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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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Typical Report Citation and Abstract

❶ **19970001126** NASA Langley Research Center, Hampton, VA USA
❷ **Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes**
❸ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA;
❹ Mar. 1996; 130p; In English
❺ Contract(s)/Grant(s): RTOP 505-68-70-04
❻ Report No(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
❼ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10’ to 50’, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65’ swept forebody serrations tended to roll together, while vortices from 40’ swept serrations were more effective in generating additional lift caused by their more independent nature.
❽ Author
❾ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*

Key

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MAY 30, 1997

01
AERONAUTICS

19970014005 Air Force Office of Scientific Research, Bolling AFB, Washington, DC USA
Theoretical Aerodynamics ***Final Report, 1 Nov. 1992 - 31 Oct. 1995***
Cole, Julian D., Air Force Office of Scientific Research, Bolling AFB, USA; Jan. 10, 1996; 8p; In English
Contract(s)/Grant(s): F49620-93-1-0022; AF Proj. 2304
Report No.(s): AD-A310010; AF-AFOSR-TR-0275-96; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Mathematical and computational studies have been carried out on problems on theoretical aerodynamics. Shock free bodies and optimum critical airfoils have been considered in transonic theory, optimum three-dimensional lifting wings in hypersonic theory. Stability and transition of boundary layers has been analyzed according to triple deck theory. The Benjamin-Davis-Acrivos equation has been derived and it has been shown how solitons can lead to chaotic motion.
DTIC
Aerodynamics; Applications of Mathematics; Boundary Layer Transition; Boundary Layer Stability; Computational Fluid Dynamics; Shock Waves

19970014330 Defence Science and Technology Organisation, Salisbury, Australia
Artificial Intelligence Applications in Aircraft Systems ***Topical Report***
Goss, Simon, Aeronautical Research Labs., Australia; Murray, Graeme, Aeronautical Research Labs., Australia; Feb. 1996; 66p; In English
Report No.(s): AD-A311545; DSTO-RR-0071; DODA-AR-008-337; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Air Operations Division at the DSTO Aeronautical and Maritime Research Laboratory is developing a capability in the use of Artificial Intelligence (AI), including knowledge based systems technology, in applications related to the operation and support of aircraft systems. A survey of the work program of Air Operations Division was undertaken to identify opportunities offered by advanced computing techniques for the solution of existing research problems. This document describes the findings of the survey. Some of the research opportunities identified have been pursued, and a brief description of progress is provided.
DTIC
Military Aircraft; Artificial Intelligence; Knowledge Based Systems; Technology Utilization

19970015384 Stanford Univ., Dept. of Aeronautics and Astronautics, Stanford, CA USA
The Research and Training Activities for the Joint Institute for Aeronautics and Acoustics, ***1 Oct. 1996 - 30 Sep. 1997***
Cantwell, Brian, Stanford Univ., USA; Sep. 1996; 50p; In English
Contract(s)/Grant(s): NCC2-55
Report No.(s): NASA-CR-203808; NAS 1.26:203808; AERO-97-04; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This proposal requests continued support for the program of activities to be undertaken by the Ames-Stanford Joint Institute for Aeronautics and Acoustics during the one-year period October 1, 1996 to September 30, 1997. The emphasis in this program is on training and research in experimental and computational methods with application to aerodynamics, acoustics and the important interactions between them. The program comprises activities in active flow control, Large Eddy Simulation of jet noise, flap aerodynamics and acoustics, high lift modeling studies and luminescent paint applications. During the proposed period there will be a continued emphasis on the interaction between NASA Ames, Stanford University and Industry, particularly in connection with the noise and high lift activities. The program will be conducted within the general framework of the Memorandum of Under-

standing (1976) establishing the Institute, as updated in 1993. As outlined in the agreement, the purposes of the institute include the following: to conduct basic and applied research. to promote joint endeavors between Center scientists and those in the academic community To provide training to graduate students in specialized areas of aeronautics and acoustics through participation in the research programs of the Institute. To provide opportunities for Post-Doctoral Fellows to collaborate in research programs of the Institute. to disseminate information about important aeronautical topics and to enable scientists and engineers of the Center to stay abreast of new advances through symposia, seminars and publications.
Author
Control Simulation; Jet Aircraft Noise; Education; Aeroacoustics

02
AERODYNAMICS

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

19970013785 Lehigh Univ., Bethlehem, PA USA
Interactions of a Quasi-Two-Dimensional Vortex with a Stationary and Oscillating Leading-Edge
Jefferies, Rhett Williams, Lehigh Univ., USA; Jul. 1996; 184p; In English
Report No.(s): AD-A311871; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

Interactions of a quasi-two-dimensional vortex with a stationary and oscillating leading-edge were examined using a scanning laser version of high-image-density Particle Image Velocimetry (PIV). The incident vortex street was generated by sinusoidal oscillation of an airfoil located upstream of the leading-edge. The reduced frequency of vortex convection and the oscillation of the leading-edge were equal, allowing the phase shift between them to be varied independently. At the lower of two Reynolds numbers, a well resolved time sequence of the interactions was obtained. PIV images provide the first quantitative description of the edge interaction, employing instantaneous vorticity distributions and streamline patterns to reveal new topological features. These include the approach, deformation and splitting of an incident clockwise vortex, and the generation of tip and surface vortices on the lower surface of the stationary leading-edge.
DTIC
Leading Edges; Frequencies; Two Dimensional Models; Vorticity; Oscillations

19970014096 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids *La Caracterisation et la Modification des Sillages Crees dans les Fluides par des Vehicules Portant*
The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 415p; In English; In French; Fluid Dynamics Panel, 20-23 May 1996, Trondheim, Norway; Also announced as 19970014097 through 19970014132; Original contains color illustrations
Report No.(s): AGARD-CP-584; ISBN-92-836-0034-7; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

Papers presented during the eight sessions addressed the following subjects: vortex wakes, air traffic control procedures, structure of a transport aircraft, the interaction between an injected vortex and a rolling up vortex sheet, three-dimensional turbulence models, and simulations of aircraft in vortex wakes.
Derived from text
Vortices; Wakes; Three Dimensional Models

19970014097 Technische Hogeschool, Dept. of Aerospace Engineering, Delft, Netherlands
Vortex Wakes in Aerodynamics
Hoeijmakers, H. W. M., Technische Hogeschool, Netherlands; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A survey is presented of the physics of vortex wakes as occur in the flow about aircraft configurations. The emphasis is on fundamental aspects of the flows and on the assessment of the mathematical models that can be used for numerically simulating vortex wakes.
Author
Wakes; Vortices; Flow Characteristics; Flow Geometry; Flow Measurement; Flow Visualization

19970014098 Boeing Commercial Airplane Co., Seattle, WA USA

Wake Vortices' Effects and the Need for Prompt Action: A US View

Mack, Gerald R., Boeing Commercial Airplane Co., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 6p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The growth of commercial aviation has placed such demand on the air traffic system that many major U.S. airports are capacity limited and are experiencing significant traffic delays. These delays inconvenience passengers, cost the aviation industry hundreds of millions of dollars each year, and limit further growth of traffic. The existing wake turbulence separation distances represent a major challenge in ameliorating this congestion. to facilitate the introduction of the airplanes now categorized as 'heavy,' U.S. manufacturers worked with the Federal Aviation Administration (FAA) to conduct flight-test evaluations of the hazards of wake turbulence. These tests underscored, among other things, the necessity of three-dimensional flight path control. In light of the flight test findings, the FAA's effort focused on three areas: aircraft categories, air traffic control (ATC) procedures, and piloting procedures.

Author

Turbulence; Vortices; Wakes; Warning Systems; Airline Operations; Hazards

19970014101 Florida Atlantic Univ., Boca Raton, FL USA

The Interaction between an Injected Vortex and a Rolling Up Vortex Sheet

Dhanak, M. R., Florida Atlantic Univ., USA; Vishwanthan, K. S., Florida Atlantic Univ., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 6p; In English; Also announced as 19970014096

Contract(s)/Grant(s): NSF BCS-92-11847; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The interaction between two symmetrically located finite Rankine vortices and an elliptically loaded vortex sheet is examined in the Treffetz plane for a range of flow parameters. The Rankine vortices, which are placed over the sheet, have vorticity of opposite sign to that of the adjacent section of the sheet. They may be considered to represent, in the Treffetz plane, vortices 'injected' into the flow from an upstream location. It is shown that there are in general three types of interactions which significantly affect the rolling up process. Accordingly, an interaction can result in straightforward merging, formation of subsidiary structures or considerable inboard displacement of the rolling up tip vortex. In the last case, the process should help to enhance the onset of the Crow instability considerably.

Author

Flow Characteristics; Vortex Sheets; Vortices

19970014102 University Coll., Aerospace Research Unit, Galway, Ireland

Flowfield Prediction of Three-Dimensional Wing Trailing Vortices using Advanced Turbulence Models

Eaton, J. A., University Coll., Ireland; OFlaherty, M. P., University Coll., Ireland; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The feasibility of employing a general-purpose Navier-Stokes code, in conjunction with a reynolds stress transport turbulence model, for predicting wake vortex flow fields is investigated. Two test cases are considered, each employing two different turbulence models, a kappa-epsilon model, which is isotropic, and an anisotropic, differential Reynolds stress model. First the flow field around a low aspect ratio wing in a wind tunnel is computed to assess the influence of the surface and velocity distributions in the wake, particularly the streamwise component, are compared with measurements. Although the grids used are suboptimal, predictions indicate a qualitative improvement for the anisotropic model, in particular where the swirl component of the flow is greater, such as in the vortex core. Next, wind tunnel data are used as a starting point for an axisymmetric model of a free vortex with axial flow. These computations allow the effects of choice of turbulence model on the aging and decay of a vortex in the far field to be observed. The kappa-epsilon model predicts a rapid growth of the vortex, whereas the differential Reynolds stress model results in a more realistic, almost uniform evolution of the core radius.

Author

K-Epsilon Turbulence Model; Navier-Stokes Equation; Low Aspect Ratio Wings; Axial Flow; Reynolds Stress; Stress Analysis; Turbulence Effects; Vortices; Wakes

19970014103 Nielsen Engineering and Research, Inc., Mountain View, CA USA

An Unsteady Vortex Wake Model for Maneuvering Vehicles

Mendenhall, M. R., Nielsen Engineering and Research, Inc., USA; Perkins, S. C., Jr., Nielsen Engineering and Research, Inc., USA; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A preliminary-design and analysis capability applicable to vehicles in unsteady maneuvers involving nonlinear, time-dependent flow conditions is described. The approach is a direct coupling of fluid dynamics and flight mechanics for use in the flight regimes where the flow phenomena are dominated by vorticity and separation associated with high angles of attack and rapid motions. The modularized computer algorithm is based on mathematical flow models, supplemented by empirical information where necessary, which accurately represent the physics of complex flows. This physics-based method is applicable to generic configurations, and it is not dependent on specific empirical information, and it is economical to use. The resulting method can be used as a prediction capability for specified vehicle motions or flow conditions, or it can be coupled with a six-degree-of freedom equation-of-motion solver to predict flight trajectories and transient performance characteristics.

Author

Turbulence Models; Fluid Dynamics; Equations of Motion; Degrees of Freedom; Angle of Attack; Vortices; Wakes; Fluid Flow

19970014104 Cambridge Univ., Engineering Dept., Cambridge, UK

Experimental Assessment of the Extended Betz Method for Wake Vortex Prediction

Graham, W. R., Cambridge Univ., UK; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The extended Betz method, whereby wake vortex velocity predictions are obtained from a given wing lift distribution, is assessed by comparison with experimental results for wake cross-flow velocities behind a wing model with flaps. The required lift distributions are found from overall lift data and a lifting-line calculation, and the comparison is made for both clean and high-lift fundamental Betz assumption of effectively two-dimensional, inviscid flow in the wake is well supported, but that a proposed approximate invariant, the second moment of vorticity, is not conserved. In spite of this, the theoretical predictions for the single vortex shed by each half of the clean wing are found to be accurate. However, the multiple vortices arising from the wing in high-lift configuration are not as well predicted, and in this case the usefulness of the method seems to be restricted to providing estimates of the number of vortices, and their overall circulations.

Author

Wakes; Vortices; Predictions; Two Dimensional Flow; Inviscid Flow; Cross Flow; Aerodynamic Configurations

19970014105 Defence Research Agency, Electronics Sector, Malvern, UK

Structure, Trajectory and Strength of B747 Aircraft Wake Vortices Measured by Laser

Vaughan, J. M., Defence Research Agency, UK; Brown, D. W., Defence Research Agency, UK; Constant, G., Defence Research Agency, UK; Eacock, J. R., Defence Research Agency, UK; Foord, R., Defence Research Agency, UK; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In English; Also announced as 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Wake vortices of aircraft landing at Heathrow have been measured with a coherent laser radar. Analysis of the vortex velocity profiles from B747 aircraft shows a series of symmetrical dip or inversions on approach to the central core. Such inversion are not predicted theoretically and contrast with the uniformly increasing velocity profiles observed from other aircraft. Vortex trajectories may also be reconstructed; in one case a B747 vortex, after initial descent, returned to the glideslope with undiminished strength over a minute later.

Author

Wakes; Vortices; Aircraft Wakes; Velocity Distribution

19970014106 Federal Aviation Administration, Cambridge, MA USA

Wake Vortex Decay Near the Ground under Conditions of Strong Stratification and Wind Shear

Rudis, R. P., Federal Aviation Administration, USA; Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Janota, P., System Resources Corp., USA; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Using the tower fly-by method, decay measurements were made on wake vortices generated by B-727, B-757 and B-767 aircraft. In addition to a 60-meter instrumented tower, two remote sensing systems were deployed: (1) Laser Doppler Velocimeter (LDV) (high resolution vortex profiles at ranges of 40-200 meters) and (2) Monostatic Acoustic Vortex Sensing System (MAVSS) (lower resolution profiles up to 500 meters beyond the tower location). Typical early morning meteorology during the test period

consisted of stratified drainage flows. Because of the persistent crosswind, the MAVSS gave the most complete vortex decay information. Meteorological conditions were measured by instruments on the tower and on a tethersonde. The analysis looked for statistical relationships between vortex lifetime and several meteorological parameters, treated independently. Due to the meteorological conditions of stratification, low turbulence and wind shear, the upwind vortex lasted longer than the downwind vortex; the circulation remained above 140 m(exp)2/s for up to 125, 150 and 170 seconds for the B-727, B-757 and B-767, respectively. However, in every case, the crosswind was strong enough to sweep both wake vortices away from the generating location; in some cases the vortices traveled more than 500 meters laterally. Although these durations are much longer than the normally observed vortex lifetimes, they are related, according to the analysis, to strong crosswind shear coupled with low turbulence levels. While this long vortex migration at the observed strength levels might represent a potential vortex encounter hazard for operations on a downwind parallel runway, the drainage flow conditions which led to this unusual vortex behavior would be unlikely to occur at most airports.
Author
Wakes; Vortices; Parallel Flow; Wind Shear; Wind Direction; Runway Conditions; Hazards

19970014107 Boeing Commercial Airplane Co., Seattle, WA USA
Wake Turbulence Training and Regulation: An Industry Team Approach
Carbaugh, David C., Boeing Commercial Airplane Co., USA; Forsythe, W. Douglas, Boeing Commercial Airplane Co., USA; Nov. 1996; 6p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the development and content of the industry endorsed Wake Turbulence Training Aid and industry's input to regulators regarding wake turbulence efforts. The Wake Turbulence Training Aid is a safety document aimed at both pilots and air traffic controllers. The aid consists of a manual with pull out sections for easy use and a video of about 25 minutes in length. The reason for developing the aid is discussed. Increased traffic, mixed traffic, accidents and incidents, ASRS reports, and calls for action all culminated in needing training to step up to the need for more awareness and education for pilots and controllers. Who was involved in the development of the aid is discussed to highlight its international scope, as well as the time progression towards completion. The content of the aid is then discussed in detail. Lastly, the efforts of the industry team to make specific inputs to the FAA regarding efforts to reduce wake turbulence encounters and to improve safety is presented.
Author
Air Traffic Controllers (Personnel); Education; Wakes; Turbulence

19970014108 Federal Aviation Administration, Volpe National Transportation Systems Center, Cambridge, MA USA
Ground-Based Anemometer Measurements of Wake Vortices from Landing Aircraft at Airports
Abramson, S., Federal Aviation Administration, USA; Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In 1994 an array of two-axis propeller anemometers was installed at 10-meter height under the approach to Runway 31 R at Kennedy Airport. Since the aircraft are typically 50 meters above the ground at the test location, the wake vortices rapidly descend toward the ground where they are readily detected and measured by the anemometers. In 1995 a similar installation was made on Runway 27 at the Memphis Airport. The ultimate goal of this study is to better understand when wake vortices remain in the flight path of following aircraft. The data collection system operates automatically and hence provides wake vortex data under all weather conditions and at all times of day and night with minimal cost. Real-time remote display of the vortex locations was implemented. The anemometers are augmented with additional weather sensors to provide meteorological data with greater detail than the standard surface weather observations. New processing methods for the anemometer data were developed to determine vortex height and strength in addition to the lateral position that was traditionally obtained from ground-based anemometers. The anemometer array is particularly appropriate for studying the interaction of wake vortices with the ground. It readily detects the secondary vortices detached from the boundary layer by the influence of the primary wake vortices; these secondary vortices produce the well known vortex bouncing. Such secondary vortices have not been seen by any other sensing system.
Author
Anemometers; Wakes; Vortices; Aircraft Landing; Wind Velocity Measurement; Flow Measurement; Flight Paths; Data Acquisition

19970014110 Technische Hogeschool, Low Speed Aerodynamics Lab., Delft, Netherlands
Experimental Analysis of the Vortex Wake Structure behind a Propeller-Wing Configuration
Veldhuis, L. L. M., Technische Hogeschool, Netherlands; Rentema, D. W. E., Technische Hogeschool, Netherlands; Nov. 1996; 18p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A flow field survey was performed with a 5-hole pressure probe at 1 chord length behind a propeller-wing configuration revealing important qualitative and quantitative information on the propeller dominated interactive flow field. The model, that consists of a low aspect ratio semi-span wing model combined with a 4 bladed tractor propeller, was tested at several low subsonic flow conditions in the Delft University Low Speed Windtunnel. The distribution of total pressure and axial vorticity show, besides the well-known spiral tip vortex, a strong deformation of the slipstream structure. The deformation of the vortex wake is strongly related to the spanwise lift distribution of the propeller/wing configuration which might be used as a starting point for prediction of vortex formation and decay. It also determines the magnitude of the overall induced drag and the deformation process therefore has implications for the proper modelling of slipstreams used within theoretical prediction codes for the analysis of airplane performance. to obtain quantitative information from the field data the theory of Betz and Maskell was applied to determine the lift, the profile drag and the induced drag for both the model with and without running propeller. Comparison of these results with external balance measurements shows a good agreement. The lift distributions which were compared with surface pressure measurements reveal that a considerable amount of swirl is left in the slipstream after passage of the wing; an important observation for future optimisation of propeller-wing configurations. In general the flow field survey with traversing 5 hole probe appears to be a powerful technique to better understand propeller/wing interactive flows.
Author
Vortices; Flow Distribution; Low Aspect Ratio Wings; Wings; Wakes; Subsonic Flow; Slipstreams; Propellers

19970014111 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
Flowfield of A Wing Embedded in the Wake of A Bursted Vortex
Longo, J. M. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Orlowski, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Strohmeyer, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the present paper the flowfield around a delta wing partially embedded in the wake of a bursted vortex is numerically studied at M(sub infinity)= 0.4. The simulation is carried out solving the Euler equations on two structured grids of about 2.3 million points and 300000 points respectively. Due to the lack of experimental results, special emphasis is put on the analysis of the effect of grid fineness on the wake-flow. The present investigation indicates that the spiraling flow of a vortex continues after breakdown with a swirl velocity comparable to that of a non-bursted vortex generated at lower angles of attack and hence interference effects coming from its wake persist long downstream.
Author
Angle of Attack; Delta Wings; Vortices; Wakes; Flow Distribution

19970014112 Boeing Commercial Airplane Co., Seattle, WA USA
Stability of Multiple Trailing-Vortex Pairs
Crouch, J. D., Boeing Commercial Airplane Co., USA; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The stability of two vortex pairs is analyzed as a model for the vortex system generated by an aircraft in flaps-down configuration. The co-rotating vortices on the starboard and port sides tumble about one another as they propagate downward. This results in a time-periodic basic state. The instabilities are periodic along the axes of the vortices with wavelengths that are large compared to the size of the vortex cores. The results show symmetric instabilities that are linked to the long-wavelength Crow instability. In addition, new symmetric and antisymmetric instabilities are observed at shorter wavelengths. These instabilities have growth rates 60-100% greater than the Crow instability. The system of two vortex pairs also exhibits transient growth which can lead to growth factors of 5 or 10 in one fourth of the time required for the same growth due to instability.
Author
Aircraft Wakes; Vortices; Blade-Vortex Interaction; Turbulent Mixing; Turbulent Flow; Vortex Generators

19970014113 NASA Ames Research Center, Moffett Field, CA USA
Initiation of the Crow Instability by Atmospheric Turbulence
Spalart, P. R., Boeing Commercial Airplane Co., USA; Wray, A. A., NASA Ames Research Center, USA; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The interaction between vortex pairs and well developed isotropic turbulence is studied by Direct Numerical Simulation. It is a model of the effect of natural environmental disturbances on airplane wakes. The nondimensional turbulence intensity eta is in the range (0 .02, 0.5), typical of airplanes. The most amplified wavelength of the Crow instability is placed within the inertial range of the turbulence, which is typical in the atmosphere and fits the theoretical setting of Tombach and Crow & Bate. The vorticity peaks in cross-flow planes are tracked to reveal the deformation of the vortices. In agreement with visual observations, the

Crow instability dominates in weak turbulence, whereas chaotic deformations are seen in stronger turbulence. The average wavelength is about 27% shorter than the most amplified one. The beginning of destruction is identified with the first changes in the connectivity of the lines; identifying the end of destruction is more elusive. The wake lifespans overlap those from flight tests, laboratory tests, and the theory of Crow & Bate. However, in strong turbulence, theory and simulation both predict shorter average lifespans than the tests do. The scatter in lifespans is almost as large in simulations as in flight tests; thus, the intermittency of turbulence appears to explain the scatter even without any other differences in conditions. We conclude that the predictability of wake destruction by this mechanism is very poor.
Author
Atmospheric Turbulence; Wakes; Vortices

19970014114 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
Direct Numeric Simulation of Sinusoidal Instability ***Simulation Numerique Directe de L'instabilite Sinusoidale***
Sipp, D., Office National d'Etudes et de Recherches Aerospatiales, France; Jacquin, L., Office National d'Etudes et de Recherches Aerospatiales, France; Sagaut, P., Office National d'Etudes et de Recherches Aerospatiales, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In French; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The results of sinusoidal instability which were developed in a vortical gate composed of two turbulent vapor trails are presented. The results are consistent with the theories of linear instability developed by Crow. The effects of the density of the airflow, the limiting conditions, and the shape of the initial perturbation on the quality of the solution are studied.
Author
Numerical Flow Visualization; Contrails

19970014115 Karlsruhe Univ., Inst. fur Stromungslehre und Stromungsmaschinen, Germany
Stability Theory for Two Wingtip Vortices Behind Cruising Aircraft
Ehret, Thorsten, Karlsruhe Univ., Germany; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

To perform a stability analysis on an interesting flow field, an undisturbed quasi steady basic velocity profile of the concerned flow field must be provided. In case of wake vortices behind cruising aircraft, the velocity distribution within the vortices has to be evaluated as a function of the height coordinate z and the spanwise coordinate y. A three-dimensional vortex filament method was used to calculate the velocity field of the wake flow, because it is an efficient tool for flows consisting of large regions of vorticity. Vortex filament methods simulate such a flow field by discretizing the regions behind the aircraft wing which contain vorticity, and tracking this discretization in a Lagrangian reference frame. The velocity field behind the aircraft is determined kinematically from the given vorticity field and computed by an application of the Biot-Savart-law. Small perturbations are then superimposed on the given quasi steady base flow and this sum is then substituted into the governing equations. After a linearization process, two fourth order perturbation differential equations are found. They give rise to an eigenvalue problem with a complex eigenvalue S and eigenfunctions for the amplitudes of the disturbances.
Author
Aircraft Wakes; Stability Tests; Flight Tests; Base Flow

19970014120 National Aerospace Lab., Marknesse, Netherlands
Flow Field Survey in Trailing Vortex System Behind a Civil Aircraft Model at High Lift
deBruin, Anton C., National Aerospace Lab., Netherlands; Hegen, Sinus H., National Aerospace Lab., Netherlands; Rohne, P. Bernd, National Aerospace Lab., Netherlands; Spalart, Philippe R., Boeing Commercial Airplane Co., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; Also announced as 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The roll-up of the trailing vortex system behind a generic civil aircraft windtunnel model with extended flaps and slats is studied up to 5 wing spans downstream. A laser light sheet flow visualisation technique is used and detailed flow field measurements are made with a spanwise traversable rake with five-hole probes. The measurement results are compared against calculations with the 2D vorticity transport equation.
Author
Vorticity Equations; Aircraft Models; Civil Aviation; Vortices

19970014121 NASA Ames Research Center, Moffett Field, CA USA

Measurements in Vortex Wakes Shed by Conventional and Modified Subsonic Aircraft

Rossow, Vernon J., NASA Ames Research Center, USA; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A theoretical and experimental program is underway at NASA Ames Research Center to first obtain a better understanding of the hazard posed by the vortex wakes of subsonic transports, and then to develop methods on how to modify the wake-generating aircraft in order to make the vortices less hazardous. This paper summarizes results obtained in the 80- by 120-Foot Wind Tunnel at NASA Ames Research Center on the characteristics of the vortex wakes that trail from 0.03 scale models of a B-747 and of a DC-10. Measurements are first described that were taken in the wakes with a hot-film anemometer probe, and with wings that range in size from 0.2 to 1.0 times the span of the wake generating models at downstream distances of 81 ft and 162 ft. behind the wake-generating model; i.e., at scale distances of 0.5 and 1.0 mile. The data are then used to evaluate the accuracy of a vortex-lattice method for prediction of the loads induced on following wings by vortex wakes.

Author

Vortex Lattice Method; Wakes; Vortices

19970014122 California Univ., Dept. of Mechanical Engineering, Berkeley, CA USA

Natural and Forced Growth Characteristics of the Vortex Wake of a Rectangular Airfoil

Jacob, J. D., California Univ., USA; Liepmann, D., California Univ., USA; Savas, O., California Univ., USA; Nov. 1996; 12p; In English; Also announced as 19970014096

Contract(s)/Grant(s): RTA-65V749; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The forced trailing vortex wake of a rectangular NACA 0012 airfoil with an aspect ratio of 8 is investigated experimentally. The experiments include limited five-hole probe measurements in the near wake in a wind tunnel and extensive DPIV measurements in the far wake in a town tank. Measurements are conducted on the natural wake and the forced wake at chord Reynolds numbers from 2 x 10(exp 4) to 6 x 10(exp 4). The wake is forced by axial jets located on each wing-tip injecting fluid into the vortex cores. The forcing is steady or pulsatile. Pulsatile forcing is varied from 1 Hz to 40 Hz and with the wing-tip jets in phase, out of phase, or one on/one off. Relevant parameters, including vortex separation, vorticity, circulation, and core size, are measured up to 1000 chord lengths behind the wing. Forcing increases both the separation of the vortex pair and the growth rate of the vortex core size. At low frequencies, these effects are monotonic with increasing forcing frequency. At high frequencies, the measurements suggest a complex response to forcing. Based on measurements and observations, some parameters of importance are suggested in exploring possible means of controlling the behavior of the vortex wake. The complexity of the problem dictates that any search for identifying practical solutions must be a concerted effort among experiments, analyses and numerics.

Author

Wakes; Vortices; Reynolds Number; Near Wakes; Aspect Ratio; Airfoils

19970014123 Centre Europeen Recherche et de Formation Advance en Calcul Scientific, CFD Project, Toulouse, France

Three-Dimensional Direct Numerical Simulations of Wake Vortices: Atmospheric Turbulence Effects and Rebound with Crosswind

Corjon, Alexandre, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; Risso, Frederic, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; Stoessel, Alain, Institut Francais du Petrole, France; Poinsot, Thierry, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 22p; In English; Also announced as 19970014096

Contract(s)/Grant(s): STNA/95/110; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents three-dimensional direct numerical simulations of a vortex pair. Two types of computations are conducted. The first type considers a vortex pair placed in an homogeneous turbulent field. The phenomenon of interaction between the vortices and the turbulence is analyzed in details from two simulations calculated on a 135(exp 3) nodes mesh grid (one case with axial core velocity, the other without). The results show that the role of large and small turbulent eddies can be separated into two fairly independent mechanisms. The large structures are stretched by velocity gradients induced by the vortex pair. That leads to the formation of both tubes of vorticity spinning azimuthally around each vortex and associated axial velocity sheets. These turbulent structures cause a strong decrease of the maximal velocity and curvature of the vortices. These deformations of the vortex induced by the turbulence initiate an antisymmetric long-wave instability of the pair which will probably lead to the collapse of the vortices. Concurrently, the small structures can enhance the diffusion of the vorticity out of the vortex core. From this analysis and dimension considerations, the correct form for a model of decay of the vortices is derived. On the other hand, nine simulations on a 813 nodes mesh grid are used to determine the sensibility of the results upon the random turbulent initial conditions. The second type of computations considers a vortex pair placed in a laminar flow field near the ground. This laminar flow is representa-

tive of a neutral surface boundary layer. The effect of variable crosswind shear is studied with the effect of an axial wind. A comparison between the two-dimensional and the three-dimensional results shows that the main phenomenom is not modified but that the altitude of rebound depends on the three components of the wind.
Author
Atmospheric Boundary Layer; Atmospheric Turbulence; Laminar Flow; Three Dimensional Models; Turbulence Effects; Turbulent Flow; Vortices; Wakes

19970014124 Institut de Mechanique de Grenoble, Div. Mechanique du Vol, Saint-Martin d'Heres, France
Characterisation and Modelling of Aircraft Wake Based on Tests of Scaled Models in a Laboratory ***Caracterisation et Modelisation du Sillage d'un Avion a Partir d'essais en vol de Maquettes en Laboratoire***
Cotton, Patricia, Institut de Mechanique de Grenoble, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In French; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The fluid Mechanics Institute of Lille (IMFL), off-site center of ONERA, has developed for many years specific experimental methods based on flight tests of scaled models performed in a laboratory. These methods are here applied to the characterization with a view to modelling of transport aircraft wake.
Author
Aircraft Wakes; Transport Aircraft

19970014125 Stanford Univ., Dept. of Aeronautics and Astronautics, Stanford, CA USA
Direct Numerical Simulation of the Breakdown of Aircraft Wake Vortices
Rennich, S. C., Stanford Univ., USA; Lele, S. K., Stanford Univ., USA; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An investigation is initiated that aims to improve the understanding of how disturbances to aircraft vortex wakes, applied at the wing, survive the roll-up process and eventually lead to destruction, or 'breakdown', of the wake. To efficiently perform this investigation, a numerical method is presented which accurately and efficiently computes flows in domains that are unbounded in two directions and periodic in the third, subject to the condition that vorticity is compactly distributed in the unbounded directions. This new code is used to compute the growth of symmetric disturbances on a pair of counter rotating columnar vortices. For high Reynolds number, the inviscid, linear vortex filament results of Crow (5) which predict the most unstable wavelength and its amplification rate, are reproduced well. From these computations an eigenfunction of the Crow instability as it exists in an evolving viscous vortex pair is extracted. The evolution of a perturbed plane wake due to an elliptically loaded wing is computed. It is observed that a perturbation of the correct wavelength rapidly evolves into the Crow instability and grows at approximately the predicted rate.
Author
Aircraft Wakes; High Reynolds Number; Inviscid Flow; Vortex Filaments; Vortices; Wakes

19970014126 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Fluid Mechanics, Goettingen, Germany
The Inviscid Motion of a Vortex Pair in a Compressible and Stratified Atmosphere
Stuff, Roland, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The movement of an inviscid vortex pair in a compressible atmosphere including buoyancy effects is described by analytic solutions. The effects of compressibility are dealt with in an isentropic atmosphere. The work of compression done by the atmosphere on the vortex is entirely consumed by the isentropic change of the thermodynamic state of the vortex pair. The acceleration of the accompanying and apparent mass is given by the displacement of the two vortices towards each other. The effects of buoyancy are investigated by means of a two-dimensional, incompressible, inviscid vortex pair which is heavier than the ambient fluid. It turns out that the condition of pressure continuity across the separating streamline can be achieved only by assuming an increase in circulation of the two vortices.The mass accompanying the vortex pair under the effect of non-conservative forces converts a fraction of its gravity potential into an increase of stagnation pressure. Both, the analytical formulas for compressibility and buoyancy, then, are combined to describe both effects simultaneously. Thus, inconsistencies of other papers are eliminated.
Author
Vortices; Inviscid Flow; Buoyancy

19970014127 Technische Hochschule, Dept. of Aerospace Engineering, Aachen, Germany

Experimental and Numerical Results on Spiral Vortex Breakdown

Backstein, Sven H., Technische Hochschule, Germany; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Experiments and numerical simulations have been performed to investigate the spiral breakdown of a wing tip vortex in flowfields of adverse axial pressure gradient. The basic idea was to stretch the transition domain between A and B by a reduction of the imposed pressure gradient. Embedding the vortex in a flowfield with only gradual axial retardation, a stretching could be achieved in both, experiment and calculation, giving some interesting insight into the mechanism of vortex breakdown. The appearance of reversed axial flow, upstream of the spiral, is identified as the distinctive feature of vortex breakdown, that must lead to the loss of axial symmetry and to an unsteady flow.

Author

Axial Flow; Flow Distribution; Reversed Flow; Unsteady Flow; Vortex Breakdown; Wing Tip Vortices

19970014128 Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA USA

Computational and Experimental Investigation of the Wakes Shed from Flapping Airfoils and their Wake Interference/ Impingement Characteristics

Dohring, C. M., Naval Postgraduate School, USA; Platzer, M. F., Naval Postgraduate School, USA; Jones, K. D., Naval Postgraduate School, USA; Tuncer, I. H., Naval Postgraduate School, USA; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Computational and experimental water tunnel investigations of the wakes shed from flapping airfoils are described. It is shown that there exists a critical nondimensional plunge velocity above which the wake changes from a symmetric thrust-producing vortical structure to an asymmetric lift and thrust-producing one. Furthermore, it is found that the impingement of the wake generated by a flapping airfoil on a stationary airfoil produces a significant thrust augmentation on the flapping/stationary airfoil combination. Similarly, there exists a beneficial ground interference effect if the airfoil is flapping near a stationary wall. The experimental data are based on flow visualization using a two-color dye injection technique and laser-doppler velocimetry. The numerical results are obtained from an unsteady inviscid incompressible two-dimensional panel code and from a two-dimensional Navier-Stokes code. Comparisons between the experimental and numerical results show good agreement.

Author

Aerodynamic Interference; Airfoils; Flow Visualization; Dye Lasers; Inviscid Flow; Navier-Stokes Equation; Panel Method (Fluid Dynamics); Wakes

19970014129 NASA Langley Research Center, Hampton, VA USA

Recent Laboratory and Numerical Trailing Vortex Studies

Delisi, Donald P., Northwest Research Associates, Inc., USA; Greene, George C., NASA Langley Research Center, USA; Robins, Robert E., Northwest Research Associates, Inc., USA; Singh, Raminder, Indian Inst. of Tech., India; Nov. 1996; 10p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Results from two laboratory studies and two numerical studies are presented. In the first laboratory study, measurements of the strength of vortices from a three-dimensional (3-D) model wing are presented. The measurements follow the vortices as they evolve in time from a two-dimensional (2-D) line vortex pair to the development and migration of 3-D vortex rings. It is shown that the resulting vortex rings can contain up to 40 percent of the initial vortex circulation. Thus, the formation of vortex rings may not necessarily signal the end of the wake hazard to following aircraft. In the second laboratory study, we present the results of an experiment which shows how the spanwise drag distribution affects wake-vortex evolution. In this experiment, we modified the spanwise drag distribution on a model wing while keeping the total lift and drag constant. The results show that adding drag on or near the centerline of the wing has a larger effect than adding drag at or near the wingtips. These measurements complement the results of NASA studies in the 1970s. In the first numerical study, results of 3-D numerical calculations are presented which show that the vortex Reynolds number has a significant influence on the evolution and migration of wake vortices. When the Reynolds number is large, 3-D vortex rings evolve from the initially 2-D line vortex pairs. These vortex rings then migrate vertically. When the Reynolds number is lower, the transition of vorticity from 2-D to 3-D is delayed. When the Reynolds number is very low, the vortices never transition to 3-D, and the vertical migration is significantly reduced. It is suggested that this effect may have been important in previous laboratory wake-evolution studies. A second numerical study shows the influence that vertical wind shear can have on trailing vortex evolution.

Author

Wakes; Wind Shear; Wings

19970014130 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fur Physik der Atmosphare, Bonn, Germany

Wake Dynamics and Exhaust Distribution Behind Cruising Aircraft

Gerz, Thomas, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Ehret, Thorsten, Karlsruhe Univ., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

By means of a vortex-filament technique and large eddy simulations dynamics are discussed which control the distribution of the exhaust of a subsonic aircraft under cruising conditions from the nozzle exit to the distance where the trailing vortex pair starts to collapse into turbulence. Emphasis is first put on the method; second on the initial roll-up process and the phenomenon of 'non-entrainment' of exhaust into the vortex cores. Third, the role of turbulence on the onset of the wingtip-vortex decay is considered; thereby it is distinguished between background atmospheric turbulence and turbulence steming from the boundary-layer around the aircraft.

Author

Aircraft Wakes; Wing Tips; Turbulence Effects; Vortex Filaments

19970014286 Cornell Univ., Ithaca, NY USA

Three-Dimensional Aspects of Nominally 2-D and 3-D Bluff Body Wakes ***Final Report, Jan. 1990 - 20 Jun. 1994***

Williamson, C. H., Cornell Univ., USA; Dec. 29, 1995; 4p; In English

Contract(s)/Grant(s): N00014-90-J-1686

Report No.(s): AD-A311428; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Over the last decade, there has been much work carried out to understand three-dimensional effects at low Reynolds numbers (Re) in the wake of bluff bodies, yielding the reaction that end effects can influence the vortex shedding across large spanwise lengths. Wake patterns such as parallel shedding, oblique shedding, cellular shedding, transient patterns, such as 'phase shocks' and 'phase expansions', as well as the existence of large-scale 'vortex dislocations', have been investigated, aspects of this research being spearheaded by me studies at Cornell under the above Contract. In particular, we have discovered a new mechanism for oblique wave resonance in the far wake. We have found a means to control the near wake by using suction at the spanwise ends of a body, which has enabled much more precise phenomena to be investigated including the critical conditions for turbulence inception, and a careful study of 3-D wake transition. We have combined our research at Cornell with studies by Dr. Peter Monkewitz at Ecole Polytechnique, Lausanne, who has effectively laid much of the foundation of the description of these near wake patterns in terms of a Guinzburg-Landau equation. For example, the now transient phenomenon known as a 'phase expansion' has been found to be directly analogous to a Prandtl-Meyer expansion found in gas dynamics. Clearly, the work under the support of the ONR has led to a surprisingly rich new understanding of three-dimensional effects in nominally two-dimensional wake flows.

DTIC

Prandtl-Meyer Expansion; Low Reynolds Number; Near Wakes; Vortex Shedding

19970014362 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

Experimental Investigation of a Supersonic Turbulent Boundary Layer with Adverse Pressure Gradient

Hale, Chad S., Air Force Inst. of Tech., USA; Dec. 1995; 145p; In English

Report No.(s): AD-A309625; AFIT/GAE/ENY/95D-12; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Laser Doppler Velocimetry (LDV) measurements were made to quantify the effect of adverse pressure gradient on the compressible turbulent flow structure in a Mach 2.9 boundary layer (Re/m = 1.75 x 10(exp 7). Measurements included profiles of 2-D mean velocities, turbulence intensities, Reynolds shear stresses, intermittency, flatness and skewness. In addition, mean strain rates were also measured. The boundary layer measurements were acquired for both flat plate and compression ramp models. LDV measurements were made at two locations on the compression ramp model at 68 cm and 71 cm downstream of the nozzle throat. At these locations, B approx. 1.12 and -0.94, respectively. Flow visualization was accomplished by nanosecond shadowgraph and schlieren photography. Results indicate that the adverse pressure gradient increased the Reynolds shear stresses by 190% and turbulence intensities by 24% of the flat plat values. In the favorable pressure gradient region, these quantities were decreased by 52% and 7% with respect to the adverse pressure gradient values, respectively.

DTIC

Experimentation; Supersonic Boundary Layers; Turbulent Boundary Layer; Pressure Gradients

19970014432 Notre Dame Univ., Dept. of Aerospace & Mechanical Engineering, IN USA

Theoretical and Numerical Study of Asymmetric Unsteady Lex and Slender-Wing Vortices Including Breakdown ***Final Report, 1 Jan. 1992 - 30 Sep. 1995***

Cheung, K., Notre Dame Univ., USA; Jumper, E. J., Notre Dame Univ., USA; Nelson, R. C., Notre Dame Univ., USA; Nov. 1995; 12p; In English

Contract(s)/Grant(s): F49620-92-J-0105

Report No.(s): AD-A311347; AFOSR-TR-96-0372; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The following final report documents the accomplishments made under AFOSR Grant F49620-92-J-9105 for the period starting January 1, 1992 and ending September 30, 1995. During this time, progress was made in better understanding the spiral vortex breakdown phenomenon. A theoretic al model of vortex breakdown was developed illustrating the self-induced cause-and-effect nature of the breakdown spiral in sustaining its geometry in an adverse pressure field. From this study a geometric compatibility condition was discovered in the form of a non-dimensional circulation strength. Experiments were conducted to experimentally confirm this geometric compatibility condition. An isolated vortex was subjected to two breakdown-inducing flowfields; the first consisted of a flow obstruction, and the second consisted of a pair of counter-rotating cylinders. The geometric compatibility condition was found to exist for the resulting spiral vortex breakdown from both of the experiments. Three papers were written and presented on this study at several AIAA Applied Aerodynamics conferences, and a journal paper is currently under review. Also, an abstract was submitted in October, 1995 for an AIAA Applied Aerodynamics conference in 1996.

DTIC

Wing Profiles; Body-Wing Configurations; Data Acquisition; Numerical Analysis

19970014652 Manchester Univ., Inst. of Science and Technology, UK

Non-linear k-epsilon-v(sup 2)(bar) modeling with application to high-lift

Lien, F. S., Manchester Univ., UK; Durbin, P. A., Stanford Univ., USA; Studying Turbulence Using Numerical Simulation Databases; Dec. 1996; Part 6, pp. 5-22; In English; Also announced as 19970014651; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The k-epsilon-v(sup 2)(bar) model has been investigated to quantify its predictive performance on two high-lift configurations: 2D flow over a single-element aerofoil, involving closed-type separation; 3D flow over a prolate spheroid, involving open-type separation. A 'code-friendly' modification has been proposed which enhances the numerical stability, in particular, for explicit and uncoupled flow solvers. As a result of introducing Reynolds-number dependence into a coefficient of the s-equation, the skin-friction distribution for the by-pass transitional flow over a flat plate is better predicted. In order to improve deficiencies arising from the Boussinesq approximation, a nonlinear stress-strain constitutive relation was adopted, in which the only one free constant is calibrated on the basis of DNS data, and the Reynolds-stress anisotropy near the wall is fairly well represented.

Author

Two Dimensional Flow; K-Epsilon Turbulence Model; Aerodynamic Configurations; Nonlinearity

19970014653 Italian Aerospace Research Center, Naples, Italy

Application of the k-epsilon-v(exp 2) model to multi-component airfoils

Iaccarino, G., Italian Aerospace Research Center, Italy; Durbin, P. A., Stanford Univ., USA; Studying Turbulence Using Numerical Simulation Databases; Dec. 1996; Part 6, pp. 23-34; In English; Also announced as 19970014651; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Flow computations around two-element and three-element configurations are presented and compared to detailed experimental measurements. The k-epsilon-v(exp 2)(bar) model has been applied and the ability of the model to capture streamline curvature effects, wake-boundary layer confluence, and laminar/turbulent transition is discussed. The numerical results are compared to experimental datasets that include mean quantities (velocity and pressure coefficient) and turbulent quantities (Reynolds normal and shear stresses).

Author

K-Epsilon Turbulence Model; Curvature; Airfoils; Computational Fluid Dynamics

19970014719 NASA Langley Research Center, Hampton, VA USA

Wind Tunnel Results of the Aerodynamic Performance of a 1/8-Scale Model of a Twin-Engine Transport with Multi-Element Wing

Laflin, Brenda E. Gile, NASA Langley Research Center, USA; Applin, Zachary T., NASA Langley Research Center, USA; Jones, Kenneth M., NASA Langley Research Center, USA; Mar. 1997; 130p; In English

Contract(s)/Grant(s): RTOP 538-05-14-01

Report No.(s): NASA-TM-110304; NAS 1.15:110304; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

A wind tunnel investigation was performed in the 14- by 22-Foot Subsonic Tunnel on a pressure instrumented 1/8-scale twin-engine subsonic transport to better understand the flow physics on a multi-element wing section. The wing consisted of a part-span, triple-slotted trailing edge flap, inboard leading-edge Krueger flap and an outboard leading-edge slat. The model was instrumented with flush pressure ports at the fuselage centerline and seven spanwise wing locations. The model was tested in cruise, take-off and landing configurations at dynamic pressures and Mach numbers from 10 lbf/ft(exp 2) to 50 lbf/ft(exp 2) and 0.08 to 0.17, respectively. This resulted in corresponding Reynolds numbers of 0.8 x 10(exp 5) to 1.8 x 10(exp 6). Pressure data were collected using electronically scanned pressure devices and force and moment data were collected with a six component strain gauge balance. Results are presented for various control surface deflections over an angle-of-attack range from -4 degrees to 16 degrees and sideslip angle range from -10 degrees to 10 degrees. Longitudinal and lateral directional aerodynamic data are presented as well as chordwise pressure distributions at the seven spanwise wing locations and the fuselage centerline.

Author

Wind Tunnel Tests; Pressure Distribution; Subsonic Speed; Wings; Reynolds Number; Angle of Attack; Mach Number; Aerodynamic Characteristics; Sideslip

19970014941 NASA Langley Research Center, Hampton, VA USA

Multidisciplinary Approach to Aerospike Nozzle Design

Korte, J. J., NASA Langley Research Center, USA; Salas, A. O., NASA Langley Research Center, USA; Dunn, H. J., NASA Langley Research Center, USA; Alexandrov, N. M., NASA Langley Research Center, USA; Follett, W. W., Boeing North American, Inc., USA; Orient, G. E., Boeing North American, Inc., USA; Hadid, A. H., Boeing North American, Inc., USA; Feb. 1997; 18p; In English

Contract(s)/Grant(s): RTOP 522-31-41-02

Report No.(s): NASA-TM-110326; NAS 1.15:110326; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A model of a linear aerospike rocket nozzle that consists of coupled aerodynamic and structural analyses has been developed. A nonlinear computational fluid dynamics code is used to calculate the aerodynamic thrust, and a three-dimensional finite-element model is used to determine the structural response and weight. The model will be used to demonstrate multidisciplinary design optimization (MDO) capabilities for relevant engine concepts, assess performance of various MDO approaches, and provide a guide for future application development. In this study, the MDO problem is formulated using the multidisciplinary feasible (MDF) strategy. The results for the MDF formulation are presented with comparisons against separate aerodynamic and structural optimized designs. Significant improvements are demonstrated by using a multidisciplinary approach in comparison with the single-discipline design strategy.

Author

Nozzle Design; Engine Design; Multidisciplinary Design Optimization; Finite Element Method; Rocket Nozzles

19970015276 NASA Ames Research Center, Moffett Field, CA USA

NASA Ames Laminar Flow Supersonic Wind Tunnel (LFSWT) Tests of a 10 deg Cone at Mach 1.6

Wolf, Stephen W. D., MCAT Inst., USA; Laub, James A., NASA Ames Research Center, USA; Mar. 1997; 26p; In English

Contract(s)/Grant(s): RTOP 537-03-23

Report No.(s): NASA-TM-110438; NAS 1.15:110438; A-976108; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This work is part of the ongoing qualification of the NASA Ames Laminar Flow Supersonic Wind Tunnel (LFSWT) as a low-disturbance (quiet) facility suitable for transition research. A 10 deg cone was tested over a range of unit Reynolds numbers (Re = 2.8 to 3.8 million per foot (9.2 to 12.5 million per meter)) and angles of incidence (O deg to 10 deg) at Mach 1.6. The location of boundary layer transition along the cone was measured primarily from surface temperature distributions, with oil flow interferometry and Schlieren flow visualization providing confirmation measurements. With the LFSWT in its normal quiet operating mode, no transition was detected on the cone in the test core, over the Reynolds number range tested at zero incidence and yaw. Increasing the pressure disturbance levels in the LFSWT test section by a factor of five caused transition onset on the cone within the test core, at zero incidence and yaw. When operating the LFSWT in its normal quiet mode, transition could only be detected in the test core when high angles of incidence (greater than 5 deg) for cones were set. Transition due to elevated pressure disturbances (Tollmien-Schlichting) and surface trips produced a skin temperature rise of order 4 F (2.2 C). Transition due to cross flows on the leeward side of the cone at incidence produced a smaller initial temperature rise of only order 2.5 F (1.4 C), which indicates a slower transition process. We can conclude that these cone tests add further proof that the LFSWT test core is normally low-disturbance (pressure fluctuations greater than 0.1%), as found by associated direct flow quality measurements discussed in this report. Furthermore, in a quiet test environment, the skin temperature rise is sensitive to the type of dominant instability causing

transition. The testing of a cone in the LFSWT provides an excellent experiment for the development of advanced transition detection techniques.
Author
Laminar Flow; Supersonic Wind Tunnels; Wind Tunnel Tests

19970015289 NASA Langley Research Center, Hampton, VA USA
Effects of Chemistry on Blunt-Body Wake Structure
Dogra, Virendra K., Vigyan Research Associates, Inc., USA; Moss, James N., NASA Langley Research Center, USA; Wilmoth, Richard G., NASA Langley Research Center, USA; Taylor, Jeff C., North Carolina State Univ., USA; Hassan, H. A., North Carolina State Univ., USA; AIAA Journal; Mar. 1995; Volume 33, No. 3, pp. 463-469; In English
Contract(s)/Grant(s): NAS1-19237
Report No.(s): NASA-CR-203412; NAS 1.26:203412; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche
Results of a numerical study are presented for hypersonic low-density flow about a 70-deg blunt cone using direct simulation Monte Carlo (DSMC) and Navier-Stokes calculations. Particular emphasis is given to the effects of chemistry on the near-wake structure and on the surface quantities and the comparison of the DSMC results with the Navier-Stokes calculations. The flow conditions simulated are those experienced by a space vehicle at an altitude of 85 km and a velocity of 7 km/s during Earth entry. A steady vortex forms in the near wake for these freestream conditions for both chemically reactive and nonreactive air gas models. The size (axial length) of the vortex for the reactive air calculations is 25% larger than that of the nonreactive air calculations. The forebody surface quantities are less sensitive to the chemistry than the base surface quantities. The presence of the afterbody has no effect on the forebody flow structure or the surface quantities. The comparisons of DSMC and Navier-Stokes calculations show good agreement for the wake structure and the forebody surface quantities.
Author
Blunt Bodies; Hypersonic Flow; Low Density Flow; Monte Carlo Method; Forebodies; Near Wakes

03
AIR TRANSPORTATION AND SAFETY

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

19970013766 Federal Aviation Administration, Research and Development Div., Atlantic City, NJ USA
Evaluation of Large Class B Cargo Compartment's Fire Protection *Final Report*
Blake, David, Federal Aviation Administration, USA; Jun. 1996; 37p; In English
Report No.(s): AD-A311563; DOT/FAA/AR-96/5; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Twenty-six tests were conducted to evaluate the effectiveness of current fire safety requirements for large Class B cargo compartments as well as proposed improvements to the requirements. The major findings were that the current requirements are not effective on the types of fires tested and that there are several alternatives that could be implemented to better enable a large Class B compartment to withstand the types of fires tested.
DTIC
DC 10 Aircraft; Boeing 707 Aircraft; Fire Extinguishers; Fire Prevention; Air Cargo; Smoke Detectors; Fire Control

19970013826 Army Aeromedical Research Lab., Fort Rucker, AL USA
U.S. Army Aviation Life Support Equipment Retrieval Program: U.S. Army Aircrew Rescue and Factors Delaying Rescue *Final Report*
Bruckart, James E., Army Aeromedical Research Lab., USA; May 1996; 12p; In English
Contract(s)/Grant(s): DA Proj. 3O1-62787-A-78
Report No.(s): AD-A309933; USAARL-96-24; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Despite strict flight discipline, U.S. Army aircraft infrequently suffer inflight mishaps. This is a retrospective study of aircrew survival and rescue in 97 mishaps investigated by the U.S. Army Safety Center from October 1988 to June 1990. to identify factors delaying rescue, later mishaps were compared with 37 mishaps where the time to reach the mishap site exceeded 2 hours. The average time to reach a mishap site was 2.2 hours, but over 90 percent were reached within 2 hours. There were two or more survivors at 82 percent of the sites, and 98 percent of the downed aircrew had at least personal survival equipment available. Adverse operational and environmental factors were more common in delayed rescue mishaps. Sudden aircraft failure was three times more common in prolonged rescue mishaps, while night or instrument meteorologic conditions contributed eight times and four times greater risk of delay, respectively. Rescues in mountainous terrain or over water were seven times more likely to be delayed.

While fatalities were more common with prolonged rescue, there were no mishaps where a delay in reaching the crash site resulted in loss of life.
DTIC
Rescue Operations; Survival; Life Support Systems; Survival Equipment

19970014099 Deutsche Flugsicherung G.m.b.H., Offenbach am Main, Germany
Air Traffic Control Procedures for the Avoidance of Wake Vortex Encounters: Today and Future Developments by Deutsche Flugsicherung GmbH
Brenner, Frank, Deutsche Flugsicherung G.m.b.H., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 14p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

An increasing number of movements of flights leads to the necessity to space aircraft more and more often with the minimum values in order to avoid delays in air traffic. The question is: What are the minimum values? Are the minima established a long time ago by ICAO still valid? On the one hand trials have shown that these values need not necessarily to be obtained if special conditions prevail and the pilot of a succeeding aircraft is able and willing to adjust his flight path in such a way that the safety of the aircraft is not endangered by wake vortices produced by the preceding aircraft. This means the pilots and the air traffic controllers need to understand the behavior of wake vortices and closely cooperate in achieving a high throughput of traffic whilst minimizing the risk of wake vortices encounters.
Derived from text
Air Traffic Control; Wakes; Vortices; Air Traffic; Safety; Collision Avoidance; Warning Systems

19970014100 Deutsche Aerospace A.G., Bremen, Germany
Structure of a Transport Aircraft-Type Near Field Wake
Huenecke, Klaus, Deutsche Aerospace A.G., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In English; Also announced as 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The wake issue has widespread concern to commerical aviation because of its hazardous effects on flight safety, and as a limiting factor to increase airport capacity and aircraft efficiency. Results reveal the structure of a near field wake to be of complex nature, even though only the steady-state sector of flow was accessible with available testing gear. Flowfield evaluation focused on: vortex relative motion; streamwise vortex development; crossflow velocity structure; streamwise velocity structure; total pressure loss; and streamwise vorticity redistribution.
Derived from text
Transport Aircraft; Wakes; Vortices; Cross Flow

19970014116 Scientific and Engineering Solutions, Inc., Orleans, MA USA
Analysis of UK Encounters 1982-1990
Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Nov. 1996; 4p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Wake vortex separation standards are used to limit the frequency and severity of wake vortex encounters under instrument flight rules (IFR). One of the goals of wake vortex research is to develop models that can specify the safe separation for any aircraft pair and hence can be used to judge the safety of proposed changes in separation standards. A direct approach to defining a safe separation model is presented in this paper. The observed UK vortex encounter rates are fitted to a model that defines equal-encounter-rate (EER) separations as a function of the parameters of the leading and following aircraft (specifically their wingspans). Safety is specified by defining the acceptable encounter rate. The first analysis fits the EER separation to powers of the wingspans of the leading and following aircraft. When these powers (1.13 and -0.95, respectively) are found to be close to one, the analysis is repeated using the leader-follower span ratio.
Author
Vortices; Aircraft Wakes

19970014187 Institute for Human Factors TNO, Soesterberg, Netherlands
Motion Analysis of Bird Migration
Ockeloen, M. W., Institute for Human Factors TNO, Netherlands; Nobel, J., Institute for Human Factors TNO, Netherlands; Apr. 1996; 29p; In English
Report No.(s): AD-A311919; TNO-FEL-94-A177; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

To reduce the in-flight bird strike risk, the TNO/FEL laboratory developed the ROBIN system for the RNLAF. The ROBIN system uses singular or summed radar images. Because motion of objects in the radar image provides much information about the nature of the object, motion analysis is an important feature to improve the filtering of radar images. For this reason the project 'Motion Analysis of Bird Migration' was started as a continuation of the ROBIN project. In this report the advantages and disadvantages of different methods of motion analysis are compared. On the basis of experimental results and theoretical aspects, a choice is made for the method of object matching. The principle and implementation of this method is discussed.
DTIC
Bird-Aircraft Collisions; Radar Imagery; Radar Tracking; Flight Hazards

19970014261 Federal Aviation Administration, Civil Aeromedical Inst., Oklahoma City, OK USA
Aircraft Evacuations Onto Escape Slides and Platforms 1: Effects of Passenger Motivation ***Final Report***
McLean, G. A., Federal Aviation Administration, USA; George, M. H., Federal Aviation Administration, USA; Funkhouser, G. E., Federal Aviation Administration, USA; Chittum, C. B., Federal Aviation Administration, USA; Jun. 1996; 18p; In English
Contract(s)/Grant(s): AM-B-94-PRS-89
Report No.(s): AD-A311257; DOT/FAA/AM-96/18; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Experimental evaluations of passenger egress during simulated emergency evacuations have provided different results, depending on such variables as subject motivation level and escape route utilized in the particular study. The study reported here was conducted to compare competitive versus cooperative subject behavior within a single study using inflatable escape slides versus door sill-height platforms connected to rigid ramps as the escape routes. Four groups of subjects, ranging in age from 18 to 44, were employed in a 2 (motivation level) x 2 (egress route) x 2 (air quality) repeated-measures design. Motivation level was the between-groups factor; evacuation route and air quality (clear air versus smoke) were within-groups factors. Main effects on total egress time were found for motivation level (p less than 0.0O8) and egress route (p less than 0.012), as competitive behavior and platforms-with-ramps produced much faster evacuation times. Air quality effects on total egress times failed to achieve statistical significance; however, the combination of air quality with the other variables produced substantial interactions. These results indicate that findings derived from evacuation studies are very susceptible to nuances in individual subject behavior and experimental techniques/protocol. Combining previously studied independent variables may produce unexpected interactions that invalidate initial assumptions about the utility of those variables in answering specific research questions. Studies intended to assess the evacuation potential of aircraft designs, configurations, and operating procedures should tightly control such variables to prevent them from inadvertently confounding the experimental questions being addressed.
DTIC
Escape Systems; Transport Aircraft; Aircraft Design; Aircraft Compartments; Evacuating (Transportation); Passengers

19970014296 Naval Air Warfare Center, Aircraft Div., Warminster, PA USA
Small Aircrew Ejection Simulation in U.S. Navy Aircraft ***Final Report***
Nichols, Jeffrey P., Naval Air Warfare Center, USA; Quartuccio, John J., Naval Air Warfare Center, USA; Marquette, Thomas J., Naval Air Warfare Center, USA; Jan. 1996; 80p; In English
Contract(s)/Grant(s): N00019-94-WXCSJ8R
Report No.(s): AD-A311652; NAWCADWAR--96-17-TR; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

With the Navy's recent expansion of the aircrew population to include a greater percentage of aviators, both male and female, the accommodation of small aircrew has become an important issue. All ejection seats currently used by the Navy were designed and test qualified for male aircrew ranging in weight from 135 lbs to 212 lbs. None of the Navy ejection seats have been test qualified for flight by aircrew smaller than a 135 lb male. It is expected that such aircrew will be subjected to higher risk of injury in the event of an ejection. Naval Air Warfare Center, Aircraft Division, Warminster has conducted simulations to predict the risk of injury in small aircrew ejections in each of the seat systems currently in the fleet. Simulations of NACES, SJU-5, SIIIS, ESCAPAC IE-1, GRU-7, and LS-lA ejections with aircrew both within and below the seat design weight ranges have been completed. The calculated risks to 100 lb and 116 lb female aircrew in ejections at speeds from 0 to 600 KEAS were examined as were the calculated risks to aircrew at the limits of the design weight range in identical ejections. This paper documents the results of the simulation effort.
DTIC
Ejection Seats; Males; Injuries; Military Aircraft; Military Aviation

19970014649 NASA Ames Research Center, Moffett Field, CA USA

LOFT Debriefings: An Analysis of Instructor Techniques and Crew Participation

Dismukes, R. Key, NASA Ames Research Center, USA; Jobe, Kimberly K., San Jose State Univ., USA; McDonnell, Lori K., San Jose State Univ., USA; Mar. 1997; 92p; In English

Contract(s)/Grant(s): RTOP 505-64-13-48-01

Report No.(s): NASA-TM-110442; NAS 1.15:110442; DOT/FAA/AR-96/122; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This study analyzes techniques instructors use to facilitate crew analysis and evaluation of their Line-Oriented Flight Training (LOFT) performance. A rating instrument called the Debriefing Assessment Battery (DAB) was developed which enables raters to reliably assess instructor facilitation techniques and characterize crew participation. Thirty-six debriefing sessions conducted at five U.S. airlines were analyzed to determine the nature of instructor facilitation and crew participation. Ratings obtained using the DAB corresponded closely with descriptive measures of instructor and crew performance. The data provide empirical evidence that facilitation can be an effective tool for increasing the depth of crew participation and self-analysis of CRM performance. Instructor facilitation skill varied dramatically, suggesting a need for more concrete hands-on training in facilitation techniques. Crews were responsive but fell short of actively leading their own debriefings. Ways to improve debriefing effectiveness are suggested.

Author

Flight Training; Flight Crews; Civil Aviation; Training Evaluation; Instructors

19970015073 Hughes STX, Inc., Lexington, MA USA

Radar Studies of Aviation Hazards, Part 2, Lightning Precursors ***Topical Report***

Harris, F. I., Hughes STX, Inc., USA; Smalley, David J., Hughes STX, Inc., USA; Tung, Shu-Lin, Hughes STX, Inc., USA; Bohne, Alan R., Hughes STX, Inc., USA; Jul. 15, 1996; 32p; In English

Contract(s)/Grant(s): F19628-93-C-0054; AF Proj. 2781

Report No.(s): AD-A320980; STX-SR-9; PL-TR-96-2178(II); No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

For convective storms developing in a weakly sheared environment, considerable evidence has been amassed that relates radar reflectivity structure and lightning activity. Marshall and Radhakant (1978) suggest that the electrical activity of thunderstorms is related to radar reflectivity observed at the 6-7 km level. This idea was further tested by Lhermitte and Krehbiel (1979). They horizontally integrated the radar reflectivity of a storm at several heights and found that lightning began when the storm top reached 8 km (-20 C). Also, they found that the peak flash rate (about 1 flash/s) occurred when the reflectivity exceeded 50 dBZ at the 100 C level. Buechier and Goodman (1991) observed that cloud-to-ground strikes began when the reflectivity values of 30-40 dBZ extended above 7 km. While all the above observations were made in Florida, similar altitude or temperature thresholds were found in New Mexico (Krehbiel, 1986) and the tropics (Williams, 1991). Other studies have looked at various methods of comparing reflectivity data and lightning activity. A recent study by Harris-Hobbs et al (1992) attempted to correlate lightning activity with storm volumes exceeding various thresholds. They found good correlations between the magnitudes of the volumes exceeding 20 dBZ and flash activity. However, for some of their data, study by Harris-Hobbs et al (1992) attempted to correlate lightning activity with storm volumes exceeding various thresholds. They found good correlations between the magnitudes of the volumes exceeding 20 dBZ and flash activity. However, for some of their data, regions with higher reflectivity thresholds attain peak volumes before that for the 20 dBZ threshold and before the time of maximum lightning activity.

DTIC

Hazards; Doppler Radar; Flight Safety

19970015074 Hughes STX, Inc., Lexington, MA USA

Radar Studies of Aviation Hazards, Part 1, Storm Sturcture Algorithm ***Topical Report***

Harris, F. I., Hughes STX, Inc., USA; Smalley, David J., Hughes STX, Inc., USA; Tung, Shu-Lin, Hughes STX, Inc., USA; Bohne, Alan R., Hughes STX, Inc., USA; Jul. 15, 1996; 35p; In English

Contract(s)/Grant(s): F19628-93-C-0054; AF Proj. 2781

Report No.(s): AD-A320981; STX-SR-8; PL-TR-96-2178(I); No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The interactions between the ambient environment, storm dynamics, and precipitation physics are complex but intrinsically deterministic of the types of thunderstorms which develop. These interactions generate the thunderstorms's precipitation and cloud structure which is monitored by Doppler radar. The severity of the resultant weather is directly related to the intensity of the thunderstorm. The most intense thunderstorms, supercells, account for a disproportionately high percentage of all thunderstorm-related severe weather events. Byers and Braham (1949) documented the life cycle of the ordinary thunderstorm which begins with an updraft that initiates development of a cumulonimbus cloud. At maturity, the resultant precipitation falls through

the generating updraft. This creates a downdraft that overwhelms the updraft in the final stage of the thunderstorm. This life cycle of a single updraft/downdraft thunderstorm cell typically occurs over an one hour period with little if any associated severe weather. little if any associated severe weather.
DTIC
Doppler Radar; Hazards; Meteorological Radar

19970015098 Hughes STX, Inc., Lexington, MA USA
Radar Studies of Aviation Hazards, Part 3, Frontal Structure Studies ***Topical Report***
Tung, Shu-Lin, Hughes STX, Inc., USA; Harris, F. I., Hughes STX, Inc., USA; Smalley, David J., Hughes STX, Inc., USA; Bohne, Alan R., Hughes STX, Inc., USA; Jul. 15, 1996; 33p; In English
Contract(s)/Grant(s): F19628-93-C-0054; AF Proj. 2781
Report No.(s): AD-A320982; STX-SR-10; PL-TR-96-2178(III); No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Automated techniques have been developed to detect fronts and to extract their three-dimensional structure. Features such as surface frontal position, three-dimensional frontal surface, gradient fields, local wind estimates, and precipitation volume and mass are all monitored as a function of time. These structures and their changes have been related to the development of potentially hazardous weather. Further refinement and testing is required. Baroclinic fronts affect air terminal operations with a variety of weather events, such as abrupt wind shifts, enhanced wind speeds, and accompanying turbulence. Precipitation produced by frontal forcing can be intense and cause flooding. Temperature chan ges can be abrupt and when combined with precipitation can result in precipitation type changes in non summer months. For these reasons, the detection and forecasting of fronts is a major concern of weather forecasting services. Fronts are zones of transition in the temperature and wind fields and their intensity is usually assessed in terms of the magnitudes of the temperature changes and associated wind velocities. Cold fronts, especially, are noted for sharp changes in both temperature and winds. In addition, associated localized intense convection will enhance these fields and may cause severe weather. Fronts always occur in pressure troughs and will always have localized vorticity and convergence maxima. Therefore, monitoring vorticity and divergence in real time could provide useful diagnostic and prognostic information. Single Doppler radar cannot measure these fields individually. However, the radial velocity fields include contributions from these fields and can, therefore, be useful in the detection and monitoring of the fronts and associated phenomena.
DTIC
Doppler Radar; Meteorological Radar; Flight Safety; Flood Control; Hazards

19970015346 NASA Ames Research Center, Moffett Field, CA USA
Facilitating LOS Debriefings: A Training Manual
McDonnell, Lori K., San Jose State Univ., USA; Jobe, Kimberly K., San Jose State Univ., USA; Dismukes, R. Key, NASA Ames Research Center, USA; Mar. 1997; 54p; In English
Contract(s)/Grant(s): RTOP 505-64-13-48-01
Report No.(s): NASA-TM-112192; NAS 1.15:112192; A-976385; DOT/FAA/AR-97/6; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This manual is a practical guide to help airline instructors effectively facilitate debriefings of Line Oriented Simulations (LOS). It is based on a recently completed study of Line Oriented Flight Training (LOFT) debriefings at several U.S. airlines. This manual presents specific facilitation tools instructors can use to achieve debriefing objectives. The approach of the manual is to be flexible so it can be tailored to the individual needs of each airline. Part One clarifies the purpose and objectives of facilitation in the LOS setting. Part Two provides recommendations for clarifying roles and expectations and presents a model for organizing discussion. Part Tree suggests techniques for eliciting active crew participation and in-depth analysis and evaluation. Finally, in Part Four, these techniques are organized according to the facilitation model. Examples of how to effectively use the techniques are provided throughout, including strategies to try when the debriefing objectives are not being fully achieved.
Derived from text
Flight Training; Flight Crews; Discussion; Airline Operations

19970015379 Hughes STX, Inc., Lexington, MA USA
Radar Studies of Aviation Hazards, Part 4, Utility of WSR-88D Doppler Spectrum Width ***Topical Report No. 3***
Bohne, Alan R., Hughes STX, Inc., USA; Jul. 15, 1996; 38p; In English
Contract(s)/Grant(s): F19628-93-C-0054; AF Proj. 2781
Report No.(s): AD-A320983; STX-SR-11; PL-TR-96-2178(IV); No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The behavior of the WSR-88D Doppler spectrum width parameter in hazardous storms is investigated for a variety of geographical locations. Analyses employ 3D visualization to identify the major associations between regions of high spectrum width

and storm precipitation structures. Also, Doppler spectrum width is correlated with other collocated radar measurables on a radar sample volume scale to observe data interdependencies. The spectrum width is found useful for the detection of very large hail, and for surface wind shift features such as gust fronts and thin lines. Often, the spectrum width signatures are more readily detected than those traditionally employed. It is also useful for identifying data artifacts such as clutter, sidelobe contamination, incorrect range placement, insufficient SNR thresholding, and potential receiver saturation events. Automated methods for removing most artifacts appear to be feasible, and incorporation of spectrum width into automated detection routines is urged.
DTIC
Gusts; Wind Shear; Doppler Radar; Storms (Meteorology); Ground Wind; Weather Forecasting

04
AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

19970014117 Boeing Commercial Airplane Co., Air Traffic Management Research, Seattle, WA USA
A Simulation-Based Study of the Impact of Aircraft Wake Turbulence Weight Categories on Airport Capacity
Robinson, Jerry J., Boeing Commercial Airplane Co., USA; Nov. 1996; 16p; In English; Also announced as 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Federal Aviation Administration (FAA) is considering revising the current aircraft wake turbulence weight categories and the associated separation standards during instrument meteorological conditions (IMC). Various proposals have been submitted to the FAA with regard to this revision. This paper presents the results and conclusions of a capacity study conducted by The Boeing Company. This study examined the impact of these proposed changes on airport capacity during IMC. The approach taken for this study was to simulate arrival and departure operations at ten major US airports by employing a database derived from the 1993 Official Airline Guide (OAG) traffic schedule. Simulations were conducted for the traffic mix at each airport utilizing one standard, representative runway configuration. The aircraft wake vortex separation requirements were changed according to the various proposed weight categories; these separations were then applied to the particular traffic set at each airport. In general, it was found that current capacity levels could be reduced by as much as 4%. This approach provides a consistent comparison of capacity results. It is hoped that the results from this study will provide useful information to assist in assessing the capacity impact of a modification to the existing aircraft wake turbulence weight categories and their associated separation standards during IMC.
Author
Aircraft Wakes; Air Traffic; Traffic; Turbulence; Vortices

19970014118 NASA Langley Research Center, Hampton, VA USA
An Aircraft Vortex Spacing System (AVOSS) for Dynamical Wake Vortex Spacing Criteria
Hinton, D. A., NASA Langley Research Center, USA; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A concept is presented for the development and implementation of a prototype Aircraft Vortex Spacing System (AVOSS). The purpose of the AVOSS is to use current and short-term predictions of the atmospheric state in approach and departure corridors to provide, to ATC facilities, dynamical weather dependent separation criteria with adequate stability and lead time for use in establishing arrival scheduling. The AVOSS will accomplish this task through a combination of wake vortex transport and decay predictions, weather state knowledge, defined aircraft operational procedures and corridors, and wake vortex safety sensors. Work is currently underway to address the critical disciplines and knowledge needs so as to implement and demonstrate a prototype AVOSS in the 1999/2000 time frame.
Author
Aircraft Wakes; Air Traffic Control; Vortices; Safety

19970014291 Army Command and General Staff Coll., Fort Leavenworth, KS USA
Federal Aviation Administration Impact On Military Air Traffic Control Force Projection, *2 Aug. 1995 - 7 Jun. 1996*
Dorward, Alan C., Army Command and General Staff Coll., USA; Jun. 07, 1996; 106p; In English
Report No.(s): AD-A312209; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

The USA (US) has changed its military force projection instead of forward basing. Key to the US strategy is the ability to rapidly secure an aerial port of de-embarkation and basing of state-side combat and support aircraft. A key requirement for successful military operations is adequate air traffic control equipment and trained personnel to enable all-weather, around-the-clock, arrival and departure of aircraft. The entire Department of Defense (DOD) air traffic control (ATC) force is trained to Federal

Aviation Administration (FAA) standards and controls 25 percent of the aircraft in the US. Military controllers are trained and work at the same level as FAA controllers to deploy for contingencies and war. This study investigates the impact of future changes to air traffic control in the US as a result of the capital investment plan for the national airspace system. This study then looks at the requirements for the deployable military ATC force. This study examines whether the DOD ATC force is adequately prepared to support the national military strategy in light of training to the same standard as the FAA and recommends training and force structure measures to insure that the DOD ATC mission is successfully carried out.
DTIC
Air Traffic Control; Military Operations; Air Traffic Controllers (Personnel); Transport Aircraft

19970014349 Air Force Inst. of Tech., National Air Intelligence Center, Wright-Patterson AFB, OH USA
Analysis of Spectrum Characteristics of GPS Time Comparison Under Two Conditions
Hu, Jin-Lin; Jian, Shu-Guang; Jiliang Xuebao (Acta Metrologica Sinica); Apr. 01, 1996; Volume 16, No.1, pp. 49-52; Transl. into ENGLISH of Jiliang Xuebao (Acta Metrologica Sinica) (China) v16 n1 p49-52 1995; In English; Translated by SCITRAN
Contract(s)/Grant(s): F33657-84-D-0165
Report No.(s): AD-A309965; NAIC-ID(RS)T-0080-96; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
In order to understand GPS time comparison characteristics associated with influences from SA (Selective Availability) effects, a number of experiments were carried out in early 1992. The data sampling time associated with the experiments was 10 seconds. Satellite tracking time was 1 hour. The results of frequency spectrum analysis clearly show that: (1) Under normal conditions, GPS time comparison spectrum characteristics are basically level. There are no clear periodic phenomena. Noise processes are phase modulated white noise; and (2) When GPS time comparisons are influenced by SA effects, low frequency spectra are relatively clearer. There are obvious periodic phenomena. Among these, 5-15 minute period signals account for approximately 77%. This is nothing else than the cause which leads to obvious drops in GPS time comparison precision.
DTIC
Global Positioning System; Spectrum Analysis; Frequency Distribution

19970014375 Federal Aviation Administration, Airport and Aircraft Safety, Atlantic City, NJ USA
Reduced Configuration Approach Lighting System: Simulator Evaluation ***Final Report***
Katz, Eric S., Federal Aviation Administration, USA; Jun. 1996; 73p; In English
Report No.(s): AD-A312120; DOT/FAA/AR-96/17; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche
Recent advances in Global Positioning System (GPS) capabilities have heightened the prospect of providing Category 1, 2, and 3 approach and landing capabilities at numerous airports. In addition to the considerable expense of installing approach lighting systems to support these approaches, many airports do not have the necessary real estate that would be required for the installation of standard approach lighting systems. In response to these concerns, an evaluation was needed to help determine if modified approach lighting system configurations could be developed that would be less expensive and occupy less real estate without compromising safety. This report describes an evaluation of a number of proposed approach lighting systems (ALS) modifications involving a reduction in the number of required lights, either through providing a lesser density within the standard configuration or through shortening the pattern length. The evaluation was conducted using the Federal Aviation Administration Boeing 727 flight simulator and employing the services of experienced air carrier and FAA pilots as volunteer subjects. Results of the test effort revealed that the guidance that was provided by the medium intensity approach lighting system with runway alignment indicator lights (Configuration E) and the high intensity approach lighting system with sequenced flashers (Configuration H) that contain three lights, in lieu of five, per centerline barrette allowed all of the subject pilots to complete the approaches and landings safely. However, configurational changes to the standard approach lighting systems should not be made until these results are validated by actual weather flight testing.
DTIC
Runway Alignment; Illuminating; Installing; Luminaires

19970015017 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
MMAE Detection of Interference/Jamming and Spoofing in a DPGS-Aided Inertial System
White, Nathan Alan, Air Force Inst. of Tech., USA; Dec. 1996; 150p; In English
Report No.(s): AD-A320882; AFIT/GE/ENG/96D-21; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
Previous research at AFIT has resulted in the development of a DGPS-aided INS-based precision landing system (PLS) capable of meeting the FAA precision requirements for instrument landings. The susceptibility of DGPS transmissions to interference/jamming and spoofing must be addressed before DGPS may be used in such a safety-of-flight critical role. This thesis applies multiple model adaptive estimation (MMAE) techniques to the problem of detecting and identifying interference/jamming and

spoofing failures in the DGPS signal. Such an MMAE is composed of a bank of parallel filters, each hypothesizing a different failure status, along with an evaluation of the current probability of each hypothesis being correct, to form a probability-weighted average output. Performance for a representative selection of navigation component cases is examined. For interference/jamming failures represented as increased measurement noise variance, results show that, because of the good FDI performance using MMAE, the blended navigation performance is essentially that of a single extended Kalman filter artificially informed of the actual interference noise variance. Standard MMAE is completely unable to detect spoofing failures (modelled as a bias or ramp offset signal directly added to the measurement). This thesis shows the development of a moving-bank pseudo-residual MMAE (PRMMAE) to detect and identify spoofing failures. Using the PRMMAE algorithm, the resulting navigation performance is equivalent to that of an extended Kalman filter operating in a no-fail environment.
DTIC
Instrument Landing Systems; Global Positioning System; Inertial Navigation; Jamming; Landing Aids

19970015078 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Optimization of a GPS-Based Navigation Reference System
McKay, Jason Bryce, Air Force Inst. of Tech., USA; Dec. 1996; 147p; In English
Report No.(s): AD-A320880; AFIT/GE/ENG/96D-12; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The development of increasingly accurate new aircraft navigation systems has caused the Air Force to develop a new Navigation Reference System to test them, called the Submeter Accuracy Reference System (SARS). The SARS is an inverted GPS system which consists of an array of GPS receivers on the ground and an airborne pseudolite mounted on the test aircraft. The SARS will provide a proof position estimate that is used to check the navigation system under test. Unfortunately, ground based inverted GPS systems tend to suffer from high geometric sensitivity to measurement errors. This research tackles the problem of optimizing the SARS receiver array configuration to minimize the system's sensitivity to pseudorange errors. The analysis determines that the proper choice of cost function for the optimization is the condition number of the H matrix, rather than the commonly used GDOP. Insight into the problem is provided by a graphical technique for evaluating receiver array geometry. Moreover, two receiver array numerical optimization programs are developed. The results of the receiver array optimization show that the geometric sensitivity to error in the SARS airspace can be reduced to acceptable levels through proper array design. Several good receiver array designs are shown. Finally, a technique for further reducing the geometric sensitivity of the SARS is discussed.
DTIC
Global Positioning System; Air Navigation; Reference Systems

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

19970014109 Boeing Commercial Airplane Co., Aerodynamics Engineering, Seattle, WA USA
The Dynamic Response of a Twin-Engine, Commercial Jet Transport to Wake Vortex Encounters
Vasatka, James, Boeing Commercial Airplane Co., USA; Nov. 1996; 12p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In order to refine existing wake-vortex separation distances through the application of technology, the issues associated with defining the basis for separation criteria must be addressed. This includes understanding the significance of a wake vortex encounter. The results from this study suggest that the airplane's response is dependent on the flight path through the wake.
Derived from text
Dynamic Response; Wakes; Vortices; Transport Aircraft

19970014119 CFD Norway A/S, Trondheim, Norway
On the Interaction between Topographical Wind and Landing Aircraft
Kubberud, Nils, CFD Norway A/S, Norway; Oye, Ivar, CFD Norway A/S, Norway; Norstrud, Helge, Norwegian Univ. of Science and Technology, Norway; Nov. 1996; 12p; In English; Also announced as 19970014096; Original contains color illustraions; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The present paper gives a qualitative study of the flow interaction between a representative landing aircraft and the wind induced vortical flow. Separate numerical analysis for the wind flow over the given terrain and the flow structure around the lifting airplane is given. The interaction is performed by superposing the two solutions in various crossflow planes along the glide path

direction of the aircraft. This leads to an estimate of the change of circulation for the lifting body and the associated need for corrective control forces.
Author
Numerical Analysis; Lifting Bodies; Glide Paths

19970014131 Technische Univ., Inst. fur Stromungsmechanik, Brunswick, Germany
The Use of Aircraft Wakes to Achieve Power Reductions in Formation Flight
Hummel, Ing. D., Technische Univ., Germany; Nov. 1996; 13p; In English; Also announced as 19970014096
Contract(s)/Grant(s): DFG-Hu254/10; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Many migrating bird species fly in regular V-shaped formations. Each wing experiences an upwash field generated by all other wings in the formation and this leads to a reduction in flight power demand for each wing as well as for the whole formation. In this paper the aerodynamic interference is studied by means of aerodynamic theory. The total energy saving for the whole formation increases with the number of wings and with decreasing lateral distance. Local power reductions are highest in the inner parts of a for nation and they decrease towards the apex and the side-edges. The technical realization of this principle is analysed for two airplanes. In calibration flights of gliders large distances have to be kept or the aerodynamic interference has to be taken into account. In formation flights of two airplanes a power reduction of 15% is obtainable for the rear airplane flying close to the wake of the front aircraft. The corresponding aileron and rudder deflections for compensation of the corresponding moments are small. Flight tests with two airplanes Do-28 show that the power reduction can be achieved in practical flight. The results are in excellent agreement with aerodynamic theory. In order to enable the rear airplane to find the proper position relative to the wake of the front airplane an automatic control system has been adapted. A formation flight controller has been designed which leads the upwash in the symmetry plane and the aileron deflections to maximum values. The application of this control system led to a considerable relief of the pilot and important power reductions could be achieved automatically.
Author
Aerodynamic Interference; Aerodynamics; Aircraft Wakes; Flight Control; Upwash

19970014132 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
On the Dynamics of Engine Jets Behind a Transport Aircraft
Jacquin, L., Office National d'Etudes et de Recherches Aerospatiales, France; Garnier, F., Office National d'Etudes et de Recherches Aerospatiales, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 8p; In English; Also announced as 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The various mechanisms that contribute to the mixing and dispersion of the engine exhausts through their interaction with the vortex wake of an aircraft are discussed. The case of a typical large transport aircraft is considered. First, the interaction between the jets and the vortices is characterized by means of non dimensional parameters. When considering aircraft under cruise conditions, it is shown the jets have almost no effect on the vortex wake dynamics. We then consider the way the jet is changed by the vortices. This is evaluated by means of an integral model. Examples are given which show that the jet is captured by the vortices at very different distances behind the aircraft depending on the engine-wingtip separation. The model does not take into account the distortion of the jet plume by the vortex shearing which becomes significant when the jet reaches the vortex center region. Results of a numerical simulation of the convection-diffusion of a passive scalar field, as well as a visualisation realized during an experiment are presented in order to illustrate this point.
Author
Transport Aircraft; Aircraft Engines; Wing Tips; Vortices

19970014188 Congressional Budget Office, Washington, DC USA
A CBO Study: An Analysis of U.S. Army Helicopter Programs,
Lussier, Frances M., Congressional Budget Office, USA; Black, Shaun, Congressional Budget Office, USA; Dec. 1995; 91p; In English
Report No.(s): AD-A311939; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The aviation branch has become an important asset of the U.S. Army. Its attack, scout, and utility helicopters played major roles in the Vietnam War and in operations in the Persian Gulf. The Army plans to rely on its aviation assets increasingly in the future to provide timely tactical intelligence and transport capabilities as well as flexible firepower. The Army's helicopter fleet is aging, however. Although the Army invested heavily in the 1980s to purchase new combat and utility helicopters, more than half of all of the helicopters currently in the Army's inventory are Vietnam-era aircraft. Many of those helicopters have exceeded their useful service life, and the Army would like to retire them. But even though the Army is reducing the size of its helicopter fleet as it reduces its overall force structure, it does not have enough modern aircraft to fill all of its requirements. The Army plans

to buy a substantial number of new helicopters starting in 2004, but those helicopters are limited to combat aircraft; they do not include any new utility helicopters. Furthermore, the Army does not intend to buy any new helicopters at all between 1996 and 2004. Consequently, it will have to retain many Vietnam-era combat helicopters well into the next century and hundreds of Vietnam-era utility helicopters for the foreseeable future.
DTIC
Military Helicopters; Service Life

19970014755 Army Aviation Applied Technology Directorate, Fort Eustis, VA USA
Helicopter Gross Weight Determination from Monitored Parameters ***Final Report, Feb. 1985 - May 1986***
Moffatt, John G ., Army Aviation Applied Technology Directorate, USA; May 1996; 29p; In English
Report No.(s): AD-A311339; USAATCOM-TR-96-D-5; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

When monitoring helicopter components knowledge of the gross weight an aircraft is operating at is required to differentiate damaging from non-damaging flight conditions. Several attempts have been made at estimating helicopter gross weight using aircraft-mounted instrumentation that have proven inaccurate and costly due to instrumentation and calibration needs. A simple algorithm which requires only engine torque, hover height, pressure altitude, and ambient temperature parameters to estimate gross weight has been developed. The algorithm is based on the UH-IH hover performance chart found in the operators user manual. Results of this effort indicate the algorithm can be used to determine the gross weight range (low, medium, high) while in a hover condition.
DTIC
Helicopters; Algorithms; Weight (Mass); Flight Conditions

19970015092 NASA Langley Research Center, Hampton, VA USA
Tiltrotor Vibration Reduction Through Higher Harmonic Control
Nixon, Mark W., NASA Langley Research Center, USA; Kvaternik, Raymond G., NASA Langley Research Center, USA; Settle, T. Ben, Bell Helicopter Co., USA; Apr. 29, 1997; 24p; In English; 53rd; American Helicopter Society Annual Forum, 29 Apr. - 1 May 1997, Virginia Beach, VA, USA; Sponsored by American Helicopter Society, Inc., USA
Report No.(s): NASA-TM-112427; NAS 1.15:112427; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The results of a joint NASA/Army/Bell Helicopter Textron wind-tunnel test to assess the potential of higher harmonic control (HHC) for reducing vibrations in tiltrotor aircraft operating in the airplane mode of flight, and to evaluate the effectiveness of a Bell-developed HHC algorithm called MAVSS (Multipoint Adaptive Vibration Suppression System) are presented. The test was conducted in the Langley Transonic Dynamics Tunnel using an unpowered 1/5-scale semispan aeroelastic model of the V-22 which was modified to incorporate an HHC system employing both the rotor swashplate and the wing flaperon. The effectiveness of the swashplate and the flaperon acting either singly or in combination in reducing IP and 3P wing vibrations over a wide range of tunnel airspeeds and rotor rotational speeds was demonstrated. The MAVSS algorithm was found to be robust to variations in tunnel airspeed and rotor speed, requiring only occasional on-line recalculations of the system transfer matrix. HHC had only a small (usually beneficial) effect on blade loads but increased pitch link loads by 25%. No degradation in aeroelastic stability was noted for any of the conditions tested.
Author
Rotary Wing Aircraft; Helicopters; Vibration Damping; V-22 Aircraft; Rotor Speed; Aeroelasticity

19970015322 Army Aviation Systems Command, Aeroflightdynamics Directorate, Moffett Field, CA USA
Performance and Pressure Data from a Small Model Tilt-Rotor in Hover
Branum, Lonnie, Army Aviation Systems Command, USA; Tung, Chee, Army Aviation Systems Command, USA; Apr. 1997; 94p; In English
Contract(s)/Grant(s): RTOP 505-59-87
Report No.(s): NASA-TM-110441; NAS 1.26:110441; USAATCOM-TR-97-A-003; A-976185; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

A test of a small three-bladed model rotor, with geometry typical of that used on tilt-rotor aircraft, was conducted in the U.S. Army Aeroflightdynamics Directorate's anechoic hover chamber. The objectives of the test were to determine the hover performance of the rotor and investigate the pressure distributions on a blade operating at various collective pitch angles and tip speeds. This report presents the rotor performance data and blade surface pressures.
Author
Tilt Rotor Aircraft; Hovering; Tilting Rotors; Pressure Measurement; Pressure Distribution

19970015432 Kaman Aerospace Corp., Bloomfield, CT USA
Advanced Rotor Blade Erosion Protection System ***Final Report***
Weigel, William C., Kaman Aerospace Corp., USA; Jul. 1996; 294p; In English
Contract(s)/Grant(s): DAAJ02-91-C-0045
Report No.(s): AD-A314355; R-2034; USAATCOM-TR-95-D-8; No Copyright; Avail: CASI; A13, Hardcopy; A03, Microfiche

Two new hydrolysis-free elastomeric materials have been identified, tested and fabricated into full length leading edge erosion guards. The were applied to K747 composite main rotor blades for operational flight evaluation on the AH-1 Cobra helicopter. One exhibits more than four times the rain resistance and twice the sand resistance as the current material. The other has six times the sand resistance and equivalent rain resistance. A worldwide survey was conducted to identify potentially suitable materials. Moldable and castable materials, films and tapes, sprayable coatings and two-component, room temperature curing systems were subjected to hydrolysis testing and whirling arm rain erosion testing. A selected group was then subjected to whirling arm sand erosion and impact testing in a Kaman-funded test facility constmcted for this program. Solar radiation, fungus, salt fog, low temperature, temperature shock and decontamination testing completed the environmental tests. Army design criteria and qualification test procedures were updated. A three-dimensional, dynamic, finite element stress wave analytical model of a raindrop impacting elastomeric material was developed. A unique test procedure was devised for measuring large strain, high strain rate, dynamic material properties required for input into the analytical model.
DTIC
Rotary Wings; Finite Element Method; Erosion; Environmental Tests; Flight Tests; Helicopters; Performance Tests; Stress Analysis

06
AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

19970014535 Army Aeromedical Research Lab., Fort Rucker, AL USA
Assessment Methodology for Integrated Helmet and Display Systems in Rotary-Wing Aircraft ***Final Report***
Rash, Clarence E., Army Aeromedical Research Lab., USA; Mozo, Ben T., Army Aeromedical Research Lab., USA; McLean, William E., Army Aeromedical Research Lab., USA; McEntire, B. Joseph, Army Aeromedical Research Lab., USA; Haley, Joseph L., Army Aeromedical Research Lab., USA; Licina, Joseph R., Army Aeromedical Research Lab., USA; Richardson, L. Wayne, Army Aviation Systems Test Activity, USA; Apr. 1996; 242p; In English
Report No.(s): AD-A311400; USAAARL-96-1; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

The U.S. Army is moving towards a trend of using helmet mounted displays in all rotary-wing aircraft. Such devices are integrated systems consisting of the basic helmet, an optical display, eye protection, and a head tracker. This report provides a comprehensive methodology for testing all aspects of such integrated helmet and display systems. The assessment methodology encompasses both laboratory and in-flight evaluations. The major evaluation areas for the laboratory assessment are optical/visual, biodynamic, and acoustical. The in-flight evaluation assesses flight performance and logistical supportability. In addition, human factors and safety issues are addressed.
DTIC
Helmet Mounted Displays; Biodynamics; Acousto-Optics; Human Factors Engineering; Rotary Wing Aircraft; Performance Tests

19970015372 Dynamics Research Corp., Wilmington, MA USA
Superimposing Instrument Symbology on a Night Vision Goggle Display During Simulated Contour Flight ***Final Report, Feb. 1992 - Jan. 1993***
Morey, John C., Dynamics Research Corp., USA; Simon, Robert A., Dynamics Research Corp., USA; Leedom, Dennis K., Army Research Inst. for the Behavioral and Social Sciences, USA; Jan. 1996; 101p; In English
Contract(s)/Grant(s): MDA903-92-D-0025
Report No.(s): AD-A314349; E-21748U; ARI-CR-96-03; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

This experiment examined the effect of superimposing Helmet-Mounted Display (HMD) flight information symbology on the Aviator Night VISion goggle (ANVIS). Twenty-five rated helicopter pilots with no previous HMD experience were assigned to either an ANVIS-HMD group or a goggles-only group (ANVIS-only). All pilots flew familiarization flights and an hour-long reconnaissance mission on the Simulator Training Research Advanced Testbed for Aviation (STRATA), a high fidelity simulator. HMD symbology and the night vision goggle effects were integrated into the out-the-window images. Performance of the ANVIS-

HMD group was comparable to that of the ANVIS-only group with respect to maintaining airspeed and altitude, detecting targets, detecting wire obstacles, and landing in a confined area. Although ANVIS-HMD users' visual activity was in the horizon area of the field of view 85% of the time (compared to 63% for the ANVIS-only group), they did not scan more effectively. No evidence of cognitive capture on the symbology was found. pilot experience level and handedness were not associated with flight performance or target detections but eye dominance was.
DTIC
Night Vision; Goggles; Display Devices; Helmet Mounted Displays

07
AIRCRAFT PROPULSION AND POWER

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

19970014307 Allison Engine Co., Indianapolis, IN USA
Small Engine Technology. Task 4: Advanced Small Turboshaft Compressor (ASTC) Performance and Range Investigation *Final Report*
Hansen, Jeff L., Allison Engine Co., USA; Delaney, Robert A., Allison Engine Co., USA; Mar. 1997; 133p; In English
Contract(s)/Grant(s): NAS3-27394; RTOP 505-62-10
Report No.(s): NASA-CR-198503; NAS 1.26:198503; E-10333; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
This contact had two main objectives involving both numerical and experimental investigations of a small highly loaded two-stage axial compressor designated Advanced Small Turboshaft Compressor (ASTC) winch had a design pressure ratio goal of 5:1 at a flowrate of 10.53 lbm/s. The first objective was to conduct 3-D Navier Stokes multistage analyses of the ASTC using several different flow modelling schemes. The second main objective was to complete a numerical/experimental investigation into stall range enhancement of the ASTC. This compressor was designed wider a cooperative Space Act Agreement and all testing was completed at NASA Lewis Research Center. For the multistage analyses, four different flow model schemes were used, namely: (1) steady-state ADPAC analysis, (2) unsteady ADPAC analysis, (3) steady-state APNASA analysis, and (4) steady state OCOM3D analysis. The results of all the predictions were compared to the experimental data. The steady-state ADPAC and APNASA codes predicted similar overall performance and produced good agreement with data, however the blade row performance and flowfield details were quite different. In general, it can be concluded that the APNASA average-passage code does a better job of predicting the performance and flowfield details of the highly loaded ASTC compressor.
Author
Turbomachinery; Turboshafts; Turbocompressors; Pressure Ratio; Engine Design

19970014315 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
Advanced Aero-Engine Concepts and Controls *Les Concepts Advances et les Commandes des Nouveaux Moteurs d'Avion*
Jun. 1996; 414p; In English; 86th, 25-29 Sep. 1995, Seattle, WA, USA
Report No.(s): AD-A311466; AGARD-CP-572; ISBN-92-836-0025-8; No Copyright; Avail: CASI; A18, Hardcopy; A04, Microfiche
The Propulsion and Energetics Panel Symposium on Advanced Aero-Engine Concepts and Controls was held from 25-29 September 1995 in Seattle, USA. It dealt with propulsion, including thrust vectoring, for future combat aircraft, vertical landing aircraft and transport aircraft. Better fuel efficiency, longer range and higher operational flexibility will be gained from aero engines with advanced cycles which require improvements in fluid dynamics, materials and cooling. Five Sessions (37 papers including the keynote): Engine research and demonstration, requirements and programmes (3); Aircraft engine integration (5); Propulsion system and component technology (10); Engine control systems (13); Integrated flight and propulsion control (5). Dual use application of results is intended.
DTIC
Thrust Vector Control; Transport Aircraft; Propulsion; Fighter Aircraft; Engine Control

19970014343 Naval Postgraduate School, Dept. of Systems Management, Monterey, CA USA
Methods for Determining Performance Expectations and Optimal No Build Times of Fielded Jet Engines
Mlikan, Mark E., Naval Postgraduate School, USA; Jun. 1996; 112p; In English
Report No.(s): AD-A311627; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

This thesis investigates methods for determining fielded jet engine performance expectations. Data exported from the Naval Aviation Logistics Data Analysis (NALDA) data base was fitted by a Weibull distribution to obtain the engine probability density function, cumulative density function, mean time between failure, failure rate, and condition reliabilities. The thesis applies the results of the data analysis by using a commercial software package, Mathcad, to find the solution to an optimizing equation for average maintenance cost per hour of engine critical component operation. The solution yields optimum no build times given the component's hard time, ratios of several inspection/repair cost factors, and properties of the failure time probability distributions of the engine and component. The goal is to economize resources by inspecting life limited components when they are available after having accumulated a predetermined number of operating hours. The procedures developed can be used for any aircraft engine or any mechanical component with failure data that can be fitted to a Weibull distribution and with maintenance cost ratios that fit the model presented herein.
DTIC
Jet Engines; Aircraft Engines; Applications Programs (Computers); Engine Parts; Component Reliability; Failure Analysis; Statistical Analysis; Life (Durability)

19970014398 Naval Postgraduate School, Monterey, CA USA
Detection and Identification of Cyclostationary Signals
DaCosta, Evandro Luiz, Naval Postgraduate School, USA; Mar. 1996; 126p; In English
Report No.(s): AD-A311555; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
Propeller noise can be modeled as an amplitude modulated (AM) signal. Cyclic Spectral Analysis has been used successfully to detect the presence of analog and digitally modulated signals in communication systems. It can also identify the type of modulation. Programs for Signal Processing based on compiled languages such as FORTRAN or C are not user friendly, and MATLAB based programs have become the de facto language and tools for signal processing engineers worldwide. This thesis describes the implementation in MATLAB of two fast methods of computing the Spectral Correlation Density (SCD) Function estimate, the FFT Accumulation Method (FAM) and the Strip Spectral Correlation Algorithm (SSCA), to perform Cyclic Analysis. Both methods are based on the Fast Fourier Transform (FFT) algorithm. The results are presented and areas of possible enhancement for propeller noise detection and identification are discussed.
DTIC
Propeller Noise; Spectrum Analysis; Fast Fourier Transformations; Signal Processing; Spectral Correlation

19970014405 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH USA
Turbine Aero Thermal Research ***Interim Report, 1 Nov. 1995 - 9 Jul. 1996***
Rivir, Richard B., Wright Lab., USA; Jul. 09, 1996; 8p; In English
Contract(s)/Grant(s): AF Proj. 2307
Report No.(s): AD-A312082; WL-TR-96-2082; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche
This report indicates current areas of turbine aero thermal research in house at the Aero Propulsion and Power Directorate and lists current publications (17) from Nov 95 to Jul 96.
DTIC
Propulsion; Thermodynamic Properties; Gas Turbine Engines

19970014823 United Technologies Corp., East Hartford, CT USA
A Three-Dimensional Linearized Unsteady Euler Analysis for Turbomachinery Blade Rows ***Final Report***
Montgomery, Matthew D., United Technologies Corp., USA; Verdon, Joseph M., United Technologies Corp., USA; Mar. 1997; 92p; In English
Contract(s)/Grant(s): NAS3-26618; RTOP 538-03-11
Report No.(s): NASA-CR-4770; NAS 1.26:4770; E-10670; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche
A three-dimensional, linearized, Euler analysis is being developed to provide an efficient unsteady aerodynamic analysis that can be used to predict the aeroelastic and aeroacoustic responses of axial-flow turbo-machinery blading.The field equations and boundary conditions needed to describe nonlinear and linearized inviscid unsteady flows through a blade row operating within a cylindrical annular duct are presented. A numerical model for linearized inviscid unsteady flows, which couples a near-field, implicit, wave-split, finite volume analysis to a far-field eigenanalysis, is also described. The linearized aerodynamic and numerical models have been implemented into a three-dimensional linearized unsteady flow code, called LINFLUX. This code has been applied to selected, benchmark, unsteady, subsonic flows to establish its accuracy and to demonstrate its current capabilities. The unsteady flows considered, have been chosen to allow convenient comparisons between the LINFLUX results and those of well-known, two-dimensional, unsteady flow codes. Detailed numerical results for a helical fan and a three-dimensional version of the

10th Standard Cascade indicate that important progress has been made towards the development of a reliable and useful, three-dimensional, prediction capability that can be used in aeroelastic and aeroacoustic design studies.
Author
Three Dimensional Flow; Euler Equations of Motion; Unsteady Flow; Aerodynamic Characteristics; Boundary Conditions; Mathematical Models; Unsteady Aerodynamics

19970015118 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Influence of Tip Clearance on the Flowfield in a Compressor Cascade With a Moving Endwall
McMullan, Richard J., Air Force Inst. of Tech., USA; Dec. 1996; 138p; In English
Report No.(s): AD-A320928; AFIT/GAE/ENY/96D-5; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The effects of changing the blade tip clearances on the velocity and pressure flowfields within a compressor cascade were investigated in this experimental thesis. All moving endwall measurements were taken at a constant flow coefficient of 0.5 and tip clearances of 0.5, 1.0 and 2.0 percent chord. Hot-wire/film probes were used to determine the three-dimensional velocity vector components in various transverse planes - one upstream of the leading edges of the blades, three within the blade cascade and one downstream of the trailing edges of the blades. The transverse velocity vector plots showed a scraping of the tip leakage vortex from the suction surface of one blade across the blade pitch to the pressure surface of the adjacent blade. A total pressure rake placed downstream of the trailing edges of the blades measured the pressure flowfield at the exit of the cascade. The mass-averaged values of total pressure loss coefficient decreased for reduced gaps. Finally, the tests performed on a crenulate blade geometry at a tip clearance of 0.01 chord showed a 15.5% reduction in the total pressure losses as compared to the straight blade geometry.
DTIC
Blade Tips; Clearances; Flow Distribution; Turbocompressors

08
AIRCRAFT STABILITY AND CONTROL

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

19970014310 Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA
Aerostructural Vortical Flow Interactions with Applications to F/A-18 and F-117 Tail Buffet
Kandil, Osama A., Old Dominion Univ., USA; Massey, Steven J., Old Dominion Univ., USA; Sheta, Essam F., Old Dominion Univ., USA; 1996; 22p; In English; High-Angle-of-Attack Technology, 17-19 Sep. 1996, Hampton, VA, USA
Contract(s)/Grant(s): NAG1-994; NAG1-648
Report No.(s): NASA-CR-203245; NAS 1.26:203245; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The buffet response of the flexible twin-tail configuration of the F/A-18 and a generic F-111 aircraft are computationally simulated and experimentally validated. The problem is a multidisciplinary one which requires the sequential solution of three sets of equations on a multi-block grid structure. The first set is the unsteady, compressible, full Navier-Stokes equations. The second set is the aeroelastic equations for bending and torsional twin-tail responses. The third set is the grid-displacement equations which are used to update the grid coordinates due to the tail deflections. The computational models consist of a 76 deg. swept back, sharp edged delta wing of aspect ratio of one and a swept-back F/A-18 or F-117 twin-tail. The configuration is pitched at 30 deg. angle-of-attack. The problem is solved for the initial flow conditions with the twin tails kept rigid. Next, the aeroelastic equations of the tails are turned on along with the grid-displacement equations to solve for the bending and torsional tails responses due to the unsteady loads produced by the vortex breakdown flow of the leading-edge vortex cores of the delta wing. Several spanwise locations of the twin tails are investigated. The computational results are validated using several existing experimental data.
Author
Aeroelasticity; Angle of Attack; Vortex Breakdown; Navier-Stokes Equation; Multiblock Grids; Flow Characteristics; Buffeting

19970014611 Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA
Optimal Formation Flight Control
McCamish, Shawn B., Air Force Inst. of Tech., USA; Dec. 1995; 182p; In English
Report No.(s): AD-A309647; AFIT/GE/ENG/95D-16; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

Automatic formation flight involves controlling multiple wing aircraft equipped with standard Mach-hold, altitude-hold, and heading-hold autopilots in order to maintain a desired position relative to a lead aircraft throughout formation maneuvers. Changes in the lead aircraft's states, including formation heading, velocity, altitude, and geometry changes, are treated as disturbance and are rejected by the formation flight control system. The work in this thesis is a continuation of five previous theses, dealing with

the design of formation flight control systems. The goal of the optimal formation flight control design is to achieve robust formation maintenance in the face of formation maneuvers and the presence of full system nonlinearities. Second-order aircraft/autopilot models are included in the design and a new control law is employed. A constrained optimization for determining the optimal controller gains of fixed structure controllers is employed. The two controllers considered are a Proportional plus FeedForward (PFF) controller, previously developed at AFIT, and a new Proportional plus Integral and FeedForward (PIFF) controller, which uses less feedforward information. Finally, the constrained optimization is applied to a wide variety of formation maneuvers and geometry changes initiated from both the tight, closely spaced, and loose, more widely dispersed, types o f formations.
DTIC
Optimal Control; Feedforward Control; Flight Control; Aircraft Maneuvers; Automatic Pilots; Control Theory; Wings

19970014738 NASA Dryden Flight Research Center, Edwards, CA USA
Evaluation of High-Speed Civil Transport Handling Qualities Criteria with Supersonic Flight Data
Cox, Timothy H., NASA Dryden Flight Research Center, USA; Jackson, Dante W., NASA Dryden Flight Research Center, USA; Apr. 1997; 30p; In English
Contract(s)/Grant(s): RTOP 529-50-24
Report No.(s): NASA-TM-4791; NAS 1.15:4791; H-2153; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Most flying qualities criteria have been developed from data in the subsonic flight regime. Unique characteristics of supersonic flight raise questions about whether these criteria successfully extend into the supersonic flight regime. Approximately 25 years ago NASA Dryden Flight Research Center addressed this issue with handling qualities evaluations of the XB-70 and YF-12. Good correlations between some of the classical handling qualities parameters, such as the control anticipation parameter as a function of damping, were discovered. More criteria have been developed since these studies. Some of these more recent criteria are being used in designing the High-Speed Civil Transport (HSCT). A second research study recently addressed this issue through flying qualities evaluations of the SR-71 at Mach 3. The research goal was to extend the high-speed flying qualities experience of large airplanes and to evaluate more recent MIL-STD-1797 criteria against pilot comments and ratings. Emphasis was placed on evaluating the criteria used for designing the HSCT. XB-70 and YF-12 data from the previous research supplemented the SR-71 data. The results indicate that the criteria used in the HSCT design are conservative and should provide good flying qualities for typical high-speed maneuvering. Additional results show correlation between the ratings and comments and criteria for gradual maneuvering with precision control. Correlation is shown between ratings and comments and an extension of the Neal/Smith criterion using normal acceleration instead of pitch rate.
Author
Evaluation; High Speed; Civil Aviation; Data Acquisition; Supersonic Flight; Flight Characteristics

19970014822 Lockheed Martin Engineering and Sciences Co., Hampton, VA USA
HARV ANSER Flight Test Data Retrieval and Processing Procedures
Yeager, Jessie C., Lockheed Martin Engineering and Sciences Co., USA; Mar. 1997; 400p; In English
Contract(s)/Grant(s): NAS1-96014; RTOP 522-21-31-01
Report No.(s): NASA-CR-201670; NAS 1.26:201670; No Copyright; Avail: CASI; A17, Hardcopy; A04, Microfiche

Under the NASA High-Alpha Technology Program the High Alpha Research Vehicle (HARV) was used to conduct flight tests of advanced control effectors, advanced control laws, and high-alpha design guidelines for future super-maneuverable fighters. The High-Alpha Research Vehicle is a pre-production F/A-18 airplane modified with a multi-axis thrust-vectoring system for augmented pitch and yaw control power and Actuated Nose Strakes for Enhanced Rolling (ANSER) to augment body-axis yaw control power. Flight testing at the Dryden Flight Research Center (DFRC) began in July 1995 and continued until May 1996. Flight data will be utilized to evaluate control law performance and aircraft dynamics, determine aircraft control and stability derivatives using parameter identification techniques, and validate design guidelines. to accomplish these purposes, essential flight data parameters were retrieved from the DFRC data system and stored on the Dynamics and Control Branch (DCB) computer complex at Langley. This report describes the multi-step task used to retrieve and process this data and documents the results of these tasks. Documentation includes software listings, flight information, maneuver information, time intervals for which data were retrieved, lists of data parameters and definitions, and example data plots.
Author
Aircraft Control; Research Vehicles; Data Retrieval; Data Systems; Data Processing; Thrust Vector Control

19970015300 Army Research Lab., Aberdeen Proving Ground, MD USA
Helicopter Trim Analysis ***Final Report, 10 - 15 Sep. 1992***
Fries, Joseph, Army Research Lab., USA; Jun. 1996; 46p; In English
Contract(s)/Grant(s): DA Proj. 1L1-62618-AH-80
Report No.(s): AD-A310293; ARL-MR-317; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report presents a generic first-principles helicopter trim analysis for use on a personal work station. Working from the helicopter's physical properties, it calculates the main rotor blade's collective, longitudinal cyclic, body pitch, and stabilator pitch angles to maintain a trimmed flight condition over a complete forward-speed range. The computer program automatically sweeps through a forward-speed range, varying the collective, longitudinal cyclic, and stabilator pitch angles to satisfy the trimmed condition. It is an improvement over earlier work where the analyst had to vary these parameters at the keyboard. It presents an example of the usage with an AH-64A helicopter, and the program's source code is included.
DTIC
Helicopters; Flight Conditions; Computer Programs; Aerodynamic Characteristics; Aerodynamic Balance; Helicopter Control

09
RESEARCH AND SUPPORT FACILITIES (AIR)

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

19970014504 Army Engineer Waterways Experiment Station, Geotechnical Lab., Vicksburg, MS USA
A State-of-the-Art Study and Survey of Flexible Pavement Construction Jointing Techniques ***Final Report***
Regan, George L., Army Engineer Waterways Experiment Station, USA; Jun. 1996; 86p; In English
Contract(s)/Grant(s): DTFA01-90-Z-02069
Report No.(s): AD-A311890; DOT/FAA/AR-95/57; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report summarizes the state-of-the-art construction joints in airport hot-mix asphalt flexible pavement surfaces. It also discusses and develops criteria for improved Federal Aviation Administration (FAA) standards and procedures. Work leading to its completion consisted of three parts: a literature and experience review. field sampling and analysis of construction density of airport pavements, and a survey of organizations involved in airport and highway pavement construction. The literature review covered highway and airport joint construction techniques, experiences, and reports of public and private organizations. Information was examined for useful joint and mat construction data and for potential improvements in construction techniques and specifications. Construction techniques for making joints were summarized. Field sampling and analysis consisted of examining the effects of manual and mechanical joint-forming techniques on constructed density at three FAA airport projects. Densities in the interior portions of paved areas were also analyzed. Data indicated that interior and joint portions of pavements were different when characterized by density. The survey portion included (1) developing a hot-mix construction and performance questionnaire for organizations; (2) distributing it to state highway agencies, FAA airports, U.S. Government offices and a few non-U.S. locations; and (3) analyzing the completed responses. The intended audience was pavement owners, designers, specifiers, and contractors. Responses from 130 organizations were presented on a question-by-question basis. Some of the overall report findings indicated that airport runway longitudinal construction joint lengths easily exceed nine times the length of runways, creating a huge maintenance problem if they are not durable enough to resist traffic and environmental conditions.
DTIC
Maintenance; Pavements; Density (Mass/Volume); Construction; Runways

19970015319 NASA Langley Research Center, Hampton, VA USA
The New Heavy Gas Testing Capability in the NASA Langley Transonic Dynamics Tunnel
Cole, Stanley R., NASA Langley Research Center, USA; Rivera, Jose A., Jr., NASA Langley Research Center, USA; 1997; 14p; In English; Royal Aeronautical Society Wind Tunnels and Wind Tunnel Test Techniques Forum, 14-16 Apr. 1997, Cambridge, UK
Report No.(s): NASA-TM-112702; NAS 1.15:112702; Paper-4; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The NASA Langley Transonic Dynamics Tunnel (TDT) has provided a unique capability for aeroelastic testing for over thirty-five years. The facility has a rich history of significant contributions to the design of many USA commercial transports and military aircraft. The facility has many features which contribute to its uniqueness for aeroelasticity testing; however, perhaps the most important facility capability is the use of a heavy gas test medium to achieve higher test densities. Higher test medium densities substantially improve model building requirements and therefore simplify the fabrication process for building aeroelastically

scaled wind-tunnel models. The heavy gas also provides other testing benefits, including reduction in the power requirements to operate the facility during testing. Unfortunately, the use of the original heavy gas has been curtailed due to environmental concerns. A new gas, referred to as R-134a, has been identified as a suitable replacement for the former TDT heavy gas. The TDT is currently undergoing a facility upgrade to allow testing in R-134a heavy gas. This replacement gas will result in an operational test envelope, model scaling advantages, and general testing capabilities similar to those available with the former TDT heavy gas. As such, the TDT is expected to remain a viable facility for aeroelasticity research and aircraft dynamic clearance testing well into the 21st century. This paper describes the anticipated advantages and facility calibration plans for the new heavy gas and briefly reviews several past test programs that exemplify the possible benefits of heavy gas testing.
Author
Transonic Wind Tunnels; Aeroelasticity; Gas Density; Wind Tunnel Calibration; Rare Gases

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CHEMISTRY AND MATERIALS

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

19970014010 Virginia Univ., Dept. of Materials Science and Engineering, Charlottesville, VA USA
NASA-UVA Light Aerospace Alloy and Structures Technology Program (LA2ST) ***Progress Report, 1 Jul. 1996 - 31 Dec. 1996***
Gangloff, Richard P., Virginia Univ., USA; Starke, Edgar A., Jr., Virginia Univ., USA; Kelly, Robert G., Virginia Univ., USA; Scully, John R., Virginia Univ., USA; Shiflet, Gary J., Virginia Univ., USA; Stoner, Glenn E., Virginia Univ., USA; Wert, John A., Virginia Univ., USA; Feb. 1997; 156p; In English; Original contains color illustrations
Contract(s)/Grant(s): NAG1-745
Report No.(s): NASA-CR-203858; NAS 1.26:203858; UVA/528266/MS97/121; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The NASA-UVA Light Aerospace Alloy and Structures Technology (LA2ST) Program was initiated in 1986 and continues with a high level of activity. Here, we report on progress achieved between July I and December 31, 1996. The objective of the LA2ST Program is to conduct interdisciplinary graduate student research on the performance of next generation, light-weight aerospace alloys, composites and thermal gradient structures in collaboration with NASA-Langley researchers. Specific technical objectives are presented for each research project. We generally aim to produce relevant data and basic understanding of material mechanical response, environmental/corrosion behavior, and microstructure; new monolithic and composite alloys; advanced processing methods; new solid and fluid mechanics analyses; measurement and modeling advances; and a pool of educated graduate students for aerospace technologies. The accomplishments presented in this report are summarized as follows. Three research areas are being actively investigated, including: (1) Mechanical and Environmental Degradation Mechanisms in Advanced Light Metals, (2) Aerospace Materials Science, and (3) Mechanics of Materials for Light Aerospace Structures.
Derived from text
Aircraft Structures; Light Alloys; Aircraft Construction Materials; Degradation; Mechanical Properties; Microstructure

19970014448 Oak Ridge National Lab., High Temperature Materials Lab., TN USA
Neutron diffraction studies of welds of aerospace aluminum alloys
Martukanitz, R. P., Pennsylvania State Univ., USA; Howell, P. R., Pennsylvania State Univ., USA; Payzant, E. A., Oak Ridge National Lab., USA; Hubbard, C. R., Oak Ridge National Lab., USA; Spooner, S., Oak Ridge National Lab., USA; 1996; 7p; In English; American Society of Mechanical Engineers and Metals Materials Week, 6-10 Oct. 1996, Cincinnati, OH, USA
Contract(s)/Grant(s): DE-AC05-96OR-22464
Report No.(s): Conf-961017-11; DE96-015321; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Neutron diffraction and electron microscopy were done on residual stress in various regions comprising variable polarity plasma arc welds of alloys 2219 (Al-6.3Cu) and 2195 (Al-4.0Cu-1.0Li-0.5Mg-0.5Ag). Results indicate that lattice parameter changes in the various weld regions may be attributed to residual stresses generated during welding, as well as local changes in microstructure. Distribution of longitudinal and transverse stress of welded panels shows peaks of tension and compression, respectively, within the HAZ and corroborate earlier theoretical results. Position of these peaks are related to position of minimum strength within the HAZ, and the magnitude of these peaks are a fraction of the local yield strength in this region. Weldments of alloy 2195-T8 exhibited higher peak residual stress than alloy 2219-T87. Comparison of neutron diffraction and microstructural analysis indicate decreased lattice parameters associated with the solid solution of the near HAZ; this results in decreased apparent

tensile residual stress within this region and may significantly alter interpretation of residual stress measurements of these alloys. Considerable relaxation of residual stress occurs during removal of specimens from welded panels and was used to aid in differentiating changes in lattice parameters attributed to residual stress from welding and modifications in microstructure.
DOE
Aluminum Alloys; Neutron Diffraction; Lattice Parameters; Welded Joints; Residual Stress; Plasma Arc Welding; Stress Distribution; Microstructure; Tensile Stress; Aircraft Structures

19970015125 Lawrence Livermore National Lab., Manufacturing and Materials Engineering Div., Livermore, CA USA
Damage initiation and propagation in metal laminates
Riddle, R. A., Lawrence Livermore National Lab., USA; Lesuer, D. R., Lawrence Livermore National Lab., USA; Syn, C. K., Lawrence Livermore National Lab., USA; Jul. 26, 1996; 20p; In English; International Mechanical Engineering Congress and Exhibition: The Winter Annual Meeting of the ASME, 17-22 Nov. 1996, Atlanta, GA, USA
Contract(s)/Grant(s): W-7405-eng-48
Report No.(s): UCRL-JC-122850; CONF-961105-15; DE96-050501; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The metal laminates proposed here for aircraft structures are Al alloy interlayers between Al alloy based metal matrix composite (MMC) plates reinforced with Si carbide particles. Properties to be tailored for jet engine fan containment and wing and auxiliary support structures include the important property fracture toughness. A method was developed for simulating and predicting crack initiation/growth using finite element analysis and fracture mechanics. An important key in predicting the failure is the tie-break slideline with prescribed (chosen based on J Integral calculations) effective plastic strain to failure in elements along the slideline. More development of the method is needed, particularly in its correlation with experimental data from various fracture toughness and strength tests of metal laminates. Results show that delamination at the interface of the ductile interlayer and MMC material can add significantly to the energy required to propagate a crack through a metal laminate.
DOE
Aircraft Structures; Aircraft Construction Materials; Aluminum Alloys; Metal Matrix Composites; Silicon Carbides; Crack Initiation; Laminates; Fracture Mechanics; Finite Element Method; Plates (Structural Members); Failure Analysis

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ENGINEERING

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

19970014519 Galaxy Scientific Corp., Egg Harbor Township, NJ USA
Digital Systems Validation Handbook, Volume 3, Chapter 2, Design, Test, and Certification Issues for Complex Integrated Circuits *Final Report*
Harrison, L., Galaxy Scientific Corp., USA; Landell, B., Galaxy Scientific Corp., USA; Jul. 1996; 65p; In English
Contract(s)/Grant(s): DTFA03-89-C-00043
Report No.(s): AD-A312265; DOT/FAA/AR-95/125-Vol-3-CH-2; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This chapter provides an overview of complex integrated circuit technology, focusing particularly upon application specific integrated circuits. This report is intended to assist FAA certification engineers in making safety assessments of new technologies. It examines complex integrated circuit technology, focusing on three fields: design, test, and certification. It provides the reader with the background and a basic understanding of the fundamentals of these fields. Also included is material on the development environment, including languages and tools. Application specific integrated circuits are widely used in Boeing 777 fly-by-wire aircraft. Safety issues abound for these integrated circuits when they are used in safety-critical applications. Since control laws are now executed in silicon and transmitted from one integrated circuit to another, reliability issues for these integrated circuits take on a new importance. This report identifies certification risks relating to the use of complex integrated circuits in fly-by-wire applications.
DTIC
Application Specific Integrated Circuits; Boeing 777 Aircraft; Avionics; Fly by Wire Control; Digital Systems; Circuit Reliability

19970013791 Arizona Univ., Aerospace and Mechanical Engineering, Tucson, AZ USA
The Forced Turbulent Wall Jet Effects of Pressure Gradient and Curvature ***Final Report, 16 Jan. 1993 - 15 Jan 1996***
Wygnanski, Israel, Arizona Univ., USA; Jun. 01, 1996; 45p; In English
Contract(s)/Grant(s): F49620-93-1-0050; AF Proj. 2307
Report No.(s): AD-A311422; AFOSR-TR-96-0386; Rept-93-1-0050; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The studies completed in the period of the proposal were in three parts: (1) Both hot wire and PIV data have been obtained on the Coanda cylinder. Strong influences of curvature and of the pressure gradient on the mean and the turbulence quantities were found. New structures were observed around the cylinder in the forced case. A theoretical model was established for the mean flow, which will be an important tool in the further stability studies. (2) Two types of weak wall jet have been observed. Length and velocity scales were found and applied in successful normalization of the mean velocity profiles. Furthermore, three instability modes, coupled to each other, were investigated through forcing. (3) A novel technique for identification of coherent motions was developed which can eliminate the influence of phase jitter and discover much more coherent energy than the conventional phase locked ensemble averaging technique, based on which a reasonable coherent energy budget was established for the first time. This technique will be applied to explore the role of coherent motion in the control of separation.
DTIC
Turbulent Jets; Pressure Gradients; Coanda Effect; Particle Image Velocimetry; Wall Jets; Curvature; Cylindrical Bodies; Aerodynamic Drag; Separated Flow

19970014335 Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA USA
Numerical Simulation of the Flow Field about a Multi-Element Airfoil with Oscillating Flap
Ortiz, Miguel A., Naval Postgraduate School, USA; Mar. 1996; 52p; In English
Report No.(s): AD-A311471; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Investigation of steady and unsteady flowfields over airfoils is an active area of current computational and experimental research. In this study, the compressible, viscous, flow over a single and multi-element airfoil is numerically simulated by solving the Navier Stokes equations. The motivation for this work includes interest in studying the effects of a stationary/flapping airfoil combination in tandem configuration. A single-block Navier-Stokes (NS) solver is employed to compute unsteady flowfields. Turbulence is treated using the Baldwin-Lomax turbulence model. A single C-grid is generated and it is partially distorted to simulate the flapping motion. Numerical solutions are obtained for flows at a fixed angle of attack and for unsteady flows over flapping airfoils. The numerical solutions agree well with the experimental data The difficulties faced during the study are discussed and future improvements are suggested.
DTIC
Numerical Flow Visualization; Airfoils; Angle of Attack; Flapping; Navier-Stokes Equation; Unsteady Flow; Viscous Flow

19970014986 Army Research Lab., Weapons and Materials Research Directorate, Aberdeen Proving Ground, MD USA
Characterization of Jet Flow from a Decaying Wave Blast Simulator ***Final Report***
Schraml, Stephen J., Army Research Lab., USA; Jan. 1997; 43p; In English
Report No.(s): AD-A320936; ARL-TR-1259; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A computational study was performed to characterize the time-dependent jet flow exiting the expansion tunnel of the large blast/thermal simulator (LB/TS). The aerodynamic environment produced by the jet flow has been identified as a possible means of testing full scale military equipment in high drag blast events. Two-dimensional (2-D) axisymmetric calculations were used to estimate the peak pressure, velocity, and impulse levels in the jet flow as a function of the initial conditions. Next, a set of 2-D planar symmetry calculations was performed to assess the effect of the ground plane on the flow field and determine the changes in flow parameters as a function of distance from the exit plane. Finally, a set of three-dimensional (3-D) calculations was used to generate a detailed description of the time-dependent flow and to determine its spatial uniformity for vehicle testing. The 3-D calculation simulating the maximum operational limit of the facility resulted in a peak flow velocity of approximately 420 m/s in an event with a duration of approximately 1.2 s.
DTIC
Jet Flow; Time Dependence; Flow Characteristics; Shock Tubes; Three Dimensional Flow; Two Dimensional Flow; Aerodynamic Drag; Jet Blast Effects; Simulators

19970014309 Vigyan Research Associates, Inc., Hampton, VA USA

Analysis of Particle Image Velocimetry (PIV) Data for Application to Subsonic Jet Noise Studies ***Final Report***

Blackshire, James L., Vigyan Research Associates, Inc., USA; Jan. 1997; 26p; In English

Contract(s)/Grant(s): NAS1-19505; RTOP 538-03-12-04

Report No.(s): NASA-CR-201665; NAS 1.26:201665; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Global velocimetry measurements were taken using Particle Image Velocimetry (PIV) in the subsonic flow exiting a 1 inch circular nozzle in an attempt to better understand the turbulence characteristics of its shear layer region. This report presents the results of the PIV analysis and data reduction portions of the test and details the processing that was done. Custom data analysis and data validation algorithms were developed and applied to a data ensemble consisting of over 750 PIV 70 mm photographs taken in the 0.85 mach flow facility. Results are presented detailing spatial characteristics of the flow including ensemble mean and standard deviation, turbulence intensities and Reynold's stress levels, and 2-point spatial correlations.

Author

Particle Image Velocimetry; Jet Aircraft Noise; Gas Jets; Turbulence; Velocity Measurement; Subsonic Flow

19970014416 Alabama Univ., Center for Automation and Robotics, Huntsville, AL USA

Study Thermographic Flaw Detection ***Final Report***

Walker, James L., Alabama Univ., USA; Workman, Gary L., Alabama Univ., USA; Jul. 1996; 130p; In English

Contract(s)/Grant(s): NAS8-38609

Report No.(s): NASA-CR-203844; NAS 1.26:203844; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The development of thermographic inspection methods for use on aerospace structures is under investigation. Several different material systems, structural geometries and defect types have been included in this study so as to establish a baseline from which future IRT testing can be made. This study examines various thermal loading techniques in an attempt to enhance the likelihood of capturing and identifying critically sized flaws under 'non-laboratory' actual working conditions. Qualification techniques and calibration standards are also being investigated to standardize the thermographic method. In conjunction with the thermographic inspections, advanced image processing techniques including digital filtering and neural networks have been investigated to increase the ability of 91 detecting and sizing flaws. Here, the digitized thermographic images are mathematically manipulated through various filtering techniques and/or artificial neural mapping schemes to enhance its overall quality, permitting accurate flaw identification even when the signal-to-noise ratio is low.

Author

Thermography; Nondestructive Tests; Aircraft Structures; Detection; Image Processing

19970015286 Alabama Univ., Center for Automation and Robotics, Huntsville, AL USA

Study Thermographic Flaw Detection ***Final Report***

Walker, James L., Alabama Univ., USA; Workman, Gary L., Alabama Univ., USA; Jul. 1996; 127p; In English; Original contains color illustrations

Contract(s)/Grant(s): NAS8-38609

Report No.(s): NASA-CR-202781; NAS 1.26:202781; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The development of thermographic inspection methods for use on aerospace structures is under investigation. Several different material systems, structural geometries and defect types have been included in this study so as to establish a baseline from which future Infrared Thermography(IRT) testing can be made. This study examines various thermal loading techniques in an attempt to enhance the likelihood of capturing and identifying critically sized flaws under 'non laboratory' actual working conditions. Qualification techniques and calibration standards are also being investigated to standardize the thermographic method. In conjunction with the thermographic inspections, advanced image processing techniques including digital filtering and neural networks have been investigated to increase the ability of detecting and sizing flaws. Here, the digitized thermographic images are mathematically manipulated through various filtering techniques and/or artificial neural mapping schemes to enhance its overall quality, permitting accurate flaw identification even when the signal-to-noise ratio is low.

Author

Aircraft Structures; Thermography; Fault Detection; Image Processing; Digital Filters; Neural Nets; Nondestructive Tests; Infrared Imagery

14
LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

19970013789 Army Aeromedical Research Lab., Fort Rucker, AL USA
Subjective Evaluation of the Communications Earplug with Flexible Harness (CEP/FH) Among CH-47D Crewmembers ***Final Report***
Ribera, John E., Army Aeromedical Research Lab., USA; Mozo, Ben T., Army Aeromedical Research Lab., USA; Murphy, Barbara A., Army Aeromedical Research Lab., USA; Jul. 1996; 18p; In English
Contract(s)/Grant(s): 3016287A878
Report No.(s): AD-A312045; USAARL-96-29; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Noise levels in Army rotary-wing aircraft, particularly the CH-47D (Chinook), can reach as high as 115 dBA. Current aviator helmets provide adequate hearing protection. However, speech communication is less than optimum. The Communication Earplug with Flexible Harness (CEP/FH), developed at the USA Army Aeromedical Research Laboratory, may provide an answer to the problem. Seventeen aviators and crewmembers of a U.S. Army Reserve CH-47D unit field tested the CEP/FH and subsequently were queried. Results of the posttrial survey are presented and discussed. When compared with the standard issue SPH-4 series aviator helmet, crewmembers wearing the CEP/FH perceived improved speech clarity and reduced levels of noise. Based on weaknesses relative to the harness and microphone components of the CEP/ FH, an advanced prototype of the CEP has evolved. It promises to be more compatible within the CH-47D environment, and more acceptable to crewmembers than the CEP/FH, while providing hearing protection and enhancing speech intelligibility in noise.
DTIC
Ear Protectors; Rotary Wing Aircraft; Noise Intensity; Harnesses; Aircraft Noise; Aerospace Medicine; Helmets

19970014766 Armstrong Lab., Aerospace Medicine Directorate, Brooks AFB, TX USA
Psychological Characteristics of USA Air Force Pilots ***Final Report, 23 Jan. - 30 Sep. 1995***
McGlohn, Suzanne E., Armstrong Lab., USA; King, Raymond E., Armstrong Lab., USA; Retzlaff, Paul D., Armstrong Lab., USA; Flynn, Christopher F., Armstrong Lab., USA; Butler, James W., Armstrong Lab., USA; Jun. 1996; 28p; In English
Contract(s)/Grant(s): AF Proj. 7755
Report No.(s): AD-A311379; AL/AO-TR-1996-0097; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This document represents the final report of the protocol entitled Assessment of Psychological Factors in Aviators, funded in fiscal year 1995 by the Department of Defense Women's Health Research Program (DWRHP). This protocol studied the psychological and psychiatric health of 64 male and 50 female non-referred USA Air Force (USAF) pilots. A number of psychological tests were administered as well as a structured interview. The Multidimensional Aptitude Battery (MAB), the NEO Five Factor Inventory (NEO-FFI), the Crew Management Attitude Questionnaire (CMAQ), and the Personal Characteristics Inventory (PCI) were presented on IBM ThinkPad computers. While MAB intelligence scores were nearly identical for men and women, women were found to have higher scores on the Extraversion, Agreeableness, and Conscientiousness scales of the NEO-FFI. CMAQ results, however, suggest no significant male/female 'resource management' differences. The semi-structured interview sought information about personal/family health, squadron relationships, and career/deployment stresses. The interview findings suggest that the USAF Academy is an important avenue for women to enter military aviation, many young female pilots are delaying childbearing for their aviation career, and the squadron members most often reported as having trouble with mixed- gender squadrons are older male enlisted crew members and male supervisors. An important area for future training proved to be men's desire to protect women in combat.
DTIC
Aircraft Pilots; Psychological Factors; Mental Health; Armed Forces (USA)

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.

19970015338 Institute for Computer Applications in Science and Engineering, Hampton, VA USA
Aerodynamic Design Optimization on Unstructured Grids with a Continuous Adjoint Formulation ***Final Report***
Anderson, W. Kyle, NASA Langley Research Center, USA; Venkatakrishnan, V., Institute for Computer Applications in Science and Engineering, USA; Computers in Fluids; Jan. 1997; 50p; In English
Contract(s)/Grant(s): NAS1-19480; RTOP 505-90-52-01
Report No.(s): NASA-CR-201650; NAS 1.26:201650; ICASE-97-9; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A continuous adjoint approach for obtaining sensitivity derivatives on unstructured grids is developed and analyzed. The derivation of the costate equations is presented, and a second-order accurate discretization method is described. The relationship between the continuous formulation and a discrete formulation is explored for inviscid, as well as for viscous flow. Several limitations in a strict adherence to the continuous approach are uncovered, and an approach that circumvents these difficulties is presented. The issue of grid sensitivities, which do not arise naturally in the continuous formulation, is investigated and is observed to be of importance when dealing with geometric singularities. A method is described for modifying inviscid and viscous meshes during the design cycle to accommodate changes in the surface shape. The accuracy of the sensitivity derivatives is established by comparing with finite-difference gradients and several design examples are presented.
Author
Unstructured Grids (Mathematics); Inviscid Flow; Navier-Stokes Equation; Computational Fluid Dynamics; Aerodynamics; Grid Generation (Mathematics)

16
PHYSICS

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

19970014255 Science Applications International Corp., McLean, VA USA
Single Event Noise Model (SENM) Description and User's Guide ***Final Report, Aug. 1993 - Jul. 1995***
Cosby, Mark R., Science Applications International Corp., USA; May 1996; 42p; In English
Contract(s)/Grant(s): F33614-89-C-0574; AF Proj. 4223
Report No.(s): AD-A308802; AL/OE-TR-1996-0062; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Public groups and some federal agencies are pressuring DoD to include single event noise and impulsive noise impact analyses in Environmental Impact Assessment Process (EIAP) documents. The Strategic Environmental Research and Development Program (SERDP) office funded an effort to improve and evaluate a single event noise model (SENM) for aircraft noise. The validation of the SENM included noise from subsonic and supersonic aircraft activity. This model provided a defensible analytical approach to assess single event noise impacts generated by DoD operations and will aid in complying with the National Environmental Policy Act (NEPA). The basis of the SENM is a noise program previously developed with Advanced Research Project Agency funding. The program was orginally developed for underwater acoustics and was recently converted to atmospheric acoustics. Development of this program directly supports the tri-service strategic plan for the compliance pillar of research and development objective of developing improved assessment tools related to environmental management. It assists DoD in producing defensible EIAP documents concerning noise generated in sensitive areas such as parks and wilderness areas. This report is a user's manual describing the SENM that was developed under this SERDP project
DTIC
User Manuals (Computer Programs); Underwater Acoustics; Research and Development; Aircraft Noise

Subject Term Index

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