROBERT STENGEL and JOHN WANGERMANN In AGARD, Machine Intelligence in Air Traffic Management 10 p Oct. 1993

(Contract DT-FA01-92-G-0011)

Copyright Avail: CASI HC A02/MF A04

The major challenge facing the world's aircraft/airspace system (AAS) today is the need to provide increased capacity, whilst 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

N94-29563# Shape Technical Center, The Hague (Netherlands).

USE OF GPS IN AUTOMATED AIR TRAFFIC CONTROL

HERMANN F. HEGELS and WILLEM E. HOEKSTRA In AGARD, Machine Intelligence in Air Traffic Management 26 p Oct. 1993

Copyright Avail: CASI HC A03/MF A04

The Global Positioning System NAVSTAR is rapidly becoming the world standard for navigation and timing. Although primarily designed to be a military system, the civil user community is expanding at a breathtaking pace. After an introduction to the general GPS policies and the technical fundamentals this paper presents an idea on how to use GPS NAVSTAR to improve Air Traffic Control. Existing selective identification features will form the key to a GPS-based position,

velocity, and acceleration message. Higher update rates and the vastly improved information on each aircraft will provide the input for a flight plan correlation function enabling an automatic air traffic monitoring and control far beyond current standards. Author

N94-29564# Raumfahrt Systemtechnik G.m.b.H., Salem (Germany).
GROUND INDEPENDENT LANDING SYSTEM
HANS MARTIN BRAUN and PHILIPP HARTL In AGARD, Machine Intelligence in Air Traffic Management 6 p Oct. 1993
Copyright Avail: CASI HC A02/MF A04

Air traffic in Central Europe is dramatically increasing today. There are some indications that present upgrades of the air traffic control system might not be efficient and that planned upgrades will not be realized in time due to budgetary restrictions. One key element in air traffic control is a precise navigation of the aircraft during landing, the most critical part of the flight. It is presently performed by use of the instrument landing system ILS and in some areas already by the microwave landing system MLS. The latter provides a very high navigation performance and allows a high landing sequence under all weather conditions. However, it requires extensive ground equipment at the airports and hence, only a few airports in Central Europe are equipped with it today. This paper presents the results of a study on a new microwave landing system with a spaceborne radar transmitter and airborne radar receivers. Based on this bistatic radar system, navigation in landing phase could also be performed independently from weather conditions. However, it does not require any active equipment at the landing site. Even taxi way guidance could be performed with this system. It is called 'Ground Independent Landing System' (GILS). Author

N94-29565# Deutsche Aerospace A.G., Ulm (Germany).
GPS/GNSS FOR ATM
THOMAS JACOB, JOCHEN MEYER-HILBERG, GERHARD BANTLE, WINIFRED ROESCH, HEINZ-GEORG WIPPICH, and HORST SCHMIDT In AGARD, Machine Intelligence in Air Traffic Management 10 p Oct. 1993
Copyright Avail: CASI HC A02/MF A04

The actual implemented Air Traffic Control (ATC) systems have radar coverage gaps on the Northern Atlantic and Trans-Siberian Routes as well as in the Pacific area. This situation results in insufficient air traffic surveillance information in the corresponding control sectors and larger separation between aircraft on these routes to ensure safe operation. Unfortunately, this procedure reduces the capacity and limits air traffic flow. These problems can be overcome by the worldwide use of the high accurate position data from Global Navigation Satellite Systems (GNSS) such as the U.S. Global Positioning System (GPS) and the Russian Global Navigation System (GLONASS) aboard the aircraft as proposed by the ICAO-FANS plan. In combination with the Automatic Dependent Surveillance (ADS) function as specified by ARINC 745, the onboard computed position and flight path data is transmitted to the Aeronautical Telecommunication Network (ATN) for further use by ATM and ATC. Based on these principles, Deutsche Aerospace AG, Airborne Systems Division has developed a demonstrator. This system integrates the precise (Differential) GNSS information with the data from an Inertial Measurement Unit (e.g. AHRS) aboard the demonstrator aircraft to fulfill the accuracy and consistency/integrity requirements during all phases of flight. This system integration has been done to ensure integrity of GNSS position information during satellite outages or satellite masking, e.g. during turns. For demonstrating ADS-functionality, the onboard computed position and flight path velocity is transmitted in combination with flight management information to the ground system using a data link. In addition to this en-route ADS function with medium accuracy requirements, a high accuracy mode using Differential GNSS data for conflict detection calculations between low separated aircraft has been implemented. The conflict detection and alert functions are based on a special designed Expert System capable of real time operation. A taxi monitoring function can also be performed by the system. All system functions have been tested and demonstrated during flight trials using a VHF data link for communication. Results of these flight tests will be presented. Author (revised)

N94-29567# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. of Flight Guidance.
CONTRIBUTIONS OF DLR TO AIR TRAFFIC CAPACITY ENHANCEMENT WITHIN A TERMINAL AREA
U. VOELCKERS, U. BROKOF, D. DIPPE, and M. SCHUBERT In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

Enhancement of air traffic capacity within the TMA cannot be achieved easily. Single solutions and improvements of technical equipment, procedures and standards, with automation support for human operators in isolated areas, e.g. for the management of the airport, airspace and Air Traffic Control very often will only yield marginal capacity increases. Whether it is: new concrete (runways, taxiways, aprons), reduced separation minima, or advanced ATM functions, all these measures will only result in significant capacity increases, if they are designed, developed and implemented in a comprehensive, combined effort, making use of set of complementary measures and functions in a well structured, optimized architecture and implementation strategy. This comprehensive approach is especially true for high density TMA's/airports, operating close to capacity limits, where any capacity enhancement measure will directly affect and/or require capacity related issues in other areas. Based upon the specific needs of the Frankfurt airport and TMA, DLR is working on a variety of tools and functions, which—combined and implemented in a well designed strategy plan—can yield significant capacity increases without the construction of new runways. Three candidate systems—under development or even already in operation—which mutually depend on and complement one another will be presented as examples of an even larger capacity enhancement plan for the TMA. Derived from text

N94-29568*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DESIGN OF CENTER-TRACON AUTOMATION SYSTEM
HEINZ ERZBERGER, THOMAS J. DAVIS, and STEVEN GREEN In AGARD, Machine Intelligence in Air Traffic Management 12 p Oct. 1993
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A system for the automated management and control of terminal area traffic, referred to as the Center-TRACON Automation System (CTAS), is being developed at NASA Ames Research Center. In a cooperative program, NASA and FAA have efforts underway to install and evaluate the system at the Denver area and Dallas/Ft. Worth area air traffic control facilities. This paper will review CTAS architecture, and automation functions as well as the integration of CTAS into the existing operational system. CTAS consists of three types of integrated tools that provide computer-generated advisories for both en-route and terminal area controllers to guide them in managing and controlling arrival traffic efficiently. One tool, the Traffic Management Advisor (TMA), generates runway assignments, landing sequences and landing times for all arriving aircraft, including those originating from nearby feeder airports. TMA also assists in runway configuration control and flow management. Another tool, the Descent Advisor (DA), generates clearances for the en-route controllers handling arrival flows to metering gates. The DA's clearances ensure fuel-efficient and conflict free descents to the metering gates at specified crossing times. In the terminal area, the Final Approach Spacing Tool (FAST) provides heading and speed advisories that help controllers produce an accurately spaced flow of aircraft on the final approach course. Data bases consisting of several hundred aircraft performance models, airline preferred operational procedures, and a three dimensional wind model support the operation of CTAS. The first component of CTAS, the Traffic Management Advisor, is being evaluated at the Denver TRACON and the Denver Air Route Traffic Control Center. The second component,

the Final Approach Spacing Tool, will be evaluated in several stages at the Dallas/Fort Worth Airport beginning in October 1993. An initial stage of the Descent Advisor tool is being prepared for testing at the Denver Center in late 1994. Operational evaluations of all three integrated CTAS tools are expected to begin at the two field sites in 1995.
Derived from text

N94-29569# National Aerospace Lab., Amsterdam (Netherlands).
SIMULATION OF FULLY AUTOMATED AIR TRAFFIC CONTROL CONCEPTS
WIM DENBRAVEN and HANS VANDENBOS In AGARD, Machine Intelligence in Air Traffic Management 16 p Oct. 1993 Sponsored by Schiphol Airport Authorities
Copyright Avail: CASI HC A03/MF A04

In order to be able to investigate various aspects of the complex Air Traffic Control (ATC) system of the future, a real-time ATC simulation facility has been constructed at NLR. The ATC automation environment of this simulator is provided by CTAS, the Center/TRACON Automation System, developed by the NASA Ames Research Center. For the simulation of air traffic, radar observations, and data link, the NLR ATC Research Simulator (NARSIM) is used. The facility can be used at various levels of automation, ranging from conventional, 'manual' ATC to fully automatic control. For the latter, CTAS has been extended with various decision and control algorithms, dealing with tasks normally executed by the air traffic controller. In a set of real-time simulation experiments different concepts of fully automated ATC are investigated, characterized by various combinations of control functions and different levels of air-ground interaction. Furthermore, the effect of different levels of aircraft navigation performance is studied. The traffic samples are based on single-runway IFR operations for Schiphol Airport, with the traffic mix and distribution based on predictions for the year 2000. The Dutch airspace is simulated with one overall area control sector, controlling traffic from all directions to the three arrival gates, and one Schiphol approach sector, merging the aircraft from these gates into a properly spaced sequence on final approach. For the analysis of the simulations, methods are under development to present overall ATC system performance in terms of safety, flight efficiency, capacity, and control performance. The results of the simulations are used to determine critical areas in ATC system automation, as well as potential benefits thereof. They can also contribute to an optimal distribution of tasks between man and machine in the ATC system of the future. Author (revised)

N94-29570# European Organization for the Safety of Air Navigation, Brussels (Belgium).
DECISION MAKING AIDS (DMA) IN ON-LINE ATC SYSTEMS
ANDRE BENOIT, JEAN-MARC POMERET, and SIP SWIERSTRA In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

This paper covers the potential of Decision Making Aids to be implemented before the year 2000 and, within the time frame considered, covers all of the aspects of automated assistance, based on flight path prediction and monitoring, which help air traffic controllers to establish and assess the predicted traffic situation more efficiently. Problem detection, problem minimization, and 'best next clearance' advisories will permit the reduction of the controller's mental workload without decreasing the level of safety or the controller's situational awareness. Author (revised)

N94-29571# Centre d'Etudes de la Navigation Aerienne, Toulouse (France).
COGNITIVE APPROACH TO SPECIFICATIONS ON AIR TRAFFIC CONTROLLERS' DECISION ASSISTANCE SYSTEMS [UNE APPROCHE COGNITIVE POUR LA SPECIFICATION D'AIDES A LA DECISION POUR LES CONTROLEURS AERIENS]
MARCEL LEROUX In AGARD, Machine Intelligence in Air Traffic Management 10 p Oct. 1993 In FRENCH
Copyright Avail: CASI HC A02/MF A04

The central problem of this investigation is the creation of an Air Traffic Control System (ATC) involving both man and machine. The present document reports on two examples which typify the man-machine relationships in systems which are partly automated. In one case, the part played by the machine is detrimental to man's involvement; in the other case, man and machine work together for better results. The manner in which this second approach was used during the development of the CENA's ERATO project is described.
Transl. by FLS

N94-29572# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Flight Guidance.
CONSIDERATIONS ON GRAPHICAL USER INTERFACES FOR INTELLIGENT ATM SUPPORT SYSTEMS
R. BEYER In AGARD, Machine Intelligence in Air Traffic Management 13 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

Considerations on the design of graphical user interfaces (GUI's) for air traffic controllers are presented in the context of a European Air Traffic Management System (EATMS). The fundamental issues discussed include the following: air traffic controller tasks; human information processing and mental models; and automation strategies with respect to the GUI design. The more specific issues of GUI design which are also discussed include the following: GUI programming environments and standards; development tools; design principles and human factors/human engineering standards; and usability testing. Conclusions are drawn regarding the current background of GUI design with respect to an EATMS and necessary future developments.
Author (revised)

N94-29573# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Flight Guidance.
INTERACTIVE ANALYSIS AND PLANNING TOOLS FOR AIR TRAFFIC AND AIRSPACE MANAGEMENT
S. E. MAHLICH In AGARD, Machine Intelligence in Air Traffic Management 13 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

Since 1989, the Institute for Flight Guidance of the German Aerospace Research Establishment (DLR) has been developing prototypes of interactive tools in close cooperation with the German Air Navigation Services (DFS) in order to achieve gradual improvements in the efficiency and productivity of the air traffic control system. The paper briefly describes the potential of a selection of analysis and planning tools that have been developed in this framework. After an introduction into the 'planning world' of tactical and strategical air traffic planning, the objectives and potentials of four tools will be demonstrated as applied to real traffic scenarios and actual problems of the current ATM system. Author (revised)

N94-29574# Alcatel ISR, Evry (France).
DAISY: A DECISION AID FOR AN AIR SITUATION INTERPRETATION SYSTEM
N. BICHAT, R. ALLOUCHE, and A. BORIES In AGARD, Machine Intelligence in Air Traffic Management 8 p Oct. 1993
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Due to increases in air traffic volume and the evolution of operational missions, Alcatel ISR has been awarded a contract to analyze the requirements of military air traffic controllers, especially in the area of the air situation interpretation and the implementation of a mock-up. DAISY is aimed at providing controllers with a decision aid for an air situation interpretation system. In this context, interpretation stands for all the rules and combined information which give an operational meaning to the air situation. Abnormal situations are highlighted, a diagnosis is given, and a proposal is made for decision. After a requirements analysis is conducted, both by experts and controllers during six months, a twelve-month technical feasibility study was led by Alcatel ISR, and a mock-up was developed dealing with typical interpretation scenario such as trajectory prediction. Author (revised)

N94-29575# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Flight Guidance.
DLR'S ATM DEMONSTRATION PROGRAMME

V. ADAM, E. KLOSTERMANN, and M. SCHUBERT In AGARD, Machine Intelligence in Air Traffic Management 12 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

The Institute for Flight Guidance of DLR is involved in medium and long term research and development of concepts, procedures, functions, and components for a future integrated Air Traffic Management System. The medium term work concentrates on improvements concerning the capacity of Frankfurt airport. This paper describes a planned demonstration program which is designed to prove concepts and tools developed by the Institute in cooperation with the German ATC Authority (DFS) and the operator of Frankfurt airport (FAG) as well as with PHARE. The aim of these experiments is to demonstrate the feasibility and merits of integration of onboard avionics with advanced ATC systems on the ground. For this purpose an Air Traffic Management Demonstrator System will be employed, which comprises an air segment and a ground segment connected via an automatic data link and voice communication. The demonstration program will be performed in several phases comprising simulation runs in an air traffic simulator as well as flight tests with a real aircraft. Author (revised)

N94-29576# Honeywell, Inc., Minneapolis, MN. Systems and Research Center.

ADVANCED AIR TRAFFIC CONTROL AND FLIGHT MANAGEMENT SYSTEM CONCEPTS

ROBERT L. SCHULTZ In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993
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A time-based air traffic control (ATC) system where vehicles are sequenced on desired time of arrival (TOA) has been proposed as one way that might help increase airport capacity. This paper evaluates three time-based ATC system concepts: (1) ground based (computing trajectories on the ground), (2) aircraft based (computing trajectories on the aircraft), and (3) ground and air based (generating parametrized velocity and acceleration profiles on the aircraft and transmitting them to the ground where trajectories are recomputed). The parameters compared are amount of database, complexity of communications, computational requirements, autonomy of aircraft, and similarity to current procedures. The ground-and-air-based approach using parametrized profiles has the best potential for providing a high-landing-rate ATC system with minimal processing and communications requirements. In this approach, ATC assigns time slots at the metering fix based on desired time of arrival (TOA) and range-TOA windows generated on the aircraft. The aircraft sends a simple set of parametrized deceleration and velocity profiles to the ground. The ground processor uses these profiles to generate trajectories and identify conflicts. The ground processor resolves conflicts by examining nearby trajectories using both the sets of parametrized deceleration and velocity profiles and the range-TOA windows. The new horizontal plan and the new profile parameters are sent to the aircraft, where the aircraft flight management system (FMS) regenerates the trajectory and precisely flies it. The advantages of such a system are that it is a natural extension of the current system; it does not require massive ground databases of aircraft thrust, drag and FMS models; it uses a ground processor generating simple models to examine and resolve conflicts; it requires only one air-to-ground interaction; and the aircraft is autonomous. A simulation was used to evaluate the concept. The models used in the simulation are ATC trajectory generator, aircraft FMS, aircraft path controller, and vehicle motion. Multiple-aircraft scenarios, starting in cruise and descent, were examined. Factors examined were separation distances between aircraft on different approach trajectories, Author

N94-29577# Federal Aviation Administration, Washington, DC.

OPPORTUNITIES FOR INTEGRATING THE AIRCRAFT FMS, AERONAUTICAL OPERATIONAL CONTROL CENTERS, AND FUTURE AIR TRAFFIC MANAGEMENT SYSTEMS IN OCEANIC AIRSPACE

CLYDE MILLER, BILL BLAKE, JOHN SORENSEN, and JOSEPH MILLER In AGARD, Machine Intelligence in Air Traffic Management 10 p Oct. 1993
Copyright Avail: CASI HC A02/MF A04

Rapid technological changes are taking place in the aviation system user facilities - both on the aircraft flight deck and at the aeronautical operational control (AOC), or flight dispatch centers. On the flight deck, the flight management system (FMS) is bringing capability for precise three-dimensional guidance, flight path optimization, and speed control to meet required time-of-arrival (RTA) constraints at key route waypoints. This is enhanced by the precision global navigation satellite system (GNSS), use of digital datalink for communications, and automatic dependent surveillance (ADS). At AOC facilities, advancements in flight planning, flight following, weather information and datalink allow the dispatcher greater flight operations management capability over the airline fleet. This is especially significant for oceanic airspace operations. In parallel, the oceanic air traffic management (ATM) system is undergoing an evolution in automation that will enhance the overall aviation system productivity. Much of the information that each of the three system components - flight deck/FMS, AOC, and ATM - have would be very useful to the other two components for flight efficiency and overall productivity enhancements. Worldwide datalink technology will provide a universal and reliable data communication capability between these components to allow this information sharing. This paper discusses the opportunity to integrate the functions of the FMS, AOC, and ATM computers by exploiting the capabilities of worldwide ground and air data link. First, the outstanding needs of both the oceanic airspace user and traffic management provider are stated. Then, the emerging technological capabilities of ATM automation, FMS and AOC are summarized. This is followed by explicit operational applications where the integration of these capabilities can bring incremental benefits to flight efficiency and human productivity. Needs of both the airspace user and air traffic management service provider are addressed. Operations using today's organized oceanic track system as well as the future free route system are discussed. The opportunities for FMS-AOC-ATM integration are illustrated by three scenarios for oceanic operation. These include a mid-oceanic route replanning task to respond to weather change, a passing maneuver to allow more flexibility in flight speed and altitude when flying along a track system, and use of the FMS RTA capability to meet scheduled track entry gate times with precise accuracy. Author (revised)

N94-29578*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PROFILE NEGOTIATION: AN AIR/GROUND AUTOMATION INTEGRATION CONCEPT FOR MANAGING ARRIVAL TRAFFIC

DAVID H. WILLIAMS, P. DOUGLAS ARBUCKLE, STEVEN M. GREEN, and WIM DENBRAVEN In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993
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NASA Ames Research Center and NASA Langley Research Center conducted a joint simulation study to evaluate a profile negotiation process (PNP) between a time-based air traffic control ATC system and an airplane equipped with a four dimensional flight management system (4D FMS). Prototype procedures were developed to support the functional implementation of this process. The PNP was designed to provide an arrival trajectory solution that satisfies the separation requirements of ATC while remaining as close as possible to the airplane's preferred trajectory. The Transport Systems Research Vehicle cockpit simulator was linked in real-time to the Center/TRACON Automation System (CTAS) for the experiment. Approximately 30 hours of simulation testing were conducted over a three week period. Active airline pilot crews and active Center controller teams participated as test subjects. Results from the experiment indicate the potential for successful incorporation of airplane preferred arrival trajectories in the CTAS automation environment. Controllers were able to consistently and effectively negotiate nominally conflict-free trajectories with pilots flying a 4D-FMS-equipped airplane. The negotiated trajectories were substantially closer to the airplane's preference than would have otherwise been possible without the PNP. Airplane fuel savings relative to baseline CTAS were achieved in the test scenarios. The datalink procedures and clearances developed for this experiment, while providing the necessary functionality, were found to be operationally unacceptable to the pilots. Additional pilot control and understanding of the proposed airplane-preferred trajectory and a simplified clearance

procedure were cited as necessary for operational implementation of the concept. From the controllers' perspective, the main concerns were the ability of the 4D airplane to accurately track the negotiated trajectory and the workload required to support thePNP as implemented in this study. Author

N94-29579# European Organization for the Safety of Air Navigation, Brussels (Belgium).
AIR-GROUND INTEGRATION OF THE ATM SYSTEM IN PHARE
B. KIRSTETTER and R. D. HUNTER In AGARD, Machine Intelligence in Air Traffic Management 11 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

This paper provides a general introduction into the Programme of Harmonised Air Traffic Management Research in EUROCONTROL (PHARE). It describes the objectives of the research program and addresses the benefits of the integration of the automated systems onboard the aircraft with those of the ATC systems on the ground using a digital air-ground data link. The assumptions on the expected infrastructure and environment are explained and the possible automation and air-ground negotiation strategies discussed. Finally descriptions of the experimental facilities available or under development and of the planned experiments are provided. Author

N94-29580# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Flight Guidance.
EXPERIMENTAL FLIGHT MANAGEMENT SYSTEM
V. ADAM, G. INGLE, and R. RAWLINGS In AGARD, Machine Intelligence in Air Traffic Management 21 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

The paper reviews the requirements for an Experimental Flight Management System (EFMS) and the methods adopted for its development. The functionality is described and the future application of the system is summarized. Author

N94-29581# National Aerospace Lab., Amsterdam (Netherlands).
THE PHARE ADVANCED TOOLS
HENK A. P. BLOM, GARFIELD DEAN, MARC LEGUILLOU, ERIC PETRE, and UWE VOELCKERS In AGARD, Machine Intelligence in Air Traffic Management 8 p Oct. 1993
Copyright Avail: CASI HC A02/MF A04

The Programme for Harmonisation of ATM Research in Eurocontrol (PHARE) has undertaken to perform the required research work necessary for the introduction of advanced ATM. Within this PHARE framework, it is the task of the PHARE Advanced Tools (PAT's) group to develop the appropriate automation and communication tools to support the air traffic controller. Although the principles for computation, prediction and control of air traffic trajectories are well developed, the various future ATM scenarios reflect different views on the way automation and communication technology can best be applied. The consequence of this is that PHARE research has to be directed towards multiple ATM scenarios, and that the PAT's to be developed should be applicable to automation and communication under different ATM scenarios. The paper gives an overview of the approach taken by the PAT's group in facing this challenge. Author

N94-29582# Centre d'Etudes de la Navigation Aerienne, Toulouse (France).
THE COMMON MODULAR SIMULATOR (CMS): AN ARCHITECTURE TEST BED FOR FUTURE ADVANCED ATM SYSTEMS
J. R. VELTEN In AGARD, Machine Intelligence in Air Traffic Management 8 p Oct. 1993
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The Common Modular Simulator (CMS) project is part of the Program for Harmonized ATM Research in Eurocontrol (PHARE). The main objective of this project is to provide a common integration environment which shall allow the creation of a homogeneous infrastructure in order to facilitate and harmonize the development as well as the evolution of ATM simulators in the different research establishments. To meet such an ambitious objective, CMS partners have adopted a system architecture based on a client-server model with active servers providing event subscription and event notification mechanisms. The main advantages of such client-server models are to offer a very modular system architecture and to provide, through the associated application programming interface (API), a very powerful mechanism of abstraction. This leads to a very flexible, evolutive, open, scalable and adaptable system. CMS will offer an architecture test bed for future advanced ATM systems. As a consequence, this project should be of great benefit to many other ATM projects.
Author (revised)

N94-29583# Eurocontrol Experimental Centre, Bretigny (France).
ARC2000: AUTOMATIC RADAR CONTROL
XAVIER FRON, BERNARD MAUDRY, JEAN-PIERRE NICOLAON, and JEAN-CLAUDE TUMELIN In AGARD, Machine Intelligence in Air Traffic Management 14 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

The 'Studies, Tests, and Applied Research' (STAR) program of the EUROCONTROL Agency is addressing several implementation timescales for air traffic management (ATM) systems and procedures. ARC2000 (automatic radar control 2000) is presently the major long-term component of the STAR program, for implementation beyond 2015. ARC2000 is addressing the enroute ATC capacity issue, which is severe in Europe, by investigating the limit case where both major constraints, workload and sectorization, are eliminated. It is often easier to solve a complex problem by first looking at the limit case. ARC2000 could not be implemented as such, but should provide precious information with respect to feasible levels of automation in the long term. There are also significant by-products which will speed up shorter term research. Indeed, ARC2000 provides a 20-30 minute conflict-free planning which is a key feature of the European Air Traffic Management System (EATMS) concept. Author (revised)

N94-29584# Technische Univ., Brunswick (Germany). Inst. of Flight Guidance and Control.
AUTOMATIC CONTROL STEPS FOR AIRCRAFT TAXI GUIDANCE
KLAUS MOEHLENKAMP and GUNTHER SCHAENZER In AGARD, Machine Intelligence in Air Traffic Management 5 p Oct. 1993 Sponsored by German Research Society
Copyright Avail: CASI HC A01/MF A04

Modern high precision navigation systems based on satellite and inertial navigation provide a positioning accuracy that has never been achieved before, for aircraft enroute as well as during approach and on the airfield. By using such combined accurate positioning systems it is possible to guide aircraft on the ground and to perform automatic taxiing, which further increases the safety of ground operations. Whenever high precision terrestrial navigation is needed, common aeronautical navigation displays are not able to provide the information, which easily can be combined with the pilot's view from the cockpit, to deliver the necessary guidance aid. A flexible map display is desired to be shown in the cockpit. The new taxi guidance system GINaS, presented in this paper, is based on an integrated navigation system (DGPS/INS) and a digital map using only the standard display and navigation hardware of modern commercial aircraft. The system was successfully tested in one of our testbeds, a van. This van can be driven automatically by the system as well as by the pilot using the information of the digital map and a drive- director. The accuracy reaches submeter level. Author (revised)

N94-29585# Marconi Radar Systems Ltd., Chelmsford (England).
AIRSIDE GROUND MOVEMENTS SURVEILLANCE
D. R. CORRALL, A. N. CLARK, and A. G. HILL In AGARD, Machine Intelligence in Air Traffic Management 13 p Oct. 1993 Sponsored in

part by Commission of the European Communities
Copyright Avail: CASI HC A03/MF A04

In the modern world there is an increasing need for surveillance, and a consequent need for automatic or semi-automatic methods for processing dynamic input data and presenting it in a form which is useful to the end user. This paper outlines advanced knowledge-based techniques for monitoring such data. The techniques have been applied to airport ground traffic applications and demonstrated in particular on data from actual turn-round scenarios for stand area servicing of an aircraft as observed by a single camera. Results are output in real-time as a status report by an integrated system which is designed to handle the vagaries of real data in respect to incompleteness and uncertainty. The new techniques developed can also be applied to other ground movements surveillance applications which have multiple sensor inputs of the same or different modalities. Author (revised)

N94-29586# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Wessling (Germany). Inst. of Radiofrequency Technology.

A NOVEL NEAR-RANGE RADAR NETWORK FOR AIRPORT SURFACE CONTROL

K.-H. BETHKE, B. ROEDE, M. SCHNEIDER, and A. SCHROTH In AGARD, Machine Intelligence in Air Traffic Management 14 p Oct. 1993
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This contribution describes a radar network for airport surface movement guidance and control. The network comprises several low power radar stations which are organized in modules of four stations each. All antennas are staring and illuminating the area continuously. Moving objects are localized by range profile measurements and a subsequent multilateration. Each module runs autonomously. The module computer at the master station calculates the multilaterations and controls the communication with three slave stations. The measured data from these stations are transferred via the radar transmitters to the master station, while the multilateration and imaging results are sent via data cables to the central computer. There, the information from all modules will be merged and tracks will be constructed; furthermore, a classification process on the basis of the images will be executed. Author (revised)

N94-29587# Federal Aviation Administration, Washington, DC. Research and Development Service.

DEVELOPMENT OF PRECISION RUNWAY MONITOR SYSTEM FOR INCREASING CAPACITY OF PARALLEL RUNWAY OPERATIONS

GENE A. WONG In AGARD, Machine Intelligence in Air Traffic Management 12 p Oct. 1993
Copyright Avail: CASI HC A03/MF A04

This paper describes the results of a research program to investigate the use of advanced radar, display systems, and controller alert automation aid to increase capacity at airports with closely spaced parallel runways. Analysis has indicated that the runway spacing could be reduced without adversely affecting capacity if a surveillance radar of higher update and accuracy and a high resolution color display system with controller alert automation aid are used. This paper first describes a research program to demonstrate the feasibility of using a precision runway monitor (PRM) system for conducting independent simultaneous approaches to parallel runways spaced at less than 3400 ft (1035 m) apart. A PRM system consists of an improved radar system that provides high azimuth and range accuracy and higher data rates than the current terminal airport surveillance radar (ASR), a processing system that monitors all approaches and generates controller alerts when an aircraft appears to be blundering, and a high resolution color display. Two airports were selected to serve as the demonstration and test facilities of the PRM system. This paper describes the key elements of the demonstration program including test criteria and scenarios, controller and pilot/aircraft response times, and risk analysis. Results of the demonstration program on the feasibility of the 3400 ft runway spacing standards using PRM are presented. Recommendations on radar update rate, accuracy, and display requirements for the PRM system are summarized. This paper also describes the follow-on research activities to investigate further reduction of parallel runway spacing standards to below 3400 ft using the PRM system and advanced navigation and landing systems. Applications and extension of research results to triple and quadruple closely spaced parallel runways are discussed. Author (revised)

N94-30189# Advanced Aviation Concepts, Jupiter, FL.

EXTREMELY LOW VISIBILITY IFR ROTORCRAFT APPROACH (ELVIRA) OPERATIONAL CONCEPT DEVELOPMENT. VOLUME 1: EXECUTIVE SUMMARY Final Report

CATHERINE A. ADAMS, RICHARD J. ADAMS, SCOTT A. FONTAINE, and HOWARD A. WHEELER Mar. 1994 51 p
(Contract DTFA01-89-C-00016)
(DOT/FAA/RD-94/1,I) Avail: CASI HC A04/MF A01

The Extremely Low Visibility IFR Rotorcraft Approach (ELVIRA) workshop was the second since 1987 to address the enhancement of safety and reliability of helicopter operations by improving the attractiveness of IFR operations in lieu of special VFR operations. The 1993 workshop was the next logical step in the FAA's Vertical Flight research and development program since significant, relevant analyses, simulation and flight test work has been accomplished in the past six years. The workshop was held in Santa Fe, New Mexico on August 24-26, 1993. The participants were a select group of 59 industry and government experts in each of their individual disciplines. The group was charged with the task of defining an ELVIRA operational concept in the areas of: operational needs, infrastructure requirements, procedural changes, technology requirements, night tests, and public benefits. These experts were asked explicitly to address affordable and practical near term solutions to issues previously identified through their experience. The deliberations at the workshop resulted in the identification near term needs of the operator types who would use ELVIRA, activity regions, safety factors and operational improvements. These needs were analyzed and the operational changes responsive to the needs were documented. The proceedings of the workshop culminated with a recommendation of ten IFR enhancements that would eliminate current penalties for using the IFR system. If action is taken to achieve these changes, safety and mission reliability will be increased through increased flight hours under positive control. Volume 1 summarizes the activities and contributions of the participants. Volume 2 provides an overview of the presentations at the workshop. Volume 3 documents the perspectives of the participants as recorded by Technical Monitors and observers. Author

N94-30285 Defence Research Establishment Suffield, Medicine Hat (Alberta).

THE USE OF LOW COST DIFFERENTIAL MODE GPS RECEIVERS IN UNMANNED VEHICLES

THOMAS E. OLLEVIER In its Proceedings of the 3rd Conference on Military Robotic Applications p 81-85 1991
Avail: Issuing Activity (Defence Research Establishment Suffield, P.O. Box 4000, Medicine Hat, AB T1A 8K6 Canada)

A critical component of the guidance and control system of an unmanned vehicle is the position and attitude determination system. This system determines the accuracy with which the unmanned vehicle system can determine the position of the behicle and hence the position of the object in the vehicle's sensor field of view. Author (CISTI)

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N94-28647# Battelle Columbus Labs., OH.
EFFECTS OF REPAIR ON STRUCTURAL INTEGRITY Final Report, Jan. 1990 - Sep. 1992
R. RICE, R. FRANCINI, S. RAHMAN, M. ROSENFELD, S. RUST, S. SMITH, and D. BROEK Dec. 1993 156 p
(Contract DTRS57-89-C-00006)
(AD-A275756; DOT-VNTSC-FAA-93-11; DOT/FAA/CT-93/79; PB94-143336) Avail: CASI HC A08/MF A02

FAA regulations require commercial aircraft operators to repair damaged aircraft structures. These repairs must be performed in a timely manner to reduce aircraft downtime and loss of revenue. A guiding principal for such repairs is to restore the structure to the original (or better) static strength and stiffness. However, the repair can also be designed for adequate fatigue resistance, damage tolerance, and inspectability. Fatigue and damage tolerance (DT) analyses should be based on realistic stress histories which, in turn, should be derived from realistic load spectra. Thus, an algorithm for the development of a stress history should be included in a comprehensive analysis of repairs. Since many damage repair stations and airlines do have at least basic computer facilities that can be used for fatigue and damage tolerance analysis, one goal has been the development of a relatively simple, yet accurate analytical tool to design aircraft repairs more effectively. The structural analysis and stress spectrum development procedures described in this report are approximate and, therefore, have certain limitations. These procedures might be used to qualitatively compare the quality of different repair options with the original structure.
DTIC

N94-28657# Foster-Miller Associates, Inc., Waltham, MA.
FULL-SCALE TESTING AND ANALYSIS OF CURVED AIRCRAFT FUSELAGE PANELS Final Report, May 1991 - Mar. 1992
G. SAMAVEDAM, D. HOADLEY, and D. THOMSON Dec. 1993 58 p
(Contract DTRS57-89-D-00009)
(AD-A275666; DOT-VNTSC-FAA-93-10; DOT/FAA/CT-93/78; PB94-142551) Avail: CASI HC A04/MF A01

This report presents data on (1) residual strength of aircraft panels containing Multiple-Site Damage (MSD) in tap splices, and (2) fatigue strength of panels subjected to cyclic pressure loading. The testing was conducted using the dedicated Aging Aircraft Test Facility previously built in the Foster-Miller laboratory. A previous report describes the work in the first phase involving the design and operation of the facility and the test data generated on residual strength of panels with longitudinal midday skin cracks. In the Phase II work presented here, several residual strength tests were conducted to develop a relationship between failure pressure and the lead crack length in the critical upper rivet line of the lap joint. In some of the panels multiple-site damage was also built in the rivet line during fabrication. The reduction in the residual strength due to MSD has been experimentally quantified. Conditions of crack arrest at tear straps and panel flapping were also investigated. Fatigue testing of the panel, with no initial damage in the tap splice except an unbonded lap joint area, was conducted to investigate the crack initiation at multiple sites, crack growth rates and eventual linkup of the ligaments and fracture failure. The ultimate life of the panel, and the damage in critical upper and lower skin rivet rows was determined. Conclusions of practical interest were drawn from the test data.
DTIC

N94-28660# Naval Postgraduate School, Monterey, CA.
A MOMENT PLOTTING METHOD FOR CHARACTERIZING AIRCRAFT FATIGUE DATA POPULATION DISTRIBUTIONS M.S. Thesis
ROLF M. LOKENSGARD Sep. 1993 106 p
(AD-A275500) Avail: CASI HC A06/MF A02

A method was developed where, by statistically analyzing samples of aircraft fatigue data from a population, the population's probability distribution function is determined. The method uses plots of a sample's coefficient of variation, and measures of skewness and kurtosis, superimposed on templates of curves created from the moment functions of normal, lognormal, Weibull, and exponential distributions. The moment functions are derived for each distribution. The plotting technique is combined with a comparison of goodness of fit statistics to form the complete distribution selection method. The method is first tested on random numbers generated from known distributions to see if the correct distributions are selected; then the method is applied to helicopter loads data, fatigue life characterization test data, and counting accelerometer data.
DTIC

N94-28817*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
MODIFICATION OF ACSYNT AIRCRAFT COMPUTER PROGRAM FOR PRELIMINARY DESIGN Semiannual Progress Report, Oct. 1993 - Mar. 1994
DANIEL J. BIEZAD and RUBEN ROJOS-OVIEDO 31 Mar. 1994 13 p
(Contract NCC2-834)
(NASA-CR-195737; NAS 1.26:195737) Avail: CASI HC A03/MF A01

This paper presents the development of a computer simulation of agility flight test techniques. Its purpose is to evaluate the agility of aircraft configurations early in the preliminary design phase. The simulation module is integrated into the NASA Ames aircraft synthesis design code. Trade studies using the agility module embedded within the design code to simulate the combat cycle time agility metric are illustrated using a Northrop F-20 aircraft model. Results 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 also compare the agility potential between different configurations and has the capability to optimize agility performance early in the design process.
Author

N94-28837# Naval Postgraduate School, Monterey, CA.
ACQUISITION, DESIGN MODIFICATION, ASSEMBLY, AND GROUND TEST OF NPS HUMMINGBIRD REMOTELY PILOTED HELICOPTER M.S. Thesis
GREGORY J. FICK Sep. 1993 93 p
(AD-A275546) Avail: CASI HC A05/MF A01

The Hummingbird is a 150-lb. gross weight, remotely piloted helicopter (RPH) with a 50-lb. payload and a rotor radius of 10.25 ft. It is powered by a 25 h.p. air cooled two-cylinder Westlake engine. As such it represents one of the largest RPH's in the world. It was purchased from Gorham Model Products in 1992 to provide a suitable rotorcraft research flight test platform for the Department of Aeronautics and Astronautics at the Naval Postgraduate School. The helicopter was delivered disassembled and was accompanied by an ample supply of replacement and spare parts. Also included was a second helicopter in a partially assembled condition that had been previously flown. Assemblies provided comprised the chassis, main rotor transmission, rotor head assembly, and tailboom with tail rotor gear box and rotor. The task undertaken by this thesis was to fabricate one operable RPH and to design, fabricate, and install whatever new assemblies that were required for its NPS mission and to make up for deficiencies in the previous design. The work completed required: (1) design, fabrication, and installation of a new skid-type landing gear system; (2) redesign and incorporation of a new engine mount system; (3) modification of the engine and main rotor transmission coupling; (4) upgrade of the

electrical system and elongation of the nose section; and (5) initial engine testing. Recommendations for future modifications to the helicopter and laboratory facilities and development of a static hover test fixture are also included. DTIC

N94-28870# Naval Postgraduate School, Monterey, CA.
PROCEDURAL GUIDE FOR MODELLING AND ANALYZING THE FLIGHT CHARACTERISTICS OF A HELICOPTER DESIGN USING FLIGHTLAB M.S. Thesis
GARY P. MCVANEY 23 Sep. 1993 150 p
(AD-A275077) Avail: CASI HC A07/MF A02

This thesis presents one method for modeling and analyzing a helicopter design using Flightlab. Flightlab is a computer program that provides for engineering design, analysis, and simulation of aircraft using nonlinear dynamic modeling techniques. The procedure to model a single main rotor helicopter is outlined using a sample helicopter design. The analysis procedure contains computer program scripts for determining the time response of the helicopter to standard control inputs such as a longitudinal impulse, a lateral step, and a pedal doublet. A linear model of the helicopter can be extracted from the nonlinear model, and a comparison of the time response to the control inputs based on these two models is presented. The procedure for conducting frequency sweep testing for the linear model is also discussed. This guide to using Flightlab for aircraft modelling and analysis is designed to make it easier to use Flightlab for creating additional aircraft models for use in control system analysis and additional engineering design. DTIC

N94-28957# Fuji Heavy Industries Ltd., Tokyo (Japan).
A DESIGN OF THIRD-GENERATION AIRFOILS FOR HELICOPTER ROTOR BLADES USING NAVIER-STOKES [NABIE SUTOKOSU KAISEKI O MOCHIITA HERIKOPUTA ROTA BUREDO YO DAI 3 SEDAI KOUSEINO YOKUGATA NO SEKKEI]
MASAAKI NAKADATE and MASAHIRO OBUKATA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 57-62 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Recent progress in the performance of helicopters has been so remarkable that maximum speeds of over 200 knot are not uncommon among experimental helicopters. Such high performance owes much to the progress in rotor aerodynamics, especially the development of advanced airfoils. Additionally, the recent progress in Computational Fluid Dynamics (CFD) and supercomputers has been quite remarkable. These improvements make it possible to accurately predict airfoil performance up to and beyond maximum lift, where viscous and vortical effects prevail. A practical design target was identified. The target was to obtain airfoil shapes with comparable performance to that of Boeing Helicopter's third-generation airfoils, VR-12 through VR-15. Prior to the design, a parametric study on leading edge thickness and camber was carried out. The study depended upon the fact that the maximum lift of airfoils is related to leading edge shape. An optimal combination of leading edge thickness and camber was decided during the parametric study. Then, the shape, especially around the leading edge, was successively refined by relaxing the leading edge pressure peak to realize much higher maximum lift without spoiling other performance. Finally, off-design and overall characteristics were verified up to transonic Mach numbers. The airfoil U896H thus designed, has a thickness over chord ratio of 0.10 and has symmetric section shape except for the optimized cambar around the leading edge. Wind tunnel results of the airfoil showed high maximum lift and high drag divergence Mach number as expected and enough to be among third-generation airfoils. Author (NASDA)

N94-28998# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EXPLORING QDES AS A TOOL FOR DETERMINING LIMITS OF ACHIEVABLE PERFORMANCE IN AIRCRAFT DESIGN M.S. Thesis
MARK F. REIDINGER Dec. 1993 151 p
(AD-A275359; AFIT/GAE/ENY/93D-23) Avail: CASI HC A08/MF A02

This thesis explores the usefulness of a computer aided control design software package called QDES in determining the limits of achievable aircraft performance as it relates to controller capability. Modern aircraft, particularly fighters, are being designed to be statically unstable to enhance their maneuverability and performance. It is possible that the aircraft, although physically capable of a certain level of performance due to its engine/airframe combination, may be uncontrollable up to this level. This study sought to develop a methodology to use QDES to make a preliminary analysis of an aircraft design to determine if there exists a controller that will enable this design to meet its performance goals and, if not, to determine what the limits of achievable performance are. DTIC

N94-29042# Logicon, Inc., Dayton, OH.
BACKSCATTER HAZE DEVICE FOR MEASUREMENT OF HAZE IN AIRCRAFT TRANSPARENCIES Final Report, Jan. 1991 - Dec. 1992
H. L. TASK (Air Force Systems Command, Wright-Patterson AFB, OH.), RICHARD J. BARTELL, and SHELDON E. UNGER May 1993 36 p
(Contract AF PROJ. 7184)
(AD-A275127; AL/CF-TR-1993-0102) Avail: CASI HC A03/MF A01

The method currently used throughout the aircraft transparency industry to measure haze is ASTM Test Method D1003. This procedure was originally developed for applications involving small, thin, and flat transparent parts. Major limitations of Test Method D1003 include its restriction to small, flat samples and its requirement for having the source and detector on opposite sides of the sample under test. In order to facilitate field testing of installed aircraft windscreens, a test method was developed which overcomes the limitations of Test Method D1003. The new method determines haze values by measuring the amount of light backscattered off the surface of the transparency under test. A prototype instrument was developed and tested against D1003. The results of those tests are presented. The new instrument consists of an integrating sphere, a mechanically chopped incandescent light source, a silicon detector, and supporting electronics. This report describes the device, which is based on U.S. Patent Number 4,687,338, in detail. Use of this type of device in the field could provide quantitative data for determining when an installed aircraft, windscreen should be replaced or refinished in place. DTIC

N94-29200# Naval Postgraduate School, Monterey, CA.
A NON-LINEAR SIMULATION FOR AN AUTONOMOUS UNMANNED AIR VEHICLE M.S. Thesis
DAVID R. KUECHENMEISTER Sep. 1993 123 p
(AD-A275062) Avail: CASI HC A06/MF A02

Unmanned Air Vehicles have become increasingly important on the modern battlefield. The restrictive requirement for runways and special equipment to take off and land was partially solved by the vertical take off and landing Airborne Remotely Operated Device, AROD. Work done at the Naval Postgraduate School has modified the AROD to not only land and launch vertically, but to fly horizontally for the majority of the mission. To realize these capabilities, as well as that of autonomous flight, an accurate computer model was required of both the AROD and the avionics test bed aircraft, Bluebird, in order to design the control and navigation systems. High fidelity, non-linear equations of motion were derived in matrix form that represented any six degree of freedom aircraft model, and they were then tailored for use on specific aircraft. Computer modeling of the resulting equations of motion, as well as the sensors used on the aircraft, was done using SIMULINK and MATLAB software. The resulting computer model provides a non-linear system of equations, which are easily linearized at any desired flight condition, as required by the proposed control and navigation system design. DTIC

N94-29391# *Aeronautical Systems Div., Wright-Patterson AFB, OH.*
KC-135 COCKPIT MODERNIZATION STUDY AND CREW REDUCTION FEASIBILITY DEMONSTRATION Final Report, 15 Aug. 1992 - 31 Aug. 1993
JOHN E. EHRHART, JR., JORDAN R. KRISS, JANET M. EMERSON, and THOMAS C. HUGHES Oct. 1993 123 p
(AD-A275230; ASC-TR-93-5023) Avail: CASI HC A06/MF A02

Future KC-135 missions will require significant increases in aircraft flexibility to respond to the Air Force vision of Global Reach, Global Power. Such flexibility typically translates into advanced avion ics systems and system capabilities; however, a large percentage of the avionics systems currently installed on the KC-135 are late 1950's and 1960's technology which has degraded the efficiency, reliability, maintainability and safety of the KC-135 mission. Strategic Air Command (SAC), now Air Mobility Command (AMC) issued a statement of need (SON, 1987) addressing the need to modernize the KC-135 cockpit avionics to attend to these problems. This report documents the evaluation phase of this program and for the first time directly compares the two-man and three-man cockpit configurations. The validation of the reduced crew consisted of a comparison of crew performance across three distinct missions - Minot, Castle and Desert. Results supported the two-person (No Nav) cockpit, given certain modifications. Based on these results, the CSEF recommended follow-on flight test of the KC-135. Recommendations are based upon using the final design, identical in system capabilities, as developed at the Crew Station Evaluation Facility. The key to the success of this program lies in the utilization of the modifications discussed in this report and the proper implementation of those modifications in future KC-135 cockpits. DTIC

N94-29594 Georgia Inst. of Tech., Atlanta.
HELICOPTER MISSION AND ROTOR PERFORMANCE OPTIMIZATION WITH QUASI-LINEAR INFLOW THEORY Ph.D. Thesis
AZHAR MANSUR KHAN 1992 149 p
Avail: Univ. Microfilms Order No. DA9315887

The enhanced performance envelope of a future generation rotorcraft is greatly desired by all the designers. This design goal can be achieved through rotor performance optimization design methodology, which in simple words is a numerical technique for obtaining the design goals by satisfying the design requirements. The design goal for rotorcraft performance optimization is the reduction of rotor power for a specific weight and mission while the design variables are the rotor chord and twist which define the rotor blade geometry. Constraints are applied to satisfy certain minimum design requirements. Since optimization is a complex numerical iterative procedure, which utilizes a considerable amount of computation time, it is desired by all designers to come up with such an aerodynamic model for helicopter performance calculations which utilizes minimum amount of computer processing time. In view of the above, a steady non-uniform inflow model is used to calculate the rotor performance for both hover and forward flight. The main emphasis of this research work has been to simplify the inflow model without loss of accuracy since, ultimately, this research work is going to be a part of the multidisciplinary helicopter design optimization. Therefore, all time dependent terms have been neglected and all pressure functions and power expressions have been time averaged. After neglecting unsteady terms it was required to take care of the blade tip loss; for which the Prandtl's tip loss function has been used. All complex integrals have also been calculated ahead of time and stored in data files to be used as input to the main program as and when required. The rotor performance code is then modified to a nonlinear constrained optimization problem to be used as input to the optimization routine. The updated version of a FORTRAN routine (CONMIN) for constrained function minimization is used for optimization purpose. Finally, the most optimum planform for the rotor is obtained from the point of view of taper and twist, that requires the least amount of power for a given thrust for hover, for forward flight, and for certain specified missions. The missions to be optimized are a combination of both hover and forward flight. Thus, this research work is an analytical formulation of an optimum rotor for various pre-defined missions. Dissert. Abstr.

N94-29685*# *Lockheed Aircraft Service, Inc., Ontario, CA.*
AIRCRAFT SYSTEM AFT TELESCOPE CAVITY CONFIGURATION STUDY FOR STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA), PHASE 2 Final Report 22 Apr. 1994
171 p Original contains color illustrations
(Contract NAS2-13872)
(NASA-CR-194266; NAS 1.26:194266; R54045007) Avail: CASI HC A08; 62 functional color pages color pages

The SOFIA Aircraft System (AS) Phase 1 Study was a broad-based study which addressed itself to satisfying technical and programmatic requirements by drawing from existing technology and applying cost-efficient commercial approaches to the aircraft modification. In this SOFIA AS Phase 2 Study, five critical areas of the aircraft were selected for more detailed investigation: forward pressure bulkhead, aft bulkhead, 'free' shell to bulkhead interface, shell cut-out to bulkhead interface, and flooring. The in-depth investigation of these areas upon a finite element model (FEM), with a fine grid model in areas of particular interest, is discussed. The FEM code used is called 'STRAP' and was developed by the engineering firm, Rasmussen and Associates. STRAP is NASTRAN compatible to within 1%. The loads applied to the model were approximated from known 747 envelope conditions. The areas of investigation, and a section through the fuselage is shown. The thrust of this investigation was to develop the design concepts conceived under phase 1 to the point where detailed design could be undertaken with a high level of confidence. Derived from text

N94-29854 Purdue Univ., West Lafayette, IN.
INTEGRATED PROPULSION-AIRFRAME DYNAMICS AND CONTROL Ph.D. Thesis
RONALD A. PEREZ 1990 329 p
Avail: Univ. Microfilms Order No. DA9313941

The development of an integrated control scheme to enhance the performance of a generic interconnected multivariable dynamical system, consisting of a turbofan engine and an airframe, in the presence of predominantly destructive dynamical interactions over the flight envelope is considered in this research. The control scheme consists of two components: a simple static forward loop or feedback loop precompensator to improve the interactions followed by a forward or feedback loop controller to improve the performance. System performance specifications dictate zero steady state errors in the engine and airframe controlled output variables as well as minimal overshoot with rapid and smooth acceleration and deceleration profiles. Furthermore the system must be tolerant to soft and hard output sensor failures by means of analytic redundancy only. A control methodology to satisfy the above specifications is presented here. Necessary and sufficient conditions are presented in order to achieve stable closed loop performance of the overall system by tuning every loop separately (i.e., decentralized stability). This leads to very simple control structures, but even for these rather simple control schemes, a significant improvement over previous integration schemes is obtained. Dissert. Abstr.

N94-29878 Georgia Inst. of Tech., Atlanta.
ROTORCRAFT AIRFRAME STRUCTURAL OPTIMIZATION FOR VIBRATION AND DYNAMIC STRESS REDUCTION INCLUDING DAMPING TREATMENT Ph.D. Thesis
ASHISH KUMAR SAREEN 1992 129 p
Avail: Univ. Microfilms Order No. DA9315910

This work focuses on the development of finite element based methodologies for mass, stiffness, and damping modifications of practical airframe structures. This preliminary design type of engineering methodology of analysis and optimization allows rapid and accurate engineering prediction and placement of responses while guiding the structural designer-dynamicist in determining the location, type and

quantity of structural modifications when the airframe is sustaining severe forced vibrations. For new airframe structures, minimum weight structures can be designed with proper placement of airframe natural frequencies and subject to constraints on forced response displacements and dynamic stresses by systematic nonlinear programming-based modifications of mass, stiffness and damping of the structure. In the case of an existing design, when significant mass and stiffness modifications cannot be affected, the designer can resort to viscoelastic type energy-dissipation damping treatments and determine their efficacy. Furthermore, should the change of excitation frequency bring about modal resonance, damping treatments can control response due to resonating modes, without resorting to stiffness or mass changes. This work focuses on the development of necessary computational tools for airframe structural optimization and implements the sensitivity analysis procedures for the various design constraints encountered in vibration and fatigue design of structures. The application of the optimization procedure is demonstrated using both an elastic-line as well as a built-up finite element model of the Bell AH-1G helicopter airframe structure. Dissert. Abstr.

N94-29887 Civil Aviation Authority, London (England).

AIRCRAFT EVACUATIONS: THE EFFECT OF A CABIN WATER SPRAY SYSTEM UPON EVACUATION RATES AND BEHAVIOUR

D. M. BOTTOMLEY (Cranfield Inst. of Tech., Bedford, England.), H. C. MUIR (Cranfield Inst. of Tech., Bedford, England.), and M. C. LOWER (Southampton Univ., England.) Mar. 1993 71 p Original contains color illustrations

(CAA-PAPER-93008; ISBN-0-86039-547-2; ETN-94-95514) Copyright Avail: Issuing Activity (Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England, HC)

An experiment which investigated the human factors aspects of water spray systems, proposed as a means of reducing the effects of fire occurring in an aircraft cabin, is reported. The potential effects of such systems upon evacuation rates and other issues such as visibility and audibility within the cabin were investigated. In total, eight full scale aircraft evacuations were conducted using a 707 airframe. Each evacuation involved a group of around forty five adults who performed one evacuation only. Four groups evacuated in dry conditions, the remaining four evacuated in the water spray. Video cameras were positioned both inside the aircraft cabin and on the platform outside to provide objective measures of evacuation performance. Subjective accounts were also obtained using post evacuation questionnaires. The results revealed that the evacuation times for the two conditions were virtually identical, the lack of a statistically significant difference suggesting that the presence of the water spray did not affect evacuation rates. Other results are given. ESA

N94-30129# Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Physics.

ACOUSTIC EMISSION MONITORING OF AGING AIRCRAFT STRUCTURES

S. L. MCBRIDE, M. R. VINER, and M. D. POLLARD Mar. 1993 13 p

(DREP-93-17; CTN-94-61135) Avail: CASI HC A03/MF A01

Acoustic emission measurements were used to detect fatigue cracks in a full-scale aircraft structure during ground durability and damage tolerance testing. Measurements were made using a 16-channel data acquisition system receiving signals from piezoelectric sensor elements. Fatigue cycling loads were applied at various loading points on the aircraft structure to simulate the known flight load spectra measured in flight. Acoustic emission data were recorded for 700 equivalent flying hours and analyzed at intervals. After 700 hours of testing it was clear from the acoustic emission data that significant crack growth was occurring in the starboard wing skin. Fasteners were removed to inspect fastener holes in the damage area identified by acoustic emission. Fatigue cracks were detected in several holes using eddy current only after the structure was loaded to open the cracks. Acoustic emission data were further analyzed to reconstruct the history of defect growth and to separate the crack growth emission data from crack face rubbing data. The tests show that cracks originating inside fastener holes can be detected easily by acoustic emission without the removal of fasteners. Acoustic emission monitoring is shown to be superior to conventional nondestructive testing in locating fatigue cracks and can be used to determine load conditions leading to crack growth. Author (CISTI)

N94-30131# Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Physics.

ENHANCED FATIGUE CRACK DETECTION IN AGING AIRCRAFT USING CONTINUOUS ACOUSTIC EMISSION MONITORING

STUART L. MCBRIDE, YANHUA HONG, and MICHAEL POLLARD Feb. 1993 12 p

(DREP-93-16; CTN-94-61137) Avail: CASI HC A03/MF A01

Acoustic emission measurements were used to detect fatigue cracks in a full-scale aircraft structure during ground durability and damage tolerance testing. Data are presented for about 3,000 equivalent flying hours of continuous monitoring. Acoustic emission data were acquired via piezoelectric sensors using a 32-channel instrumentation system. The regions of the aircraft structure monitored were located on the lower wing skin, particularly the 15 percent, 39 percent, and 44 percent spar regions. Fatigue cycling loads were applied at various loading points to simulate the known flight load spectra measured on flying aircraft. Defects detected by acoustic emission and confirmed by conventional nondestructive methods were of two types: fatigue cracks in fastener holes repaired at or before 9,754 equivalent flying hours or new defects occurring principally at the wing skin edge aft of the 44 percent spar. For a number of defects, acoustic emission detection preceded conventional detection by about 3,000 equivalent flying hours. Compared to periodic monitoring, continuous acoustic emission monitoring increases the number of crack advance events available for analysis and enables more secure confirmation of their source. Continuous monitoring also improves the location of crack advance sources and provides a better estimate of distributed structural noise.

Author (CISTI)

N94-30293 Defence Research Establishment Suffield, Ralston (Alberta).

HATT-X: A HIGH PERFORMANCE FLYING LABORATORY FOR AUTONOMOUS UNMANNED AIRCRAFT RESEARCH AND DEVELOPMENT

ALEX B. MARKOV and ROBERT W. HERRING In its Proceedings of the 3rd Conference on Military Robotic Applications p 136-142 1991 Avail: Issuing Activity (Defence Research Establishment Suffield, P.O. Box 4000, Medicine Hat, AB T1A 8K6 Canada)

An experimental flight vehicle has been developed by the Canadian Forces to serve as a flying platform on which to investigate and demonstrate a variety of emerging technologies. This vehicle is the High-speed Aeronautical Technologies Testbed (HATT-X), a high subsonic speed rocket powered drone that has evolved from the ROBOT-X aerial target drone. HATT-X is a highly maneuverable platform that is capable of autonomous and semiautonomous flight. It is currently being used to investigate a number of drone technologies. Capabilities that are being pursued include highly agile evasive maneuvering, the ability to take intelligent actions to counter defensive measures, and supersonic flight. Current capabilities of HATT-X and ongoing research and development are reviewed. Planned enhancements that will facilitate a number of advanced configurations are also discussed. Author (CISTI)

N94-30342 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

DEVELOPMENT OF A METHOD TO PREDICT TRANSONIC LIMIT CYCLE OSCILLATION CHARACTERISTICS OF FIGHTER AIRCRAFT (CONTINUED)

JOS J. MEIJER and ATLEE M. CUNNINGHAM, JR. 10 Apr. 1992 21 p Presented at the 33rd AIAA/ASME/AHS/ASC Structures, Structural Dynamics and Materials Conference/Dynamics Specialist Conference,

Dallas, TX, 16-17 Apr. 1992 Sponsored by USAF; General Dynamics Corp.; Ministry of Defence; and National Aerospace Lab. Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract NIVR-07801N)
(NLR-TP-92156-U; ETN-94-95576) Copyright Avail: Issuing Activity (European Space Agency (ESA))

The continued development of a method to predict the transonic limit cycle oscillation characteristics for a fighter aircraft is reported. An earlier analysis of steady wind tunnel data, obtained for a fighter type aircraft, 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 semi-empirical LCO prediction method is being developed. Its preliminary version was applied to several configurations and correctly identified those which have encountered LCO. It showed the potential for application early in the design process of new aircraft to determine and understand the nonlinear aeroelastic characteristics. The method has been upgraded since. It is described in its present form and results of the latest predictions are used to further assess various parametric effects. The ultimate refinements are expected from recent unsteady wind tunnel force and pressure measurements of which a few preliminary results are analyzed. ESA

06
AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N94-29005# Texas Univ., Arlington. Dept. of Industrial Engineering.
INFORMATION PRESENTATION FOR EXPERT SYSTEMS IN FUTURE FIGHTER AIRCRAFT Final Report, Dec. 1992 - Aug. 1993
MICA R. ENDSLEY and ESIN O. KIRIS Sep. 1993 31 p
(Contract F33616-89-C-0532)
(AD-A275126; AL/CF-TR-1993-0164) Avail: CASI HC A03/MF A01

This study explored the method for presentation of information in the context of a crew-aiding intelligent associate. Forty-five male Air Force pilots and forty-five male and female students served as subjects in the evaluation of prototype display designs. Categorical information coding produced the shortest processing and response times for both groups of subjects. Confidence in decision making was shown to be affected by both coding schema and subject experience level.
DTIC

N94-29048# Logicon, Inc., Dayton, OH.
A COMPARISON OF THREE AIRCRAFT ATTITUDE DISPLAY SYMBOLOGY STRUCTURES Interim Report, Dec. 1990 - Dec. 1991
ERIC E. GEISELMAN, ROBERT K. OSGOOD, and DAVID W. BIERS Jun. 1993 106 p Prepared in cooperation with Dayton Univ., OH
(Contract F33615-89-C-0532)
(AD-A275172; AL/CF-TR-1993-0134) Avail: CASI HC A06/MF A02

This study evaluated the attitude information conveyance of a new aircraft attitude display concept. The new symbology format, called the THETA symbology, was developed by integrating the shape of the conventional ADI and the transparency of the HUD into a single format. This research addressed whether or not there was a significant performance advantage or decrement incurred by the symbology integration. The THETA symbology, ADI, and HUD were evaluated during an attitude maintenance task and an attitude recovery task. The results of the study suggest few differences between the THETA and ADI formats while performance and training time were better with both the THETA symbology and the ADI than with the HUD format. The findings of the study lend support to the hypothesis that an attitude display formed of the integration of ADI and HUD type symbology will demonstrate a performance benefit over a pure HUD format. DTIC

N94-29316# Aerospatiale, Toulouse (France).
HOW TO CONTROL THE INCREASE IN THE COMPLEXITY OF CIVIL AIRCRAFT ON-BOARD SYSTEMS
P. CHANET and V. CASSIGNEUL In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

After showing how the complexity of digital systems is doubling about every five years, and evoking the difficulties caused by this evolution, a methodological approach is described called the 'Systems Development Workshop' aiming to gain mastery of this evolution. Among design, production and validation stages, the importance of the design process is emphasized. The most acute problems of system development are generally described, and examples are given of the power and benefits that can be expected from computer design tools. System architecture design and functional specification are expanded somewhat, to show what benefits can be expected from an integrated approach. Through the SAO example, all development stages are evoked. A rough outline of the necessary capacities for a common work environment is drawn. Finally, it is noted that the increasing necessity of international cooperation in civil aviation consolidates the proposed approach. Author

N94-29332# Alsys, Inc., Saint Cloud (France).
ADA RUN TIME SYSTEM CERTIFICATION FOR AVIONICS APPLICATIONS
JACQUES BRYGIER and MARC RICHARD-FOY In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 9 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

The certification procedures apply to a fully developed system including both hardware and software components. The issue is that the equipment supplier must integrate various components coming from separate sources. In particular, the Ada Run Time System is embedded in the equipment like any other application component. This leads to two major requirements: the Ada Run Time System must be a glass box, and unused run-time services must be eliminated from the embedded components. The first requirement comes from the civil aviation procedures DO 178A, and the second is a consequence of the need to proof the system. This can lead to the elimination of some unpredictable or unsafe Ada language features. The criticality of the system consists of three levels: critical, essential, and non-essential. The report ARINC 613 (from the Airlines Electronic Engineering Committee) surveys the Ada language and provides a list of features not to be used in avionics embedded software, at least for the first two levels.
Author (revised)

N94-29334# Alenia, Torino (Italy).
ON GROUND SYSTEM INTEGRATION AND TESTING: A MODERN APPROACH
B. DIGIANDOMENICO In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 7 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

Modern aircraft, military or civil, incorporate the most up-to-date technology from all fields of research and development. There is an increasing tendency to develop digital control systems to replace analog control systems in all areas: engine control, power generation, fuel control, and environmental control. Digital systems are felt to be irreplaceable in avionics, and they are quickly approaching this level in flight control systems. Indeed, digital systems are responsible for the increased sophistication of modern aircraft and for the success of

avionics as it now exists. The net result is that, while in the first generation of jet planes there were no onboard computers, modern aircraft may have more than twenty—with single or multiple 32 bit microprocessors, multiple megabytes of RAM, and sophisticated real time operating systems. Author (revised)

N94-29389# Air Univ., Maxwell AFB, AL. Airpower Research Inst.
COCKPIT VIDEO: A LOW COST BDA SOURCE
KEVIN W. SMITH Dec. 1993 96 p
(AD-A275228; AU-ARI-93-1) Avail: CASI HC A05/MF A01

This research can not address all the bomb damage assessment (BDA) problems experienced during the Gulf War, as time and classification would preclude such an analysis. Instead, it will focus on unit level war-fighting interfaces, particularly those to which onboard video was a key contributor. DTIC

07
AIRCRAFT PROPULSION AND POWER

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

N94-28960# Tokyo Univ. (Japan). Graduate School.
NUMERICAL STUDY ON THE INTERACTION BETWEEN SCRAMJET ENGINE MODULES CAUSED BY THERMAL CHOKE [SAMARU CHOKU NITORU SUKUMARA JETTO ENJIN NO MOJURU KANNO KANSHO]
TAKUO ONODERA and SHOJIRO KAJI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 75-80 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Airframe-integrated scramjet engines are now proposed as one of the most promising propulsion systems for hypersonic transports and transatmospheric vehicles for single-stage-to-orbit. Such engines are composed of several modules, each of which consists of an air-intake, a combustion chamber, and a nozzle, and these modules are attached side by side to the bottom surface of the fuselage of a vehicle. In such a configuration, it is considered that when disturbances cause one of the modules to be unstarted, such influences propagate to the adjoining modules through the intake and/or the nozzle, and that the normal operation of the propulsion system should be destroyed. In this study, such interactions between modules of the airframe-integrated scramjet engines are investigated numerically. Shock waves generated by thermal choke in the heating region of the module are used to trigger unstart. The flow field, including the yaw cross section of the modules, is approximated. An inviscid compressible flow is assumed, so Euler equations with heating terms are used as the governing equations. The explicit symmetric TVD (Total Variation Diminishing) scheme is used. From the two-dimensional calculations, the following conclusions are obtained: (1) when thermal choke occurs in one module of a scramjet engine, its influence reaches the adjoining modules through shock wave propagation and they become unstarted; and (2) the transient process from the started condition to unstarted is completed in about 30 msec, and the unstarted modules generate not thrust but drag. Author (NASDA)

N94-28977# National Aerospace Lab., Tokyo (Japan).
NUMERICAL STUDY ON INTERNAL FLOWS OF CENTRIFUGAL COMPRESSORS [ENSHIN ASSHUKUKI NO NAIBU NAGARE NIKANSURU SUCHI KAISEKI]
TAKASHI YAMANE and TOSHIO NAGASHIMA In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 169-174 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical calculations have been performed for the analysis of internal flow structures of centrifugal compressors. Computational results reveal the jet and wake structure at the impeller exit. The effects of the wake against diffuser vanes were also investigated by an unsteady rotor-stator interaction calculation and a steady stage calculation. Author (NASDA)

N94-28978# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
APPLICATION OF FLOW FIELD SIMULATION TO TURBINE VANE DESIGN [SUCHI SHIMYURESHON TO TABIN YOKURETSU SEKKEI]
KOJI MATSUNAGA, HISAO TAKEUCHI, ATSUSHIGE TANAKA, RURIKO YAMAWAKI, HIROSHI HAMAZAKI, KAZUO KIKUCHI, and OSAMU NOZAKI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 175-180 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

This paper presents an application of the three dimensional Navier-Stokes computations in designing a turbine vane cascade. The accurate prediction of the cascade flow characteristics such as total pressure loss and outlet flow angle is important for aerodynamic engineers to evaluate the performance of airfoil contour shapes. Curvilinear leaned and swept stator vanes, adopted to suppress the secondary flow and reduce the losses, are studied in detail. The advanced design based on the three dimensional Navier-Stokes computations succeeded in reducing the losses, showing the capability of the code as a design tool. Author (NASDA)

N94-28981# National Aerospace Lab., Tokyo (Japan). Aeroengine Div.
AN ELLIPTIC-HYPERBOLIC GRID GENERATION METHOD AND APPLICATION TO COMPRESSOR FLOWS [DAEN-SOKYOKUSEN GATA KOSHI SEISEIHO TO ASSHUKUKI NAGARE ENO OYO]
KAZUOMI YAMAMOTO In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 193-198 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A three dimensional grid generation method was developed in which an elliptic grid generation equation can be locally changed into a simple hyperbolic type to specify exact grid spacings and directions explicitly. Some simple weighting functions are utilized in order to change the equation type smoothly. Resultant grids for several kinds of blade rows show the method's robustness in the convergence characteristics and its flexibility in application to a variety of complicated geometries. Author (NASDA)

N94-29103*# Sverdrup Technology, Inc., Brook Park, OH.
STRUCTURAL/AERODYNAMIC BLADE ANALYZER (SAB) USER'S GUIDE, VERSION 1.0 Final Report
M. R. MOREL Mar. 1994 112 p
(Contract NAS3-25266; RTOP 505-63-5B; RTOP 535-03-10; RTOP 505-62-10)
(NASA-CR-194460; E-8490; NAS 1.26:194460) Avail: CASI HC A06/MF A02

The structural/aerodynamic blade (SAB) analyzer provides an automated tool for the static-deflection analysis of turbomachinery blades with aerodynamic and rotational loads. A structural code calculates a deflected blade shape using aerodynamic loads input. An aerodynamic solver computes aerodynamic loads using deflected blade shape input. The two programs are iterated automatically until deflections converge. Currently, SAB version 1.0 is interfaced with MSC/NASTRAN to perform the structural analysis and PROP3D to perform the aerodynamic analysis. This document serves as a guide for the operation of the SAB system with specific emphasis on its use at NASA Lewis Research Center (LeRC). This guide consists of six chapters: an introduction which gives a summary of SAB; SAB's methodology, component files, links, and interfaces; input/output file structure; setup and execution of the SAB files on the Cray computers; hints and tips to advise the user; and an example problem demonstrating the SAB process. In addition, four appendices are presented to define the different computer programs used within the SAB analyzer and describe the required input decks. Author (revised)

N94-29254# Technische Hochschule, Darmstadt (Germany). Inst. fuer Energie- und Kraftwerkstechnik.
NUMERICAL MODELLING OF TURBINE COMBUSTION CHAMBERS
S. MAIDHOF and J. JANICKA In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 10 p Sep. 1993
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This paper focuses on the calculation of the flow and scalar fields of axisymmetric gas turbine combustion chambers with non-premixed combustion. Modelling of the turbulent swirling flow is carried out both by viscosity and Reynolds stress closure. It is our intention to specify the shortcomings as well as the potential of the different schemes with regard to prediction capabilities, numerical performance, and economic worth. The various aspects of modelling are discussed. A short description of the governing transport equations as well as the turbulence closure is given. An equilibrium chemistry model is compared to a laminar flamelet model, both schemes applied in conjunction with a probability density formulation for scalar properties. Numerical results of velocities and temperature in model gas turbine combustion chambers are compared with experimental results. Probable reasons for deviations are deduced and some prospects for possible future development of numerical simulation of gas turbine combustion are given. Author (revised)

N94-29255# Alfa Romeo S.p.A., Naples (Italy). Research and Development Dept.
NUMERICAL SIMULATION OF AEROTHERMAL CHARACTERISTICS IN GAS TURBINE COMBUSTORS WITH COMPLEX GEOMETRIES
P. DIMARTINO, G. CINQUE, and C. PADUANO In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 14 p Sep. 1993
Copyright Avail: CASI HC A03/MF A04

A method is presented for calculating steady three-dimensional two-phase turbulent reactive flows with curved irregular boundaries. The gas phase equations are solved in an Eulerian frame of reference by a numerical technique based on the finite volume approach, while the equations describing droplet motion, evaporation, and burning are treated in a Lagrangian frame of reference. Turbulent transport is described by the standard k-epsilon model. The combustion model utilizes a conserved scalar formulation and an assumed shape probability density function to account for chemistry-turbulence interaction. The numerical scheme employs structured non-orthogonal grids, a node-centered variable arrangement, and Cartesian velocity components. A special interpolation procedure is used to avoid checkerboard oscillations due to pressure-velocity coupling, and a low diffusive and bounded scheme is introduced to approximate the convective terms in the transport equations. The capabilities of the numerical procedure are demonstrated by simulating an annular combustion chamber for which experimental results were available. The agreement between calculation and experiments ranges from fair to good. Author (revised)

N94-29256# General Motors Corp., Indianapolis, IN. Gas Turbine Div.
APPLICATION OF CFD IN COMBUSTOR DESIGN TECHNOLOGY
HUKAM C. MONGIA In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 18 p Sep. 1993
Copyright Avail: CASI HC A03/MF A04

Multidimensional computational combustion dynamics has been used over the last twenty years to provide improved insight during gas turbine combustor design and development processes. The empirical/analytical combustor design methodology that was first demonstrated under the Army sponsored Combustor Design Criteria Validation program conducted during 1974-1978 has been used in the design and demonstration of 15 advanced rig combustors, four technology demonstrator engine combustors, three engine combustors, and one small turbine augmentor. Recognizing the limitations of turbulent combustion models, numerics, and the assumptions required to fully specify the boundary conditions for practical gas turbine combustion systems, a new technique that combines state-of-the-art turbulent combustion models with 'consistent' macro-volume expressions ('hybrid combustor modelling') was proposed. This hybrid modeling approach has been calibrated with combustors that include diffusion flame, lean premix/prevaporized, or rich-lean types of combustion processes. The hybrid modeling technique gives good 'quantitative' agreement with measured data on gaseous emissions, smoke, combustion efficiency, lean blowout fuel-air ratio, pattern factor, liner wall temperature levels, and gradients of a number of combustors. Author (revised)

N94-29257# Pratt and Whitney Aircraft of Canada Ltd., Mississauga (Ontario).
RECENT CFD APPLICATIONS IN SMALL GAS TURBINE COMBUSTION SYSTEMS DEVELOPMENT
T. C. J. HU and L. A. PROCIW In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993
Copyright Avail: CASI HC A03/MF A04

A typical small gas turbine combustor is modelled using CFD, and the numerical results are compared with laser doppler velocimetry (LDV) measured data. The predicted flow characteristics are in excellent agreement with the measurements. Some aspects of CFD application in combustor design are discussed. CFD can be used in the following ways: as a tool in studying the flowfield development; in the optimization of location, size, and quantity of flow devices; in monitoring flow performance; and in correlating important design parameters. Use of CFD can significantly reduce the lapse time and the development cost of gas turbine combustors. Author

N94-29258# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
AEROTHERMOCHEMICAL CALCULATIONS IN AFTERBURNERS [CALCULS AEROTHERMOCHIMIQUES DANS LES FOYERS DE RECHAUFFE]
C. DEJEU, J. L. SCHULTZ, and S. MEUNIER In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 8 p Sep. 1993 In FRENCH Original contains color illustrations
Copyright Avail: CASI HC A02/MF A04

The detailed study of the aerodynamics and the thermodynamics of systems is an important part in the process of dimensioning and optimizing the afterburning chambers of modern turbojets. In this context, the article presents two examples of geometries and recent results drawn from concrete cases. The aerothermochemical code which was used was developed by ONERA within the framework of the Cooperative Action for Combustion Chambers (A3C). It is based on a volumes type technique finished with a structured three-dimensional mesh adapted to the walls. The model of combustion used of the generalized type 'Eddy Break Up' is the subject of a more detailed presentation. Author (revised)

N94-29263# General Electric Co., Cincinnati, OH. Advanced Engine Combustor Aero Design.
FUEL INJECTOR DESIGN FOR HIGH TEMPERATURE AIRCRAFT ENGINE
R. W. STICKLES, W. J. DODDS, T. R. KOBLISH, J. SAGER, and S. CLOUSER In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993
(Contract N00140-87-C-6321)
Copyright Avail: CASI HC A03/MF A04

The objective of the Innovative High Temperature Aircraft Engine Fuel Nozzle Program was to design and evaluate a nozzle capable of operating at a combustor inlet air temperature of 1600 F (1144 K) and a fuel temperature of 350 F (450 K). The nozzle was designed to meet the same performance requirements and fit within the size envelope of a current production dual orifice fuel nozzle. The design approach was to use improved thermal protection and fuel passage geometry in combination with fuel passage surface treatment to minimize coking at these extreme fuel and air temperatures. Heat transfer models of several fuel injector concepts were used to optimize the thermal protection, while sample tube coking tests were run to evaluate the effect of surface finish, coatings and tube material on the coking rate. Based on heat transfer analysis, additional air gaps, reduced fuel passage flow area and use of ceramic tip components reduced local

fuel wetted wall temperatures by more than 200 F (100 K) when compared to a current production fuel nozzle. Sample tube coking test results showed the importance of surface finish on the fuel coking rate. Therefore, a one micro-inch (0.025 micron) roughness was specified for all fuel passage surfaces. A novel flow divider valve in the tip was also employed to reduce weight, allow room for additional thermal protection, and provide back pressure to reduce the risk of fuel vaporization. The fuel nozzle was fabricated and evaluated in a series of high temperature coking tests. Initial results of these tests indicate that thermal protection and surface treatments were partially successful in preventing nozzle fouling, but additional refinement of the internal flowpath is needed to prevent buildup of coke particles that partially blocked the spin slots which meter the nozzle fuel flow. *Author*

N94-29264# Pratt and Whitney Aircraft of Canada Ltd., Mississauga (Ontario).

DESIGN ASPECTS IN SMALL AIRCRAFT GAS TURBINE FUEL INJECTORS

K. MCCALDON, L. A. PROCIW, and P. SAMPATH In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 10 p Sep. 1993

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The causes of fuel injector spray deterioration and the effects of this deterioration on engine durability and performance are discussed. Small aircraft gas turbine fuel injectors present special design challenges due to low fuel flow rates involved and the physical size limitations. The principal fuel injector performance requirements are discussed in relation to their effect on the hydraulic, aerodynamic, and thermal design of aerating fuel injectors. *Author*

N94-29267# *Leeds Univ. (England). Dept. of Fuel and Energy.*

ULTRA LOW NO(X) ULTRA LEAN GAS TURBINE PRIMARY ZONES WITH LIQUID FUELS

G. E. ANDREWS, H. S. ALKABIE, U. S. ABDULHUSSAIN, and M. ABDULAZIZ In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 14 p Sep. 1993 Sponsored in part by Science Research Council

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Three low NOx gas turbine combustor design concepts, Jet Mix, Grid Mix and radial swirlers, which have been demonstrated to give very low NOx emissions using gaseous fuels have been successfully tested on liquid fuels and low NOx emissions demonstrated. The Jet Mix was shown to have low NOx emissions at atmospheric pressure and has been tested at pressure, with similar low NOx results. Kerosene performance and emissions was very similar to that for propane as the fuel. The scale up of the Jet Mix was found to be possible without increasing the NOx emissions greatly and is a preferable design option to the use of large numbers of smaller Jet Mix modules. Sector tests at pressure showed the Jet Mix design produced emission reductions close to the best of the NASA clean combustor results. The Grid Mix low NOx design was shown to be capable of low NOx performance using kerosene. There was a much wider flame stability than for the Jet Mix design and lower NOx emissions were demonstrated. The radial swirler with vane passage of 76mm wall fuel injection was shown to have ultra low NOx emissions with liquid fuels, only slightly higher than for gaseous fuels. For a high air flow radial swirler it was found that central kerosene injection gave lower NOx emissions than for gaseous fuels and had the potential to yield a NOx EI of below 10 at simulated take off conditions. *Author*

N94-29269# United Technologies Research Center, East Hartford, CT. Aerothermal Technology/Chemical Sciences.

EVALUATION OF THE TRANSIENT OPERATION OF ADVANCED GAS TURBINE COMBUSTORS

T. J. ROSFJORD and J. M. COHEN In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 10 p Sep. 1993 Sponsored by Pratt and Whitney Aircraft

(Contract N00140-87-C-9902)

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A unique test capability has been defined and used at the United Technologies Research Center to evaluate the transient response of advanced gas turbine combustors. This UTC Transient Combustion Facility offers the opportunity to achieve pre-defined time variations of the air and fuel flow rates and air temperature delivered to a combustor model. This capability can be used for model scales ranging from multi-nozzle combustor sectors to smaller setups focusing on one component or process. A dedicated control computer aids in establishing time profiles for the input parameters and automatically executing the transient test. Among its applications, the facility has been used to study the occurrence of in-nozzle fuel vaporization during Bodie cycles and to assess the tolerance of a fuel-staged combustor to rapid fuel redistribution. *Author*

N94-29270# Fiat Aviazione S.p.A., Turin (Italy). Direzione Progettazione.

TECHNOLOGY RIGS: A TOOL FOR AFTERBURNER DEVELOPMENT

G. RICCARDI, A. TASSELLI, and A. TROVATI In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 17 p Sep. 1993

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To develop a component of an advanced aircraft engine, heavy experimental activities are necessary. To avoid very long and expensive test campaigns on development engines, tests on the so-called technology rigs are fundamental. Particularly in the case of combustion components, whose analytical simulations by means of computer code are still not completely satisfactory and where very high gas temperatures may cause important problems of mechanical integrity, it is essential to check the behavior of the component on the rig before testing on the engine. This paper gives an overview of the test rigs which are used by FiatAvio in the development of the afterburner system for an advanced fighter aircraft engine. The tests which are carried out on these rigs are described and some of the most important results are reported, discussing the benefit they have given to the engine development. Even if this paper obviously does not cover all the results obtained from rig tests over years of engine development, the few examples reported clearly show the importance of these rigs and confirm that the financial outlay to build and update the rigs, test plants and models is worthwhile. *Author*

N94-29291# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Lab.

RESEARCH AND DEVELOPMENT OF RAM/SCRAMJETS AND TURBORAMJETS IN RUSSIA [LA RECHERCHE ET LE DEVELOPPEMENT DES STATOREACTEURS, DES STATOREACTEURS A COMBUSTION SUPERSONIQUE ET DES TURBOSTATOREACTEURS EN RUSSIE]

Dec. 1993 230 p Lecture series held in Laurel, MD, 1-2 Dec. 1993, in Cologen, Germany, 13-14 Jan. 1994, and in Paris, France, 17-18 Jan. 1994

(AGARD-LS-194; ISBN-92-835-0732-0) Copyright Avail: CASI HC A11/MF A03

Russia has a long tradition of achievement in ramjet research and development. The need for new and effective products has led to the establishment of ramjet research as a priority in Russian research and development. This Lecture Series will present and discuss the scientific problems associated with the development of ramjets/scramjets and turboramjets. Some specific aspects of liquid/solid ramjet development, the concepts of LH2 high efficiency RAM combustors, the results of full scale turboramjet testing, scramjet or CFD analyses, and ground

flight tests will be studied. This Lecture Series, endorsed by the Propulsion and Energetics Panel of AGARD, has been implemented by the Consultant and Exchange program.

N94-29292# Central Inst. of Aviation Motors, Moscow (Russia).
INTRODUCTION AND OVERVIEW OF RESEARCH AND DEVELOPMENT OF SOLID PROPELLANT RAMROCKETS, LIQUID FUEL RAMJETS AND EXPERIMENTAL HYDROGEN RAM COMBUSTORS
V. SOSOUNOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 19 p Dec. 1993
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Ramjets, turboramjets, and scramjets have been studied intensively as possible propulsion systems for missiles, high velocity planes, and aerospace planes, which would use this type of propulsion during the atmospheric acceleration phase. All of these propulsion system configurations have a degree of commonality: ram ducts. This fact is discussed in this section of the Lecture Series. CASI

N94-29293# Central Inst. of Aviation Motors, Moscow (Russia).
TURBORAMJET ENGINES: TYPES AND PERFORMANCES
M. M. TSKHOVREBOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 22 p Dec. 1993
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In this report on turboramjet engines, some of the properties of variable cycle propulsion plants based on a combination of ramjet and various turbine-type engines are considered. Various measures of engine thrust performance vs. Mach number are represented. Turboramjet engines (TRE) are classified according to their manner of energy transfer to the ramjet parts. The defining principles of essential TRE propulsion plant working parameters are considered. TRE's with various levels of thrust performance are presented. An effectiveness comparison of various combined propulsion plants for future hypersonic transport planes and a TSTO first stage with LH2 fuel is given. A preference is shown for the turboramjet engine as a universal multimode propulsion plant. The optimization of operating modes in response to changing conditions is adopted as an approach to governing the operation of a combined engine working process. Author (revised)

N94-29294# Central Inst. of Aviation Motors, Moscow (Russia).
RESEARCH AND DEVELOPMENT OF RAMJETS/RAMROCKETS. PART 1: INTEGRAL SOLID PROPELLANT RAMROCKETS
V. SOSOUNOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 31 p Dec. 1993
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Solid propellant ramrockets (SPRR) combine the exclusive operational advantages of solid rockets with the higher fuel efficiency of air breathing engines. The specific feature of an SPRR which differs from a liquid fuel ramjet is the arrangement of the ram combustor in which the products of the primary burning of the solid propellant inside the gas generator are injected through nozzles and reburned. The second feature of the SPRR combustion process is that the gas by-products of primary gas generator are reburned in the ram combustor as turbulent or quasi-turbulent gas flames. Usually there is no need for special flameholders. These special features can lead to some peculiarities in the inserted booster case and to rather complicated gasified fuel supply devices. The third special (negative) feature of SPRR is the constant or programmed fuel supply rate during the flight. Hence, the problem of SPRR fuel flow rate control arises. This lecture discusses the following topics: integration of SPRR with a booster rocket engine; the energy capabilities of different ramjet solid propellants and their application; the effectiveness of secondary fuel combustion in the ram combustor; model and full scaled ramrocket ground testing; and fuel flowrate control in ramrockets. Author (revised)

N94-29295# Central Inst. of Aviation Motors, Moscow (Russia).
SOME PROBLEMS OF SCRAMJET PROPULSION FOR AEROSPACE PLANES. PART 1: SCRAMJET: AIMS AND FEATURES
A. ROUDAKOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 20 p Dec. 1993
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This lecture addresses problems of scramjet propulsion for single-stage aerospace planes. The aerospace plane main objective is acceleration of some payload up to orbital speed. It defines a requirement for the propulsion system to be frugal in the wide flight speed range under conditions of propulsion mass limitation and thrust compared with flight vehicle weight. In accordance with modern estimations, real hydrogen fuel scramjet specific impulse may be several times more than that of a rocket engine in the wide flight speed range, from Mf = 5...6 up to Mf = 15...20. But hydrogen scramjet propulsion requires significant air ram connected with high heating of vehicle structure, large hydrogen tanks (and vehicle), and special forms of the flight vehicle. As a result the scramjet advantage, as well as any other air breathing engine advantage, over the modern liquid rocket engines is not doubtless. Nevertheless scramjets can provide good efficiency in aerospace planes if each scramjet element and units are developed very carefully and have high performances. In another case, scramjet may lose competition with liquid rocket engines and a full scale scramjet will be never created. Theoretical and experimental investigations, ground and flight model tests have demonstrated the possibility of supersonic combustion ramjet for hypersonic flights. But we must carry out serious investigations to obtain high efficiency of scramjet elements and scramjet propulsion as a whole to be sure of scramjet success in aerospace plane competition with liquid rocket engine. Author (revised)

N94-29296# Central Inst. of Aviation Motors, Moscow (Russia).
SCRAMJET CFD METHODS AND ANALYSIS. PART 1: SCRAMJET CFD METHODS. NUMERICAL SIMULATION OF THE FLOW IN SCRAMJET DUCT
V. KOPCHENOV, K. LOMKOV, L. MILLER, V. KRJUKOV, I. RULEV, V. VINOGRADOV, V. STEPANOV, N. ZACHAROV, R. TAGUIROV, and M. AUKIN In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 20 p Dec. 1993
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The computer analysis of scramjet flow became of great importance because of the limited possibilities of ground tests and difficulties of measurements in high speed/enthalpy flows. This fact is a powerful stimulus in CFD development. A short description and examples of applications of the mathematical model for scramjet duct flow developed in CIAM are presented in this paper. Derived from text

N94-29297# Central Inst. of Aviation Motors, Moscow (Russia).
RESEARCH AND DEVELOPMENT OF RAMJETS/RAMROCKETS. PART 2: INTEGRAL LIQUID FUEL RAMJETS
V. SOSOUNOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 23 p Dec. 1993
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Integral liquid fuel ramjets (LFRJ) have some specific features influencing their arrangement and construction. Among such features are: a larger size and working duration than solid propellant ramjets (SPRR), the necessity of fuel manifolds and flameholders, the wall cooling system arrangement in the combustion chamber, and the possibility of fuel flow and nozzle position control during flight on different speed/altitude trajectories. This lecture will discuss some items concerning the mentioned LFRJ features: the integration of ram combustor and booster; duct flow instability during the ejection of booster case; fuel supply device and effective combustion in ramjet; and adaptive control of ramjet on different flight trajectories.
Author (revised)

N94-29298# Central Inst. of Aviation Motors, Moscow (Russia).
RESEARCH AND DEVELOPMENT OF RAMJETS/RAMROCKETS. PART 3: THE STUDY OF GASEOUS HYDROGEN RAM COMBUSTORS
V. A. SOSOUNOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 6 p Dec. 1993
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The peculiarities of H2 ramjet turboramjet high efficiency ram combustors are discussed which include some special topics such as: flame stabilization behind the nozzle edge; increase of the number of nozzles and ram combustor length reduction; separate combustion

without mixing of flames; uniform spread of fuel and air in chamber section; the experiment on model burner series; and methods of effective H2 combustion in a short combustor. Author (revised)

N94-29299# Central Inst. of Aviation Motors, Moscow (Russia).
CIAM EXPERIMENTAL TURBORAMJETS
M. M. TSKHOVREBOV, V. I. SOLONIN, and P. A. K. ADJARDOUZOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 23 p Dec. 1993
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In this report, some results of the TRE operating process including those performed on specially developed demonstrator engines are considered. Essential technical requirements and design features of the experimental TRE designed and developed at CIAM for investigatory study on a test bench are shown. Test facilities for experimental investigations of TRE in 'connected tube' manner and experimental work technology features are presented. Some results of the CIAM TRE experimental study included engine parameters on changing to ramjet operation mode variation. Working parameters in the windmilling (ramjet) mode of operation, and flow characteristics in the afterburner-ramjet combustion chamber are shown. A TRE based on TF parts characteristics matching on changing to ramjet operation mode and engine working parameter variations when going to windmilling in the ramjet mode are discussed. Author (revised)

N94-29300# Central Inst. of Aviation Motors, Moscow (Russia).
SCRAMJET CFD METHODS AND ANALYSIS. PART 2: SCRAMJET CFD ANALYSIS. NUMERICAL SIMULATION OF SUPERSONIC MIXING AND COMBUSTION APPLIED TO SCRAMJET COMBUSTOR
V. KOPCHENOV, K. LOMKOV, S. ZAITSEV, and I. BORISOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 30 p Dec. 1993
Copyright Avail: CASI HC A03/MF A03

A short description of a mathematical model developed in CIAM for numerical simulation of supersonic mixing and combustion, which permits the analysis of the three-dimensional effects, is presented. Some aspects of mixing and combustion enhancement will also be considered on the base of CIAM experience. Derived from text

N94-29301# Central Inst. of Aviation Motors, Moscow (Russia).
SOME PROBLEMS OF SCRAMJET PROPULSION FOR AEROSPACE PLANES. PART 2: SCRAMJET: DEVELOPMENT AND TEST PROBLEMS
A. ROUDAKOV In AGARD, Research and Development of Ram/Scramjets and Turboramjets in Russia 26 p Dec. 1993
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The topics covered include the following: SCRAMJET development strategy; subscale model SCRAMJET flight tests; hypersonic flying laboratory and experimental double mode SCRAMJET; SCRAMJET operation in flight conditions; and experimental dual model SCRAMJET parameters. Derived from text

N94-29438*# General Motors Corp., Indianapolis, IN. Gas Turbine Div.
INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 2: UNSTEADY DUCTED PROPFAN ANALYSIS COMPUTER PROGRAM USERS MANUAL Final Report, Mar. 1990 - Mar. 1991
EDWARD J. HALL, ROBERT A. DELANEY, and JAMES L. BETTNER May 1991 116 p
(Contract NAS3-25270; RTOP 535-03-10)
(NASA-CR-187105; NAS 1.26:187105) Avail: CASI HC A06/MF A02

The primary objective of this study was the development of a time-dependent three-dimensional Euler/Navier-Stokes aerodynamic analysis to predict unsteady compressible transonic flows about ducted and unducted propfan propulsion systems at angle of attack. The computer codes resulting from this study are referred to as Advanced Ducted Propfan Analysis Codes (ADPAC). This report is intended to serve as a computer program user's manual for the ADPAC developed under Task 2 of NASA Contract NAS3-25270, Unsteady Ducted Propfan Analysis. Aerodynamic calculations were based on a four-stage Runge-Kutta time-marching finite volume solution technique with added numerical dissipation. A time-accurate implicit residual smoothing operator was utilized for unsteady flow predictions. For unducted propfans, a single H-type grid was used to discretize each blade passage of the complete propeller. For ducted propfans, a coupled system of five grid blocks utilizing an embedded C-grid about the cowl leading edge was used to discretize each blade passage. Grid systems were generated by a combined algebraic/elliptic algorithm developed specifically for ducted propfans. Numerical calculations were compared with experimental data for both ducted and unducted propfan flows. The solution scheme demonstrated efficiency and accuracy comparable with other schemes of this class. Author

N94-29860*# Eloret Corp., Palo Alto, CA.
A STUDY OF LOW EMISSIONS GAS TURBINE COMBUSTIONS Final Technical Report, 1 Oct. 1990 - 31 Jan. 1994
HENRY G. ADELMAN 25 Apr. 1994 11 p
(Contract NCC2-699)
(NASA-CR-195763; NAS 1.26:195763) Avail: CASI HC A03/MF A01

Analytical studies have been conducted to determine the best methods of reducing NO(x) emissions from proposed civilian supersonic transports. Modifications to the gas turbine engine combustors and the use of additives were both explored. It was found that combustors which operated very fuel rich or lean appear to be able to meet future emissions standards. Ammonia additives were also effective in removing NO(x), but residual ammonia remained a problem. Studies of a novel combustor which reduces emissions and improves performance were initiated. In a related topic, a study was begun on the feasibility of using supersonic aircraft to obtain atmospheric samples. The effects of shock heating and compression on sample integrity were modeled. Certain chemical species, including NO2, HNO3, and ClONO2 were found to undergo changes to their composition after they passed through shock waves at Mach 2. The use of detonation waves to enhance mixing and combustion in supersonic airflows was also investigated. This research is important to the use of airbreathing propulsion to obtain orbital speeds and access to space. Both steady and pulsed detonation waves were shown to improve engine performance. Author (revised)

N94-30013*# Duke Univ., Durham, NC. Dept. of Mechanical Engineering and Materials Science.
AEROACOUSTIC SENSITIVITY ANALYSIS AND OPTIMAL AEROACOUSTIC DESIGN OF TURBOMACHINERY BLADES Status Report, 11 Jul. 1993 - 10 Jan. 1994
KENNETH C. HALL 10 Jan. 1994 24 p
(Contract NAG3-1433)
(NASA-CR-195786; NAS 1.26:195786) Avail: CASI HC A03/MF A01

During the first year of the project, we have developed a theoretical analysis - and wrote a computer code based on this analysis - to compute the sensitivity of unsteady aerodynamic loads acting on airfoils in cascades due to small changes in airfoil geometry. The steady and unsteady flow though a cascade of airfoils is computed using the full potential equation. Once the nominal solutions have been computed, one computes the sensitivity. The analysis takes advantage of the fact that LU decomposition is used to compute the nominal steady and unsteady flow fields. If the LU factors are saved, then the computer time required to compute the sensitivity of both the steady and unsteady flows to changes in airfoil geometry is quite small. The results to date are quite encouraging, and may be summarized as follows: (1) The sensitivity procedure has been validated by comparing the results obtained by 'finite difference' techniques, that is, computing the flow using the nominal flow solver for two slightly different airfoils and differencing the results. The 'analytic' solution computed using the

method developed under this grant and the finite difference results are found to be in almost perfect agreement. (2) The present sensitivity analysis is computationally much more efficient than finite difference techniques. We found that using a 129 by 33 node computational grid, the present sensitivity analysis can compute the steady flow sensitivity about ten times more efficiently that the finite difference approach. For the unsteady flow problem, the present sensitivity analysis is about two and one-half times as fast as the finite difference approach. We expect that the relative efficiencies will be even larger for the finer grids which will be used to compute high frequency aeroacoustic solutions. Computational results show that the sensitivity analysis is valid for small to moderate sized design perturbations. (3) We found that the sensitivity analysis provided important insight into how airfoils should be modified to improve their aeroelastic stability. Using this insight, we redesigned an aeroelastically unstable cascade to produce a stable cascade. Derived from text

N94-30130# Atlantis Scientific Systems Group, Inc., Ottawa (Ontario).
RADAR JET ENGINE HEALTH MONITORING PROJECT Final Report
CATHERINE HARRISON, NICHOLAS WISE, LEONARD LIGHSTONE, and L. PHILIP CARR Jun. 1993 47 p
(ASSGI-301; CTN-94-61136) Avail: CASI HC A03/MF A01

Radar returns of aircraft exhibit jet engine modulation (JEM) lines. The JEM lines are caused by the rotating parts in the turbine engines. The radar returns from the engines suggest that it may be possible to monitor the health of the engine, more specifically blade damage and possibly blade tip rub, by using radar as a sensor. A feasibility study was conducted using continuous wave K-band and X-band radar on CF-700 and J-85 engines. Results showed that to make realistic JEM measurements, a radar with two channels (in-phase and quadrature) is required and that there are optimal viewing angles for different fan blade configurations. Radars were accordingly modified and tested including an X-band cross polarization radar for seeing further into the engine and a X-band dual channel radar. It is not yet known if the radar can see into the engine beyond the second compressor stage. Work remains to be done in order to decide whether radar as an engine health monitoring device would present any advantages over conven tional maintenance methods. Author (CISTI)

08
AIRCRAFT STABILITY AND CONTROL

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

N94-28632# Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
CLOSED LOOP VIBRATIONAL CONTROL: THEORY AND APPLICATIONS Final Report, 1 Jan. 1990 - 30 Sep. 1993
SEMYON M. MEERKOV, PIERRE T. KABAMBA, and ENG-KEE POH 15 Dec. 1993 95 p
(Contract DAAL03-90-G-0004)
(AD-A275451; ARO-27510.3-EG) Avail: CASI HC A05/MF A01

In this project, a novel control technique, referred to as Closed Loop Vibrational Control, is developed and applied to the problem of fuselage vibrations suppression in helicopter dynamics. This technique is applicable to systems where the control input enters the open loop dynamics as an amplitude of a periodic, zero average function, and this amplitude can be chosen to depend on the systems outputs. An example of such a system is the helicopter with Higher Harmonic Control (HHC) where periodic feathering of rotor blades around a fixed pitch angle is introduced in order to suppress the fuselage vibrations. For systems with this structure, a number of control-theoretic problems, including stabilizability, pole placement and robustness, have been solved, and the results are reported in this document. DTIC

N94-29317# Societe de Fabrication d'Instruments de Mesure, Massy (France). Industries Groupe Avionique.
PERFORMING SPECIFICATIONS FOR COMPLEX SYSTEMS' SOFTWARE [SPECIFICATIONS EXECUTABLES DES LOGICIELS DES SYSTEMES COMPLEXES]
F. DELHAYE and D. PAQUOT In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 14 p Nov. 1993 In FRENCH
Copyright Avail: CASI HC A03/MF A03

The role played by numerical technologies has increased with each generation of flight control systems. Most of the functions of these systems are now assumed by integrated software and to industrialize the production of these software systems is rapidly becoming a necessity. The SFIM Industries have created a system which can successfully address each phase of the life cycle. Helicopter operating is intrinsically complex and any redundancy in the control systems increases this complexity. To create specifications for such systems is difficult but it is critical, as errors in specifications are often detected in the final phases of development, resulting in costly corrections. It is thus necessary to verify the precision and the justification of the specifications as early as possible. Within its Research and Development activities in avionics, SFIM evaluated the specifications' techniques in the cycle of complex systems' development. Several techniques have been studied (structural analysis, synchronized languages, expert systems) and two of them were tested in experiments. These techniques made it possible to create and validate some of the specifications, with varying degrees of success. The positive aspect of these techniques was clearly shown, they are significant elements in the cost management program of complex systems' software. Author

N94-29728 Kansas Univ., Lawrence.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF LEADING EDGE EXTENSIONS ON DIRECTIONAL STABILITY AND THE EFFECTIVENESS OF FOREBODY NOSE STRAKES Ph.D. Thesis
AN-KUO FU 1992 197 p
Avail: Univ. Microfilms Order No. DA9323014

Low speed wind tunnel testing was conducted at Aeronautical Research Laboratory in Taiwan, ROC, using a generic configuration, to investigate the effect of leading-edge extensions (LEX) on directional stability and the effectiveness of forebody nose strakes. To help interpret the wind tunnel measurements, flow visualization including dye and laser sheet was also conducted. It was found that for the present configuration, the LEX vortices dominated the flow field such that the forebody vortices were depressed to stay close to the body surface. Because of this, the nose strakes on this configuration were found to be ineffective in reducing directional instability and producing control moment with a single strake. Directional instability for the configuration with the LEX's was mainly caused by the vertical tail. However, for the configuration with a single small nose strake at very high angles of attack, the instability was caused by a second forebody vortex formed under the nose strake which stayed close to the body surface. Using a single large nose strake, effectiveness for yaw control was significantly improved. However, for sideslip control, the proper forebody side for its deployment depends on the angle of attack. In addition, with a pair of large nose strakes, the untrimmed yawing moment was almost eliminated at zero sideslip. A bi-stable condition was identified for the configuration without the LEX's at alpha = 46 deg. in the water tunnel and 48 deg. in the wind tunnel. For the baseline configuration with the LEX's, a bi-stable condition was also found at alpha = 55 deg. Dissert. Abstr.

N94-29850 Wichita State Univ., KS.
DECOUPLED FLIGHT CONTROL SYSTEM DESIGN USING THE SINGULAR PERTURBATION METHOD
SUKJUNE PARK 1992 209 p
Avail: Univ. Microfilms Order No. DA9311976

A new approach is developed to design the high gain output feedback with proportional plus integral (P-I) controller. The singular

perturbation theory is utilized for the theoretical development. This approach is simpler and more comprehensive than the other methods. The controller produces desirable closed-loop response with minimal interaction between outputs. The new design method is applied to the design of decoupling flight control systems for the full aircraft model (i.e., lateral and longitudinal dynamics). The complete process used to obtain a decoupling flight control law is presented. A robustness study is included to test the controller performance with parameter variations. The results show that the controller is robust with respect to varying maneuver commands. Also, this study includes the six degree of freedom nonlinear simulation to validate the design method. The nonlinear simulation results show that output-feedback solutions from the linear case satisfy the required conditions for application to nonlinear systems. A computer aided design program is developed to assist in the interactive design process. Dissert. Abstr.

N94-30204*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A NOVEL APPROACH TO NOISE-FILTERING BASED ON A GAIN-SCHEDULING NEURAL NETWORK ARCHITECTURE

T. TROUDET (Sverdrup Technology, Inc., Brook Park, OH.) and W. MERRILL Apr. 1994 10 p

(Contract NAS3-25266; RTOP 584-03-11)

(NASA-TM-106563; E-8739; NAS 1.15:106563) Avail: CASI HC A02/MF A01

A gain-scheduling neural network architecture is proposed to enhance the noise-filtering efficiency of feedforward neural networks, in terms of both nominal performance and robustness. The synergistic benefits of the proposed architecture are demonstrated and discussed in the context of the noise-filtering of signals that are typically encountered in aerospace control systems. The synthesis of such a gain-scheduled neurofiltering provides the robustness of linear filtering, while preserving the nominal performance advantage of conventional nonlinear neurofiltering. Quantitative performance and robustness evaluations are provided for the signal processing of pitch rate responses to typical pilot command inputs for a modern fighter aircraft model. Author (revised)

N94-30284 Combustion Dynamics Ltd., Medicine Hat (Alberta).

PAYLOAD CENTRAL CONTROL FOR UNMANNED AIRCRAFT

D. R. WEILER, M. G. HENDERS, R. H. CHESNEY, and D. EHMAN In Defence Research Establishment Suffield, Proceedings of the 3rd Conference on Military Robotic Applications p 74-80 1991

Avail: Issuing Activity (Defence Research Establishment Suffield, P.O. Box 4000, Medicine Hat, AB T1A 8K6 Canada)

A control system concept is being developed for use in unmanned surveillance aircraft to control the aircraft automatically in response to the imagin g sensor payload requirement. The implementation of such a control system is discussed and results of simulation tests are presented. Author (CISTI)

09
RESEARCH AND SUPPORT FACILITIES (AIR)

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

N94-28510*# General Electric Co., Cincinnati, OH. Advanced Technology Operations.

DESIGN AND FABRICATION OF FORWARD-SWEPT COUNTERROTATION BLADE CONFIGURATION FOR WIND TUNNEL TESTING Final Report

G. H. NICHOLS 1 Mar. 1994 164 p

(Contract NAS3-25269)

(NASA-CR-194868; NAS 1.26:194868) Avail: CASI HC A08/MF A02

Work performed by GE Aircraft on advanced counterrotation blade configuration concepts for high speed turboprop system is described. Primary emphasis was placed on theoretically and experimentally evaluating the aerodynamic, aeromechanical, and acoustic performance of GE-defined counterrotating blade concepts. Several blade design concepts were considered. Feasibility studies were conducted to evaluate a forward-swept versus an aft-swept blade application and how the given blade design would affect interaction between rotors. Two blade designs were initially selected. Both designs involved in-depth aerodynamic, aeromechanical, mechanical, and acoustic analyses followed by the fabrication of forward-swept, forward rotor blade sets to be wind tunnel tested with an aft-swept, aft rotor blade set. A third blade set was later produced from a NASA design that was based on wind tunnel test results from the first two blade sets. This blade set had a stiffer outer ply material added to the original blade design, in order to reach the design point operating line. Detailed analyses, feasibility studies, and fabrication procedures for all blade sets are presented. Author (revised)

N94-28749*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE NOZZLE ACOUSTIC TEST RIG: AN ACOUSTIC AND AERODYNAMIC FREE-JET FACILITY

RAYMOND S. CASTNER Apr. 1994 12 p Presented at the 18th AIAA Aerospace Ground Testing Conference, Colorado Springs, CO, 20-23 Jun. 1994; sponsored by AIAA

(Contract RTOP 505-62-84)

(NASA-TM-106495; E-8485; NAS 1.15:106495; AIAA PAPER 94-2565) Avail: CASI HC A03/MF A01

The nozzle acoustic test rig (NATR) was built at NASA Lewis Research Center to support the High Speed Research Program. The facility is capable of measuring the acoustic and aerodynamic performance of aircraft engine nozzle concepts. Trade-off studies are conducted to compare performance and noise during simulated low-speed flight and takeoff. Located inside an acoustically treated dome with a 62-ft radius, the NATR is a free-jet that has a 53-in. diameter and is driven by an air ejector. This ejector is operated with 125 lb/s of compressed air, at 125 psig, to achieve 375 lb/s at Mach 0.3. Acoustic and aerodynamic data are collected from test nozzles mounted in the free-jet flow. The dome serves to protect the surrounding community from high noise levels generated by the nozzles, and to provide an anechoic environment for acoustic measurements. Information presented in this report summarizes free-jet performance, fluid support systems, and data acquisition capabilities of the NATR. Author (revised)

N94-28950# National Aerospace Lab., Tokyo (Japan). Aerodynamics Div.

RAREFIED GAS NUMERICAL WIND TUNNEL. PART 8: HOPE [KIHAKU KITAI SUCHI FUDO. 8: HOPE]

KATSUHISA KOURA, MIKINARI TAKAHIRA, and HIROAKI MATSUMOTO In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 17-20 Dec. 1992 In JAPANESE

Avail: CASI HC A01/MF A03

The Rarefied Gas Numerical Wind Tunnel (RGNWT) developed for the simulation of rarefied gas flows around three dimensional whole flight bodies is applied to the H-2 Orbiting Plane (HOPE). Some flowfield properties and aerodynamic characteristics are presented.

Author (NASDA)

N94-28951# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SIMULATION OF ARC HEATED WIND TUNNEL FLOW [AKU KANETSU GATA FUDO NO SUCHI KAISEKI]
RYOJI TAKAKI, YASUHIRO WADA, and YASUO WATANABE In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 21-26 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A numerical analysis of thermochemical nonequilibrium inviscid flow is made for the arc heated wind tunnel at NAL (National Aerospace Laboratory). The calculation is carried out with the Harten-Yee type TVD (Total Variation Diminishing) scheme, using finite-rate seven species chemical reactions and the Park's 2-temperature model in order to take account of nonequilibrium thermochemistry. Results of numerical simulations for three models (perfect gas model, 1-temperature model, and 2-temperature model) are presented and are compared with each other. Author (NASDA)

N94-29052*# *Texas A&M Univ., College Station. Engineering Experiment Station.*
WIND TUNNEL TESTING AND RESEARCH Final Report, 25 Jan. 1990 - 12 Mar. 1993
ORAN W. NICKS 15 Nov. 1993 21 p
(Contract NAS9-18261)
(NASA-CR-188273; NAS 1.26:188273) Avail: CASI HC A03/MF A01

The topics covered include the following: a test of a Space Shuttle model with various base enhancements intended to help reduce the drag of the Shuttle in the landing configuration; further tests conducted using a Shuttle model to explore base drag improvement techniques; testing of parafoils having different airfoil shapes and line lengths; a study of ground effects on a Shuttle model; and three dimensional velocity profiles in the wake aft of the Space Shuttle were determined to study the effects of wake velocities on the Orbiter drag chute. Derived from text

N94-29151# Air Force Civil Engineering Center, Tyndall AFB, FL. Engineering and Services Lab.
ASPHALTIC CONCRETE PERFORMANCE UNDER HEAVY FIGHTER AIRCRAFT LOADING Final Report, Apr. 1988 - Nov. 1990
D. A. TIMIAN, S. M. DASS, W. C. DASS, R. H. SUES, and M. B. HARDY Feb. 1993 359 p
(AD-A275046; AFCESA/ESL-TR-91-26; XC-AFCESA/ESL) Avail: CASI HC A16/MF A03

Rutting of asphaltic concrete pavements is rapidly becoming a cause for concern among AF civil engineers. Modern fighter aircraft often have operating tire pressures well above the capacity of the existing pavements. To reduce rutting, a mix design technique that explicitly considers the expected loading was investigated. Pavement test sections were constructed and trafficked by high pressure tires. Variations in test sections included mix design (Marshall and gyratory), airfield design (4- and 6-inch flexible and rigid composite), and wheel loading (F-15C/D). Pavement loading was monitored throughout trafficking, including dynamic load magnitude, position, and velocity. Pavement response was measured by taking profilographs before, during, and after trafficking. Damage parameters were defined and calculated to evaluate test section response and performance. Damage varied significantly between test sections, with the most obvious factors being the mix design and the base layer support. The gyratory test sections outperformed their Marshall counterparts with the gyratory composite section performing the best. This study has shown that pavements can be designed using gyratory methods. However, improvements in base layer performance are needed to improve the overall performance of flexible airfield pavements. DTIC

N94-29754# Systems Control Technology, Inc., Arlington, VA.
ROOFTOP EMERGENCY HELIPORTS Final Report
WILLIAM T. SAMPSON, III, SANDRA HENNINGER, and RICHARD S. FIXLER Jun. 1993 61 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/RD-93/2) Avail: CASI HC A04/MF A01

The research for this project included an in-depth analysis of high-rise fire incidents in which helicopters have been used. Following this effort, a survey was conducted of building codes that were applicable to the construction of heliports and helistops on the roofs of high-rise buildings. These codes were examined to determine common and uncommon elements and to identify strengths and weaknesses. After analyzing this data, the FAA's Heliport Design Advisory Circular (AC) 150/5390-2 was reviewed. This data was then used to develop recommendations for additions or changes to the AC. Author

N94-30200*# *National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.*
APPLICATION OF FUZZY LOGIC TO THE CONTROL OF WIND TUNNEL SETTLING CHAMBER TEMPERATURE
DAVID A. GWALTNEY and GREGORY L. HUMPHREYS Mar. 1994 16 p
(Contract RTOP 505-70-59-03)
(NASA-TM-109105; NAS 1.15:109105) Avail: CASI HC A03/MF A01

The application of Fuzzy Logic Controllers (FLC's) to the control of nonlinear processes, typically controlled by a human operator, is a topic of much study. Recent application of a microprocessor-based FLC to the control of temperature processes in several wind tunnels has proven to be very successful. The control of temperature processes in the wind tunnels requires the ability to monitor temperature feedback from several points and to accommodate varying operating conditions in the wind tunnels. The FLC has an intuitive and easily configurable structure which incorporates the flexibility required to have such an ability. The design and implementation of the FLC is presented along with process data from the wind tunnels under automatic control. Author

N94-30399 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
CORRECTION OF X HOT-WIRE MEASUREMENTS FOR GRADIENTS NORMAL TO THE PLANE OF THE WIRES
J. H. M. GOODEN 9 Jul. 1992 53 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-125473; NLR-TP-95592; ETN-94-95592) Avail: CASI HC A04

A gradient correction method, which allows correction of the results obtained from X hot wire measurements for flow gradients normal to the plane of the hot wires, is described. The influence of these gradients on the hot wire response is determined from the hot wire response equations. A data processing method which allows a correction of the measured data after the measurements have been completed is described. The method was applied to hot wire measurements of the mean and fluctuating flow velocities in the turbulent wake shed from a two dimensional wing above a single trailing edge flap. ESA

N94-30423 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
A MODERNISED HST OF NLR
F. JAARSMA, J. SMITH, and R. K. VANDERDRAAI 31 Oct. 1992 22 p Presented at the European Windtunnels and Forum on Windtunnel Test Techniques, Southampton Univ., England, 14-17 Sep. 1992 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-B179220; NLR-TP-92420-U; ETN-94-95961) Avail: CASI HC A03

The modernization underway and plans for the future of the High Speed Tunnel (HST) are reported. The improvement comprised three main objectives, namely: improvement of testing capabilities; improvement of Reynolds number range; and improvement of productivity. Because of budget limitations the total plan will be executed in phases. The first phase, now under full execution, concerns the following more

specific items: extension of test section length to reduce buoyancy effects; adaptability to two different test section heights (1.6 and 1.8 m) allowing extended incidence range; new model support system allowing a selection between slender sting support boom with limited incidence range (30 deg), double roll sting boom with moderate incidence range (30 deg in a single sweep) and limited yaw (+ and -10 deg), or articulated sting boom with large incidence range (50 deg) and large yaw (+ and - 30 deg); automated tunnel operation for improved productivity and improved accuracy; and modernization of the controls of the power plant. Wall and support interference effects were studied in detail in order to arrive at improved mechanical systems and correction methods. Further improvements planned in the future include application of adaptive walls and an increase of power to extend the range in terms of Reynolds number testing. ESA

11

CHEMISTRY AND MATERIALS

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

N94-28654# Naval Postgraduate School, Monterey, CA.
SERVICE LIFE PREDICTION OF COMPOSITE STRUCTURES THROUGH FIBER TESTING M.S. Thesis
GREGORY S. MORIN Sep. 1993 94 p
(AD-A275661) Avail: CASI HC A05/MF A01

Increasing the severity of the stress history of a structure reduces its service life. Feasibility studies to increase the zero fuel weight of the P-3 Orion depend heavily on the resulting decrease in service life of the wing box and airframe. One option of extending the service life of existing aircraft is through the replacement or augmentation of critical structural members with composite materials. Since structural composites do not yet have adequate service life statistics, life predication must be through probability modeling. Such modeling can begin with experimental data on accelerated testing of fiber life under several sustained load levels. This data can be the basis for an appropriate strength-life model of the fiber which can in term be related to the strength-life model of the composite by the local-load sharing model. The local-load sharing model captures the physical failure sequence of fiber failure within a composite. Such a strength-life model, when combined with structural analysis, can be used to predict an airframe's service life under the changed conditions associated with the zero fuel weight increase. DTIC

N94-28655# Naval Postgraduate School, Monterey, CA.
SAFETY ENHANCEMENT OF COMPOSITES VIA PERIODIC PROOF TESTING M.S. Thesis
JOSEPH H. WOODWARD Sep. 1993 74 p
(AD-A275662) Avail: CASI HC A04/MF A01

The development of new composite materials, which lack the historical field data base, has led to the need for an accelerated life testing method applicable to composites. Accelerated life testing by increasing the sustained stress levels requires the modeling and validation of a strength-life relation. Proof testing of composite fibers by over-loading is one step in the understanding of the relationship. It is also important in the reliability and safety assurance in deployment of composite structures. A parametric study examined the strength-life relation of composite fibers and a methodology to analyze the fiber failures after proof testing. The fiber statistical strength was modeled by a probability of failure model while a deterministic approach was taken considering individual fibers and the associated life reduction each fiber experienced during the proof testing procedure. Also studied was the distribution of the first failure to occur after proof testing in order to understand the effects of the sustained load and the proof load on fiber life. DTIC

N94-28823*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PREDICTION OF STRESS-STRAIN RESPONSE OF SCS-6/TIMETAL-21S SUBJECTED TO A HYPERSONIC FLIGHT PROFILE
MASSOUD MIRDAMADI (Analytical Services and Materials, Inc., Hampton, VA.) and W. STEVEN JOHNSON Feb. 1994 32 p
(Contract RTOP 505-63-50-04)
(NASA-TM-109026; NAS 1.15:109026) Avail: CASI HC A03/MF A01

Thermomechanical response of a cross-ply SCS-6/Timetal-21S composite subjected to a generic hypersonic flight profile with the temperature ranging from -130 C to 816 C was evaluated experimentally and analytically. A two dimensional micromechanical anlaysis, VISCOPLY, was used to predict the stress-strain response of the laminate and of the constituents in each ply during thermomechanical loading conditions. In the analysis, the fiber was modeled as elastic with transverse orthotropic and temperature dependent properties and the matrix was modeled using a thermoviscoplastic constitutive relation. The fiber transverse modulus was reduced in the analysis to simulate fiber-matrix interface failure. Reasonable agreement was found between measured and predicted laminate stress-strain response when fiber-matrix debonding was modeled. Author

N94-28830 Aluminum Co. of America, Alcoa Center, PA.
ROLE OF MICROSTRUCTURE ON THE FATIGUE DURABILITY OF ALUMINUM AIRCRAFT ALLOYS Progress Summary Report, Mar. - Dec. 1993
J. R. BROCKENBROUGH, R. J. BUCCI, A. J. HINKLE, P. E. MAGNUSEN, and S. M. MIYASATO 29 Dec. 1993 40 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract N00014-91-C-0128)
(AD-A275814) Avail: CASI HC A03

The goal of this program is to provide a framework through which metallic alloy development programs and aircraft life assessment methodologies may exploit the potentially significant advantages in performance, weight reduction, and cost savings offered by quality improved materials and processes. The key performance attribute studied in this investigation is fatigue durability as identified by cracking which originates from microstructural features and grows to an inspectable dimension of economic consequences (i.e., a crack requiring diagnostic or corrective action during the operational lifetime of a part). Meeting the program objective consists of the following steps: (1) coupling historical material performance data with new data to formulate the opportunity and validate the concept, (2) quantifying the relationship between microstructure and performance, (3) synthesizing and verifying analytical models for predicting statistical fatigue response from microstructure data, and (4) developing test/evaluation protocols to facilitate technology implementation and concept scale-up to quantify payoff potential. DTIC

N94-28901 Allied-Signal Aerospace Co., Des Plaines, IL. Research and Development.
ADVANCED FUEL PROPERTIES: A COMPUTER PROGRAM FOR ESTIMATING PROPERTY VALUES Final Report, Sep. 1987 - Jan. 1993
C. A. PARKER, J. T. DONNER, K. R. SQUIRE, R. J. SCHOFIELD, and K. R. KRIHA May 1993 175 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract F33615-87-C-2709)

(AD-A275248; WL-TR-93-2086) Avail: CASI HC A08

The U.S. Air Force has seen that in order to develop fuels needed for the high performance aircraft of the future, the ability to design fuels based on the satisfaction of a set needed properties is necessary. This report covers all phases of a project to develop software to accomplish this goal. This report discusses the methods used by the software to obtain the thermochemical properties of organic fuel candidates. Emphasis was placed on describing the methods used to determine the properties of a mixture of compounds, since it is these types of mixtures that are most likely to befound in fuels. DTIC

N94-29004# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

FUELS COMBUSTION RESEARCH Annual Technical Report, 1 Oct. 1992 - 30 Sep. 1993

IRVIN GLASSMAN and KENNETH BREZINSKY 10 Dec. 1993 24 p (Contract AF-AFOSR-0431-91)

(AD-A275122; AFOSR-94-0032TR) Avail: CASI HC A03/MF A01

Future Air Force aircraft fuels will contain chemical constituents that not only contribute to the propulsion of the aircraft but also to the temperature control of both the combustor walls and the aircraft body. Temperature control may require the use of new, endothermic fuels such as methylcyclohexane (MCH). This cycloalkane in the presence of a catalyst dehydrogenates to toluene. The toluene and hydrogen product, containing a small amount of unreacted MCH, fuel the combustor. The burning characteristics of the mixture as well as its temperature stability as it is transferred to the combustor, most likely as a supercritical fluid, are largely unknown. Clarifying the combustion and thermal stability characteristics of both gaseous and supercritical fluid mixtures of toluene and methylcyclohexane has been the focus of the past year's research. Gas phase flow reactor studies of the pyrolysis and oxidation of pure MCH and of the oxidation of mixtures of MCH and toluene have revealed the chemical means by which MCH affects the oxidation chemistry of toluene. Supercritical fluid flow reactor examinations of the thermolysis of MCH and toluene mixtures have suggested chemical routes to deposit formation in the fluid fuels. These results are described in greater detail in this report. DTIC

N94-29246# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.

FUELS AND COMBUSTION TECHNOLOGY FOR ADVANCED AIRCRAFT ENGINES [LES PROPERGOLS ET LES SYSTEMES DE COMBUSTION POUR LES MOTEURS D'AERONEFS]

Sep. 1993 495 p In ENGLISH and FRENCH Symposium held in Fiuggi, Italy, 10-14 May 1993 Original contains color illustrations

(AGARD-CP-536; ISBN-92-835-0719-3) Copyright Avail: CASI HC A21/MF A04

The conference proceedings contains 38 papers that cover new technologies for low NO(x) combustors and advanced high pressure/high temperature cycle engines. The technical evaluation report and the keynote address are included at the beginning, and discussions follow most papers. The symposium was arranged in the following sessions: technology overview papers (two papers); modeling: pollutant formation (four); modeling: combustor design (five); high temperature fuels and fuel systems (six); combustion research: performance (six); combustion research: emissions (five); fuel atomization: diagnostics and modeling (five); and combustion research: flowfield and mixing (four). The last paper is a contribution from Russia not allocated to a session.

N94-29248# Naval Air Warfare Center, Trenton, NJ. Aircraft Div.

COMBUSTION TECHNOLOGY NEEDS FOR ADVANCED HIGH PRESSURE CYCLE ENGINES

STEPHEN D. CLOUSER and RICHARD A. KAMIN In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 8 p Sep. 1993

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The challenges in designing high performance aircraft combustion systems have not changed significantly over the years, but the approach has shifted towards a more sophisticated analytical process. Initially an overview of the U.S. Navy's component technology development procedure is presented to show how technology development is still tied into mission requirements. A more technical discussion on combustion technology status and needs will show that the classic impediments that have hampered progress towards near-stoichiometric combustion still exist. Temperature rise, mixing, liner cooling, stability, fuel effects, temperature profile control, and emissions continue to confront the aerodynamic and mechanical designers with a plethora of engineering dilemmas and trade-offs. In addition, new materials such as ceramic matrix composites (CMC) and intermetallics like titanium aluminides (TiAl) are now being incorporated into every advanced design. The process of combustion design has taken on a new meaning over the past several years as three dimensional codes and other advanced design and validation tools have finally changed the approach from a 'cut and burn' technique to a much more analytical process. All of these new aspects are now integral elements of the new equation for advanced combustion design that must be fully understood and utilized. Only then will the operable, high temperature capable combustion systems needed for future military aircraft be developed. Author

N94-29249# Rolls-Royce Ltd., Bristol (England).

COMBUSTION FOR FUTURE SUPERSONIC TRANSPORT PROPULSION

B. W. LOWRIE In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 6 p Sep. 1993

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Even with it's marginal performance, Concorde has demonstrated that supersonic civil aircraft are a practical proposition. A second generation machine will need sufficiently good performance for a robust operating system that can provide reliable, frequent service with competitive economics. Additionally, the propulsion system must be acceptable environmentally. That is it must create acceptable noise levels around airports and have acceptable emissions throughout its mission including cruise. Whatever devices may be used to improve the acceptability at subsonic flight conditions, the high operating temperatures at cruise can create difficult targets for the operation of the combustion system both mechanically and in the combustion process itself. While the driving force is ever better fuel consumption and weight to achieve economic viability, a future supersonic transport engine will have cycle temperatures limited only by the mechanical integrity of the major components. The environment of the major components in modern gas turbine engines is dominated by the air delivered by the compressor system. Consequently the maximum compression temperature is governed by materials available for the turbine and compressor discs. The continued improvement of the disc material leads to combustion inlet temperatures beyond today's experience and sets difficult targets for combustion system emissions. This is worsened by the requirement being at cruise and therefore maintained for the major part of the mission. Problems such as creep and oxidation of metallic parts are also considered. Author (revised)

N94-29252# Cranfield Inst. of Tech., Bedford (England). School of Mechanical Engineering.

FLOWFIELD PREDICTION OF NO(X) AND SMOKE PRODUCTION IN AIRCRAFT ENGINES

S. ALIZADEH and J. B. MOSS In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 20 p Sep. 1993 Sponsored by Science Research Council

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CFD predictions of nitric oxide and smoke production in a tubular combustor are described for a range of inlet temperature and pressure conditions up to 800 K and 8 bar, chosen to distinguish the effects of both state properties and turbulence on formation rates. Combustion models based on both laminar flamelet and chemical equilibrium

representations are contrasted and compared with measurements in the literature. While uncertainties persist with respect to the detailed mechanisms, notably for soot formation, a strategy is identified which extends the role of mixture fraction in the calculation of the influence of turbulent scalar fluctuations on emissions prediction. Author (revised)

N94-29259# Pratt and Whitney Aircraft, West Palm Beach, FL. Fuels and Lubricants Group.

HIGH TEMPERATURE FUEL REQUIREMENTS AND PAYOFFS

TEDD B. BIDDLE and BENNETT M. CROSWELL In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993 Sponsored by AFWAL and Naval Air Propulsion Test Center

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This paper describes a study performed under contract to Air Force Wright Laboratory, Wright-Patterson Air Force Base, Dayton, OH in association with the Naval Air Propulsion Laboratory, Trenton, NJ. The study projected fuel temperature capability requirements for future tactical fighter applications and the payoffs that would be realized by achieving these capabilities. The study was approached on the basis of the maximum benefit that might be realized through the use of high temperature fuels, i.e. elimination of the recirculation system. Heat loads were projected for different missions spanning IHPTET technology phases 1, 2, and 3 at different flight conditions. Fuel temperatures across fuel system components were calculated at these heat loads. Shortfalls of the current 163 C fuel capability were shown, and minimun fuel temperature requirements were defined. The study concluded that elimination of the recirculation system is not feasible but shows how high temperature fuel capability can minimize the weight penalty associated with fuel recirculation. In this way, potential payoffs for high temperature fuel development were shown in the form of reduced weight penalties that would normally be encountered as larger and larger recirculation systems are required to accommodate the increasing heat loads projected for advanced aircraft. Author (revised)

N94-29260# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain). Fuels and Lubricants Lab.

HIGH TEMPERATURE RESISTANT JET FUELS

LUIS M. PELOCHE and SANTIAGO ASENSIO In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 9 p Sep. 1993 Sponsored by British Petroleum Oil, Inc.

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The thermal stability of aviation fuels is evaluated according to the ASTM D 2341 method. This characteristic is linked to the presence of generators of instability, mainly diolephins and N and S derivates. The objectives of the present work are as follows: to obtain, in the laboratory, kerosene which is thermally stable; the isolation and identification of generators of instability; and the regeneration of thermally unstable kerosenes. Author (revised)

N94-29261# Wright Lab., Wright-Patterson AFB, OH.

RESEARCH AND DEVELOPMENT OF HIGH THERMAL STABILITY FUELS

T. EDWARDS, W. M. ROQUEMORE, W. E. HARRISON, and S. D. ANDERSON In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 19 p Sep. 1993

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Increases in aircraft performance are leading to increases in the thermal stress on the primary aircraft coolant—the fuel. Fuel thermal stability limitations may offset future aircraft performance gains. The Air Force's Wright Laboratory is sponsoring several research programs to address this problem. The development of an additive package for JP-8 to improve its thermal stability is the primary focus of this paper. This program involves extensive testing of fuels and additives in a variety of test devices, culminating in tests in a fuel system simulator and engine tests. These tests involve Air Force personnel, on-site contractors (University of Dayton Research Institute, Systems Research Laboratories), Pratt and Whitney Aircraft Co., additive manufacturers, and Sandia National Laboratory. The test devices include several flowing and static tests, where the behavior of a fuel is investigated in a wide variety of environments. The study of several baseline fuels in these devices has led to some new insights into the mechanisms of fuel thermal (in)stability. It is becoming clear that a fuel's tendency to oxidize (to form peroxides, for example) is often inversely proportional to its ten dency to form insoluble deposits. Author (revised)

N94-29262# Systems Research Labs., Inc., Dayton, OH.

DEVELOPMENT OF GLOBAL/CHEMISTRY MODEL FOR JET-FUEL THERMAL STABILITY BASED ON OBSERVATIONS FROM STATIC AND FLOWING EXPERIMENTS

V. R. KATTA, E. G. JONES, and W. M. ROQUEMORE In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 11 p Sep. 1993

(Contract F33615-90-C-2033)

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Two global-chemistry models for oxidative deposition of jet fuels are evaluated by integrating them into a Computational Fluid Dynamics with Chemistry (CFDC) code. A previously developed two-step global-chemistry model was found to be insufficient to describe the thermal-oxidation and -deposition rates associated with a Jet-A fuel. A new global-chemistry model has been developed systematically based on observations from flowing and static experiments. The global-autoxidation reaction is modified such that the reaction rate becomes zeroth-order with respect to the dissolved oxygen concentration. The generation of deposit-forming precursor is coupled with the autoxidation reaction by introducing a radical species ROO. A formulation for the sticking probability has also been developed. Deposition profiles are well represented by this new model under a variety of temperature and flow conditions. The model correctly predicts the changes in magnitude and spatial location of the deposition peak due to changes in flow. The CFDC model, which is designed for flowing systems, has been extended to static experiments. The model incorporates a non-depleting species F(sub s) representing all non-oxygen compounds responsible for deposition. Static experiments were found to provide a useful and inexpensive method for estimating the concentration of F(sub s) in the fuel. Author

N94-29265*# Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering.

THE EFFECT OF INCOMPLETE FUEL-AIR MIXING ON THE LEAN LIMIT AND EMISSIONS CHARACTERISTICS OF A LEAN PREVAPORIZED PREMIXED (LPP) COMBUSTOR

D. A. SANTAVICCA, R. L. STEINBERGER, K. A. GIBBONS, J. V. CITENO, and S. MILLS In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993 Sponsored by NASA. Lewis Research Center and GE

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Results are presented from an experimental study of the effect of incomplete fuel-air mixing on the lean limit and emissions characteristics of a lean, prevaporized, premixed (LPP), coaxial mixing tube combustor. Two-dimensional exciplex fluorescence was used to characterize the degree of fuel vaporization and mixing at the combustor inlet under non-combusting conditions. These tests were conducted at a pressure of 4 atm., a temperature of 400 C, a mixer tube velocity of 100 m/sec and an equivalence ratio of .8, using a mixture of tetradecane, 1 methyl naphthalene and TMPD as a fuel simulant. Fuel-air mixtures with two distinct spatial distributions were studied. The exciplex measurements showed that there was a significant amount of unvaporized fuel at the combustor entrance in both cases. One case, however, exhibited a very non-uniform distribution of fuel liquid and vapor at the combustor entrance, i.e., with most of the fuel in the upper half of the combustor tube, while in the other case, both the fuel liquid and vapor were much more uniformly distributed across the width of the combustor entrance. The lean limit and emissions measurements were all made at a pressure of 4 atm. and a mixer tube velocity of 100 m/sec, using Jet A fuel and both fuel-air mixture distributions. Contrary to what was expected, the better mixed case was found to have a substantially

leaner operating limit. The two mixture distributions also unexpectedly resulted in comparable NO(x) emissions, for a given equivalence ratio and inlet temperature, however, lower NO(x) emissions were possible in the better mixed case due to its leaner operating limit. Author

N94-29268# Centro Applicazioni Militari dell'Energia Nucleare, Pisa (Italy).
COMPUTATIONAL AND EXPERIMENTAL RESULTS IN HIGH PRESSURE COMBUSTIONS OF H2/AIR AND H2/O2/H2O
DINO DINI In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 10 p Sep. 1993
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The first results of a research and development program on combustion characteristics of gaseous hydrogen fuel in a 'can' type gas turbine combustor, both in combination with air or with oxygen and water, are here presented. Application of a H2/O2/H2O combustion chamber is suggested for the launch-boost phase of an advanced turboramjet. Experiments have been conducted to determine the configuration and the operation of the hydrogen-air combustion chamber test facility, to be transferred to two different kinds of small power turboshafts. Computations, project details and tests, are presented regarding high pressure and temperature stoichiometric H2/O2 combustion in which water is gradually injected. Referring to an already realized and operated (on behalf of the author) H2/O2/H2O combustor for a water steam closed cycle in a turbine/alternator electrically propelled automobile, a detailed design is developed for a quite higher steam temperature, as required in high performance boost phase of a low noxious emission advanced turboramjet, in which H2 and O2 are stored in liquid form. Author

N94-29271*# California Univ., Irvine. Combustion Lab.
POLLUTANT EMISSIONS FROM AND WITHIN A MODEL GAS TURBINE COMBUSTOR AT ELEVATED PRESSURES AND TEMPERATURES
S. A. DRENNAN, C. O. PETERSON, F. M. KHATIB, W. A. SOWA, and G. S. SAMUELSEN In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 10 p Sep. 1993 Sponsored by Northrop Corp.
(Contract NAG3-1124; F08635-90-C-0100)
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Conventional and advanced gas turbine engines are coming under increased scrutiny regarding pollutant emissions. This, in turn, has created a need to obtain in-situ experimental data at practical conditions, as well as exhaust data, and to obtain the data in combustors that reflect modern designs. The in-situ data are needed to (1) assess the effects of design modifications on pollutant formation, and (2) develop a detailed data base on combustor performance for the development and verification of computer modeling. This paper reports on a novel high pressure, high temperature facility designed to acquire such data under controlled conditions and with access (optical and extractive) for in-situ measurements. To evaluate the utility of the facility, a model gas turbine combustor was selected which features practical hardware design, two rows of jets (primary and dilution) with four jets in each row, and advanced wall cooling techniques with laser drilled effusive holes. The dome is equipped with a flat-vaned swirler with vane angles of 60 degrees. Data are obtained at combustor pressures ranging from 2 to 10 atmospheres of pressure, levels of air preheat to 427 C, combustor reference velocities from 10.0 to 20.0 m/s, and an overall equivalence ratio of 0.3. Exit plane and in-situ measurements are presented for HC, O2, CO2, CO, and NO(x). The exit plane emissions of NO(x) correspond to levels reported from practical combustors and the in-situ data demonstrate the utility and potential for detailed flow field measurements. Author

N94-29272# Pratt and Whitney Aircraft, East Hartford, CT.
REDUCTION OF NO(X) BY FUEL-STAGING IN GAS TURBINE ENGINES: A COMMITMENT TO THE FUTURE
I. SEGALMAN, R. G. MCKINNEY, G. J. STURGESS, and L.-M. HUANG In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 17 p Sep. 1993
Copyright Avail: CASI HC A03/MF A04

As part of an ongoing program of continuous improvement by control of gaseous emissions from the combustors of gas turbines, a unique fuel-staged annular combustor is being developed for application to current and future Pratt & Whitney aircraft engines. The configuration advantages of this combustor are outlined, and discussions are presented on staging considerations and fuel system impacts. Development of the fuel-staged combustor is described by reference to supporting mixing experiments and computational fluid dynamic studies, and rig tests at high pressures. Measured results are given appropriate for the International Aero Engines (IAE) V2500 engine that show progressive reductions in achieved emissions compared to the goals established for this program. Author

N94-29274# Defence Research Agency, Farnborough (England).
THE INFLUENCE OF AIR DISTRIBUTION ON HOMOGENEITY AND POLLUTANT FORMATION IN THE PRIMARY ZONE OF A TUBULAR COMBUSTOR
J. R. TILSTON, M. I. WEDLOCK, and A. D. MARCHMENT In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993
(Contract BRITE/EURAM-1019)
Copyright Avail: CASI HC A03/MF A04

This paper summarizes the work undertaken by the Defense Research Agency (DRA Pyestock) for the BRITE/EURAM Low Emissions Combustor Technology Project No 1019. The work was jointly funded by the CEC (DGXIIH), the UK DTI (CARAD - ATF4) and the UK MOD (DCSA). The gas turbine emissions problem is summarized and the design philosophy of the experimental program is described. The principal objective was to demonstrate a simultaneous reduction of NO(x) and smoke emissions together with acceptable idling emissions and stability in an unstaged combustor. A secondary objective was to demonstrate the extent to which NO(x) and smoke could be reduced if the combustor was to be used as the main stage of a staged combustor where a poorer idling performance could be accepted. The work consisted of a parametric investigation of the principal factors controlling the emissions produced in the combustor primary zone. Particular emphasis was placed on the influence of the distribution, number, and size of air entry holes and of residence time on pollutant formation. The results from the complete experimental program are summarized. These suggest that NO(x) reductions of about 30-40 percent should be possible together with excellent smoke and idling performance. The results suggest that NO(x) was formed very close to stoichiometric flame temperatures even at very weak combustor mixture strengths and under well mixed conditions. The reductions that were achieved were largely as a result of reductions of residence time. Author

N94-29275# Universidad Politecnica de Madrid (Spain). Dept. de Motopropulsion y Termofluidodinamica.
EFFECTS OF HYDROGEN ADDITION ON POLLUTANT EMISSIONS IN A GAS TURBINE COMBUSTOR
J. SALVA and G. LOPEZ In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 9 p Sep. 1993
Copyright Avail: CASI HC A02/MF A04

This paper presents an experimental work on the control of pollutants produced in a tubular hydrocarbon fueled combustor, by the injection of hydrogen in small quantities (less than 4 percent of total fuel). Hydrogen is introduced in the primary zone premixed with the air. Using this technique, with lean primary zone, it is possible to reduce the NO(x) emission level while maintaining CO and HC emission index at normal levels (CO and HC levels are greater without hydrogen injection). Injecting butane, instead of hydrogen, shows that there is no beneficial effect, so the influence of hydrogen in CO and HC reduction is due mainly to factors such as hydrocarbon substitution and chemical kinetics. An analysis to estimate the contribution of these factors is also included. Author

N94-29276# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
DUCTED KEROSENE SPRAY FLAMES
R. M. PEREZ-ORTIZ, S. SIVASEGARAM, and J. H. WHITELAW In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 16 p Sep. 1993 Sponsored by Rolls-Royce Ltd.
(Contract N00014-89-J-1721)
Copyright Avail: CASI HC A03/MF A04

Reaction progress in premixed methane-air flames in round ducts without and with kerosene sprays has been quantified on the basis of species concentration measurements for different fueling arrangements of kerosene with equivalence ratio, proportion of liquid to gaseous fuel, duct length and air preheat temperature as variables in smooth and in rough combustion. The intensity of heat release close to the flame holder in rough combustion was greater than that in smooth combustion, and the duct length necessary to ensure complete combustion decreased with air preheat temperature and upstream turbulence intensity and was weakly dependent on the proportion of methane to kerosene in flow arrangements where the kerosene was sprayed upstream of the flame-holder. The injection of kerosene through the flame holder at a velocity larger than that of the mean flow past the disk led to uneven mixing and incomplete combustion. Pulsed injection of kerosene through a pintle-type injector also resulted in incomplete combustion due to the larger droplet size than in arrangements with a steady flow of kerosene. Oscillations of large amplitude were induced at equivalence ratios usually associated with smooth combustion and oscillations in rough combustion ameliorated by pulsed injection of kerosene comprising around 10 percent of the total fuel. Author

N94-29277*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SPRAY COMBUSTION EXPERIMENTS AND NUMERICAL PREDICTIONS
EDWARD J. MULARZ (Army Research Lab., Cleveland, OH.), DANIEL L. BULZAN, and KUO-HUEY CHEN In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 21 p Sep. 1993 Original contains color illustrations
Copyright Avail: CASI HC A03/MF A04

The next generation of commercial aircraft will include turbofan engines with performance levels significantly better than those in the current fleet. Control of particulate and gaseous emissions will also be an integral part of the engine design criteria. These performance and emission requirements present a technical challenge for the combustor: control of the fuel and air mixing and control of the local stoichiometry will have to be maintained much more rigorously than with combustors in current production. A better understanding of the flow physics of liquid fuel spray combustion is necessary. This paper describes recent experiments on spray combustion where detailed measurements of the spray characteristics were made, including local drop-size distributions and velocities. Also, an advanced combustor CFD code has been under development and predictions from this code are compared with experimental results. Studies such as these will provide information to the advanced combustor designer on fuel spray quality and mixing effectiveness. Validation of new fast, robust, and efficient CFD codes will also enable the combustor designer to use than as valuable additional design tools for optimization of combustor concepts for the next generation of aircraft engines. Author

N94-29281# Technische Hochschule, Darmstadt (Germany). Flight Propulsion.
THE MIXING PROCESS IN THE QUENCHING ZONE OF THE RICH-LEAN-COMBUSTION CONCEPT
TH. DOERR and D. K. HENNECKE In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 9 p Sep. 1993 Sponsored by DFG Original contains color illustrations
Copyright Avail: CASI HC A02/MF A04

The rich burn/quick quench/lean burn (RQL) combustion system is a potential concept to reduce both NO(x) and CO, UHC emissions. In view of the concept's crucial mixing process, an experimental investigation of a nonreacting multiple jet mixing with a confined crossflow has been conducted. Temperature distributions, mixing rate, and standard deviation were determined for measurements with round jet orifices by parametric variation of flow and geometric conditions. The results show that best mixing strongly depends on an optimum momentum flux ratio. Too high ratios yield a deterioration of mixing process, due to the mutual impact of opposed entraining jets. Furthermore, over a wide range of geometries investigated, inline and staggered configurations provide similar mixing rates. An appreciable enhancement of mixing with staggered orifice configurations only occurs for high momentum flux ratios and large spacings. Author

N94-29285# Central Inst. of Aviation Motors, Moscow (Russia).
ENDOTHERMIC FUELS FOR HYPERSONIC AVIATION
LEONID S. IANOVSKI and CLIFFORD MOSES In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 8 p Sep. 1993
Copyright Avail: CASI HC A02/MF A04

The creation of hypersonic vehicles and the use of jet engines with higher temperature cycles has resulted in a significant increase in the thermal stresses of the engine elements. In order to use the fuel as the coolant for these elements, it is necessary to increase the heat capacity of hydrocarbon fuels. This problem can be solved by taking advantage of such high temperature chemical processes as catalytic dehydrogenation and thermal cracking or pyrolysis of hydrocarbon fuels, including the addition of the initiators and catalysts. The chemical heat capacity of hydrocarbon fuels can be used for the direct cooling of such elements as combustion chambers, nozzles, and front wing edges; indirect cooling of these elements can be accomplished by using a heat-transport medium in the fuel/air or fuel/gas heat exchangers. The gaseous products of the decomposed fuels can be used as a working medium for the drive ofthe equipment of a fuel/feeding system. Author (revised)

N94-29356*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUEL-RICH CATALYTIC COMBUSTION OF A HIGH DENSITY FUEL
THEODORE A. BRABBS (Sverdrup Technology, Inc., Brook Park, OH.) and SYLVIA A. MERRITT Washington Jul. 1993 13 p
(Contract RTOP 505-62-52)
(NASA-TP-3281; E-7298; NAS 1.60:3281) Avail: CASI HC A03/MF A01

Fuel-rich catalytic combustion (ER is greater than 4) of the high density fuel exo-tetrahydrocyclopentadiene (JP-10) was studied over the equivalence ratio range 5.0 to 7.6, which yielded combustion temperatures of 1220 to 1120 K. The process produced soot-free gaseous products similar to those obtained with iso-octane and jet-A in previous studies. The measured combustion temperature agreed well with that calculated assuming soot was not a combustion product. The process raised the effective hydrogen/carbon (H/C) ratio from 1.6 to over 2.0, thus significantly improving the combustion properties of the fuel. At an equivalence ratio near 5.0, about 80 percent of the initial fuel carbon was in light gaseous products and about 20 percent in larger condensable molecules. Fuel-rich catalytic combustion has now been studied for three fuels with H/C ratios of 2.25 (iso-octane), 1.92 (jet-A), and 1.6 (JP-10). A comparison of the product distribution of these fuels shows that, in general, the measured concentrations of the combustion products were monotonic functions of the H/C ratio with the exception of hydrogen and ethylene. In these cases, data for JP-10 fell between iso-octane and jet-A rather than beyond jet-A. It is suggested that the ring cross-linking structure of JP-10 may be responsible for this behavior. All the fuels studied showed that the largest amounts of small hydrocarbon molecules and the smallest amounts of large condensable molecules occurred at the lower equivalence ratios. This corresponds to the highest combustion temperatures used in these studies. Although higher temperatures may improve this mix, the temperature is limited. First, the life of the present catalyst would be greatly shortened when operated at temperatures of 1300 K or greater. Second, fuel-rich catalytic combustion does not produce soot because the combustion temperatures used in the experiments were well below the threshold temperature (1350 K) for the formation of soot. Increasing the temperature above this value would remove the soot-free nature of

the process. Since all the fuels studied show a similar breakdown of the primary fuel into smaller molecular combustion products, this technique can be applied to all hydrocarbon fuels. Author (revised)

N94-29457# Aerospatiale, Suresnes (France). Dept. Materiaux.
FIRE BEHAVIOR OF AERONAUTICAL MATERIALS [COMPORTEMENT AU FEU DES MATERIAUX AERONAUTIQUES]
B. COSTES, C. KURAS, and B. CARRIERE 1993 25 p In FRENCH
(REPT-932-600-105; DCR/M-61546/C-92; ETN-94-95484) Avail: CASI HC A03/MF A01

A set of graphics that introduce the aeronautical problems of toxicity and safety linked to fire in an aircraft and the combustion of aircraft construction materials are presented. Materials currently used, their certification, and present solutions to their associated problems, are considered. Previous aircraft accidents and their causes are addressed as case studies. Combustion tests and environmental constraints are reported. ESA

N94-29900 Wichita State Univ., KS.
THE EFFECT OF MECHANICAL PAINT STRIPPING ON THE FATIGUE AND FRACTURE OF THIN ALUMINUM AIRPLANE SKIN Ph.D. Thesis
JOE P. AMRO 1992 150 p
Avail: Univ. Microfilms Order No. DA9311975

An experimental investigation has been carried out to evaluate the affects of dry stripping (paint removal by plastic particle blasting) on aluminum aircraft skins (2024-T3). Analytical procedures were carried out for determining changes in fatigue life and relevant fracture resistance parameters such as number of cycles required to generate a surface crack of certain length, crack propagation rate, and number of cycles to failure while indicating the dependence of these parameters on the surface condition (morphology). The surface morphology dependence on deformation, fracture resistance properties, and defects presented on the surface were characterized using scanning electron microscopy, optical microscopy, and other modern metallographic techniques. The results indicated that all the parameters of plastic media blasting had significant effects on the fatigue life of the specimens. Minor changes in the blasting parameters may reveal different results. All fatigue samples were found to exhibit a general decrease in life of 10 to 46 percent after being subjected to four cycles of paint removal. The samples were cyclically loaded to 20,000 cycles then stripped and repainted four times; 20,000 cycles represents approximately 5 years of life. The initial stress ratio for loading was 0.1 with stresses varying from 20 to 65 ksi. Dissert. Abstr.

12
ENGINEERING

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

N94-28466# Sandia National Labs., Albuquerque, NM.
HOLOGRAPHIC INTERFEROMETRY: A USER'S GUIDE
D. GRIGGS Oct. 1993 31 p
(Contract DE-AC04-94AL-85000)
(DE94-003136; SAND-92-2909) Avail: CASI HC A03/MF A01

This manual describes the procedures and components necessary to produce a holographic interferogram of a flow field in the Sandia National Laboratories hypersonic wind tunnel. In contrast to classical interferometry, holographic interferometry records the amplitude and phase distribution of a lightwave passing through the flow field at some instant of time. This information can then be reconstructed outside the wind tunnel for visual analysis and digital processing. This yields precise characterizations of aerodynamic phenomena. The reconstruction and subsequent hologram image storage process is discussed, with particular attention paid to the digital image processor and the data reduction technique. DOE

N94-28646# Instron Corp., Canton, MA.
DEVELOPMENT OF ALTERNATING CURRENT POTENTIAL DROP (ACPD) PROCEDURES FOR CRACK DETECTION IN ALUMINUM AIRCRAFT PANELS Final Report, May - Dec. 1990
D. A. JABLONSKI Dec. 1993 108 p
(Contract DTRS57-89-D-00007)
(AD-A275755; DOT-VNTSC-FAA-93-9; DOT/FAA/CT-93/76) Avail: CASI HC A06/MF A02

The Alternating Current Potential Drop (ACPD) method is investigated as a means of making measurements in laboratory experiments on the initiation and growth of multiple site damage (MSD) cracks in a common aluminum alloy used for aircraft construction. Procedures for instrumenting MSD test specimens are recommended. The ACPD method is found to be capable of the following: (1) detecting crack initiation at a crack length of the order of 1 mm; (2) monitoring crack propagation at a resolution of the order of 5 micrometers; and (3) providing an indirect measurement of crack extension in R-curve type tests of fastener hole details. DTIC

N94-28665# Ohio State Univ., Columbus. Dept. of Mechanical Engineering.
BOUNDARY LAYERS INDUCED BY THREE-DIMENSIONAL VORTEX LOOPS Final Report, 1 May 1989 - 31 Aug. 1993
A. T. CONLISK, H. AFFES, O. R. BURGGRAF, and ZHENHUA XIAO
Dec. 1993 278 p
(Contract DAAL03-89-K-0095)
(AD-A275678; RF-767440/722045; ARO-26595.7-EG) Avail: CASI HC A13/MF A03

The flow field generated by a helicopter in flight is extremely complex and it has been recognized that interactions between different components can significantly affect helicopter performance. In particular, the effects of the interaction between the rotor wake and the helicopter fuselage are extremely difficult to predict and pose a challenging problem for researchers and designers in the rotorcraft area. In the present work, a model for the interaction of a rotor-tip-vortex with the airframe of a helicopter is developed. The present report describes the calculation of the motion of the tip-vortex toward the airframe, the calculation of the induced pressure on the airframe, and the calculation of the boundary-layer flow under the vortex during the time period prior to the time when a portion of the tip-vortex collides with the airframe. DTIC

N94-28704*# Naval Air Warfare Center, Indianapolis, IN.
NAVAIR AIRCRAFT WIRING STANDARDIZATION AND QUALIFICATION PROGRAM
THOMAS MEINER In NASA. Lewis Research Center, Second NASA Workshop on Wiring for Space Applications p 59-61 Jan. 1994
Avail: CASI HC A01/MF A03; 8 functional color pages

The topics are presented in viewgraph form and include the following: wiring responsibilities; purpose of the program; measurement of program effectiveness; results; and summary. CASI

N94-28705*# Naval Air Warfare Center, Indianapolis, IN.
ORGANIZED WIRING SYSTEMS
THOMAS MEINER In NASA. Lewis Research Center, Second NASA

Workshop on Wiring for Space Applications p 63-77 Jan. 1994 Original contains color illustrations
Avail: CASI HC A03/MF A03; 8 functional color pages

The topics are presented in viewgraph form and include the following: wiring systems, quality control, qualification and standardization, and maintenance costs. CASI

N94-28724*# Stanford Univ., CA. Joint Inst. for Aeronautics and Acoustics.

A METHOD FOR THE MODELLING OF POROUS AND SOLID WIND TUNNEL WALLS IN COMPUTATIONAL FLUID DYNAMICS CODES

THOMAS JOHN BEUTNER Dec. 1993 124 p
(Contract NCC2-55)
(NASA-CR-195699; NAS 1.26:195699; JIAA-TR-111) Avail: CASI HC A06/MF A02

Porous wall wind tunnels have been used for several decades and have proven effective in reducing wall interference effects in both low speed and transonic testing. They allow for testing through Mach 1, reduce blockage effects and reduce shock wave reflections in the test section. Their usefulness in developing computational fluid dynamics (CFD) codes has been limited, however, by the difficulties associated with modelling the effect of a porous wall in CFD codes. Previous approaches to modelling porous wall effects have depended either upon a simplified linear boundary condition, which has proven inadequate, or upon detailed measurements of the normal velocity near the wall, which require extensive wind tunnel time. The current work was initiated in an effort to find a simple, accurate method of modelling a porous wall boundary condition in CFD codes. The development of such a method would allow data from porous wall wind tunnels to be used more readily in validating CFD codes. This would be beneficial when transonic validations are desired, or when large models are used to achieve high Reynolds numbers in testing. A computational and experimental study was undertaken to investigate a new method of modelling solid and porous wall boundary conditions in CFD codes. The method utilized experimental measurements at the walls to develop a flow field solution based on the method of singularities. This flow field solution was then imposed as a pressure boundary condition in a CFD simulation of the internal flow field. The effectiveness of this method in describing the effect of porosity changes on the wall was investigated. Also, the effectiveness of this method when only sparse experimental measurements were available has been investigated. The current work demonstrated this approach for low speed flows and compared the results with experimental data obtained from a heavily instrumented variable porosity test section. The approach developed was simple, computationally inexpensive, and did not require extensive or intrusive measurements of the boundary conditions during the wind tunnel test. It may be applied to both solid and porous wall wind tunnel tests.
Author

N94-28815*# Pratt and Whitney Aircraft, East Hartford, CT.

THERMAL/STRUCTURAL TAILORING OF ENGINE BLADES (T/SEAEBL). THEORETICAL MANUAL Final Report

K. W. BROWN and W. B. CLEVENGER Mar. 1994 40 p
(Contract NAS3-22525; RTOP 505-63-5B)
(NASA-CR-194462; E-8495; NAS 1.26:194462) Avail: CASI HC A03/MF A01

The Thermal/Structural Tailoring of Engine Blades (T/STAEBL) system is a family of computer programs executed by a control program. The T/STAEBL system performs design optimizations of cooled, hollow turbine blades and vanes. This manual describes the T/STAEBL data block structure and system organization. The approximate analysis and optimization modules are detailed, and a validation test case is provided. Author

N94-28894# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

DESIGN AND CONSTRUCTION OF THE AEROBOT ROBOTIC MANIPULATOR (ARM) M.S. Thesis

WILLIAM L. COCHRAN Dec. 1993 118 p
(AD-A275362; AFIT/GA/ENY-93D-2) Avail: CASI HC A06/MF A02

This thesis designed, constructed, and tested a robotic arm for the Aerobot (Aerial Robot). The main purpose of the ARM is to enable the Aerobot to retrieve objects during an annual robotics competition. Design of the ARM involved synthesizing the characteristics of simplicity, weight, strength, and size. The result was a three-degree-of-freedom manipulator that uses electric motors, cable linkages, and telescoping tubes to access a work space below the Aerobot. Forward and inverse kinematics were investigated to enable automation of the ARM. Data was collected from infrared sensors to validate the model. Manipulation of the ARM is presently under open loop control (joy stick) which demonstrates the use of tele-robotics and its capabilities.
DTIC

N94-28948# National Aerospace Lab., Tokyo (Japan).

MONTE CARLO SIMULATION OR NORMAL SHOCK WAVE. PART 2: VHS MODEL AND VSS MODEL [SHOGEKIHA NO MONTE KARURO SHIMYURESHON. 2: VHS MODERU TO VSS MODERU]

HIROAKI MATSUMOTO and KATSUHISA KOURA In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 7-10 Dec. 1992 In JAPANESE
Avail: CASI HC A01/MF A03

The validity of the Variable Soft Sphere (VSS) molecular model, which is consistent with both the viscosity and diffusion coefficients of any intermolecular potential, is investigated by the Monte Carlo simulation of the shock wave structure in binary gas mixtures of Maxwell molecules. Calculations are made by the null-collision direct-simulation Monte Carlo method. The VSS model yields the same shock wave structures as Maxwell molecules even when the Variable Hard Sphere (VHS) molecular model reveals a different structure. The computation time and simplicity of the VSS model are confirmed to be almost the same as those of the VHS model. The VSS model is, therefore, preferable to the VHS model in practical use. Using the reliable values of the VSS parameters, the shock wave structure in He and Xe gas mixtures is investigated to compare with the measured density profiles. The density gradient and separation distance are in reasonable agreement with the experimental results. Author (NASDA)

N94-28949# National Aerospace Lab., Tokyo (Japan). Aerodynamics Div.

VARIABLE SOFT SPHERE MOLECULAR MODEL IN THE MONTE CARLO SIMULATION OF AIR SPECIES [KUKI BUNSHI NO MONTE KARURO SHIMYURESHON NIOKERU VSS BUNSHI MODERU]

KATSUHISA KOURA, HIROAKI MATSUMOTO, and MIKINARI TAKAHIRA In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 11-15 Dec. 1992 In JAPANESE
Avail: CASI HC A01/MF A03

The Variable Soft Sphere (VSS) molecular model is developed so that both the viscosity and diffusion coefficients are consistent with those for any intermolecular potential. The values of the VSS cross-section parameters are listed for air species together with the viscosity coefficients, which may be required in the evaluation of the Knudsen number. The VSS model is applied to the 'Rarefied Gas Numerical Wind Tunnel (RGNWT)' and some results obtained using the RGNWT are presented for the flowfield around the H-2 Orbiting Plane (HOPE).
Author (NASDA)

N94-28956# National Aerospace Lab., Amsterdam (Netherlands).

ENGRID: A GRAPHICAL INTERACTIVE CODE FOR THE COMPUTATION OF STRUCTURED GRIDS FOR BLOCKED FLOW DOMAINS

S. P. SPEKREIJSE In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 51-56 Dec. 1992 Prepared in cooperation with Alenia, Rome, Italy Sponsored by Netherlands Agency for Aerospace Programs, Delft, Netherlands
Avail: CASI HC A02/MF A03

The underlying idea of the widely used and accepted multiblock approach for flow analysis is to subdivide a geometrical complex flow

domain region into several smaller, more manageable regions, referred to as blocks. Typically there are several individual blocks in a given flow domain, each block having three computational coordinates. In the present approach the grid generation process is divided into two subprocesses: (1) block decomposition, i.e., the creation of blocked flow domains; and (2) grid generation, i.e., the computation of structured grids in the blocks. The ENGRID code is a general purpose multi-block grid generation code for the computation of Euler or Navier-Stokes types of grids in flow domains which are already subdivided into blocks. The two required input files for ENGRID are a topology and a geometry file. The topology file defines the topology of a multi-block flow domain. The topology of a blocked flow domain describes how the blocks are connected to each other. The geometry file contains the geometrical information of a multi-block flow domain. The file contains the geometrical definition of all vertices, all non-default elementary edges, and all non-default elementary faces. Author (NASDA)

N94-28964# Kawasaki Heavy Industries Ltd., Gifu (Japan).
ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING. PART 10: NUMERICAL ANALYSIS OF FLOW AROUND 2-D MULTI-ELEMENT HLD [SEKKEI NICKERU SUCHI KAISEKI NO KATSUYO NITSUITE. SONO 10: 2 JIGEN TAYOKUSO MAWARI NAGARE NO SUCHI KAISEKI]
KOICHI EGAMI, EIJI SHIMA, KANICHI AMANO, and SHINGO NAKAMURA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 99-104 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A 2-D Navier-Stokes analysis of flow around multi-element high lift devices was carried out. In order to calculate the aerodynamic characteristics in a wide range of angle of attack, the q-omega 2-equations turbulence model was used. Numerical results show flowfields with large viscous wake region without flow separation on the top surface of the flap at large angle of attack. In high Reynolds number cases, numerical results of decrease in lift coefficient were computed.
Author (NASDA)

N94-28976# Kawasaki Heavy Industries Ltd., Tokyo (Japan).
VERIFICATION OF A THREE-DIMENSIONAL VISCOUS FLOW ANALYSIS FOR A SINGLE STAGE COMPRESSOR [NS KAISEKI NIYORU TANDAN ASSHUKUKI YOKURETSU NAGARE NO KENSHO]
AKINORI MATSUOKA, KEISUKE HASHIMOTO, OSAMU NOZAKI, KAZUO KIKUCHI, MASAHIRO FUKUDA, and ATSUHIRO TAMURA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 163-168 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A transonic flowfield around rotor blades of a highly loaded single stage axial compressor was numerically analyzed by a three dimensional compressible Navier-Stokes equation code using Chakravarthy and Osher type total variation diminishing (TVD) scheme. A stage analysis which calculates both flowfields around inlet guide vane (IGV) and rotor blades simultaneously was carried out. Comparing with design values and experimental data, computed results show slight difference quantitatively. But the numerical calculation simulates well the pressure rise characteristics of the compressor and its flow pattern including strong shock surface. Author (NASDA)

N94-28979# Osaka Prefecture Univ., Sakai (Japan). Dept. of Aeronautical Engineering.
THREE-DIMENSIONAL EXTERNAL FLOW COMPUTATIONS USING PRISMATIC GRID [PURIZUMU KOSHI NIYORU SANJIG EN GAIBURYU NO SUICHI KEISAN]
KAZUHIRO NAKAHASHI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 181-186 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

A new approach to compute external viscous flows around three dimensional configurations is proposed. A prismatic grid is used where the three dimensional surface is covered by triangles similar to the unstructured grid. The direction away from the body surface is structured so as to achieve efficient and accurate computations for high Reynolds number viscous flows. The prismatic grid is generated by a newly developed marching-type procedure in which grid spacings are controlled by a variational method. The capability of the method is demonstrated by applying it to a viscous flow computation around a complete aircraft configuration. Author (NASDA)

N94-28985# Tokyo Inst. of Tech. (Japan). Dept. of Energy Sciences.
TRANSONIC EXPANDING FLOW THROUGH AXIALLY SYMMETRIC ORIFICES [JIKU TAISHO ORIFISU O TORU SENONSOKU BOCHORYU]
YUMINOBU IGARASHI and HISASHI MIKAMI In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 215-220 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

This paper describes a method of finding the flow pattern of an axially symmetric transonic gas jet through a circular orifice. Numerical solutions were obtained by hodograph transformation and the method of characteristics. The contraction coefficient, velocity profiles and centerline Mach number distributions were calculated. The numerical results are found to agree with the experimental data by Sherman.
Author (NASDA)

N94-28986# National Aerospace Lab., Kakuda (Japan).
SIMILARITY BETWEEN TURBULENT FLOWS THROUGH CURVED PIPE AND ORTHOGONAL ROTATING PIPE [NIJI NAGARE O TOMONAU KANNAI RANRYU NO SOJISEI]
HIROSHI ISHIGAKI In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 221-224 Dec. 1992 In JAPANESE
Avail: CASI HC A01/MF A03

The secondary flow due to Coriolis force takes place when viscous fluid flows through a straight pipe rotating about an axis perpendicular to the pipe axis. This is analogous to the secondary flow due to centrifugal force in the flow through a stationary curved pipe. The quantitative similarities between the two flows are demonstrated for turbulent flow by the similarity arguments and computational study using kappa-epsilon turbulence model. It is demonstrated that the mutual similarity between two flows is established for friction factors and flow patterns. Author (NASDA)

N94-29091 Aeronautical Research Labs., Melbourne (Australia).
COLD EXPANSION AND INTERFERENCE FOR EXTENDING THE FATIGUE LIFE OF MULTI-LAYER METAL JOINTS
J. M. FINNEY Oct. 1993 34 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A274982; ARL-RR-17; DODA-AR-008-369) Avail: CASI HC A03

The influences of both hole cold expansion and interference-fit fasteners for extending the fatigue life of multilayer aluminum alloy joint specimens under variable amplitude loading have been examined experimentally. Improvements in fatigue life were markedly dependent on the degree of load transfer in the specimen joint. The cold expansion of fastener holes enhanced fatigue life in low load transfer joints but not in 100% load transfer joints. The use of interference-fit fasteners, especially at high degrees of interference, was an effective means of life improvement irrespective of proportion of load transfer. Interfacial fretting limited the improvement in fatigue life of low load transfer joints to a factor of about six, and, although some fretting occurred in 100% load transfer joints, it was not determinative, and a 40-fold increase in fatigue life was obtained with a combination of hole cold expansion and interference-fit fastener. DTIC

N94-29104*# Sverdrup Technology, Inc., Brook Park, OH.
TURBOMACHINERY FORCED RESPONSE PREDICTION SYSTEM (FREPS): USER'S MANUAL Final Report
M. R. MOREL and D. V. MURTHY Mar. 1994 115 p
(Contract NAS3-25266; NAG3-1669; RTOP 505-63-58; RTOP 232-01-0B)
(NASA-CR-194465; E-8518; NAS 1.26:194465) Avail: CASI HC A06/MF A02

The turbomachinery forced response prediction system (FREPS), version 1.2, is capable of predicting the aeroelastic behavior of axial-flow turbomachinery blades. This document is meant to serve as a guide in the use of the FREPS code with specific emphasis on its use at NASA Lewis Research Center (LeRC). A detailed explanation of the aeroelastic analysis and its development is beyond the scope of this document, and may be found in the references. FREPS has been developed by the NASA LeRC Structural Dynamics Branch. The manual is divided into three major parts: an introduction, the preparation of input, and the procedure to execute FREPS. Part 1 includes a brief background on the necessity of FREPS, a description of the FREPS system, the steps needed to be taken before FREPS is executed, an example input file with instructions, presentation of the geometric conventions used, and the input/output files employed and produced by FREPS. Part 2 contains a detailed description of the command names needed to create the primary input file that is required to execute the FREPS code. Also, Part 2 has an example data file to aid the user in creating their own input files. Part 3 explains the procedures required to execute the FREPS code on the Cray Y-MP, a computer system available at the NASA LeRC. Derived from text

N94-29282# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Inst. for Propulsion Technology.
INVESTIGATION OF THE TWO-PHASE FLOW IN A RESEARCH COMBUSTOR UNDER REACTING AND NON-REACTING CONDITIONS
C. HASSA, A. DEICK, and H. EICKHOFF In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 12 p Sep. 1993 Sponsored by TECFLAM
Copyright Avail: CASI HC A03/MF A04

The flow resulting from an airblast atomizer with prefilmer and corotating swirl was investigated in a cylindrical combustion chamber. Gas and droplet velocities were measured by a phase Doppler anemometer and species and gas temperature by gas sampling probes respectively, thermoelements at atmospheric conditions and without fuel and air preheat. Because of interference with the liquid phase, the species measurements were restricted to a minimum distance of 40 mm from the atomizer lip. The temperature measurements showed the dominating influence of the external recirculation zone on flame stabilization for the investigated nozzle configuration with a small expansion angle of the swirling flow. The species concentration fields exhibit homogeneous radial profiles at an axial distance of 100 mm behind the atomizer, although droplets are observed up to 140 mm. Integrating the measured liquid volume flux density profiles, it was found that the fuel flux at 45 mm behind the atomizer had diminished to 14 percent of the maximum measured value. The axial profile of the liquid flux weighted Sauter mean diameter is almost linearly increasing from 22 to 31 micrometers. Systematic experimental errors and losses of the system sensitivity, which enter the results partly with opposite signs, have an influence on the measured flux densities and moments of the particle size distribution. The measurement of individual flux density profiles was reproducible to within 45 percent. A comparison between the gas flow in the nearfield of the atomizer under reacting and nonreacting conditions showed a partial suppression of the expansion of the velocity profiles by the hot corner vortex. Together with the combustion induced axial acceleration, the thus effected reduction of the effective swirl number leads to the breakdown of the recirculation at 29 mm. Author (revised)

N94-29283# Karlsruhe Univ. (Germany). Lehrstuhl und Inst. fuer Thermische Stroemungsmaschinen.
TIME-RESOLVED MEASUREMENTS IN A THREE DIMENSIONAL MODEL COMBUSTOR
R. JECKEL and S. WITTIG In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 15 p Sep. 1993 Sponsored by Arbeitsgemeinschaft Hochtemperatur Gasturbine and BMFT
Copyright Avail: CASI HC A03/MF A04

Locally and time-resolved measurements of the velocity, temperature, and species concentration in a three dimensional jet-stabilized combustor are presented. The combustor was developed at the Institute for Thermal Turbomachinery, University of Karlsruhe, for extended benchmark experiments. For the present investigation, the combustor was fired by propane. The profiles of the velocity, temperature, and species distribution were determined at seven planes along the combustor axis. A comparison between the cold flow and the reacting hot gas conditions is given. The time-resolved velocity and temperature measurements were performed by a two component LDA-system as well as specially designed and optimized thermocouple probes. The time-dependent analysis demonstrates that the velocity and turbulence and/or the temperature fluctuations are dramatically increased under hot combusting conditions. Finally, the locally determined species distributions are compared with the global concentrations at the exit of the combustor providing a data base for numerical tests. Author (revised)

N94-29353*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
TUNED MASS DAMPER FOR INTEGRALLY BLADED TURBINE ROTOR Patent Application
JOHN J. MARRA, inventor (to NASA) (Pratt and Whitney Aircraft, West Palm Beach, FL.) 12 Oct. 1993 12 p
(NASA-CASE-MFS-28697-1; NAS 1.71:MFS-28697-1; US-PATENT-APPL-SN-134443) Avail: CASI HC A03/MF A01

The invention is directed to a damper ring for damping the natural vibration of the rotor blades of an integrally bladed rocket turbine rotor. The invention consists of an integral damper ring which is fixed to the underside of the rotor blade platform of a turbine rotor. The damper ring includes integral supports which extend radially outwardly therefrom. The supports are located adjacent to the base portion and directly under each blade of the rotor. Vibration damping is accomplished by action of tuned mass damper beams attached at each end to the supports. These beams vibrate at a predetermined frequency during operation. The vibration of the beams enforce a local node of zero vibratory amplitude at the interface between the supports and the beam. The vibration of the beams create forces upon the supports which forces are transmitted through the rotor blade mounting platform to the base of each rotor blade. When these forces attain a predetermined design frequency and magnitude and are directed to the base of the rotor blades, vibration of the rotor blades is effectively counteracted. NASA

N94-29448*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
LANDING GEAR ENERGY ABSORPTION SYSTEM Patent Application
CHRISTOPHER P. HANSEN, inventor (to NASA) 1 Dec. 1993 17 p
(NASA-CASE-MSC-22277-1; NAS 1.71:MSC-22277-1; US-PATENT-APPL-SN-159606) Avail: CASI HC A03/MF A01

A landing pad system is described for absorbing horizontal and vertical impact forces upon engagement with a landing surface where circumferentially arranged landing struts respectively have a clevis which receives a slidable rod member and where the upper portion of a slidable rod member is coupled to the clevis by friction washers which are force fit onto the rod member to provide for controlled constant force energy absorption when the rod member moves relative to the clevis. The lower end of the friction rod is pivotally attached by a ball and socket

to a support plate where the support plate is arranged to slide in a transverse direction relative to a housing which contains an energy absorption material for absorb-ing energy in a transverse direction. NASA

N94-29456# Aerospatiale, Cannes (France). Espace et Defense.
THEORETICAL AND EXPERIMENTAL STUDY OF A CYLINDRICAL MICROSTRIP ANTENNA
M. MONACO (Nice Univ., France.), G. GHIO (Nice Univ., France.), E. CAMBIAGGIO (Nice Univ., France.), J. P. BOISSET, M. SAUVAN, and B. BURALLI 1993 5 p
(REPT-932-440-109; ETN-94-95479) Avail: CASI HC A01/MF A01

A low profile microstrip belt antenna concept was developed and tested. The antenna radiation pattern was optimized. The antenna is suitable for optimal air or space based reception of radio localized signals. The antenna, along with a 3.78 bandwidth, offers ripple within +/- 2 dB and 98 percent coverage probability. The system was conceived to receive the global positioning system radio signals beamed from the navigation system by time and range satellite network. The resulting microstrip belt antenna is a low cost, low profile, low weight, and easy integration antenna concept. ESA

N94-29460*# High Technology Corp., Hampton, VA.
LONG-WAVELENGTH ASYMPTOTICS OF UNSTABLE CROSSFLOW MODES, INCLUDING THE EFFECT OF SURFACE CURVATURE
MEELAN CHOUDHARI Apr. 1994 43 p
(Contract NAS1-19299; RTOP 538-05-15-03)
(NASA-CR-4579; NAS 1.26:4579) Avail: CASI HC A03/MF A01

Stationary vortex instabilities with wavelengths significantly larger than the thickness of the underlying three-dimensional boundary layer are studied with asymptotic methods. The long-wavelength Rayleigh modes are locally neutral and are aligned with the direction of the local inviscid streamline. For a spanwise wave number Beta much less than 1, the spatial growth rate of these vortices is O(Beta(exp 3/2)). When Beta becomes O(R(exp -1/7)), the viscous correction associated with a thin sublayer near the surface modifies the inviscid growth rate to the leading order. As Beta is further decreased through this regime, viscous effects assume greater significance and dominate the growth-rate behavior. The spatial growth rate becomes comparable to the real part of the wave number when Beta = O(R(exp -1/4)). At this stage, the disturbance structure becomes fully viscous-inviscid interactive and is described by the triple-deck theory. For even smaller values of Beta, the vortex modes become nearly neutral again and align themselves with the direction of the wall-shear stress. Thus, the study explains the progression of the crossflow-vortex structure from the inflectional upper branch mode to nearly neutral long-wavelength modes that are aligned with the wall-shear direction. Author

N94-29474# Aerospatiale, Suresnes (France). Centre Commun de Recherches Louis-Bleriot.
AUTOMATION OF THE NDT DIAGNOSTIC USING NEURAL NETS. APPLICATION: INSPECTION OF AIRBUS LONGITUDINAL JOINTS DURING MAINTENANCE [AUTOMATISATION DU DIAGNOSTIC EN CND PAR L'UTILISATION DE RESEAUX NEURONAUX. APPLICATION: INSPECTION EN MAINTENANCE DES LIAISONS LONGITUDINALES AIRBUS]
CHRISTINE BROUSSET and GILLES BAUDRILLARD 1993 11 p In FRENCH
(REPT-932-600-104; ETN-94-95483) Avail: CASI HC A03/MF A01

A neural network tool was developed to automate the Non Destructive Testing (NDT) of aeronautical structures carried out with the SIAM system. The SIAM system is used to reveal splits in longitudinal metal joints on the Airbus fuselage. The integration of the neural net tool within the SIAM control system is considered possible. The automatic diagnostic should provide the operator with an aid which will permit a greater reliability of maintenance control. The diagnostic performed with this tool would be rapid;: the control of 30,000 rivets on the Airbus fuselage would take approximately 45 minutes. ESA

N94-29534 Cincinnati Univ., OH.
RNS OPTIMIZATION PROCEDURE FOR THREE-DIMENSIONAL COMPOSITE VELOCITY MULTI-BLOCK APPLICATIONS Ph.D. Thesis
HUSSAIN MOHAMED HASA ALMAHROOS 1992 215 p
Avail: Univ. Microfilms Order No. DA9313812

RNS analysis of the composite velocity formulation has been applied for three dimensional flows. A consistent coupled strongly implicit procedure has been used to solve the coupled system of equations in general nonorthogonal coordinate system. Different forms of contravariant momentum balances have been examined. A multiblock analogy and optimization strategies have been implemented and are presented. Three dimensional subsonic and transonic, viscous-inviscid interacting flows over afterbody configurations have been evaluated. Laminar and turbulent flow solutions, with and without regions of recirculation and shock wave boundary layer interaction, are presented. Three dimensional flows over multiple body configurations are also presented. Dissert. Abstr.

N94-29552*# Kentucky Univ., Lexington.
EXPERIMENTAL VALIDATION OF FINITE ELEMENT AND BOUNDARY ELEMENT METHODS FOR PREDICTING STRUCTURAL VIBRATION AND RADIATED NOISE Final Report
A. F. SEYBERT, T. W. WU, and X. F. WU Jan. 1994 94 p Original contains color illustrations
(Contract NAG3-912; DA PROJ. 1L1-62211-A-47A; RTOP 505-62-10)
(NASA-CR-4561; ARL-CR-109; E-8264; NAS 1.26:4561) Avail: CASI HC A05/MF A01; 3 functional color pages

This research report is presented in three parts. In the first part, acoustical analyses were performed on modes of vibration of the housing of a transmission of a gear test rig developed by NASA. The modes of vibration of the transmission housing were measured using experimental modal analysis. The boundary element method (BEM) was used to calculate the sound pressure and sound intensity on the surface of the housing and the radiation efficiency of each mode. The radiation efficiency of each of the transmission housing modes was then compared to theoretical results for a finite baffled plate. In the second part, analytical and experimental validation of methods to predict structural vibration and radiated noise are presented. A rectangular box excited by a mechanical shaker was used as a vibrating structure. Combined finite element method (FEM) and boundary element method (BEM) models of the apparatus were used to predict the noise level radiated from the box. The FEM was used to predict the vibration, while the BEM was used to predict the sound intensity and total radiated sound power using surface vibration as the input data. Vibration predicted by the FEM model was validated by experimental modal analysis; noise predicted by the BEM was validated by measurements of sound intensity. Three types of results are presented for the total radiated sound power: sound power predicted by the BEM model using vibration data measured on the surface of the box; sound power predicted by the FEM/BEM model; and sound power measured by an acoustic intensity scan. In the third part, the structure used in part two was modified. A rib was attached to the top plate of the structure. The FEM and BEM were then used to predict structural vibration and radiated noise respectively. The predicted vibration and radiated noise were then validated through experimentation. Author (revised)

N94-29566# Shape Technical Center, The Hague (Netherlands).
ACCS SURVEILLANCE EXPLORATORY PROTOTYPE (ASEP)
K. GAEBLER In AGARD, Machine Intelligence in Air Traffic Management 18 p Oct. 1993
 Avail: CASI HC A03/MF A04

The increasing sophistication of surveillance systems, both civilian and military, has generated a great deal of interest in techniques of multi-target tracking and sensor integration. To help SHAPE and the NATO Air Command and Control System (ACCS) Management Agency (NACMA) to specify and implement the ACCS surveillance subsystem, in particular in the areas of data fusion and identification, the SHAPE Technical Center (STC) is currently developing an ACCS Surveillance Exploratory Prototype (ASEP) as an element of its new integrated testbed. The purpose of the ASEP is to demonstrate the feasibility and operational benefits of future air picture generation systems. The significant difference between this advanced system and currently available systems is that ASEP will provide better tracking continuity, more accurate estimates of track positions, velocity, acceleration, and additional information on targets. The provision of this information on air targets is also of great importance for civil ATC systems, especially in view of growing requirements for ATC planning, conflict alert and conflict resolution. The use of multiple sensors and sources requires the fusion of different types of data, including sensor reports containing measured attributes such as the target type and other target features. Since advanced fusion algorithms are using kinematic data as well as attribute data for the identification process, the majority of all air targets can be identified automatically. This paper gives an overview of the following components that are implemented in the ACCS Surveillance Exploratory Prototype at STC: scenario generation and sensor simulation; real-time multi-sensor tracking; real-time radar data integration; external track and flight plan data integration; and air picture presentation on a Surveillance Workstation using new human-computer interface (HCI) techniques. Derived from text

N94-29647*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MINIATURE LINEAR-TO-ROTARY MOTION ACTUATOR

MICHAEL R. SOROKACH, JR. In NASA. Ames Research Center, The 27th Aerospace Mechanisms Symposium p 299-314 May 1993
Avail: CASI HC A03/MF A03

A miniature hydraulic actuation system capable of converting linear actuator motion to control surface rotary motion has been designed for application to active controls on dynamic wind tunnel models. Due to space constraints and the torque requirements of an oscillating control surface at frequencies up to 50 Hertz, a new actuation system was developed to meet research objectives. This new actuation system was designed and developed to overcome the output torque limitations and fluid loss/sealing difficulties associated with an existing vane type actuator. Static control surface deflections and dynamic control surface oscillations through a given angle are provided by the actuation system. The actuator design has been incorporated into a transonic flutter model with an active trailing edge flap and two active spoilers. The model is scheduled for testing in the LaRC 16 Foot Transonic Dynamics Tunnel during Summer 1993. This paper will discuss the actuation system, its design, development difficulties, test results, and application to aerospace vehicles. Author

N94-29675 Texas Univ., Austin.

MODELS FOR VIBRATION-DISSOCIATION COUPLING IN HIGH-TEMPERATURE GASES Ph.D. Thesis

DAVID ALBERT GONZALES 1993 199 p
Avail: Univ. Microfilms Order No. DA9323408

Nonequilibrium conditions are expected in the flowfields about high speed, high altitude research vehicles. These conditions may be found in regions of rapid compression and rapid expansion in the flowfield. The impact of nonequilibrium effects on such quantities as heat transfer rate and pressure distribution is not clear. This is due in part to the lack of reliable theoretical models with which to predict nonequilibrium processes in high temperature gases. Accurate computational chemistry techniques cannot be used for engineering analyses because they are prohibitively expensive. The focus of this research is on the development of engineering models that suitably reproduce the elaborate computational chemistry results with far greater efficiency. Models are presented which represent both microscopic and macroscopic processes. At the microscopic level, the N-state approximation of Rapp and coworkers is extended to compute velocity dependent inelastic and dissociative transition probabilities for atom-diatom and diatom-diatom collisions. Nitrogen atoms and diatoms are considered in this part of the study and an anharmonic model of the diatom is used. Dissociated product states are modeled by dividing the continuum into discrete states. The acceleration scheme of Secrest is applied to the N-state method and preliminary calculations on the simpler H2-He collision system show order of magnitude increases in efficiency. The N-state approximation is seen to be more accurate than currently used first order theories. At the macroscopic level, master equation simulations are performed. A new model for the state-specific dissociative rate coefficient is presented and validated. The present results are compared to published dissociative cross sections for the para-H2-Ar collision system as computed by the quasiclassical trajectory (QCT) technique. In order to make the comparison consistent, all inelastic rate coefficients used in the master equation are scaled to published inelastic QCT results. The present model is seen to reproduce the more sophisticated dissociative QCT cross sections to within a factor of two in general. The master equation results also indicate that the most significant contribution to the average dissociative rate coefficient comes from the low-to-mid vibrational levels. Similar results have been obtained by other researchers from more expensive detailed computations. Dissert. Abstr.

N94-29726* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

SIX-DEGREE-OF-FREEDOM PARALLEL MINIMANIPULATOR WITH THREE INEXTENSIBLE LIMBS Patent

FARHAD TAHMASEBI, inventor (to NASA) and LUNG-WEN TSAI, inventor (to NASA) 18 Jan. 1994 13 p Filed 20 Jul. 1992
(NASA-CASE-GSC-13485-1; US-PATENT-5,279,176; US-PATENT-APPL-SN-915567; US-PATENT-CLASS-74-479B; US-PATENT-CLASS-74-479PF; US-PATENT-CLASS-901-14; US-PATENT-CLASS-901-19; INT-PATENT-CLASS-G05G-11/00; INT-PATENT-CLASS-B25J-11/00) Avail: US Patent and Trademark Office

A Six-Degree-of-Freedom Parallel-Manipulator having three inextensible limbs for manipulating a platform is described. The three inextensible limbs are attached via universal joints to the platform at non-collinear points. Each of the inextensible limbs is also attached via universal joints to a two-degree-of-freedom parallel driver such as a five-bar linkage, a pantograph, or a bidirectional linear stepper motor. The drivers move the lower ends of the limbs parallel to a fixed base and thereby provide manipulation of the platform. The actuators are mounted on the fixed base without using any power transmission devices such as gears or belts.

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

N94-29740* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

METHOD FOR CANCELLING EXPANSION WAVES IN A WAVE ROTOR Patent

DANIEL E. PAXSON, inventor (to NASA) 29 Mar. 1994 10 p Filed 6 Jul. 1993 Division of US-Patent-Appl-SN-889003, filed 26 May 1992
(NASA-CASE-LEW-15218-2; US-PATENT-5,297,384; US-PATENT-APPL-SN-086581; US-PATENT-APPL-SN-889003; US-PATENT-CLASS-60-39.02; INT-PATENT-CLASS-F02C-3/02) Avail: US Patent and Trademark Office

A wave rotor system includes a wave rotor coupled to first and second end plates. Special ports are provided, one in each of the first and second end plates, to cancel expansion waves generated by the release of working fluid from the wave rotor. One of the expansion waves is reflected in the wave rotor from a reflecting portion, and provided to the special port in the second end plate. Fluid present at the special port in the second end plate has a stagnation pressure and mass flow which is substantially the same as that of the cells of the wave rotor communicating with such special port. This allows for cancellation

of the expansion wave generated by the release of working fluid from the wave rotor. The special port in the second end plate has a first end corresponding substantially to the head of the expansion wave, and a second end corresponding substantially to the tail of the expansion wave. Also, the special port is configured to continually change along the circumference of the second end plate to affect expansion wave cancellation. An expansion wave generated by a second release of working fluid from the wave rotor is cancelled in a similar manner to that described above using a special port in the first end plate. Preferably the cycle of operation of the wave rotor system is designed so that the stagnation pressure and mass flow of the fluid present at the special ports is the same so that the special ports may be connected by a common duct.

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

N94-29839 Missouri Univ., Rolla.
LIQUID ATOMIZATION IN SUPERSONIC FLOWS Ph.D. Thesis
AZZEDINE MISSOUM 1993 138 p
Avail: Univ. Microfilms Order No. DA9326598

An experimental investigation of the atomization of a round liquid jet by coaxial, costream injection into a supersonic, Mach 1.5 air flow is reported. Extensive flow visualization was conducted using schlieren/shadowgraph, flash photography, and short duration (ns) laser imaging. The finer details of the jet were revealed when viewed under high magnification with the help of a microscope. The liquid and air pressures were varied individually. Photographic evidence indicates the presence of three regions within the liquid jet: a primary region enclosed by the first shock cell where the primary breakup occurs, a secondary region in which the jet is totally broken because of its interaction with the supersonic wave structure, and a third, subsonic region further downstream. It was found that the breakup mechanism of liquid jets in supersonic airstreams is quite complex. The breakup seems to be initiated by the growth of the turbulent structure on the liquid surface and the subsequent detachment of the three-dimensional structure as fine droplets by the intense shear at the liquid-gas interface. This seems to confirm the boundary layer stripping mechanism. The liquid jet expands into a bubble like formation as it interacts with the first set of waves. Higher liquid injection pressures resulted in higher initial spray angles. The liquid jet displayed a geometry strongly dependent on the pressure distribution resulting from the wave structure present in the supersonic jet. Droplet size and velocity distributions were measured by the P/DPA (Phase/Doppler Particle Analyzer) system. The Sauter Mean Diameter (SMD) was measured at several axial and radial locations at various liquid and air pressures. The SMD shows a decrease with increase in both the air-to-liquid mass flow ratio and the Weber number. The drop size decreased towards the outer edges of the jet. The results lead one to conclude that the coaxial, coflowing configuration is very attractive for atomizing scramjet liquid fuels. Dissert. Abstr.

N94-29942*# MCAT Inst., San Jose, CA.
ALGORITHM AND CODE DEVELOPMENT FOR UNSTEADY THREE-DIMENSIONAL NAVIER-STOKES EQUATIONS
SHIGERU OBAYASHI Apr. 1994 6 p
(Contract NCC2-605)
(NASA-CR-195774; NAS 1.26:195774; MCAT-94-002) Avail: CASI HC A02/MF A01

Aeroelastic tests require extensive cost and risk. An aeroelastic wind-tunnel experiment is an order of magnitude more expensive than a parallel experiment involving only aerodynamics. By complementing the wind-tunnel experiments with numerical simulations, the overall cost of the development of aircraft can be considerably reduced. In order to accurately compute aeroelastic phenomenon it is necessary to solve the unsteady Euler/Navier-Stokes equations simultaneously with the structural equations of motion. These equations accurately describe the flow phenomena for aeroelastic applications. At ARC a code, ENSAERO, is being developed for computing the unsteady aerodynamics and aeroelasticity of aircraft, and it solves the Euler/Navier-Stokes equations. The purpose of this cooperative agreement was to enhance ENSAERO in both algorithm and geometric capabilities. During the last five years, the algorithms of the code have been enhanced extensively by using high-resolution upwind algorithms and efficient implicit solvers. The zonal capability of the code has been extended from a one-to-one grid interface to a mismatching unsteady zonal interface. The geometric capability of the code has been extended from a single oscillating wing case to a full-span wing-body configuration with oscillating control surfaces. Each time a new capability was added, a proper validation case was simulated, and the capability of the code was demonstrated. Author (revised)

13
GEOSCIENCES

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

N94-28600*# Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
THE RADIOCARBON HYDROXYL TECHNIQUE Abstract Only
MALCOLM J. CAMPBELL and JOHN C. SHEPPARD In SRI International Corp., Local Measurement of Tropospheric HO(x) 1 p Feb. 1994
Avail: CASI HC A01/MF A01

The Radiocarbon Technique depends upon measuring the rate of oxidation of CO in an essentially unperturbed sample of air. The airborne technique is slightly different. Hydroxyl concentrations can be calculated directly; peroxyl concentrations can be obtained by NO doping. Author

N94-29247# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). Inst. fuer Physik der Atmosphaere.
ON THE EFFECT OF EMISSIONS FROM AIRCRAFT ENGINES ON THE STATE OF THE ATMOSPHERE
U. SCHUMANN In AGARD, Fuels and Combustion Technology for Advanced Aircraft Engines 19 p Sep. 1993 Sponsored by DFG; BMFT; and Commision of the European Communities
Copyright Avail: CASI HC A03/MF A04

Emissions from aircraft engines include carbon dioxide, water vapor, nitrogen oxides, sulphur components, and various other gases and particles. Such emissions from high-flying global civil subsonic aircraft contribute to anthropogenic climate changes by increase of ozone and cloudiness in the upper troposphere, and by enhanced greenhouse effect. The absolute emissions by air traffic are small (a few percent of total) in comparison to surface emissions. However, the greenhouse effect of emitted water and of nitrogen oxides at cruise altitude is large in comparison to that of the same emissions near the earth's surface because of relatively large residence times at flight altitudes, low background concentrations, low temperature, and large radiative efficiency. At present, it appears that the emissions of nitrogen oxides have changed the background concentration in the upper troposphere in between 40 deg N and 60 deg N by 100 percent, causing an increase of ozone by about 20 percent. Regionally the observed annual mean change in cloudiness is of order 0.4 percent. The resultant greenhouse effect of changes in ozone and thin cirrus cloud cover causes a climatic surface temperature change of the order 0.01 to 0.1 K. These temperature changes are small in comparison to the natural variability. Recent research indicates that the emissions at cruise altitude may increase the amount of stratospheric aerosols and polar stratospheric clouds and thereby may have an impact on the atmosphere environment, to a yet unknown degree. Air traffic is increasing by about five to six percent per year; fuel consumption grows by about three percent per year. Moreover, the climatic changes due to air traffic enhance other environmental problems originating, e.g., from anthropogenic carbon dioxide or methane emissions. Hence, air traffic

induced emissions are of growing importance. This calls for the development of efficient and low-emission propulsion systems and other means to reduce the emissions. This paper surveys the state of knowledge and describes several items of results from recent and ongoing research. Author (revised)

15

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

N94-28947# National Aerospace Lab., Amsterdam (Netherlands).
ENGINEERING OF SYSTEMS FOR APPLICATION OF SCIENTIFIC COMPUTING IN INDUSTRY
W. LOEVE In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 1-5 Dec. 1992
Avail: CASI HC A01/MF A03

Mathematics software is of growing importance for computer simulation in industrial computer aided engineering. To be applicable in industry, the mathematics software and supporting software must be structured in such a way that functions and performance can be maintained easily. In the present paper, a method is described for development of mathematics software in such a way that this requirement can be met. Author (NASDA)

N94-28980# Kyoto Univ., Sakyoku (Japan).
APPLICATION OF DIGITAL CONTROL THEORY TO ADAPTIVE GRID GENERATION [SAITEKI SEIGYO O MOCHIITA TEKIO KOSHI SEISEIHO]
MAKOTO KOBAYAKAWA and EITARO YAMADA In NAL, Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 187-192 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

New methods for adaptive grid generation through optimal regulator of digital control are presented. The performance index of linear optimal regulator problem has a strong relation to the characteristics of adaptive grid generation. Paying attention to this point, one and two dimensional Poisson equations are transformed into the state-space form. The numerical examples of NACA-0012 airfoil flow field and supersonic flow around corners show strong clustering of grid lines at shock waves through these two kinds of adaptation. Author (NASDA)

N94-28992# National Aerospace Lab., Tokyo (Japan).
PERFORMANCE EVALUATION OF THE NWT WITH PARALLEL FORTRAN [NWT HEIRETSU FORTRAN NI MOTODUKU HEIRETSU HYOKA]
TAKASHI NAKAMURA, MASAHIRO YOSHIDA, MASAHIRO FUKUDA, SHUICHI NAKAMURA, TAKEO MURASE, and TATSUYA MATSUZAKI In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 253-258 Dec. 1992 In JAPANESE Prepared in cooperation with Fujitsu Ltd., Tokyo, Japan
Avail: CASI HC A02/MF A03

The Numerical Wind Tunnel (NWT) is under research and development by NAL-Fujitsu joint activity. It is a parallel computer system of distributed memory architecture composed of vector processors. In this paper, the performance on the desk of two application programs that were parallelized by current parallel language processor is shown. The performance using network simulator and evaluation software 'VTAP' which is based on VP400 performance analysis is evaluated. The estimation that the present machine performs CFD (Computational Fluid Dynamics) simulation about 100 times faster than Fujitsu VP400 is presented. Author (NASDA)

N94-28993# National Aerospace Lab., Tokyo (Japan).
A METHOD OF USER INTERFACE FOR NWT [NWT NO YUZA INTAFEISU JITSUGEN HOSHIKI]
MASAKO TSUCHIYA, KAZUYO SUEMATSU, SHUNJI SUEMATSU, HARUO HATAMA, HIROSHI MORISHIGE, YASUSHI YAMAGUCHI, and YUKIHIRO KARUBE In its Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics p 259-264 Dec. 1992 In JAPANESE
Avail: CASI HC A02/MF A03

Numerical Wind Tunnel (NWT) is a CFD (Computational Fluid Dynamics)-oriented parallel computer system with distributed memory, and the operating system of NWT is UNIX. In order to provide users much convenience and to maintain efficient functions of management on 'MSP' operating system, it is preferable to use NWT with user interface of MSP which is the operating system up to this time. In this paper the procedure how to construct user interface of MSP for NWT is presented. Author (NASDA)

N94-29315# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
AEROSPACE SOFTWARE ENGINEERING FOR ADVANCED SYSTEMS ARCHITECTURES [L'INGENIERIE DES LOGICIELS POUR LES ARCHITECTURES DES SYSTEMES AEROSPATIAUX]
Nov. 1993 333 p In ENGLISH and FRENCH Symposium held in Paris, France, 10-13 May 1993
(AGARD-CP-545; ISBN-92-835-0725-8) Copyright Avail: CASI HC A15/MF A03

During the past decade, many avionics functions which have traditionally been accomplished with analogue hardware technology are now being accomplished by software residing in digital computers. The purpose of this Symposium was to bring together military aerospace software experts from all NATO countries to share the results of their software research and development and virtually every aspect of software was considered with the following representing a partial set of topics: Aerospace Electronics Software Specification, Software Design, Programming Practices and Techniques, Software Validation and Testing, Software Management and Software Environments.

N94-29320# Dassault-Breguet Aviation, Saint Cloud (France). Div. des Etudes Avancees.
FLIGHT COMMAND SOFTWARE DEVELOPMENT: RAFALE STUDIES [LE DEVELOPPEMENT DES LOGICIELS DE COMMANDES DE VOL, L'EXPERIENCE RAFALE]
D. BEURRIER, F. VERGNOL, and PH. BOURDAIS In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 13 p Nov. 1993 In FRENCH
Copyright Avail: CASI HC A03/MF A03

After the introduction of the RAFALE's Flight Command System (Systeme de Commande de Vol: SCV). DASSAULT Aviation presents its studies on software applications to critical safety systems, with an emphasis on the following: (1) The methodology used in the development. It includes a phase for the formalization of the software specifications, its objective being to improve on the dialogue between two distinct entities: the automaticians on one hand and the computer programmers on the other hand. (2) The key support systems used in this methodology: GISELE: specification tool using a formal language whose testing and automatic prototype potential guarantee a descriptive quality, and VALIRAF: validation tool which automatically compares the results of the system to the models obtained during the studies on specifications. It manages the testing process and evaluates its level of reliability. An assessment of the results and a presentation of future programs of study are also included. Author (revised)

N94-29325# Electronic System G.m.b.H., Munich (Germany). Elektroniksystem-und Logistik.
EXPERIENCES WITH THE HOOD DESIGN METHOD ON AVIONICS SOFTWARE DEVELOPMENT
W. MALA and E. GRANDI In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 12 p Nov. 1993
Copyright Avail: CASI HC A03/MF A03

HOOD represents one of the most interesting approaches of the recent years to support an object oriented SW design for large

embedded systems written in Ada. This paper reports about experiences gained by the authors in the context of a current large European avionic development project, where the Ada SW design has been performed using HOOD Version 3.0. A simplified example describes the approach taken in the project for SW architectural design. A critical evaluation of the HOOD method follows, where advantages and disadvantages are discussed and some hints are given to overcome some identified weak areas. The paper concludes with the recognition of HOOD as a promising approach and encourages further discussion to remove the weak areas. Derived from text

N94-29337# Wright Lab., Wright-Patterson AFB, OH. Avionics Logistics Branch.
TESTING OPERATIONAL FLIGHT PROGRAMS (OFPS)
CHARLES P. SATTERTHWAITE In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 10 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

The ability to accurately test a system is a highly desirable feature in the engineering design process. The ability to model your system's environment and to exercise your system, in that environment, is also highly desirable. Operational Flight Programs are the software programs of avionics embedded computer systems. Not only is it desirable to be able to test and model Operational Flight Programs, it is essential. The consequences of not performing accurate Operational Flight Program testing can be devastating. Some of these include premature weapons release, erroneous flight instrument displays, and complete system failure. In order to test Operational Flight Programs, there are several things one must know about the Operational Flight Program, its weapons system host, its support environment, and how to generate and perform its test. This paper will address these issues as it develops a strategy to test an Operational Flight Program. Author (revised)

N94-29338# TA Consultancy Services Ltd., Farnham (England).
INTEGRATED FORMAL VERIFICATION AND VALIDATION OF SAFETY CRITICAL SOFTWARE
N. J. WARD In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 11 p Nov. 1993
Copyright Avail: CASI HC A03/MF A03

Embedded software providing the functionality for a flight vehicle self destruct system was judged to be safety critical and required the highest level of assurance in its correctness. In order to achieve this a program of independent verification and validation was initiated which involved the definition of a formal specification of the software combined with static analysis and dynamic testing. The formal specification, written in an Object Oriented form of Z, was used to clarify the requirements and to provide a definition against which the code could be formally verified. A range of static analyses were performed culminating in Compliance analysis which effectively provided a proof of the code against low level mathematical specifications that were refined down from the Z specification. The dynamic test sets were chosen partly from the requirements specification and partly from the static analysis results so that complete path coverage through every module was achieved. The work revealed a number of errors within the code and its specifications, which were corrected. Through its rigor and the identification of errors, the analysis has given a very high degree of confidence in the correctness of the software. Author (revised)

N94-29339# Air Force Systems Command, Wright-Patterson AFB, OH.
A DISCIPLINED APPROACH TO SOFTWARE TEST AND EVALUATION
J. LEA GORDON In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 8 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

This paper discusses the impact DOD development standards and Integrated Product Teams have had on influencing F-22 cockpit Controls and Displays software test and evaluation. Autho

N94-29344# British Aerospace Defence Ltd., Preston (England). Military Aircraft Div.
SDE'S FOR THE YEAR 2000 AND BEYOND: AN EF PERSPECTIVE
D. J. GOODWIN In AGARD, Aerospace Software Engineering for Advanced Systems Architectures 8 p Nov. 1993
Copyright Avail: CASI HC A02/MF A03

The process of selecting a software development environment for the embedded software of a large, complex military aircraft project can be long and costly. The process adopted on the European Fighter Aircraft (EFA) project by British Aerospace (BAe) is described, from the initial research and prototyping exercises performed in the seventies to the demonstration of the technology on the experimental aircraft project and finally leading to the collaboration with the Eurofighter partner companies (EPC's), building on European software experience to specify, procure, and release the EFA software development environment (EFA SDE). Issues arising within the EF forum that could influence the development of SDE's for future military aircraft projects are described. Author (revised)

N94-29727*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SOFTWARE MANAGEMENT ENVIRONMENT (SME) CONCEPTS AND ARCHITECTURE, REVISION 1
ROBERT HENDRICK (Computer Sciences Corp., Beltsville, MD.), DAVID KISTLER (Computer Sciences Corp., Beltsville, MD.), and JON VALETT Sep. 1992 84 p
(NASA-CR-189293; NAS 1.26:189293; SEL-89-103-REV-1) Avail: CASI HC A05/MF A01

This document presents the concepts and architecture of the Software Management Environment (SME), developed for the Software Engineering Branch of the Flight Dynamic Division (FDD) of GSFC. The SME provides an integrated set of experience-based management tools that can assist software development managers in managing and planning flight dynamics software development projects. This document provides a high-level description of the types of information required to implement such an automated management tool. Author (revised)

16
PHYSICS

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

N94-29175# Swedish Inst. for Materials Testing, Boras.
DETERMINATION OF SOUND POWER LEVELS OF AIR TERMINAL UNITS ACCORDING TO ISO 5135-NORDIC INTERLABORATORY TESTS, NORDTEST PROJECT NO. 968-91 Technical Report No. 214
G. ANDRESEN and H. G. JONASSON 1993 46 p
(PB94-137411; SP-RAPP-1993-43) Avail: CASI HC A03/MF A01

An inter-laboratory test program to determine the sound power level of air terminal units was carried out. The measurements were performed in accordance with ISO 5135. Four laboratories participated, each carrying out measurements on six test objects: two non-adjustable air terminal units, two adjustable air terminal units and two dampers. The diameters of the chosen units were 125 and 250 mm. The statistical basis for firm conclusions has not been satisfactory. One of

the participating laboratories was unable to measure on such low flow rates as those used for the test objects chosen for this investigation and two of the test objects were damaged during the transportation between the participating laboratories. NTIS

N94-29362*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BOUNDARY LAYER CONTROL DEVICE FOR DUCT SILENCERS Patent Application
FREDRIC H. SCHMITZ, inventor (to NASA) and PAUL T. SODERMAN, inventor (to NASA) 15 Nov. 1993 12 p
(NASA-CASE-ARC-12030-1; NAS 1.71:ARC-12030-1; US-PATENT-APPL-SN-151690) Avail: CASI HC A03/MF A01

A boundary layer control device includes a porous cover plate, an acoustic absorber disposed under the porous cover plate, and a porous flow resistive membrane interposed between the porous cover plate and the acoustic absorber. The porous flow resistive membrane has a flow resistance low enough to permit sound to enter the acoustic absorber and high enough to damp unsteady flow oscillations. NASA

N94-29407*# Old Dominion Univ., Norfolk, VA.
REVIEW OF SONIC FATIGUE TECHNOLOGY
B. L. CLARKSON (University Coll. of Swansea, Wales.) Apr. 1994 75 p
(Contract NAG1-363; RTOP 763-23-45-70)
(NASA-CR-4587; NAS 1.26:4587) Avail: CASI HC A04/MF A01

From the early-1960s until the mid-1980s, there was very little theoretical development for sonic fatigue prediction. Design nomographs based on simple theoretical models and results of specially designed tests were developed for most common aircraft structures. The use of advanced composites in the 1980s, however, generated an increased interest in development of more sophisticated theoretical models because of the possibilities for a much wider range of structural designs. The purpose of this report is to review sonic fatigue technology and, in particular, to assess recent developments. It also suggests a plan for a coordinated program of theoretical and experimental work to meet the anticipated needs of future aerospace vehicles. Author

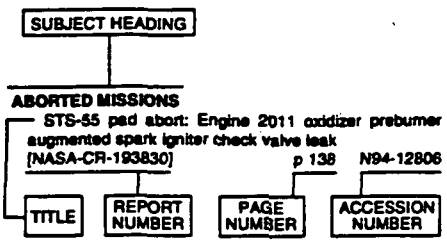
N94-29464*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SUBJECTIVE RESPONSE TO SONIC BOOMS HAVING DIFFERENT SHAPES, RISE TIMES, AND DURATIONS
DAVID A. MCCURDY Mar. 1994 44 p
(Contract RTOP 537-03-21-03)
(NASA-TM-109090; NAS 1.15:109090) Avail: CASI HC A03/MF A01

Two laboratory experiments were conducted to quantify the subjective response of people to simulated outdoor sonic booms having different pressure signatures. The specific objectives of the experiments were to compare subjective response to sonic booms when described in terms of 'loudness' and 'annoyance'; to determine the ability of various noise metrics to predict subjective response to sonic booms; to determine the effects on subjective response of rise time, duration, and level; and to compare the subjective response to 'N-wave' sonic boom signatures with the subjective response to 'minimized' sonic boom signatures. The experiments were conducted in a computer-controlled, man-rated sonic boom simulator capable of reproducing user-specified pressure signatures for a wide range of sonic boom parameters. One hundred and fifty sonic booms representing different combinations of two wave shapes, four rise times, seven durations, and three peak overpressures were presented to 36 test subjects in each experiment. The test subjects in the first experiment made judgments of 'loudness' while the test subjects in the second experiment judged 'annoyance.' Subjective response to sonic booms was the same whether expressed in terms of loudness or in terms of annoyance. Analyses of several different noise metrics indicated that A-weighted sound exposure level and Perceived Level were the best predictors of subjective response. Further analyses indicated that, of these two noise metrics, only Perceived Level completely accounted for the effects of wave shape, rise time, and peak overpressure. Neither metric fully accounted for the effect of duration. However, the magnitude of the duration effect was small over the very wide range of durations considered. Author

N94-29856*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMIC FRACTURE MECHANICS ANALYSIS FOR AN EDGE DELAMINATION CRACK
STEPHEN A. RIZZI and JAMES F. DOYLE Apr. 1994 13 p Proposed for presentation at the Fifth International Conference on Recent Advances in Structural Dynamics, Southampton, England, 18-21 Jul. 1994
(Contract RTOP 505-63-50-10)
(NASA-TM-109106; NAS 1.15:109106) Avail: CASI HC A03/MF A01

A global/local analysis is applied to the problem of a panel with an edge delamination crack subject to an impulse loading to ascertain the dynamic J integral. The approach uses the spectral element method to obtain the global dynamic response and local resultants to obtain the J integral. The variation of J integral along the crack front is shown. The crack behavior is mixed mode (Mode 2 and Mode 3), but is dominated by the Mode 2 behavior. Author

Typical Subject Index Listing



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C

E

F

G

H

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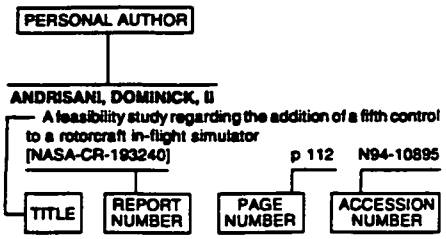

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G

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P

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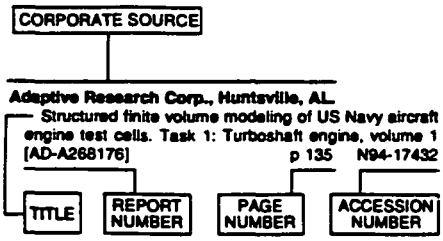

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G

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I

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K

L

M

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O

P

R

S

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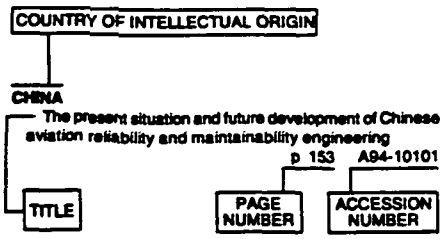

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AUSTRALIA

Fishermans Bend: A centre of Australian aviation
[AD-A274981] p 373 N94-29090

Cold expansion and interference for extending the fatigue life of multi-layer metal joints
[AD-A274982] p 410 N94-29091

B

BELGIUM

Decision Making Aids (DMA) in on-line ATC systems
p 386 N94-29570

Air-ground integration of the ATM system in *PHARE*
p 388 N94-29579

C

CANADA

Recent CFD applications in small gas turbine combustion systems development p 396 N94-29257

Design aspects in small aircraft gas turbine fuel injectors p 397 N94-29264

Intelligent systems for air space control and management p 384 N94-29560

Acoustic emission monitoring of aging aircraft structures
[DREP-93-17] p 393 N94-30129

Radar jet engine health monitoring project
[ASSGI-301] p 400 N94-30130

Enhanced fatigue crack detection in aging aircraft using continuous acoustic emission monitoring
[DREP-93-16] p 393 N94-30131

A capacity planning model for Canadian military airlift requests
[ISBN-0-315-86079-0] p 382 N94-30144

Payload central control for unmanned aircraft
p 401 N94-30284

The use of low cost differential mode GPS receivers in unmanned vehicles p 389 N94-30285

HATT-X: A high performance flying laboratory for autonomous unmanned aircraft research and development p 393 N94-30293

F

FRANCE

Fuels and Combustion Technology for Advanced Aircraft Engines
[AGARD-CP-536] p 404 N94-29246

Aerothermochemical calculations in afterburners
p 396 N94-29258

Research and Development of Ram/Scramjets and Turboramjets in Russia
[AGARD-LS-194] p 397 N94-29291

Aerospace Software Engineering for Advanced Systems Architectures
[AGARD-CP-545] p 415 N94-29315

How to control the increase in the complexity of civil aircraft on-board systems p 394 N94-29316

Performing specifications for complex systems' software p 400 N94-29317

Flight command software development: RAFALE studies p 415 N94-29320

Ada run time system certification for avionics applications p 394 N94-29332

Theoretical and experimental study of a cylindrical microstrip antenna
[REPT-932-440-109] p 412 N94-29456

Fire behavior of aeronautical materials
[REPT-932-600-105] p 408 N94-29457

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[REPT-932-710-101] p 374 N94-29463

Automation of the NDT diagnostic using neural nets. Application: Inspection of Airbus longitudinal joints during maintenance
[REPT-932-600-104] p 412 N94-29474

Machine Intelligence in Air Traffic Management
[AGARD-CP-538] p 383 N94-29558

Use of advanced technologies in ATM (air traffic management) domain p 384 N94-29561

Cognitive approach to specifications on air traffic controllers' decision assistance systems
p 386 N94-29571

DAISY: A decision aid for an air situation interpretation system p 386 N94-29574

The Common Modular Simulator (CMS): An architecture test bed for future advanced ATM systems
p 388 N94-29582

ARC2000: Automatic radar control
p 388 N94-29583

G

GERMANY

On the effect of emissions from aircraft engines on the state of the atmosphere p 414 N94-29247

Numerical modeling of turbine combustion chambers
p 396 N94-29254

The mixing process in the quenching zone of the rich-lean-combustion concept p 407 N94-29281

Investigation of the two-phase flow in a research combustor under reacting and non-reacting conditions
p 411 N94-29282

Time-resolved measurements in a three dimensional model combustor p 411 N94-29283

Experiences with the HOOD design method on avionics software development p 415 N94-29325

Ground independent landing system
p 385 N94-29564

GPS/GNSS for ATM p 385 N94-29565

Contributions of DLR to air traffic capacity enhancement within a terminal area p 385 N94-29567

Considerations on graphical user interfaces for intelligent ATM support systems p 386 N94-29572

Interactive analysis and planning tools for air traffic and airspace management p 386 N94-29573

DLR's ATM demonstration programme
p 386 N94-29575

Experimental flight management system
p 388 N94-29580

Automatic control steps for aircraft taxi guidance
p 388 N94-29584

A novel near-range radar network for airport surface control p 389 N94-29586

I

ITALY

Numerical simulation of aerothermal characteristics in gas turbine combustors with complex geometries
p 396 N94-29255

Computational and experimental results in high pressure combustions of H2/air and H2/O2/H2O
p 406 N94-29268

Technology rigs: A tool for afterburner development
p 397 N94-29270

On ground system integration and testing: A modern approach p 394 N94-29334

J

JAPAN

Proceedings of the 10th NAL Symposium on Aircraft Computational Aerodynamics
[NAL-SP-19] p 375 N94-28946

Monte Carlo simulation of normal shock wave. Part 2: VHS model and VSS model p 409 N94-28948

Variable soft sphere molecular model in the Monte Carlo simulation of air species p 409 N94-28949

Rarefied gas numerical wind tunnel. Part 8: HOPE
p 401 N94-28950

Numerical simulation of arc heated wind tunnel flow
p 402 N94-28951

Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 375 N94-28952

Numerical simulation of steady Mach reflection by shock capturing schemes p 375 N94-28953

Higher-order accurate numerical simulation of 3D supersonic mixing layers p 375 N94-28954

Numerical simulation of aerothermodynamic heating of hypersonic space transportation vehicles
p 375 N94-28955

A design of third-generation airfoils for helicopter rotor blades using Navier-Stokes p 391 N94-28957

Numerical analysis of airfoil for helicopter blade at high angle of attack using Navier-Stokes code
p 375 N94-28958

Numerical analysis of supersonic transport wings
p 375 N94-28959

Numerical study on the interaction between scramjet engine modules caused by thermal choke
p 395 N94-28960

Numerical simulation of supersonic flow around space plane with engine installed p 376 N94-28961

Numerical analysis of sonic boom in the near field
p 376 N94-28962

Numerical analysis of two dimensional/axisymmetric non-equilibrium hypersonic flow p 376 N94-28963

Role of computational fluid dynamics in aeronautical engineering. Part 10: Numerical analysis of flow around *2-D multi-element HLD* p 410 N94-28964

Numerical solution of inverse problem in aerodynamics p 376 N94-28965

Code development for hypersonic real-gas flow simulations toward the design of space vehicles, part 2
p 376 N94-28966

Three dimensional simulation of compressible flow induced by a high-speed train moving into a tunnel
p 376 N94-28967

Unsteady aerodynamic computations around NACA0012 at high angles of attack p 377 N94-28969

Study on mixing and injection of hydrogen into a supersonic flow p 377 N94-28975

Verification of a three-dimensional viscous flow analysis for a single stage compressor p 410 N94-28976

Numerical study on internal flows of centrifugal compressors p 395 N94-28977

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R

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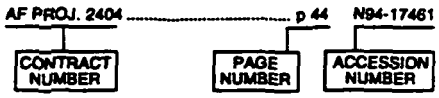

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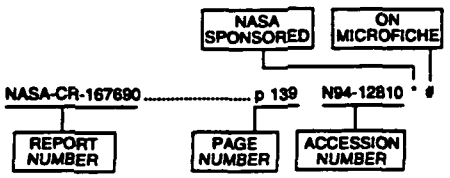

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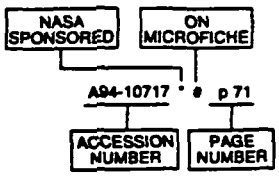

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Logan, UT 84322-3000
(801) 750-2684 Fax: (801) 750-2677

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