NASA SP-7037 (334)
September 1996

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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Introduction

This issue of *Aeronautical Engineering, A Continuing Bibliography with Indexes* (NASA SP-7037) lists 425 reports, articles, and other documents recently announced in the NASA STI Database.

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

Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract.

Two indexes—subject and author are included.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.

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Select **Appendix** for important information about NASA Scientific and Technical Information (STI) Office products and services, including registration with the NASA Center for AeroSpace Information (CASI) for access to the NASA CASI TRS (Technical Report Server), and availability and pricing information for cited documents.

Typical Report Citation and Abstract

ACCESSION NUMBER ↓

DOCUMENT ID NUMBER → **19960021053;** 96N24540 NASA Langley Research Center, Hampton, VA USA. ← CORPORATE SOURCE

TITLE → **An Extended Compact Tension Specimen for Fatigue Crack Propagation and Fracture**

AUTHORS → Piascik, R. S., NASA Langley Research Center, USA; Newman, J. C., Jr., NASA Langley Research Center, USA; ← AUTHORS' AFFILIATION

PUBLICATION DATE → Mar. 1996, pp. 16; In English

CONTRACTS/GRANTS → Contract(s)/Grant(s): RTOP 538–02–10–01

REPORT NO.(S) → Report No.(s): NASA–TM–110243; NAS 1.15:110243; No Copyright; Avail: CASI A03, Hardcopy; A01, Microfiche ← AVAILABILITY AND PRICE CODE

ABSTRACT → An extended compact tension specimen, EC(T) has been developed for fatigue and fracture testing. Documented herein are stress-intensity factor and compliance expressions for the EC(T) specimen.

ABSTRACT AUTHOR → Author

SUBJECT TERMS → *Crack Propagation; Stress Intensity Factors; Fatigue (Materials)*

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 334)

SEPTEMBER 1996

01
AERONAUTICS

19960018485; 96N23762 NASA Lewis Research Center, Cleveland,OH USA

Determination of Local Densities in Accreted Ice Samples Using X-Ray and Digital Imaging

Broughton, Howard, Cortez 3 Service Corp., USA; Sims, James, Cortez 3 Service Corp., USA; Vargas, Mario, NASA Lewis Research Center, USA; Mar. 199614p; In English; 48th Annual Conference, 7-12 May 1995, Washington, DC, USA; Sponsored by Society of Imaging Science and Technology, USA

Contract(s)/Grant(s): RTOP 505-68-10

Report No.(s): NASA-TM-107106; E-1002; NAS 1.15:107106; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

At the NASA Lewis Research Center's Icing Research Tunnel ice shapes, similar to those which develop in-flight icing conditions, were formed on an airfoil. Under cold room conditions these experimental samples were carefully removed from the airfoil, sliced into thin sections, and x-rayed. The resulting microradiographs were developed and the film digitized using a high resolution scanner to extract fine detail in the radiographs. A procedure was devised to calibrate the scanner and to maintain repeatability during the experiment. The techniques of image acquisition and analysis provide accurate local density measurements and reveal the internal characteristics of the accreted ice with greater detail. This paper will discuss the methodology by which these samples were prepared with emphasis on the digital imaging techniques.

Author

Ice Formation; Density Measurement; Airfoils; Digital Techniques; Imaging Techniques; Density Distribution; X Rays

19960018580; 96N23782 Purdue Univ., West Lafayette, IN USA

Dynamic Performance of High Bypass Ratio Turbine Engines With Water Ingestion ***Final Report***

Murthy, S. N. B., Purdue Univ., USA; Apr. 199640p; In English

Contract(s)/Grant(s): NAG3-481; RTOP 505-62-52; DTFA03-83-A-00328

Report No.(s): NASA-CR-4703; E-10085; NAS 1.26:4703; DOT/FAA/AR95-96; M/NAFA/95-F; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The research on dynamic performance of high bypass turbofan engines includes studies on inlets, turbomachinery and the total engine system operating with air-water mixture; the water may be in vapor, droplet, or film form, and their combinations. Prediction codes (WISGS, WINCOF, WINCOF-1, WINCLR, and Transient Engine Performance Code) for performance changes, as well as changes in blade-casing clearance, have been established and demonstrated in application to actual, generic engines. In view of the continuous changes in water distribution in turbomachinery, the performance of both components and the total engine system must be determined in a time-dependent mode; hence, the determination of clearance changes also requires a time-dependent approach. In general, the performance and clearances changes cannot be scaled either with respect to operating or ingestion conditions. Removal of water prior to phase change is the most effective means of avoiding ingestion effects. Sufficient background has been established to perform definitive, full scale tests on a set of components and a complete engine to establish engine control and operability with various air-water vapor-water mixtures.

Author

Turbofan Engines; Water Vapor; Clearances; Phase Transformations; Propulsion System Performance; Turbocompressors; Dynamic Characteristics

19960021074; 96N24561 NASA Langley Research Center, Hampton,VA USA

Transportation Beyond 2000: Technologies Needed for Engineering Design

Huebner, Lawrence D., Compiler, NASA Langley Research Center, USA; Asbury, Scott C., Compiler, NASA Langley Research Center, USA; Lamar, John E., Compiler, NASA Langley Research Center, USA; McKinley, Robert E., Jr., Compiler, NASA Langley Research Center, USA; Scott, Robert C., Compiler, NASA Langley Research Center, USA; Small, William J., Compiler, NASA Langley Research Center, USA; Torres, Abel O., Compiler, NASA Langley

Research Center, USA; Feb. 1996222p; In English; Transportation Beyond 2000: Technologies Needed for Engineering Design Workshop, 26-28 Sep. 1995, Hampton, VA, USA; Also announced as 19960021074 through 1996002108
Contract(s)/Grant(s): RTOP 282-10-01-01
Report No.(s): NASA-CP-10184-Pt-2; NAS 1.55:10184-Pt-2; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

The purpose of the workshop was to acquaint the staff of the NASA Langley Research Center with the broad spectrum of transportation challenges and concepts foreseen within the next 20 years. The hope is that the material presented at the workshop and contained in this document will stimulate innovative high-payoff research directed towards the efficiency of future transportation systems. The workshop included five sessions designed to stress the factors that will lead to a revolution in the way we will travel in the 21st century. The first session provides the historical background and a general perspective for future transportation, including emerging transportation alternatives such as working at a distance. Personal travel is the subject of Session Two. The third session looks at mass transportation, including advanced rail vehicles, advanced commuter aircraft, and advanced transport aircraft. The fourth session addresses some of the technologies required for the above revolutionary transportation systems to evolve. The workshop concluded with a wrap-up panel discussion, Session Five. The topics presented herein all have viable technical components and are at a stage in their development that, with sufficient engineering research, one or more of these could make a significant impact on transportation and our social structure.
Author
Aerospace Engineering; Propulsion System Configurations; Electric Propulsion; Electromagnetic Propulsion; Plasma Propulsion; Laser Propulsion; Nuclear Propulsion; Alternatives

19960023064; 96N25893 NASA Washington, Scientific and Technical Information Office., Washington, DC USA
Aeronautical Engineering: A Continuing Bibliography with Indexes
Aug. 199594p; In English
Report No.(s): NASA-SP-7037 (320); NAS 1.21:7037; No Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

This bibliography lists 193 reports, journal articles, and other documents introduced in the NASA scientific and technical system in Aug. 1995. Subject coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles
CASI
Aerodynamics; Aeronautical Engineering; Bibliographies; Indexes (Documentation)

19960023610; 96N26302 NASA Langley Research Center, Hampton, VA USA
Transportation Beyond 2000: Technologies Needed for Engineering Design
Huebner, Lawrence D., Compiler, NASA Langley Research Center, USA; Asbury, Scott C., Compiler, NASA Langley Research Center, USA; Lamar, John E., Compiler, NASA Langley Research Center, USA; McKinley, Robert E., Jr., Compiler, NASA Langley Research Center, USA; Scott, Robert C., Compiler, NASA Langley Research Center, USA; Small, William J., Compiler, NASA Langley Research Center, USA; Torres, Abel O., Compiler, NASA Langley Research Center, USA; Feb. 1996536p; In English, 26-28 Sep. 1995, Hampton, VA, USA; Also announced as 19960023610 through 1996002362
Contract(s)/Grant(s): RTOP 282-10-01-01
Report No.(s): NASA-CP-10184-Pt-1; NAS 1.55:10184-Pt-1; No Copyright; Avail: CASI; A23, Hardcopy; A04, Microfiche

The purpose of the workshop was to acquaint the staff of the NASA Langley Research Center with the broad spectrum of transportation challenges and concepts foreseen within the next 20 years. The hope is that material presented at the workshop and contained in this document will stimulate innovative high-payoff research directed towards the efficiency of future transportation systems. The workshop included five sessions designed to stress the factors that will lead to a revolution in the way we will travel in the 21st century. The first session provides the historical background and a general perspective for future transportation, including emerging transportation alternatives such as working at a distance. Personal travel is the subject of Session Two. The third session looks at mass transportation, including advanced rail vehicles, advanced commuter aircraft, and advanced transport aircraft. The fourth session addresses some of the technologies required for the above revolutionary transportation systems to evolve. The workshop concluded with a wrap-up panel discussion, Session Five. The topics presented herein all have viable technical components and are at a stage in their development that, with sufficient engineering research, one or more of these could make a significant impact on transportation and our social structure.
Author
Transportation; Conferences; Electric Automobiles; Transport Aircraft; Research and Development; Research Vehicles

19960023611; 96N26303 Maryland Univ., Dept. of Aerospace Engineering., College Park, MD USA
The history of transportation, with a peak into the future
Anderson, John D., Jr., Maryland Univ., USA; Transportation Beyond 2000: Technologies Needed for Engineering Design;

Feb. 1996, pp. 3-58; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A04, Hardcopy; A04, Microfiche

In the first part of this presentation, a general historical review of the heydays of various modes of transportation will be given, where 'heydays' will be interpreted as periods of fundamental technological development. With this as background, focus will then be placed on the airplane -- the mode of transportation that has changed the world in the 20th century, and which in the minds of many has been the most important technological development in this century. The technical history of air transportation (the airplane) will be reviewed, with special emphasis on the aerodynamic evolution of the airplane. Some specific examples of pivotal technical advances (and breakthroughs) from the history of applied aerodynamics will be discussed. Finally, this historical perspective will be used to help us peek into the future of transportation in the 21st century.

Author

Histories; Air Transportation; Technology Assessment; Transportation

19960023612; 96N26304 Arizona Univ., Aerospace and Mechanical Engineering Dept., Tucson, AZ USA

In search of cybernautics

Crow, Steven, Arizona Univ., USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 59-82; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This is a talk about the future of aviation in the information age. Ages come and go. Certainly the atomic age came and went, but the information age looks different. This talk reviews some recent experiments on navigation and control with the Global Positioning System. Vertical position accuracies within 1 foot have been demonstrated in the most recent experiments, and research emphases have shifted to issues of integrity, continuity, and availability. Inertial navigation systems (INS) contribute much to the reliability of GPS-based autoland systems. The GPS data stream can cease, and INS can still complete a precision landing from an altitude of 200 feet. The future of aviation looks like automatic airplanes communicating among each other to schedule ground assets and to avoid collisions and wake hazards. The business of the FAA will be to assure integrity of global navigation systems, to develop and maintain the software rules of the air, and to provide expert pilots to handle emergencies from the ground via radio control. The future of aviation is democratic and lends itself to personal airplanes. Some data analyses reveal that personal airplanes are just as efficient as large turbofan transports and just as fast over distances up to 1,000 miles, thanks to the decelerative influence of the hub and spoke system. Maybe by the year 2020, the airplane will rank with the automobile and computer as an agent of personal freedom.

Author (revised)

Cybernetics; Aeronautical Engineering; Global Positioning System; Inertial Navigation

19960023620; 96N26312 NASA Langley Research Center, Hampton, VA USA

Far term visions: The frontiers of the responsibly imaginable

Bushnell, Dennis M., NASA Langley Research Center, USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 261-295; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This lecture discusses envisaged advanced concepts across the speed range including VTOL converticars (personal air transportation), advanced subsonic and supersonic long haul transports, hypersonic transports, and developments/applications of flow control technology. In most cases, these concepts and approaches offer at least the potential of 100 percent improvements in various performance metrics and, in some cases, far more. Special emphasis is given to advanced VTOL configurations which may offer simultaneous opportunities for mitigation of both drag-due-to-lift and wake vortex hazard and to synergistic propulsive and aerodynamic interactions. The lecture concludes that a virtual revolution in the civilian aeronautical world is conceivable as a result of technology maturation in several areas which could enable the exploitation of 'end-point' designs.

Author (revised)

Air Transportation; Transport Aircraft; Vertical Takeoff Aircraft; Feasibility Analysis; Aircraft Design; Aeronautical Engineering

19960023621; 96N26313 NASA Langley Research Center, Hampton, VA USA

History, a projection of the future: A rotary wing perspective

Huston, Robert J., NASA Langley Research Center, USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 297-330; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The success and failure of past vehicle concepts is reviewed in an attempt to highlight some of the advanced vehicle concepts attempted in the past failed because of a lack of appreciation, by both the sponsors and the developer, for the technical and societal requirements critical to their success. This paper will review the history of some attempts to provide both good hover and forward flight efficiency and will point out some of the technical and societal obstacles encountered. Two examples, that of the tiltrotor and tiltwing

vehicles. will be highlighted show the different paths followed by a successful and an unsuccessful concept. The outlook for future VTOL/rotary wing concepts will be evaluated.
Author
Vertical Takeoff Aircraft; Horizontal Flight; Histories; Tilt Rotor Aircraft; Tilt Wing Aircraft

19960023730; 96N26387 Stanford Univ., Dept. of Aeronautics and Astronautics., CA USA
The Research and Training Activities for the Joint Institute for Aeronautics and Acoustics ***Annual Report***
Cantwell, Brian, Stanford Univ., USA; Jul. 199551p; In English
Contract(s)/Grant(s): NCC2-55
Report No.(s): NASA-CR-201006; NAS 1.26:201006; Aero-42-95; No Copyright; Avail: CASI; A04, 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 period 1 Oct. 1995 - 30 Sept. 1996. 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 and high lift modeling studies. 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 high lift activities.
Author
Aeroacoustics; Active Control; Jet Aircraft Noise; Angle of Attack; Delta Wings; Aircraft Control; Unsteady Flow; Aerodynamics; Noise Generators; Noise Reduction

19960023929; 96N26557 NASA Lewis Research Center, Cleveland,OH USA
Study of Water Droplet Trajectories in the NASA Lewis Research Center Icing Research Tunnel (IRT)
Reehorst, Andrew L., NASA Lewis Research Center, USA; May 1996220p; In English
Contract(s)/Grant(s): RTOP 505-68-10
Report No.(s): NASA-TM-107221; E-10253; NAS 1.15:107221; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

Water droplet trajectories within the NASA Lewis Research Center's Icing Research Tunnel (IRT) were studied through both experiment and computer analysis. of interest was the influence of the wind tunnel contraction and wind tunnel model blockage on the water droplet trajectories. The computer analysis was carried out with a program package consisting of a three-dimensional potential panel code with integral boundary layer modeling and a three-dimensional droplet trajectory code utilizing a 'local Stokes' approximation. An initial computational parameter study was performed using a spherical geometry to assess the accuracy of the computer code methodology. The gravity term was examined by calculating droplets falling in stagnant air. An experiment was conducted that consisted of a single moveable nozzle spraying water onto a grid installed in the center of the tunnel test section. Water impingement on the grid was recorded with the use of blotter paper. Agreement between the calculated trajectories within the IRT and the experimental data was found to be very good. The wind tunnel contraction was found to influence the water droplet cloud size distribution and liquid water content distribution across the test section from that at the inlet. The wind tunnel walls were found to have negligible influence upon the impingement of water droplets upon a wing model.
Author
Aircraft Icing; Aircraft Safety; Ice Prevention; Panel Method (Fluid Dynamics); Computational Fluid Dynamics; Drops (Liquids); Computer Programs; Particle Trajectories; Wind Tunnel Tests

02
AERODYNAMICS

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

19960017996; 96N23428 Cornell Univ., Ithaca, NY USA
A theoretical and experimental study of the interaction of a streamwise vortex with a surface
Bodstein, Gustavo Cesar Rachid, Cornell Univ., USA; 1993180p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9401886, Hardcopy, Microfiche

The interaction of a streamwise vortex with a surface is studied theoretically and experimentally. This type of vortex flow is of relevance to an aircraft possessing a close-coupled canard-wing configuration. A physical model is developed based on the assumption that the wing has a large surface, with a large chord. The wing is represented by a semi-infinite surface set at zero angle of attack. It is assumed that the vortex, generated upstream, is a straight vortex filament, with constant strength, and laying in the direction of the free-stream. The vortex filament is orthogonal to the leading-edge and it passes a certain distance over the surface. The three-dimensional flow obtained is assumed to be incompressible, steady, inviscid and irrotational. A mathematical formulation for this model is devised based on Laplace's equation for the velocity potential. The boundary value problem is solved analytically using Fourier transforms and the Wiener-Hopf technique. A closed form solution for the velocity potential is determined, from which the velocity and pressure distributions and a vortex path correction are calculated. Experimental results are obtained for the pressure distribution on the

surface and the velocity field around the vortex. Helium-soap bubble flow visualization studies are performed to trace the vortex, and oil-surface flow pattern visualization results are also obtained to assess the occurrence of boundary-layer separation. The main conclusions are: both the theoretical and the experimental results indicate that the pressure distribution is anti-symmetric along the surface's span, in regions near the leading-edge, and symmetric downstream from it; the agreement between experimental and theoretical results is good for weak interactions; when the interaction becomes strong, the model overestimates the suction peak and does not predict the occurrence of a secondary vortex due to secondary boundary layer separation; vortex core/boundary layer interaction and vortex breakdown are also observed to occur in the strong interaction cases, the vertical displacement of the vortex is observed to be small and is predicted well by the theory, whereas the lateral displacement is non-negligible and is predicted well only for weak interactions.
Dissert. Abstr.
Aerodynamic Configurations; Boundary Value Problems; Flow Visualization; Free Flow; Inviscid Flow; Leading Edges; Three Dimensional Flow; Two Phase Flow; Vortex Filaments; Wiener Hopf Equations; Wings

19960018005; 96N23437 California Inst. of Tech., Pasadena, CA USA
Hypervelocity flow over spheres
Wen, Chihyung, California Inst. of Tech., USA; 1994185p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9431871, Hardcopy, Microfiche

The nature of the non equilibrium flow of dissociating gases over spheres was investigated experimentally, numerically and theoretically. A series of experiments with three different gases, nitrogen, air and carbon dioxide, was performed in the shock tunnel T5 at GALCIT. Five spheres of different radii equipped with thermocouples for surface heat flux measurements were used. The state-of-the-art numerical method by Candler (1988) was used to conduct a parallel study which strongly complemented the experimental and theoretical efforts. Experimental heat flux measurements are presented. Good agreement was observed among the measured stagnation point heat transfer rates, computational results and Fay and Riddell's theoretical predictions. For nitrogen and air, the measured heat flux distributions were also in good agreement with numerical computation results and Lees' theory. For carbon dioxide, large deviations were observed. Early transition tripped by surface roughness is a possible cause for the deviation of heat flux distribution from the theory. The experimental differential interferograms were compared with the images constructed from computational flowfields. Good agreement of fringe pattern and shock shape was observed. An analytical solution is obtained for inviscid hypervelocity dissociating flow over spheres. The solution explains the correlation between the dimensionless stand-offdistance and the dimensionless reaction rate parameter previously observed by Hornung (1972) for nitrogen. The physics of the correlation can be shown as the binary scaling. Based on the solution, a new dimensionless reaction rate parameter is defined to generalize Hornung's correlation for more complex gases than nitrogen. Experimental and numerical results confirm the new correlation. The effect of nonequilibrium recombination downstream of a curved two-dimensional shock was also addressed. An analytical solution for an ideal dissociating gas was obtained, giving an expression for dissociation fraction as a function of temperature on a streamline. The solution agrees well with the numerical result and provides a rule of thumb to check the validity of binary scaling for the experimental conditions. The effects upon the binary scaling of the large difference in freestream temperature between flight and free-piston shock tunnel conditions are discussed.
Dissert. Abstr.
Hypervelocity Flow; Spheres; Dissociation; Gas Flow; Nitrogen; Carbon Dioxide; Shock Tunnels; Aerodynamic Heat Transfer; Flow Distribution

19960018010; 96N23442 Stanford Univ., CA USA
Numerical analysis of three-dimensional flow solvers applied to high-angle-of-attack flows
Levy, Yuval, Stanford Univ., USA; 1994157p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9429963, Hardcopy, Microfiche

When slender bodies of revolution are placed at high incidence, the flow around them becomes asymmetric. The flow asymmetry is characterized by vortices that curve away from the body from alternate sides to almost align with the free-stream. Despite countless experiments the question of the origin of flow asymmetry remains unresolved. However, experimenters agree that, there is an angle-of-attack range, where the flow is very sensitive to minute imperfections of the body's tip and to free-stream disturbances, suggesting the existence of inherent instabilities in the expected symmetric flow. Large efforts were recently directed to computational studies of high incidence flows around slender bodies. The potential capacity of computations to obtain disturbance-free solutions seemed to be the key to resolving the mystery. But, numerical solutions of such flows are sensitive to minute imperfections caused by numerical errors, including grid imperfections and round-off and truncation errors. Numericists using different algorithms presented conflicting results regarding the role of symmetry-breaking disturbances. Are they needed only to trigger the asymmetry, or is their permanent presence necessary to sustain an asymmetric solution? This work contains comparisons among a flux-split algorithm, the Beam and Warming algorithm in its original and diagonal forms, and a hybrid algorithm combining block and diagonal forms. The results show that numerical simulations based on the diagonal or hybrid algorithms could yield asymmetric flows without the introduction of asymmetric per-

turbations, while simulations based on the flux-split or the Beam and Warming algorithm maintain symmetry. Analyses of the algorithms showed that the flux-split and Beam and Warming algorithms maintain symmetry-preserving properties and that the diagonal algorithm lacks them. The second part of this work includes simulations of asymmetric flows using the flux-split algorithm and a simulated disturbance placed near the body apex. Good quantitative agreement between the numerical and experimental results was achieved after systematically varying the disturbance size. A well defined progression of the flow asymmetry as a function of the disturbance size was observed. Analysis of the numerical results and the correlation between the disturbances and the asymmetric flow pointed to a convective instability mechanism as the origin of flow asymmetry.
Dissert. Abstr.
Numerical Analysis; Three Dimensional Flow; Angle of Attack; Slender Bodies; Asymmetry; Vortices; Bodies of Revolution; Actuators

19960018095; 96N23525 Stanford Univ., CA USA
Turbulence measurements in the near-field of a wingtip vortex
Chow, Jim Sean, Stanford Univ., USA; 1994241p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9508338, Hardcopy, Microfiche

The roll-up of a wingtip vortex, at Reynolds number based on chord of 4.6 million, was studied with an emphasis on suction side and near wake measurements. The research was conducted in a 32 in. x 48 in. low-speed wind tunnel. The half-wing model had a semi-span of 36 in., a chord of 48 in., and a rounded tip. Seven-hole pressure probe measurements of the velocity field surrounding the wingtip showed that a large axial velocity, of up to 1.77 U(sub infinity), developed in the vortex core. This level of axial velocity has not been previously measured. Triple-wire probes have been used to measure all components of the Reynolds stress tensor. It was determined from correlation measurements that meandering of the vortex was small and did not appreciably contribute to the turbulence measurements. The flow was found to be turbulent in the near-field (as high as 24 percent RMS w-velocity on the edge of the core) and the turbulence decayed quickly with streamwise distance because of the nearly solid body rotation of the vortex core mean flow. A streamwise variation of the location of peak levels of turbulence, relative to the core centerline, was also found. Close to the trailing edge of the wing, the peak shear stress levels were found at the edge of the vortex core, whereas in the most downstream wake planes they occurred at a radius roughly equal to one-third of the vortex core radius. The Reynolds shear stresses were not aligned with the mean strain rate, indicating that an isotropic-eddy-viscosity based prediction method cannot accurately model the turbulence in the vortex. In cylindrical coordinates, with the origin at the vortex centerline, the radial normal stress was found to be larger than the circumferential.
Dissert. Abstr.
Core Flow; Near Wakes; Turbulence; Wind Tunnel Tests; Wing Tip Vortices

19960018103; 96N23533 Stanford Univ., CA USA
A theoretical and computational study on the effects of leading edge lateral blowing on delta wing aerodynamics
Hong, John Suh, Stanford Univ., USA; 1994160p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9508374, Hardcopy, Microfiche

The aerodynamics of slender delta wings are dominated by the vortical flowfield created by the leading edge vortices. Because these vortices play such a significant aerodynamic role, this study investigates how to further enhance their favorable influence. In particular, it examines the effect of using leading edge lateral blowing to artificially alter and control their development, thereby increasing the maneuverability and control of an aircraft. Experimental, theoretical, and computational approaches have been used to study the aerodynamic aspects of leading edge lateral blowing. Building on the results of Celik's experiments with leading edge lateral blowing, this study developed a theoretical model to analyze the origin of the aerodynamic forces and the effects of various parameters such as the angle of attack or the jet ejection angle. This model, however, did not explain the control reversal phenomenon and the higher efficiency of partial slot blowing compared to full slot blowing observed in the experiments. CFD was then used to obtain a detailed description of the flowfield that did account for these phenomena. The underlying mechanisms and physics of this blowing scheme were determined by examining the computational results. Finally, to demonstrate the feasibility and effectiveness of this blowing scheme as a list and roll control mechanism, the theoretical model was extended to the dynamic case. The model was coupled with the equation of motion of the wing to capture wing rock. The effects of leading edge lateral blowing and a simple open loop control law were then added, which successfully eliminated the wing rock.
Dissert. Abstr.
Delta Wings; Lateral Control; Blowing; Flow Distribution; Leading Edges; Slender Wings; Vortices; Mathematical Models

19960018126; 96N23556 Texas Univ., Austin, TX USA
A computational study of the aerodynamics of a body immersed in a compressible wake
Ober, Curtis Curry, Texas Univ., USA; 1994212p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9428619, Hardcopy, Microfiche

A computational investigation of a trailing body within the supersonic wake of a leading body was performed to determine the aerodynamic characteristics and possible flight tra-

jectory of the trailing body. A Reynolds-averaged, thin-layer, Navier-Stokes code, F3D Zonal, was compared against experimental data of single-body wakes and it was determined that the thin-layer approximation with the Baldwin-Lomax turbulence model was an effective and economical means to predict the near wake behind the leading body. However, the computational method was found to be insufficient to model the complex reverse flow and nonequilibrium turbulence within the recirculation zone. With the upstream conditions computable, the effects of (1) two leading body geometries, (2) wake profile perturbations, (3) laminar versus turbulent wakes, and (4) various placements of the trailing body were examined. At larger separation distances ((Delta x)/D = 4.63, 7.20) which placed the trailing body downstream of the wake neck and coaxial with the incoming wake, a toroidal vortex was formed at the nose of the trailing body. This structure developed from the high pressure at reattachment, causing the lower momentum fluid along the wake centerline to separate and reattach at the body shoulder. The size of the toroidal vortex was dependent on the relative strengths of the reattachment pressure and the stagnation pressure behind the shock at the centerline. When the trailing body was radially displaced ((Delta r)/D = 0.05, 0.15, and 0.25), the toroidal vortex was replaced with a horseshoe vortex which diminished in size with increasing displacement. At (Delta r)/D = 0.25, no vortical structure was evident. the drag coefficient for the trailing body with coaxial alignment increased with increasing separation distance for both leading body geometries. However, the trailing-body drag should be considered in order to obtain a desirable body spacing. For off-axis alignments, the drag increased wiht exposure to freestream conditions. The lift coefficient indicated that the trailing body will tend to move towards the wake centerline, but the pitching moment suggested that an angle of attack will develop.
Dissert. Abstr.
Compressible Flow; Aerodynamic Characteristics; Supersonic Wakes; Trailing Edges; Flight Paths; Flow Distribution

19960018140; 96N23570 Colorado Univ., Boulder, CO USA
An experimental study of impulsively stopping flow over airfoils and finite wings
Busch, Hauke Christian, Colorado Univ., USA; 1994200p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9506313, Microfiche

This thesis reflects experimental parametric investigations done on impulsively stopped flow over airfoils and finite wings. Impulsively stopped flow is an unsteady flow phenomenon which occurs when the steady free stream flow field over a body is decelerated instantaneously to rest. After the flow is stopped, vortex patterns, dependent on a variety of nondimensional parameters, develop. Impulsively stopping flow is one unsteady flow type of a large family of unsteady flow phenomena. Unsteady flow has numerous applications in the practical, as in the scientific, world. Sudden decelerating flows occur very frequently during airplane maneuvers, and to flow inside internal combustion engines. More frequently stopping flow can be observed in nature in sudden wind gushes stressing a structure, or in birds and insects which carry out fast aerodynamic maneuvers to kill their prey. This study on impulsively stopping flow focuses primarily in exploring systematically vortex pattern developments over a NACA 0015 airfoil with a range of angles of attack from -10 deg to 90 deg and a Reynolds number ranging between 600 and 150,000, including both separated and attached stopping flow phenomena over this airfoil. Furthermore a large amount of quantitative results (e.g. unsteady lift and drag coefficients) were experimentally obtained. Other explorations of stopping flow focused on square, rectangular, and circular cylinders and flat plates, over an equally large range of dimensionless parameters. Additional explorations were carried out, studying stopping flow over finite wings (delta, circular, square, and rectangular), which created unique stopping flow vortex structures. The stopping flow boundary layer was analyzed in detail. With help of this analysis, a criteria was developed which sets requirements for wind and water tunnels that are intended to be used for stopping flow experimentation. Finally this thesis presents some numerically generated stopping flow visualization results and compares them with experimentally obtained visualization results. The results of this experimental study are intended to provide a resource for understanding other unsteady flows, where stopping flow or only a partial impulsive deceleration occurs. Furthermore the experimental results are also intended to provide a challenge as well as 'ground truth' for comparison with future two and three dimensional unsteady computer models.
Dissert. Abstr.
Airfoils; Angle of Attack; Reynolds Number; Unsteady Flow; Vortices; Wings; Wind Tunnel Tests; Stagnation Flow

19960018309; 96N23637 Stanford Univ., CA USA
Numerical study of the trailing vortex of a wing with wing-tip blowing
Lim, Hock-Bin, Stanford Univ., USA; 1994139p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9429969, Hardcopy, Microfiche

Trailing vortices generated by lifting surfaces such as helicopter rotor blades, ship propellers, fixed wings, and canard control surfaces are known to be the source of noise, vibration, cavitation, degradation of performance, and other hazardous problems. Controlling these vortices is therefore of practical interest. The formation and behavior of the trailing vortices are studied in the present research. In addition, wing-tip blowing concepts employing axial blowing and spanwise blowing are studied to determine their effectiveness in controlling these vortices and their effects on the performance of the wing. The three-dimensional, unsteady, thin-layer compressible Navier-Stokes equations are solved using a time-

accurate, implicit, finite difference scheme that employs LU-ADI factorization. The wing-tip blowing is simulated using the actuator plane concept, thereby not requiring resolution of the jet slot geometry. Furthermore, the solution blanking feature of the chimera scheme is used to simplify the parametric study procedure for the wingtip blowing. Computed results are shown to compare favorably with experimental measurements. It is found that axial wing-tip blowing, although delaying the rolling-up of the trailing vortices and the near field behavior of the flowfield, does not dissipate the circulation strength of the trailing vortex farther downstream. Spanwise wing-tip blowing has the effect of displacing the trailing vortices outboard and upward. The increased 'wingspan' due to the spanwise wing-tip blowing has the effect of lift augmentation on the wing and the strengthening of the trailing vortices. Secondary trailing vortices are created at high spanwise wing-tip blowing intensities.
Dissert. Abstr.
Numerical Analysis; Vortices; Wing Tips; Navier-Stokes Equation; Flow Distribution; Cavitation Flow; Canard Configurations; Lift Augmentation; Rotary Wings; Spanwise Blowing

19960018378; 96N23704 Texas A&M Univ., Houston, TX USA
Experimental investigation of the influence of wing sweep on juncture flow
Khan, Mohammad Javed, Texas A&M Univ., USA; 1994329p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9432707, Hardcopy, Microfiche

Influence of wing sweep on juncture flow has been investigated using three component laser Doppler velocimetry and body-surface pressure measurements. Configurations with forward and back sweep angles of 7.5 deg, 15 deg, 22.5 deg, 30 deg and 45 deg were studied. Comparisons were made with a zero-sweep wing-body juncture. A multi-vortex system transitioning with increasing Reynolds numbers from a static three-vortex structure (Mode 1) to an oscillating three-four vortex system (Mode 2) and finally to a three-four vortex shedding/splitting system (Mode 3) was observed. Increase in back-sweep angle delayed the transition to the higher modes and modified Mode 3 behavior. Strengthening of the vortex-system up to +15 deg back-sweep angles was observed as an increased pressure difference between the local extrema in the plane of symmetry on the body-surface and maximum back-flow mean velocity. With increasing forward-sweep, the vortex-system was less observable as fully formed in the plane of symmetry. However immediately outside the region of influence of the spanwise flow along the attachment line, the vortex system was seen to be fully formed. Additionally a strong counter-rotating vortex closer to the wing was also observed. Variation of horizontal location of the vortex in the transverse planes with changes in sweep angle was in contrast to that suggested by the surface flow patterns. In these planes the vortex lifted up higher for forward-swept wings and was insensitive to changes in sweep angle compared to back-swept configurations. Larger portions of the wing leading-edge were contaminated by the turbulence in the separated flow for increasing back-sweep angles. Relatively lower levels of turbulence were noted in the plane of symmetry of the forward-swept configurations Unsteady nature of flow in the juncture was observed in the form of multi-modal velocity histograms but was limited to regions much closer to the body-surface for forward-swept wings as compared to other configurations.
Dissert. Abstr.
Swept Forward Wings; Body-Wing Configurations; Flow Distribution; Laser Doppler Velocimeters; Vortex Shedding; Separated Flow; Vortices; Leading Edges

19960018412; 96N23738 North Carolina State Univ., Raleigh, NC USA
Thermo-chemical nonequilibrium effects on the aerothermodynamics of hypersonic vehicles
Hassan, Basil, North Carolina State Univ., USA; 1993163p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9404140, Hardcopy, Microfiche

A three-dimensional computational fluid dynamics algorithm is developed to study the effect of thermal and chemical nonequilibrium on blunt and slender body aerothermodynamics. Both perfect gas and reacting gas air models are used to compute the flow over several hypersonic vehicles. The reacting air mixture is characterized by a translational-rotational temperature and a vibrational-electron-electronic temperature and includes eight chemical species. The Navier-Stokes computations are compared to wind tunnel and flight data where available to examine the effects of chemical reaction, vibrational excitation, and ionization on lift-to-drag ratio and trim angle of attack. A modified Diagonal Implicit time advancement scheme is developed to handle flows in thermochemical nonequilibrium and is shown to have improved convergence behavior as compared to a previous method. Results from the numerical algorithm are compared to computations from other investigators for Project Fire 2. Flow and surface properties are found to be in good agreement for axisymmetric non-ionized and ionized flows. Perfect gas and five species air reacting gas models are used to compute the flow over the Apollo Command Module and are compared to wind tunnel and flight aerodynamic data from the unmanned Apollo AS-202 mission. A lower trim angle of attack and lift-to-drag ratio results from including effects of dissociation and vibrational nonequilibrium when compared to predictions by nonreacting gas wind tunnel simulations. Both perfect gas and reacting gas calculations compare well with the wind tunnel and flight data, respectively, and the results are consistent with the observed aerodynamic trends. Results over a generic transatmospheric vehicle show significant differences in center of gravity location between typical flight and tunnel configurations at the same Mach number, Reynolds number, and

trim angle of attack. For the same center of gravity location, the wind tunnel model trims at lower angle of attack than the full scale flight case. Non-ionized and ionized results for a proposed lunar transfer vehicle compare well to computational results obtained from a previously validated reacting gas algorithm. Under the conditions investigated, effects of weak ionization on the heat transfer and aerodynamic coefficients were minimal. The results obtained demonstrate that the computation of nonequilibrium, reacting gas flows in three dimensions can be accomplished in an efficient manner. Real gas effects are shown to significantly influence the aerothermodynamic behavior of two classes of hypersonic vehicles. This work gives evidence that proper modeling of the physical processes is essential for hypersonic vehicle design.
Dissert. Abstr.
Aerothermodynamics; Chemical Equilibrium; Hypersonic Vehicles; Thermodynamic Equilibrium; Slender Bodies; Blunt Bodies; Real Gases; Reacting Flow; Three Dimensional Flow

19960020413; 96N23990 Virginia Polytechnic Inst. and State Univ., Dept. of Aerospace and Ocean Engineering., Blacksburg, VA USA
Sensitivity Analysis of Wing Aeroelastic Responses
Issac, Jason Cherian, Virginia Polytechnic Inst. and State Univ., USA; Nov. 1995161p; In English
Contract(s)/Grant(s): NAG1-1411
Report No.(s): NASA-CR-200813; NAS 1.26:200813; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

Design for prevention of aeroelastic instability (that is, the critical speeds leading to aeroelastic instability lie outside the operating range) is an integral part of the wing design process. Availability of the sensitivity derivatives of the various critical speeds with respect to shape parameters of the wing could be very useful to a designer in the initial design phase, when several design changes are made and the shape of the final configuration is not yet frozen. These derivatives are also indispensable for a gradient-based optimization with aeroelastic constraints. In this study, flutter characteristic of a typical section in subsonic compressible flow is examined using a state-space unsteady aerodynamic representation. The sensitivity of the flutter speed of the typical section with respect to its mass and stiffness parameters, namely, mass ratio, static unbalance, radius of gyration, bending frequency, and torsional frequency is calculated analytically. A strip theory formulation is newly developed to represent the unsteady aerodynamic forces on a wing. This is coupled with an equivalent plate structural model and solved as an eigenvalue problem to determine the critical speed of the wing. Flutter analysis of the wing is also carried out using a lifting-surface subsonic kernel function aerodynamic theory (FAST) and an equivalent plate structural model. Finite element modeling of the wing is done using NASTRAN so that wing structures made of spars and ribs and top and bottom wing skins could be analyzed. The free vibration modes of the wing obtained from NASTRAN are input into FAST to compute the flutter speed. An equivalent plate model which incorporates first-order shear deformation theory is then examined so it can be used to model thick wings, where shear deformations are important. The sensitivity of natural frequencies to changes in shape parameters is obtained using ADIFOR. A simple optimization effort is made towards obtaining a minimum weight design of the wing, subject to flutter constraints, lift requirement constraints for level flight and side constraints on the planform parameters of the wing using the IMSL subroutine NCONG, which uses successive quadratic programming.
Author (revised)
Aeroelasticity; Aircraft Design; Aerodynamic Forces; Critical Velocity; Flutter Analysis; Wings; Flutter; Unsteady Aerodynamics; Computer Aided Design

19960020422; 96N23995 Kansas Univ., Center for Research, Inc., Lawrence, KS USA
An Investigation of Cavity Vortex Generators in Supersonic Flow
Hazlewood, Richard, Kansas Univ., USA; Feb. 1996136p; In English; Original contains color illustrations
Contract(s)/Grant(s): NCC1-172; RTOP 307-50-14-03
Report No.(s): NASA-CR-198202; NAS 1.26:198202; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The purpose of this report is to document the results of experiments performed at the University of Kansas and at the NASA Langley Research Center (LaRC) into the use of shaped cavities to generate vortices in supersonic flow, as well as the progress made in simulating the observed flow using the PAB3D flow solver. The investigation was performed on 18 different cavity configurations installed in a convergent-divergent nozzle at the Jet Exit Facility at the LaRC. Pressure sensitive paint, static-pressure ports, focusing Schliern, and water tunnel flow visualization techniques were used to study the nature of the flow created by these cavities. The results of these investigations revealed that a shaped cavity can generate a pair of counter-rotating streamwise vortices in supersonic flow by creating weak, compression Mach waves and weak shocks. The PAB3D computer program, developed at the LaRC, was used to attempt to reproduce the experimental results. Unfortunately, due to problems with matching the grid blocks, no converged results were obtained. However, intermediate results, as well as a complete definition of the grid matching problems and suggested courses of actions are presented.
Author
Vortex Generators; Supersonic Flow; Convergent-Divergent Nozzles; Flow Distribution; Vortices; Flow Visualization; Computational Fluid Dynamics; Wind Tunnel Tests; Cavity Flow

19960020435; 96N24008 NASA Langley Research Center, Hampton,VA USA

Experimental Surface Pressure Data Obtained on 65 deg Delta Wing Across Reynolds Number and Mach Number Ranges. Vol. 3: Medium-radius leading edge

Chu, Julio, NASA Langley Research Center, USA; Luckring, James M., NASA Langley Research Center, USA; Feb. 199644p; In English

Contract(s)/Grant(s): RTOP 505-59-54-01

Report No.(s): NASA-TM-4645-Vol-3; L-17411C-Vol-3; NAS 1.15:4645-Vol-3; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An experimental wind tunnel test of a 65 deg delta wing model with interchangeable leading edges was conducted in the Langley National Transonic Facility (NTF). The objective was to investigate the effects of Reynolds and Mach numbers on slender-wing leading-edge vortex flows with four values of wing leading-edge bluntness. Experimentally obtained pressure data are presented without analysis in tabulated and graphical formats across a Reynolds number range of 6 x 10(exp 6) to 120 x 10(exp 6) at a Mach number of 0.85 and across a Mach number range of 0.4 to 0.9 at Reynolds numbers of 6 x 10(exp 6), 60 x 10(exp 6), and 120 x 10(exp 6). Normal-force and pitching-moment coefficient plots for these Reynolds number and Mach number ranges are also presented.

Author

Delta Wings; Slender Wings; Reynolds Number; Mach Number; Blunt Leading Edges; Wind Tunnel Tests; Subsonic Speed; Static Pressure; Vortices

19960020440; 96N24013 NASA Lewis Research Center, Cleveland, OH USA

Implementation of a Two-Equation k-omega Turbulence Model in NPARC

Yoder, Dennis A., NASA Lewis Research Center, USA; Georgiadis, Nicholas J., NASA Lewis Research Center, USA; Orkwis, Paul D., Cincinnati Univ., USA; Apr. 199624p; In English; 34th Aerospace Sciences Meeting and Exhibit, 15-18 Jan. 1996, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 537-02-23

Report No.(s): NASA-TM-107080; E-9955; NAS 1.15:107080; AIAA Paper 96-0383; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The implementation of a two-equation k-omega turbulence model into the NPARC flow solver is described. Motivation for the selection of this model is given, major code modifications are outlined, new inputs to the code are described, and results are presented for several validation cases: an incompressible flow over a smooth flat plate, a subsonic diffuser flow, and a shock-induced separated flow. Comparison of results with the k-epsilon model indicate that the k-omega model predicts simple flows equally well whereas, for adverse pressure gradient flows, the k-omega model outperforms the other turbulence models in NPARC.

Author

Turbulence Models; Computational Fluid Dynamics; Flow Distribution; Navier-Stokes Equation; Applications Programs (Computers); Separated Flow; Incompressible Flow; Pressure Gradients; Shock Waves; Turbulent Boundary Layer

19960020449; 96N24022 NASA Langley Research Center, Hampton,VA USA

Effect of Full-Chord Porosity on Aerodynamic Characteristics of the NACA 0012 Airfoil

Mineck, Raymond E., NASA Langley Research Center, USA; Hartwich, Peter M., Vigyan Research Associates, Inc., USA; Apr. 199696p; In English

Contract(s)/Grant(s): RTOP 505-59-10-30

Report No.(s): NASA-TP-3591; L-17492; NAS 1.60:3591; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

A test was conducted on a model of the NACA 0012 airfoil section with a solid upper surface or a porous upper surface with a cavity beneath for passive venting. The purposes of the test were to investigate the aerodynamic characteristics of an airfoil with full-chord porosity and to assess the ability of porosity to provide a multipoint or self-adaptive design. The tests were conducted in the Langley 8-Foot Transonic Pressure Tunnel over a Mach number range from 0.50 to 0.82 at chord Reynolds numbers of 2 x 10(exp 6), 4 x 10(exp 6), and 6 x 10(exp 6). The angle of attack was varied from -1 deg to 6 deg. At the lower Mach numbers, porosity leads to a dependence of the drag on the normal force. At subcritical conditions, porosity tends to flatten the pressure distribution, which reduces the suction peak near the leading edge and increases the suction over the middle of the chord. At supercritical conditions, the compression region on the porous upper surface is spread over a longer portion of the chord. In all cases, the pressure coefficient in the cavity beneath the porous surface is fairly constant with a very small increase over the rear portion. For the porous upper surface, the trailing edge pressure coefficients exhibit a creep at the lower section normal force coefficients, which suggests that the boundary layer on the rear portion of the airfoil is significantly thickening with increasing normal force coefficient.

Author

Porosity; Aerodynamic Characteristics; Airfoils; Wind Tunnel Tests; Mach Number; Reynolds Number; Angle of Attack; Pressure Distribution; Upper Surface Blowing; Airfoil Profiles

19960020459; 96N24031 NASA Langley Research Center, Hampton,VA USA

Experimental Surface Pressure Data Obtained on 65 deg Delta Wing Across Reynolds Number and Mach Number Ranges. Vol. 4: Large-radius leading edge

Chu, Julio, NASA Langley Research Center, USA; Luckring, James M., NASA Langley Research Center, USA; Feb. 199638p; In English
Contract(s)/Grant(s): RTOP 505-59-54-01
Report No.(s): NASA-TM-4645-Vol-4; L-17411D-Vol-4; NAS 1.15:4645-Vol-4; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An experimental wind tunnel test of a 65 deg delta wing model with interchangeable leading edges was conducted in the Langley National Transonic Facility (NTF). The objective was to investigate the effects of Reynolds and Mach numbers on slender-wing leading-edge vortex flows with four values of wing leading-edge bluntness. Experimentally obtained pressure data are presented without analysis in tabulated and graphical formats across a Reynolds number range of 6 x 10(exp 6) to 120 x 10(exp 6) at a Mach number of 0.85 and across a Mach number range of 0.4 to 0.9 at Reynolds numbers of 6 x 10(exp 6) and 60 x 10(exp 6). Normal-force and pitching-moment coefficient plots for these Reynolds number and Mach number ranges are also presented.
Author
Delta Wings; Reynolds Number; Mach Number; Vortices; Wind Tunnel Tests; Slender Wings; Blunt Leading Edges; Subsonic Speed; Static Pressure

19960020475; 96N24047 Research Inst. for Advanced Computer Science, Moffett Field, CA USA
An Overset Grid Navier-Stokes/Kirchhoff-Surface Method for Rotorcraft Aeroacoustic Predictions
Duque, Earl P. N., Army Aviation Systems Command, USA; Strawn, Roger C., Army Aviation Systems Command, USA; Ahmad, Jasim, Sterling Software, Inc., USA; Biswas, Rupak, Research Inst. for Advanced Computer Science, USA; Feb. 199620p; In English; AIAA 34th Aerospace Sciences Meeting and Exhibit, 15-18 Jan. 1996, Reno, NV, USA
Contract(s)/Grant(s): NAS2-13721
Report No.(s): NASA-CR-200854; NAS 1.26:200854; RIACS-TR-96-06; AIAA Paper 96-0152; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper describes a new method for computing the flowfield and acoustic signature of arbitrary rotors in forward flight. The overall scheme uses a finite-difference Navier-Stokes solver to compute the aerodynamic flowfield near the rotor blades. The equations are solved on a system of overset grids that allow for prescribed cyclic an flapping blade motions and capture the interactions between the rotor blades and wake. The far-field noise is computed with a Kirchhoff integration over a surface that completely encloses the rotor blades. Flowfield data are interpolated onto this Kirchhoff surface using the same overset-grid techniques that are used for the flowfield solution. As a demonstration of the overall prediction scheme, computed results for far-field noise are compared with experimental data for both high-speed impulsive (HSI) and blade-vortex interaction (BVI) cases. The HSI case showed good agreement with experimental data while a preliminary attempt at the BVI case did not. The computations clearly show that temporal accuracy, spatial accuracy and grid resolution in the Navier-Stokes solver play key roles in the overall accuracy of the predicted noise. These findings will be addressed more closely in future BVI computations. Overall, the overset-grid CFD scheme provides a powerful new framework for the prediction of helicopter noise.
Author
Navier-Stokes Equation; Rotary Wing Aircraft; Flow Distribution; Aircraft Noise; Computational Grids; Computational Fluid Dynamics; Finite Difference Theory; Aeroacoustics; Noise Prediction (Aircraft); Blade-Vortex Interaction; Rotary Wings

19960020515; 96N24064 National Research Council of Canada, Ottawa, Ontario Canada
Torque and Thrust from Five-Hole Pressure Probe Measurements in the Near Slipstream of a Propeller in Compressible Flow *Couple et Traction Derives des Mesures Obtenues au Moyen des Sondes a Cinq Trous dans le Sillage Proche d'Une Helice en Ecoulement Compressible*
Ohman, L. H., Institute for Aerospace Research, Canada; Apr. 199560p; In English
Report No.(s): NRC-32168; IAR-AN-81; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

A momentum analysis of the compressible flow through a propeller, leading to integral expressions for torque and thrust in terms of local flow quantities such as flow angles, total pressure and Mach number, that can be derived from five-hole pressure probe measurements in the near slipstream, has been performed. Such data, obtained for two similar propellers at Mach numbers 0.6 and 0.7, were processed to yield torque and thrust coefficients. The coefficients thus obtained compared favorably with those derived from balance measurements. Two examples of radial torque and thrust loading distributions, derived from the probe data were compared with theoretical data based on strip-analysis, showing good agreement. The report demonstrates that the five-hole pressure probe technique can be successfully employed to obtain torque and thrust characteristics for propellers in compressible flow.
Author
Compressible Flow; Momentum; Torque; Thrust Loads; Propeller Slipstreams; Integral Equations; Subsonic Flow

19960020523; 96N24072 NASA Langley Research Center, Hampton,VA USA
Internal Performance of Highly Integrated Deployable Exhaust Nozzles Applicable to Advanced Short-Takeoff and Vertical-Landing Aircraft
Asbury, Scott C., NASA Langley Research Center, USA; Mason, Mary L., NASA Langley Research Center, USA;

Lamb, Milton, NASA Langley Research Center, USA; OCT. 1995284p; In English
Contract(s)/Grant(s): RTOP 505-59-70
Report No.(s): NASA-TP-3542; L-17467; NAS 1.60:3542; No Copyright; Avail: CASI; A13, Hardcopy; A03, Microfiche

An investigation was conducted in the Jet-Exit Test Facility of the Langley 16-Foot Transonic Tunnel to evaluate the internal performance of highly integrated deployable exhaust nozzles (HIDEN) applicable to advanced short-takeoff and vertical-landing tactical aircraft. This investigation studied the performance of four HIDEN nozzle concepts in both the forward (thrust) and vertical (lift) operation modes. Two plenum designs with different offtake duct geometries varied the vertical distance between the plenum centerline and bearing plane surface centerline. Four plenum centerbodies with interchangeable blockers were tested to simulate engine fan- and core-mounted nozzle installations. All tests were conducted with no external flow and nozzle pressure ratio (NPR) was varied from 1.5 to approximately 6.0. Results indicate that the HIDEN nozzle concept has internal performance characteristics comparable to thrust-vectoring convergent-divergent nozzles. However, the exhaust flow was slightly underturned with each nozzle design, which resulted in a cosine thrust loss. Nozzles installed on the offset plenum had higher internal performance than the same nozzles installed on the centerline plenum throughout the entire NPR range investigated. Changing operation mode had only small effects on internal performance characteristics. Centerbody and blocker effects were also small.
Author
Short Takeoff Aircraft; Stovl Aircraft; Thrust Vector Control; Convergent-Divergent Nozzles; Duct Geometry

19960020544; 96N24093 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA USA
Study of Semi-Span Model Testing Techniques
Gatlin, Gregory M., National Aeronautics and Space Administration. Langley Research Center, USA; McGhee, Robert J., National Aeronautics and Space Administration. Langley Research Center, USA; Jun. 199622p; In English; 14th Applied Aerodynamics Conference, 17-20 Jun. 1996, New Orleans, LA, USA
Report No.(s): NASA-TM-111454; NAS 1.15:111454; AIAA Paper 96-2386; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

An investigation has been conducted in the NASA Langley 14- by 22-Foot Subsonic Tunnel in order to further the development of semi-span testing capabilities. A twin engine, energy efficient transport (EET) model with a four-element wing in a takeoff configuration was used for this investigation. Initially a full span configuration was tested and force and moment data, wing and fuselage surface pressure data, and fuselage boundary layer measurements were obtained as a baseline data set. The semi-span configurations were then mounted on the wind tunnel floor, and the effects of fuselage standoff height and shape as well as the effects of the tunnel floor boundary layer height were investigated. The effectiveness of tangential blowing at the standoff/floor juncture as an active boundary-layer control technique was also studied. Results indicate that the semi-span configuration was more sensitive to variations in standoff height than to variations in floor boundary layer height. A standoff height equivalent to 30 percent of the fuselage radius resulted in better correlation with full span data than no standoff or the larger standoff configurations investigated. Undercut standoff leading edges or the use of tangential blowing in the standoff/ floor juncture improved correlation of semi-span data with full span data in the region of maximum lift coefficient.
Derived from text
Semispan Models; Aerodynamic Configurations; Takeoff; Wind Tunnel Tests; Lift

19960020554; 96N24103 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA USA
Sensitivity Analysis of the Static Aeroelastic Response of a Wing
Eldred, Lloyd B., Virginia Polytechnic Inst. and State Univ., USA; Feb. 1993147p; In English
Contract(s)/Grant(s): NAG1-1411
Report No.(s): NASA-CR-200793; NAS 1.26:200793; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

A technique to obtain the sensitivity of the static aeroelastic response of a three dimensional wing model is designed and implemented. The formulation is quite general and accepts any aerodynamic and structural analysis capability. A program to combine the discipline level, or local, sensitivities into global sensitivity derivatives is developed. A variety of representations of the wing pressure field are developed and tested to determine the most accurate and efficient scheme for representing the field outside of the aerodynamic code. Chebyshev polynomials are used to globally fit the pressure field. This approach had some difficulties in representing local variations in the field, so a variety of local interpolation polynomial pressure representations are also implemented. These panel based representations use a constant pressure value, a bilinearly interpolated value. or a biquadratically interpolated value. The interpolation polynomial approaches do an excellent job of reducing the numerical problems of the global approach for comparable computational effort. Regardless of the pressure representation used. sensitivity and response results with excellent accuracy have been produced for large integrated quantities such as wing tip deflection and trim angle of attack. The sensitivities of such things as individual generalized displacements have been found with fair accu-

racy. In general, accuracy is found to be proportional to the relative size of the derivatives to the quantity itself.
Author
Aeroelasticity; Three Dimensional Models; Wings; Pressure Distribution; Chebyshev Approximation; Polynomials; Angle of Attack; Static Characteristics; Wing Tips; Finite Difference Theory

19960020615; 96N24155 Army Research Lab., Aberdeen Proving Ground, MD USA
Roll Damping for Finned Projectiles Including: Wraparound, Offset, and Arbitrary Number of Fins *Final Report, Jan. 1992 - May 1993*
Mikhail, Ameer, Army Research Lab., USA; Aug. 199535p; In English
Contract(s)/Grant(s): DA Proj. 1L1-62618-AH-80
Report No.(s): ARL-TR-846; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An algebraic correlation for the roll-damping and roll-producing moments coefficients for finned projectiles and missiles has been extended and verified to accept (1) bodies with arbitrary number of fins (i.e., not only four cruciform fins), (2) curved wraparound fins with fin cant, and (3) fins with offset angles. The extended correlation is also applicable in subsonic, transonic, and supersonic speed regimes. A direct method to compute the fin roll-producing moment from the fin normal force is provided to circumvent the lengthy and cumbersome semi-empirical existing methods. Seven different missile and projectile configurations with widely varying fin shapes and sizes were tested, and their measured data are provided for completeness. The present correlation is very simple and can be used to refine initial configuration selection and thus reduces the number of costly full flow field computations.
Author
Finned Bodies; Projectiles; Lateral Control; Roll; Damping; Missile Bodies

19960020631; 96N24167 Korea Univ., Seoul, Korea, Republic of
Design and implementation of fuzzy-logic based aircraft drag-chute system
Lee, Kyung-Keun, Korea Univ., Korea, Republic of; Hwang, Chong-Sun, Korea Univ., Korea, Republic of; Cho, Young-im, Korea Univ., Korea, Republic of; IFSA 1995: Proceedings of the 6th International Fuzzy Systems Association World Congress; 1995, pp. 41-44; In English; Also announced as 19960020627; No Copyright; Avail: CASI; A01, Hardcopy; A06, Microfiche

Real world does not always exist stable state. Especially, manual control in aircraft need choose real-time processing fuzzy implication operator because of execution in variable situation and limited area such as runway. In this paper, we adaptive show that apply selection fuzzy implication operator R(sub 8) R(sub 25) to aircraft model requiring real-time processing in limited area. Also, we suggest FADS (Fuzzy-logic based Aircraft Drag-chute System) that can ease a less-experienced pilots anxiety and support the aircraft safely.
Author
Fuzzy Systems; Logic Programming; Mathematical Logic; Aerodynamic Drag; Drag Chutes; Human Factors Engineering; Operators (Mathematics)

19960020712; 96N24235 Kyushu Univ., Faculty of Engineering., Fukuoka, Japan
Analysis of nonlinear aircraft dynamics
Kawabe, Hiroyasu, Kyushu Univ., Japan; Hayashi, Yuki, Kyushu Univ., Japan; Goto, Norihiro, Kyushu Univ., Japan; Nov. 1995, pp. 589-596; In Japanese; Also announced as 19960020708; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Airplanes maneuvering, especially at high angles of attack, sometimes undergo sudden jumps in their response to the pilot's inputs. In order to explain these phenomena it is necessary to solve nonlinear simultaneous equations that result when all time-derivatives are set equal to zero. In order to solve these equations, this study uses the PSS(Pseudo Steady States) analysis and continuation method. In the PSS, the gravity effects are ignored. On the other hand, the continuation method has the advantage in that no simplification is required. These methods not only provide quantitative global stability information, but also provide the capability to predict and explain such nonintuitive phenomena such as jumps, limit cycles, and hysteresis that often induce the pilot to controlling actions which worsens the situation. Numerical calculations were carried out for a jet-type airplane, and the region of steady roll states, which are obtained as the singular points of the equations of motion, is determined for combinations of parameters which are the aileron, the elevator and the rudder deflections. The stability characteristics of the steady roll states are identified by the first method of Lyapunov and the center manifold theory.
Author
Aerodynamic Characteristics; Flight Characteristics; Aircraft Maneuvers; Nonlinear Equations; Simultaneous Equations; Equations of Motion; Prediction Analysis Techniques; Aircraft Stability

19960020781; 96N24304 Old Dominion Univ., Dept. of Electrical and Computer Engineering., Norfolk, VA USA
Sensitivity analysis in multipole-accelerated panel methods for potential flow
Leathrum, James F., Jr., Old Dominion Univ., USA; The 1995 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1995, pp. 90; In English; Also announced as 19960020755; No Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

In the design of an airframe, the effect of changing the geometry on resulting computations is necessary for design optimization. The geometry is defined in terms of a series of design variables, including design variables to define the wing planform, tail, canard, pylon, and nacelle. Design optimization in this research is based on how these design variable affect the potential flow. The potential flow is computed as a function of the geometry and location of a series of panels describing the airframe, which are in turn a function of the design variables. Multipole accelerated panel methods improve the computational complexity of the problem and thus are an attractive approach. To utilize the methods in design optimization, it was necessary to define the appropriate sensitivity derivatives. The overhead incurred from finding the sensitivity derivatives in conjunction with the original computation should be small. This research developed the background for multipole-accelerated panel methods and the framework for finding sensitivity derivatives in the methods. Potential flow panel codes are commonly used for powered-lift aerodynamic predictions for three dimensional geometries. Given an airframe which has been discretized into a series of panels to define the airframe geometry, potential is computed as a function of the influence of all panels on all other panels. This is a computationally intensive problem for which efficient solutions are desired to improve the computational time and to allow greater resolution by use of more panels. One such solution is the use of hierarchical multipole methods which entail approximations of the effects of far-field terms. Hierarchical multipole methods have become prevalent in molecular dynamics and gravitational physics, and have been introduced into the fields of capacitance calculations, computational fluid dynamics, and electromagnetics. The methods utilize multipole expansions to describe the effect of bodies (i.e. particles, astrophysical bodies, panels, etc.) within a sphere on points distant from the sphere, where the influence diminishes as a function of distance. The expansions are exact with infinite series, however, for practical computations, the series are truncated and accuracy is selected based on the number of terms retained in the expansions. A hierarchical tree structure groups bodies together based on proximity to allow definition of multipole expansions for each group. The multipole expansions are then used to compute the effect of the bodies in a group on distant bodies.
Author
Airframes; Potential Flow; Powered Lift Aircraft; Panel Method (Fluid Dynamics); Computational Fluid Dynamics

19960020822; 96N24345 National Aerospace Lab., Amsterdam, Netherlands
Wind tunnel flutter testing on shingles in the transonic and supersonic speed regime
Persoon, Albert J., National Aerospace Lab., Netherlands; Nov. 199516p; In English; Also announced as 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Various types of shingles, being part of the heat protection system of re-entry vehicles, were investigated in the transonic and supersonic speed regime using NLR's High Speed (HST) and Supersonic (SST) wind tunnels. The investigations were carried out in close cooperation with Marcel Dassault Aviations (AMD) and Daimler Benz Raumfahrt Infrastruktur GmbH (DASA-RI). A review is given of the wind tunnel experiments with emphasis on the generation and control of noise levels of the boundary layer in which the shingles were placed during the tests. The use of a spoiler or suction of the flow, both affecting the flutter characteristics of a shingle, will be discussed. The behavior of unsteady pressures close to the shingle (upstream and downstream) is highlighted as these pressures might act as a monitoring device to define the onset of flutter or limit cycle oscillations of a panel.
Author
Wind Tunnel Tests; Flutter; Transonic Speed; Supersonic Speed; Boundary Layers; Aeroacoustics; Noise Intensity; Sound Pressure; Thermal Protection; Reentry Shielding; Tiles

19960020827; 96N24350 NASA Langley Research Center, Hampton, VA USA
A quarter century of NASA wind-tunnel and flight experiments involving aeroservoelasticity
Noll, Thomas E., NASA Langley Research Center, USA; Perry, Boyd, III, NASA Langley Research Center, USA; Perry, Boyd, III, NASA Dryden Flight Research Center, USA; Nov. 199512p; In English; Also announced as 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Over the past quarter century, the NASA Langley Research Center (LaRC) and the NASA Dryden Flight Research Center (DFRC) have played major roles in the development, demonstration, and validation of aeroservoelastic modeling, analysis, design, and testing methods. Many of their contributions resulted from their participation in wind-tunnel and flight-test programs aimed at demonstrating advanced active control concepts that interact with and/or exploit the aeroelastic characteristics of flexible structures. Other contributions are a result of their interest in identifying and solving adverse aeroservoelastic interactions that allow unique flight-test demonstrations or flight envelope clearance programs to be successfully completed. This paper provides an overview of some of the more interesting aeroservoelastic investigations conducted in the transonic dynamics tunnel (TDT) at LaRC and in flight at DFRC. Four flight-test projects are reviewed in this paper. These test projects were selected because of their contributions to the state-of-the-art in active controls technology (ACT) or because of the knowledge

gained in further understanding the complex mechanisms that cause adverse aeroservoelastic interactions.
Author
Aeroservoelasticity; Transonic Wind Tunnels; Wind Tunnel Tests; Flight Tests; Active Control

19960020958; 96N24464 NASA Langley Research Center, Hampton,VA USA
Aerothermal Study of Mars Pathfinder Aeroshell
Gupta, Roop N., NASA Langley Research Center, USA; Lee, K. P., Vigyan Research Associates, Inc., USA; Scott, Carl D., NASA Johnson Space Center, USA; 199512p; Repr. from Journal of Spacecraft and Rockets, v. 33, no. 1, p 61-69, Jan. - Feb. 1996; In English
Report No.(s): NASA-TM-111461; NAS 1.15:111461; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

An aerothermodynamic study of the Mars Pathfinder aeroshell is carried out through a viscous-shock layer (VSL) analysis with and without surface ablation. Stagnation-point results are obtained along a specified trajectory, and detailed calculations along the body are provided at the peak-heating point. The formulation of VSL equations with a new length scale and the implementation of the Vigneron pressure condition predict the extent of the subsonic region and the surface pressure, which compare well with Navier-Stokes calculations. For equilibrium as well as nonequilibrium flow results, a gas composed of 16 species is used to model the shock layer for the Martian atmosphere (97% CO2 and 3% N2). A physically consistent surface recombination model (which allows for the diffusion limitation of reactants) for CO2 is obtained. A parametric study as the trajectory peak-heating point suggests that surface catalysis has the largest effect on heating prediction. The maximum stagnation point heating of 127 W/cm(exp 2) is obtained at an altitude of 40.7 km from nonequilibrium chemistry calculations with fully recombined CO2 as the surface boundary condition. Equilibrium chemistry gives a similar value for the nonablation case at this altitude. Calculations have also been carried out to evaluate the reduction in heating because of ablation. A decrease of about 9% in the stagnation-heating value (with equilibrium chemistry) is obtained at the peak heating point.
Author
Aerothermodynamics; Mars Pathfinder; Shock Layers; Ablation; Mars Atmosphere; Atmospheric Entry; Aerodynamic Heating

19960020976; 96N24481 Old Dominion Univ., Dept. of Aerospace Engineering., Norfolk, VA USA
Coupled Rolling and Pitching Oscillation Effects on Transonic Shock-Induced Vortex-Breakdown Flow of a Delta Wing
Kandil, Osama A., Old Dominion Univ., USA; Menzies, Margaret A., Old Dominion Univ., USA; Aeroelastic, CFD, and Dynamic Computation and Optimization for Buffet and Flutter Applications; Feb. 199612p; In English; 34th Aerospace Sciences Meeting and Exhibit, 13-18 Jan. 1996, Reno, NV, USA; Also announced as 19960020975
Report No.(s): AIAA Paper 96-0828; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

Unsteady, transonic vortex dominated flow over a 65 deg. sharp edged, cropped-delta wing of zero thickness undergoing forced coupled pitching and rolling oscillations is investigated computationally. The wing mean angle of attack is 20 deg. and the free stream Mach number and Reynolds number are 0.85 and 3.23 x 10(exp 6), respectively. The initial condition of the flow is characterized by a transverse terminating shock and vortex breakdown of the leading edge vortex cores. The computational investigation uses the time-accurate solution of the laminar, unsteady, compressible, full Navier-Stokes equations with the implicit, upwind, Roe flux-difference splitting, finite volume scheme. The main focus is to analyze the effects of coupled motion on the wing response and vortex breakdown flow by varying oscillation frequency and phase angle while the maximum pitch and roll amplitude is kept constant at 4.0 deg. Four cases demonstrate the following: simultaneous motion at a frequency of 1(pi), motion with a 90 deg. phase lead in pitch, motion with a rolling frequency of twice the pitching frequency, and simultaneous motion at a frequency of 2(pi). Comparisons with single mode motion at these frequencies complete this study and illustrate the effects of coupling the oscillations.
Author
Delta Wings; Shock Waves; Transonic Flow; Unsteady Flow; Pitching Moments; Navier-Stokes Equation; Vortex Breakdown; Rolling Moments; Flux Difference Splitting; Oscillating Flow

19960020977; 96N24482 Old Dominion Univ., Dept. of Aerospace Engineering., Norfolk, VA USA
Effects of Coupled Rolling and Pitching Oscillations on Transonic Shock-Induced Vortex-Breakdown Flow of a Delta Wing
Kandil, Osama A., Old Dominion Univ., USA; Menzies, Margaret A., Old Dominion Univ., USA; Aeroelastic, CFD, and Dynamic Computation and Optimization for Buffet and Flutter Applications; Feb. 19968p; In English; 6th International Symposium on Computational Fluid Dynamics, 4-8 Sep. 1995, Lake Tahoe, NV, USA; Also announced as 19960020975; Copyright Waived (NASA); Avail: CASI; A02, Hardcopy; A01, Microfiche

Unsteady, transonic vortex-breakdown flow over a 65 deg. sharp edged, cropped-delta wing of zero thickness undergoing forced coupled pitching and rolling oscillations is investigated computationally. The initial condition of the flow is characterized by a transverse terminating shock which induces of the leading edge vortex cores to breakdown. The computational investigation uses the time-accurate solution

of the laminar, unsteady, compressible, full Navier-Stokes equations with the implicit, upwind, Roe flux-difference splitting, finite-volume scheme. The main focus is to analyze the effects of coupled motion on the wing response and vortex-breakdown flow by varying oscillation frequency and phase angle while keeping the maximum pitch and roll amplitude equal.
Author
Delta Wings; Navier-Stokes Equation; Oscillating Flow; Roll; Transonic Flow; Unsteady Flow; Vortex Breakdown; Computational Fluid Dynamics

19960020978; 96N24483 Old Dominion Univ., Dept. of Aerospace Engineering., Norfolk, VA USA
Structural Dynamic/CFD Interaction for Computation of Vertical Tail Buffet
Kandil, Osama A., Old Dominion Univ., USA; Massey, Steven J., Old Dominion Univ., USA; Sheta, Essam F., Old Dominion Univ., USA; Aeroelastic, CFD, and Dynamic Computation and Optimization for Buffet and Flutter Applications; Feb. 199616p; In English; The Royal Aeronautical Society International Forum on Aeroelasticity and Structural Dynamics 1995, 26-28 Jun. 1995, Manchester, UK; Also announced as 19960020975
Contract(s)/Grant(s): NAG1-994
Report No.(s): RAS Paper 16.52; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

The multi-disciplinary problem of tail buffeting is solved using three sets of equations. The first set is the unsteady, compressible, full Navier Stokes equations which are used for obtaining the flow-field vector and the aerodynamic loads. The second set is the coupled aeroelastic equations which are used for obtaining the bending and torsional deflections of the tail. The third set is the grid-displacement equations which are used for updating the grid coordinates due to the tail deflections. For the computational applications a sharp-edged delta wing of aspect ratio one and a rectangular vertical tail of aspect ratio one placed in the plane of geometric symmetry behind the wing are considered. The configuration is pitched at a critical angle of attack (alpha = 38 deg.) which produces asymmetric, vortex-breakdown flow of the delta wing primary vortices. The results show the effects of coupled and uncoupled bending-torsional responses and the effects of the Reynolds number.
Author
Aerodynamic Loads; Aeroelasticity; Angle of Attack; Buffeting; Delta Wings; Navier-Stokes Equation; Tail Assemblies; Vortex Breakdown; Computational Fluid Dynamics; Dynamic Structural Analysis

19960020979; 96N24484 Old Dominion Univ., Dept. of Aerospace Engineering., Norfolk, VA USA
Forced Rolling Oscillation of a 65 deg-Delta Wing in Transonic Vortex-Breakdown Flow
Menzies, Margaret A., Old Dominion Univ., USA; Kandil, Osama A., Old Dominion Univ., USA; Kandil, Hamdy A., Old Dominion Univ., USA; Aeroelastic, CFD, and Dynamic Computation and Optimization for Buffet and Flutter Applications; Feb. 199622p; In English; 13th AIAA Applied Aerodynamics Conference, 19-22 Jun. 1995, Sheraton Harbor, CA, USA; Also announced as 19960020975
Report No.(s): AIAA Paper 95-1771-CP; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

Unsteady, transonic, vortex dominated flow over a 65 deg. sharp-edged, cropped-delta wing of zero thickness undergoing forced rolling oscillations is investigated computationally. The wing angle of attack is 20 deg. and the free stream Mach number and Reynolds number are 0.85 and 3.23 x 10(exp 6), respectively. The initial condition of the flow is characterized by a transverse terminating shock which induces vortex breakdown of the leading edge vortex cores. The computational investigation uses the time accurate solution of the laminar, unsteady, compressible, full Navier-Stokes equations with the implicit, upwind, Roe flux difference splitting, finite-volume scheme. While the maximum roll amplitude is kept constant at 4.0 deg., both Reynolds number and roll frequency are varied covering three cases of forced sinusoidal rolling. First, the Reynolds number is held at 3.23 x 10(exp 6) and the wing is forced to oscillate in roll around the axis of geometric symmetry at a reduced frequency of 2(pi). Second, the Reynolds number is reduced to 0.5 x 10(exp 6) to observe the effects of added viscosity on the vortex breakdown. Third, with the Reynolds number held at 0.5 x 10(exp 6), the roll frequency is reduced to 1(pi) to complete the study.
Author
Angle of Attack; Delta Wings; Computational Fluid Dynamics; Rolling Moments; Vortex Breakdown; Navier-Stokes Equation; Flux Difference Splitting; Transonic Flow; Unsteady Flow; Oscillating Flow

19960020980; 96N24485 Hampton Univ., Dept. of Mathematics., VA USA
A Hybrid Boundary Element-Finite Volume Method for Unsteady Transonic Airfoil Flows
Hu, Hong, Hampton Univ., USA; Kandil, Osama A., Old Dominion Univ., USA; Aeroelastic, CFD, and Dynamic Computation and Optimization for Buffet and Flutter Applications; Feb. 199610p; Repr. from Engineering Analysis with Boundary Elements (UK, Elsevier Science Limited), v. 14, 1994 p 149-157; In English; Also announced as 19960020975; Copyright Waived (NASA); Avail: CASI; A02, Hardcopy; A01, Microfiche

A hybrid boundary element finite volume method for unsteady transonic flow computation has been developed. In this method, the unsteady Euler equations in a moving frame of reference are solved in a small embedded domain (inner domain) around the airfoil using an implicit finite volume

scheme. The unsteady full-potential equation, written in the same frame of reference and in the form of the Poisson equation. is solved in the outer domain using the integral equation boundary element method to provide the boundary conditions for the inner Euler domain. The solution procedure is a time-accurate stepping procedure, where the outer boundary conditions for the inner domain are updated using the integral equation -- boundary element solution over the outer domain. The method is applied to unsteady transonic flows around the NACA0012 airfoil undergoing pitching oscillation and ramp motion. The results are compared with those of an implicit Euler equation solver, which is used throughout a large computational domain, and experimental data.
Author
Computational Fluid Dynamics; Boundary Element Method; Euler Equations of Motion; Finite Volume Method; Poisson Equation; Transonic Flow; Unsteady Flow; Airfoils

19960021011; 96N24504 Arizona State Univ., Tempe, AZ USA
Aerodynamic Requirements for BVI Noise Control ***Final Report***
Wells, Valana L., Arizona State Univ., USA; Apr. 199642p; In English
Contract(s)/Grant(s): NAG2-844
Report No.(s): NASA-CR-200880; NAS 1.26:200880; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

As a rotor blade moves through the air, it sheds vortices. These vortices shed along the length of the blade over time form the wake. The strongest vortices of the wake are those trailing from the tip of the blade. When a rotating blade system moves under certain operating conditions, each blade will impinge on the tip vortices shed by itself or other blades. This impingement is called a blade-vortex interaction, or BVI. Although the blade and trailing tip vortices interact with many different orientations, one of the two extremes, either parallel or perpendicular interaction, is usually modelled. In a perpendicular interaction, the portion of the blade that is actually interacting with the travelling vortex at any given time is very small. A parallel interaction, however, has the largest concurrent interaction with the blade, as a result this case is given the most attention. One of the most commonly studied occurrences of blade-vortex interactions is associated with low-speed descending rotorcraft flight. BVI occur when the tip vortices shed by the blades intersect the plane of the rotor. BVI cause local pressure changes over the blades which are responsible, in part, for the acoustic signature of the rotorcraft. The local pressure changes also cause vibrations which lead to fatigue of both the blades and the mechanical components driving the blades.
Author
Blade-Vortex Interaction; Aerodynamic Noise; Blade Slap Noise; Blade Tips; Rotary Wing Aircraft; Rotors; Vortices

19960021049; 96N24536 NASA Langley Research Center, Hampton,VA USA
A Longitudinal Aerodynamic Data Repeatability Study for a Commercial Transport Model Test in the National Transonic Facility
Adcock, J. B., NASA Langley Research Center, USA; Wahls, R. A., NASA Langley Research Center, USA; Witkowski, D. P., Boeing Commercial Airplane Co., USA; Wright, F. L., Boeing Commercial Airplane Co., USA; Aug. 199598p; In English
Contract(s)/Grant(s): RTOP 505-59-10-11
Report No.(s): NASA-TP-3522; L-17412; NAS 1.60:3522; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche

A high Reynolds number investigation of a commercial transport model was conducted in the National Transonic Facility (NTF) at Langley Research Center. This investigation was part of a cooperative effort to test a 0.03-scale model of a Boeing 767 airplane in the NTF over a Mach number range of 0.70 to 0.86 and a Reynolds number range of 2.38 to 40.0 x 10(exp 6) based on the mean aerodynamic chord. One of several specific objectives of the current investigation was to evaluate the level of data repeatability attainable in the NTF. Data repeatability studies were performed at a Mach number of 0.80 with Reynolds numbers of 2.38, 4.45, and 40.0 x 10(exp 6), and also at a Mach number of 0.70 with a Reynolds number of 40.0 x 10(exp 6). Many test procedures and data corrections are addressed in this report, but the data presented do not include corrections for wall interference, model support interference, or model aeroelastic effects. Application of corrections for these three effects would not affect the results of this study because the corrections are systematic in nature and are more appropriately classified as sources of bias error. The repeatability of the longitudinal stability-axis force and moment data has been assessed. Coefficients of lift, drag, and pitching moment are shown to repeat well within the pretest goals of +/- 0.005, +/- 0.0001, and +/- 0.001, respectively, at a 95-percent confidence level over both short- and near-term periods.
Author
High Reynolds Number; Mach Number; Wind Tunnel Tests; Pitching Moments; Yawing Moments; Longitudinal Stability; Commercial Aircraft; Transport Aircraft; Lift; Aerodynamic Drag

19960021105; 96N24579 Arizona State Univ., Coll. of Engineering and Applied Science., Tempe, AZ USA
Transition Studies on a Swept-Wing Model ***Final Report, 6 Jan. 1989 - 14 May 1994***
Saric, William S., Arizona State Univ., USA; Apr. 1996478p; In English
Contract(s)/Grant(s): NAG1-937
Report No.(s): NASA-CR-200873; NAS 1.26-200873; No Copyright; Avail: CASI; A21, Hardcopy; A04, Microfiche

The present investigation contributes to the understanding of boundary-layer stability and transition by providing detailed measurements of carefully-produced stationary crossflow vortices. It is clear that a successful prediction of transition in swept-wing flows must include an understanding of the detailed physics involved. Receptivity and nonlinear effects must not be ignored. Linear stability theory correctly predicts the expected wavelengths and mode shapes for stationary crossflow, but fails to predict the growth rates, even for low amplitudes. As new computational and analytical methods are developed to deal with three-dimensional boundary layers, the data provided by this experiment will serve as a useful benchmark for comparison.
Derived from text
Boundary Layer Stability; Swept Wings; Wind Tunnel Tests; Cross Flow; Vortices; Reynolds Number; Boundary Layer Transition; Turbulence Effects; Three Dimensional Boundary Layer; Surface Roughness

19960021635; 96N24942 NASA Ames Research Center, Moffett Field,CA USA
Wing-Body Aeroelasticity Using Finite-Difference Fluid/ Finite-Element Structural Equations on Parallel Computers
Byun, Chansup, NASA Ames Research Center, USA; Guruswamy, Guru P., NASA Ames Research Center, USA; Jan. 01, 199314p; In English; AIAA/ASME/ASCE/AHS/ASC 35th Structural, Structural Dynamics, and Materials Conference, 18-20 Apr. 1994, Hilton Head, SC, USA
Contract(s)/Grant(s): NCC2-740
Report No.(s): NASA-TM-111450; NAS 1.15:111450; AIAA Paper 94-1487; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper presents a procedure for computing the aeroelasticity of wing-body configurations on multiple-instruction, multiple-data (MIMD) parallel computers. In this procedure, fluids are modeled using Euler equations discretized by a finite difference method, and structures are modeled using finite element equations. The procedure is designed in such a way that each discipline can be developed and maintained independently by using a domain decomposition approach. A parallel integration scheme is used to compute aeroelastic responses by solving the coupled fluid and structural equations concurrently while keeping modularity of each discipline. The present procedure is validated by computing the aeroelastic response of a wing and comparing with experiment. Aeroelastic computations are illustrated for a High Speed Civil Transport type wing-body configuration.
Author
Aeroelasticity; Body-Wing Configurations; MIMD (Computers); Finite Difference Theory; Finite Element Method; Computational Fluid Dynamics; Structural Analysis; Aircraft Structures; Grid Generation (Mathematics)

19960022281; 96N25304 California Univ., Dept. of Mechanical and Aeronautical Engineering., Davis, CA USA
A Comparison of Computed and Experimental Flowfields of the RAH-66 Helicopter *Final Report*
vanDam, C. P., California Univ., USA; Budge, A. M., California Univ., USA; Duque, E. P. N., Army Aviation Systems Command, USA; Jan. 01, 199612p; In English
Contract(s)/Grant(s): NCC2-5137
Report No.(s): NASA-CR-200906; NAS 1.26:200906; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper compares and evaluates numerical and experimental flowfields of the RAH-66 Comanche helicopter. The numerical predictions were obtained by solving the Thin-Layer Navier-Stokes equations. The computations use actuator disks to investigate the main and tail rotor effects upon the fuselage flowfield. The wind tunnel experiment was performed in the 14 x 22 foot facility located at NASA Langley. A suite of flow conditions, rotor thrusts and fuselage-rotor-tail configurations were tested. In addition, the tunnel model and the computational geometry were based upon the same CAD definition. Computations were performed for an isolated fuselage configuration and for a rotor on configuration. Comparisons between the measured and computed surface pressures show areas of correlation and some discrepancies. Local areas of poor computational grid-quality and local areas of geometry differences account for the differences. These calculations demonstrate the use of advanced computational fluid dynamic methodologies towards a flight vehicle currently under development. It serves as an important verification for future computed results.
Author
Helicopters; Flow Distribution; Navier-Stokes Equation; Computational Fluid Dynamics; Wind Tunnel Tests; Body-Wing and Tail Configurations; Computational Grids; Fuselages

19960022344; 96N25365 Southampton Univ., Dept. of Aeronautics and Astronautics., UK
Pressure Drag Induced by a Supersonic Flow Over Cavities
Zhang, Xin, Southampton Univ., UK; Feb. 199610p; In English; Also announced as 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Pressure distribution and pressure drag due to a supersonic flow over a dual cavity geometry were studied at Mach 1.5 and 2.5. The study was performed numerically and results compared with an earlier experiment. The mass-averaged Navier-Stokes equations were solved using a finite-volume scheme. The inviscid cell interface fluxes were estimated using Roe's approximate Riemann solver with a second-order extension. Turbulence was modeled using a two-equation k-z model with compressibility corrections. Two test configurations were selected: (1) a length to depth ratio L/D = 1 cavity followed by another L/D = 1 cavity separated by a distance of

1D, and (2) an L/D = 3 cavity followed by an L/D = 1 cavity separated by a distance of 3D. The pressure and drag of the individual cavity was compared with those of a single cavity of same L/D. It was found that the pressure field around the L/D = 1 was substantially modified by a preceding L/D = 3 cavity.
Author
Pressure Drag; Supersonic Flow; Cavity Flow; Aerodynamic Configurations; Pressure Distribution

19960022381; 96N25390 Lockheed Martin Aeronautical Systems, Marietta, GA, USA
Euler Technology Assessment for Preliminary Aircraft Design: Compressibility Predictions by Employing the Unstructured Grid USM3D Code ***Progress Report, 1 Feb. 1995 - 30 Sep. 1995***
Kinard, Tom A., Lockheed Martin Aeronautical Systems, Marietta; Raj, Pradeep, Lockheed Martin Aeronautical Systems, Marietta; Mar. 199676p; In English
Contract(s)/Grant(s): NAS1-19000; RTOP 505-68-30-03
Report No.(s): NASA-CR-4711; NAS 1.26:4711; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This study has been conducted in support of a NASA project aimed at assessing the viability of using Euler technology to produce aerodynamic data for preliminary design. The primary objective is to evaluate the effectiveness of unstructured-grid techniques in simulating compressibility effects for vortical flows. The approach involves comparing computed subsonic- and transonic-flow solutions with each other and with experimental data for a twin-tail and a centerline-tail modular transonic vortex interaction (MTVI) model, representative of generic fighter configurations. The present effort is focused on the application of the unstructured tetrahedral-grid USM3D code. This code, developed at the NASA-Langley Research Center, employs a cell-centered finite-volume upwind algorithm with explicit or implicit time marching scheme to solve the inviscid compressible-flow Euler equations. In this report, correlations of USM3D solutions with measured data are presented at 0.4 and 0.85 Mach numbers for symmetric as well as asymmetric flow conditions. For symmetric cases, the angle of attack varies from 10 to 30 degrees; asymmetric cases cover side-slip angles of 2, 4 and 7 degrees at selected angles of attack. The results show that Euler solutions can provide meaningful guidelines for preliminary design of flight vehicles which exhibit vortex flows in parts of their flight envelope.
Author
Computational Fluid Dynamics; Angle of Attack; Compressibility Effects; Unstructured Grids (Mathematics); Aircraft Design; Vortices; Fighter Aircraft; Finite Volume Method; Inviscid Flow; Compressible Flow; Mach Number

19960022611; 96N25555 Tokai Univ., Faculty of Engineering., Hiratsuka, Japan
BEM analysis of unsteady aerodynamics on an elastically vibrating lifting body
Umejima, Tatsuo, Tokai Univ., Japan; Beppu, Goro, Tokai Univ., Japan; Matsushita, Hiroshi, Tokai Univ., Japan; Yanagisawa, Mitsunori, Tokai Univ., Japan; Proceedings of the Faculty of Engineering of Tokai University, Volume 33, no. 2; 1993, pp. 181-186; In Japanese; Also announced as 19960022600; No Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche; Abstract Only; Abstract Only

BEM (Boundary Element Method) based on Green's function is extended functionally to calculate unsteady aerodynamic forces acting on an elastically vibrating lifting body. This paper treats an aeroelastically scaled wind tunnel model as a lifting body which executes harmonic oscillation in compressible flow. The key variables which describe the boundary condition are panel center velocity vector and normal vector increment at a panel center. The present paper shows how to determine these two variables using FEM (Finite Element Method) vibration analysis data. The model has rigid airfoil segments attached to a flexible spar at a partial spanwise position and a leading and trailing edge control surfaces; variable determination is therefore treated separately according to these structurally different parts. Several typical cases of elastic vibration and control surface oscillation are calculated by the present method and compared with DPM (Doublet Point Method) analysis. The correspondence between these two methods is fairly good.
Author
Aerodynamic Forces; Lifting Bodies; Control Surfaces; Boundary Element Method; Dynamic Structural Analysis; Unsteady Aerodynamics; Wind Tunnel Tests; Harmonic Oscillation

19960022946; 96N25818 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX USA
Modification and Validation of Conceptual Design Aerodynamic Prediction Method HASC95 With VTXCHN ***Final Report, Apr. - Nov. 1995***
Albright, Alan E., Lockheed Martin Tactical Aircraft Systems, USA; Dixon, Charles J., Consulting Aviation Services, USA; Hegedus, Martin C., Nielsen Engineering and Research, Inc., USA; Mar. 1996308p; In English
Contract(s)/Grant(s): NAS1-19000; RTOP 505-68-70-09
Report No.(s): NASA-CR-4712; NAS 1.26:4712; No Copyright; Avail: CASI; A14, Hardcopy; A03, Microfiche

A conceptual/preliminary design level subsonic aerodynamic prediction code HASC (High Angle of Attack Stability and Control) has been improved in several areas, validated, and documented. The improved code includes improved methodologies for increased accuracy and robustness, and simplified input/output files. An engineering method called VTXCHN (Vortex Chine) for prediciting nose vortex shed-

ding from circular and non-circular forebodies with sharp chine edges has been improved and integrated into the HASC code. This report contains a summary of modifications, description of the code, user's guide, and validation of HASC. Appendices include discussion of a new HASC utility code, listings of sample input and output files, and a discussion of the application of HASC to buffet analysis.
Author
Prediction Analysis Techniques; Aerodynamic Stability; Robustness (Mathematics)

19960023033; 96N25876 National Renewable Energy Lab., Golden, CO USA
The evaluation of a turbulent loads characterization system
Kelley, N. D., National Renewable Energy Lab., USA; McKenna, H. E., National Renewable Energy Lab., USA; 19969p; In English; 15th Wind Energy Symposium, 28 Jan. - 2 Feb. 1996, Houston, TX, USA
Contract(s)/Grant(s): AC36-83CH10093; FC36-86CH10311
Report No.(s): NREL/TP-442-20164; CONF-960114-2; DE96-000469; No Copyright; Avail: CASI; A02, Hardcopy

In this paper we discuss an on-line turbulent load characterization system that has been designed to acquire loading spectra from turbines of the same design operating in several different environments and from different turbine designs operating in the same environment. This system simultaneously measures the rainflow-counted alternating and mean loading spectra and the hub-height turbulent mean shearing stress and atmospheric stability associated with the turbulent inflow. We discuss the theory behind the measurement configuration and the results of proof-of-concept testing recently performed at the National Wind Technology Center (NWTC) using a Bergey EXCEL-S 10-kW wind turbine. The on-line approach to characterizing the load spectra and the inflow turbulent scaling parameter produces results that are consistent with other measurements. The on-line approximation of the turbulent shear stress or friction velocity u(*) also is considered adequate. The system can be used to characterize turbulence loads during turbine deployment in a wide variety of environments. Using the WISPER protocol, we found that a wide-range, variable-speed turbine will accumulate a larger number of stress cycles in the low-cycle, high-amplitude (LCHA) region when compared with a constant speed rotor under similar inflow conditions.
DOE
Wind Turbines; Shear Stress; Load Distribution (Forces); Turbulence Effects; Stress Cycles; Turbine Blades; Flow Distribution; On-Line Systems; Fatigue (Materials)

19960023078; 96N25905 Kyushu Univ., Faculty of Engineering., Fukuoka, Japan
Experimental study of bow shock wave/turbulent boundary layer interaction region induced by blunt protuberance
Aso, Shigeru, Kyushu Univ., Japan; Maekawa, Syozo, Kyushu Univ., Japan; Karashima, Keiichi, Kyushu Univ., Japan; Sato, Kiyoshi, Kyushu Univ., Japan; Jan. 1995, pp. 65-70; In Japanese; Also announced as 19960023071; No Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche; Abstract Only; Abstract Only

An experimental study on the bow shock wave/turbulent boundary layer interaction region induced by a blunt protuberance has been conducted. The experiments have been performed under testing conditions of freestream Mach numbers of 2, 3 and 4, total pressure of 0.3-0.6 MPa and unit Reynolds number of 1.8-3.8 X 10(exp 7)/m. The flow fields are visualized by a conventional oil flow technique for investigating surface flow patterns and the Schlieren method for investigating unsteady oscillating shock wave structures in a separation region. Also, surface pressure distributions have been measured. The primary separation lines for various Mach numbers appear at almost the same locations, and Mach number independence of the primary separated region has been revealed. The streamwise pressure distributions along the centerline show a pressure plateau in the primary separated region, and the peak pressure is located just after the flow attachment line. For the freestream Mach number of 4, the peak pressure is increased up to almost 6 times of the undisturbed pressure. The results show the detailed flow structures of a bow shock wave/turbulent boundary layer interaction region induced by a blunt protuberance.
Author
Bow Waves; Shock Waves; Turbulent Boundary Layer; Wave Interaction; Blunt Bodies; Protuberances; Reynolds Number; Mach Number; Pressure; Free Flow; Supersonic Speed; Turbulent Flow

19960023329; 96N26108 Research Inst. for Advanced Computer Science, Moffett Field, CA USA
Business Jet Wing Design Using Aerodynamic Shape Optimization
Gallman, John W., NASA Ames Research Center, USA; Reuther, James J., Research Inst. for Advanced Computer Science, USA; Pfeiffer, Neal J., Raytheon Aircraft Co., USA; Forrest, William C., Raytheon Aircraft Co., USA; Bernstorf, David J., Raytheon Aircraft Co., USA; Jan. 199618p; In English; AIAA 34th Aerospace Sciences Meeting and Exhibit, Jan. 1996, USA
Contract(s)/Grant(s): NAS2-13721
Report No.(s): NASA-CR-200962; NAS 1.26:200962; RIACS-TR-96-03; AIAA Paper 96-0554; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

A new method that relies on computational fluid dynamics (CFD) and numerical optimization is used to design a transonic business jet wing. The first step of this new design method is to develop target pressures for a three-dimensional wing design using a two-dimensional airfoil optimization code (MSES-LINDOP). This airfoil optimization method is

fast enough to solve a six-point design problem that is representative of an entire aircraft mission in a few minutes. A full-potential finite element code with a solution adaptive cartesian grid (TRANAIR) is used to analyze the wing-body-nacelle configuration and establish the influence of the fuselage mounted nacelles on the wing pressures. The blockage in the flow caused by these nacelles is approximated in a wing-body Euler CFD code (SYN87) with a large bump on the aft fuselage. The SYN87 code also solves an adjoint set of equations to evaluate the flowfield sensitivities in approximately the same time as that required to solve the Euler equations for one flowfield. These flowfield sensitivities enable three dimensional shape optimization in this study with a quasi-Newton optimization routine. The objective function used to design both the fuselage bump and the wing contours was a sum-of-squares of the difference between computed and target wing pressures. Finally, the surface contours are modified slightly with a computer aided drawing machine to reduce manufacturing complexity. Wind tunnel data from the Boeing transonic Wind Tunnel is in very good agreement with the pressure distributions developed for 20 deg swept wing considered in this study. This data shows that the design goals of natural laminar flow at a Mach number of 0.75 and minimum wave drag at a Mach number of 0.80 have been met and provides a validation of the design method developed in this study.

Author

Computational Fluid Dynamics; Body-Wing Configurations; Wing Nacelle Configurations; Aircraft Design; Computational Grids; Pressure Distribution; Finite Element Method; Flow Distribution; Swept Wings; Laminar Flow; Iterative Solution; Transonic Flow; Three Dimensional Models

19960023330; 96N26109 NASA Langley Research Center, Hampton,VA USA

Prediction of Airfoil Characteristics With Higher Order Turbulence Models

Gatski, Thomas B., NASA Langley Research Center, USA; Apr. 199626p; In English

Contract(s)/Grant(s): RTOP 505-59-50-05

Report No.(s): NASA-TM-110246; NAS 1.15:110246; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This study focuses on the prediction of airfoil characteristics, including lift and drag over a range of Reynolds numbers. Two different turbulence models, which represent two different types of models, are tested. The first is a standard isotropic eddy-viscosity two-equation model, and the second is an explicit algebraic stress model (EASM). The turbulent flow field over a general-aviation airfoil (GA(W)-2) at three Reynolds numbers is studied. At each Reynolds number, predicted lift and drag values at different angles of attack are compared with experimental results, and predicted variations of stall locations with Reynolds number are compared with experimental data. Finally, the size of the separation zone predicted by each model is analyzed, and correlated with the behavior of the lift coefficient near stall. In summary, the EASM model is able to predict the lift and drag coefficients over a wider range of angles of attack than the two-equation model for the three Reynolds numbers studied. However, both models are unable to predict the correct lift and drag behavior near the stall angle, and for the lowest Reynolds number case, the two-equation model did not predict separation on the airfoil near stall.

Author

Airfoils; Turbulence Models; Turbulent Flow; Reynolds Number; Aerodynamic Coefficients; Eddy Viscosity; Flow Distribution

19960023571; 96N26264 NASA Ames Research Center, Moffett Field,CA USA

Spatial Resolution, Grayscale, and Error Diffusion Trade-offs: Impact on Display System Design *Final Report*

Gille, Jennifer L., Principal Investigator, NASA Ames Research Center, USA; May 199612p; In English

Contract(s)/Grant(s): NCC2-788

Report No.(s): NASA-CR-201011; NAS 1.26:201011; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

We examine technology trade-offs related to grayscale resolution, spatial resolution, and error diffusion for tessellated display systems. We present new empirical results from our psychophysical study of these trade-offs and compare them to the predictions of a model of human vision.

Author

Tradeoffs; Discrimination; Display Devices; Gray Scale; Performance Prediction; Spatial Resolution

19960023576; 96N26269 Research Inst. for Advanced Computer Science, Moffett Field,CA USA

Aerodynamic design optimization via reduced Hessian SQP with solution refining

Feng, Dan, Research Inst. for Advanced Computer Science, USA; Pulliam, Thomas H., Research Inst. for Advanced Computer Science, USA; Dec. 199524p; In English

Contract(s)/Grant(s): NAS2-13721

Report No.(s): NASA-CR-201054; NAS 1.26:201054; RIACS-TR-95-24; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An all-at-once reduced Hessian Successive Quadratic Programming (SQP) scheme has been shown to be efficient for solving aerodynamic design optimization problems with a moderate number of design variables. This paper extends this scheme to allow solution refining. In particular, we introduce a reduced Hessian refining technique that is critical for making a smooth transition of the Hessian information from coarse grids to fine grids. Test results on a nozzle design using quasi-one-dimensional Euler equations show that

through solution refining the efficiency and the robustness of the all-at-once reduced Hessian SQP scheme are significantly improved.
Author
Quadratic Programming; Design Analysis; Aerodynamics; Computational Grids; Hessian Matrices

19960023578; 96N26271 Research Inst. for Advanced Computer Science, Moffett Field, CA USA
A Solution Adaptive Structured/Unstructured Overset Grid Flow Solver with Applications to Helicopter Rotor Flows
Duque, Earl P. N., Research Inst. for Advanced Computer Science, USA; Biswas, Rupak, Research Inst. for Advanced Computer Science, USA; Strawn, Roger C., Research Inst. for Advanced Computer Science, USA; Apr. 199516p; In English; 13th; AIAA Applied Aerodynamics Conference, 19-21 Jun. 1995, San Diego, CA, USA
Contract(s)/Grant(s): NAS2-13721
Report No.(s): NASA-CR-201053; NAS 1.26:201053; RIACS-TR-95-09; AIAA Paper 95-1766; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper summarizes a method that solves both the three dimensional thin-layer Navier-Stokes equations and the Euler equations using overset structured and solution adaptive unstructured grids with applications to helicopter rotor flowfields. The overset structured grids use an implicit finite-difference method to solve the thin-layer Navier-Stokes/Euler equations while the unstructured grid uses an explicit finite-volume method to solve the Euler equations. Solutions on a helicopter rotor in hover show the ability to accurately convect the rotor wake. However, isotropic subdivision of the tetrahedral mesh rapidly increases the overall problem size.
Author
Navier-Stokes Equation; Structured Grids (Mathematics); Unstructured Grids (Mathematics); Finite Difference Theory; Flow Distribution; Helicopters; Computational Grids; Helicopter Wakes; Computational Fluid Dynamics; Rotary Wings

19960023622; 96N26314 NASA Ames Research Center, Moffett Field, CA USA
Highly nonplanar lifting systems
Kroo, Ilan, Stanford Univ., USA; McMasters, John, Boeing Commercial Airplane Co., USA; Smith, Stephen C., NASA Ames Research Center, USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 331-370; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper deals with nonplanar wing concepts -- their advantages and possible applications in a variety of aircraft designs. A brief review and assessment of several concepts from winglets to ring wings is followed by a more detailed look at two recent ideas: exploiting nonplanar wakes to reduce induced drag, and applying a 'C-wing' design to large commercial transports. Results suggest that potential efficiency gains may be significant, while several nonaerodynamic characteristics are particularly interesting.
Author
Aircraft Design; Aircraft Wakes; Wing Profiles; Drag Reduction; Aerodynamic Characteristics

19960023729; 96N26386 NASA Langley Research Center, Hampton,VA USA
Improved Method for Prediction of Attainable Wing Leading-Edge Thrust
Carlson, Harry W., Lockheed Martin Engineering and Sciences Co., USA; McElroy, Marcus O., NASA Langley Research Center, USA; Lessard, Wendy B., NASA Langley Research Center, USA; McCullers, L. Arnold, Vigyan Research Associates, Inc., USA; Apr. 199670p; In English
Contract(s)/Grant(s): RTOP 505-68-70-02
Report No.(s): NASA-TP-3557; L-17440; NAS 1.60:3557; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Prediction of the loss of wing leading-edge thrust and the accompanying increase in drag due to lift, when flow is not completely attached, presents a difficult but commonly encountered problem. A method (called the previous method) for the prediction of attainable leading-edge thrust and the resultant effect on airplane aerodynamic performance has been in use for more than a decade. Recently, the method has been revised to enhance its applicability to current airplane design and evaluation problems. The improved method (called the present method) provides for a greater range of airfoil shapes from very sharp to very blunt leading edges. It is also based on a wider range of Reynolds numbers than was available for the previous method. The present method, when employed in computer codes for aerodynamic analysis, generally results in improved correlation with experimental wing-body axial-force data and provides reasonable estimates of the measured drag.
Author
Leading Edge Thrust; Aircraft Design; Sharp Leading Edges; Blunt Leading Edges; Reynolds Number; Angle of Attack; Applications Programs (Computers); Aerodynamic Drag; Computational Fluid Dynamics

19960023927; 96N26555 NASA Langley Research Center, Hampton,VA USA
Viscous Shock-Layer Analysis of Two-Dimensional and Axisymmetric Flows
Gupta, Roop N., NASA Langley Research Center, USA; Zoby, Ernest V., NASA Langley Research Center, USA; Lee, Kam-Pui, Vigyan Research Associates, Inc., USA; Sep. 19948p; Repr. from Journal of Thermophysics and Heat Transfer, v. 8 no. 3, Jul. - Sep.1994 p 494-499; In English; 28th; Thermophysics Conference, 6-9 Jul. 1993, Orlando, FL,

USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Report No.(s): NASA-TM-111564; NAS 1.15:111564; AIAA Paper 93-2751; Copyright Waived (NASA); Avail: CASI; A02, Hardcopy; A01, Microfiche

Results are obtained for cylindrical leading edges of proposed transatmospheric vehicles by employing a two-dimensional viscous shock-layer code for nonequilibrium gas flows. The accuracy and efficiency of the planar code is verified through detailed comparisons with other predictions. This study includes results for 6-deg half-angle bodies with nose radii ranging from 0.01 to 2.0 ft for both cylindrically blunted wedges and spherically blunted cones (included for comparison). Some results are presented as a ratio of the noncatalytic to the corresponding fully catalytic heating value to illustrate the maximum potential for a heating reduction in dissociated nonequilibrium flows. Generally, this ratio and the individual heating rates are smaller for cylindrically blunted wedges with small nose radii as compared to the spherically blunted cones (for the same nose radius). Therefore, a larger potential exists for heating reduction in cylindrically blunted as compared with the spherically blunted surfaces. However, the results presented at higher altitudes (where the slip effects become important) show that the spherically, blunted nose gives lower stagnation-point heating due to stronger merged shock-layer effects as compared with a cylindrically blunted nose.
Author
Computational Fluid Dynamics; Two Dimensional Flow; Axisymmetric Flow; Shock Layers; Nonequilibrium Flow; Gas Flow; Blunt Leading Edges

19960023945; 96N26573 NASA Langley Research Center, Hampton,VA USA
Direct Monte Carlo Simulations of Hypersonic Low-Density Flows about an ASTV Including Wake Structure
Dogra, V. K., Vigyan Research Associates, Inc., USA; Moss, J. N., NASA Langley Research Center, USA; Wilmoth, R. G., NASA Langley Research Center, USA; Price, J. M., NASA Langley Research Center, USA; 199216p; Repr. from Progress in Astronautics and Aeronautics. Rarefied Gas Dynamics: Space Science and Engineering (Washington, DC, AIAA), v. 160, 1992 p 199-208; In English
Report No.(s): NASA-TM-111529; NAS 1.15:111529; ISBN-1-56347-081-0; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

Results of a numerical study concerning flow past a 70-deg blunted cone in hypersonic low-density flow environments are presented using the direct simulation Monte-Carlo method. The flow conditions simulated are those that can be obtained in existing low-density hypersonic wind tunnels. Results indicate that a stable vortex forms in the near wake at and below a freestream Knudsen number (based on cone diameter) of 0.01 and the size of the vortex increases with decreasing Knudsen number. The base region of the flow remains in thermal nonequilibrium for all cases considered herein.
Author
Monte Carlo Method; Hypersonic Flow; Low Density Flow; Knudsen Flow; Near Wakes; Hypersonic Wakes; Axisymmetric Flow; Aerospace Vehicles

19960023946; 96N26574 NASA Langley Research Center, Hampton,VA USA
Hover Acoustic Characteristics of the XV-15 with Advanced Technology Blades
Conner, David A., NASA Langley Research Center, USA; Wellman, J. Brent, NASA Ames Research Center, USA; May 199312p; Repr. from Journal of Aircraft, v. 31, no. 4, Jul.-Aug. 1994; In English
Report No.(s): NASA-TM-111578; NAS 1.15:111578; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

An experiment has been performed to investigate the far-field hover acoustic characteristics of the XV-15 aircraft with advanced technology blades (ATB). An extensive, high-quality, far-field acoustics data base was obtained for a rotor tip speed range of 645-771 ft/s. A 12-microphone, 500-ft radius semicircular array combined with two aircraft headings provided acoustic data over the full 360-deg azimuth about the aircraft with a resolution of 15 deg. Altitude variations provided data from near in-plane to 45 deg below the rotor tip path plane. Acoustic directivity characteristics in the lower hemisphere are explored through pressure time histories, narrow-band spectra, and contour plots. Directivity patterns were found to vary greatly with azimuth angle, especially in the forward quadrants. Sharp positive pressure pulses typical of blade-vortex interactions were found to propagate aft of the aircraft and were most intense at 45 deg below the rotor plane. Modest overall sound pressure levels were measured near in-plane indicating that thickness noise is not a major problem for this aircraft when operating in the hover mode with ATB. Rotor tip speed reductions reduced the average overall sound pressure level (dB (0.0002 dyne/cm(exp 2)) by nearly 8 dB in-plane, and 12.6 deg below the rotor plane.
Author
XV-15 Aircraft; Flight Tests; Far Fields; Hovering; Acoustic Properties; Sound Pressure; Aeroacoustics; Blade-Vortex Interaction

19960023958; 96N26586 NASA Langley Research Center, Hampton,VA USA
Rarefield-Flow Shuttle Aerodynamics Flight Model
Blanchard, Robert C., NASA Langley Research Center, USA; Larman, Kevin T., Lockheed Engineering and Sciences Co., USA; Moats, Christina D., Lockheed Engineering and Sciences Co., USA; Aug. 19948p; Repr. from Journal of Spacecraft and Rockets, v. 31, no. 4, Jul - Aug. 1994 p

550-556; In English; 11th; Applied Aerodynamics Conference, 9-11 Aug. 1993, Monterey, CA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Report No.(s): NASA-TM-111566; NAS 1.15:111566; AIAA Paper 93-3441; Copyright Waived (NASA); Avail: CASI; A02, Hardcopy; A01, Microfiche

A model of the Shuttle Orbiter rarefied-flow aerodynamic force coefficients has been derived from the ratio of flight acceleration measurements. The in-situ, low-frequency (less than 1Hz), low-level (approximately 1 x 10(exp -6) g) acceleration measurements are made during atmospheric reentry. The experiment equipment designed and used for this task is the High Resolution Accelerometer Package (HiRAP), one of the sensor packages in the Orbiter Experiments Program. to date, 12 HiRAP re-entry mission data sets spanning a period of about 10 years have been processed. The HiRAP-derived aerodynamics model is described in detail. The model includes normal and axial hypersonic continuum coefficient equations as function of angle of attack, body-flap deflection, and elevon deflection. Normal and axial free molecule flow coefficient equations as a function of angle of attack are also presented, along with flight-derived rarefied-flow transition bridging formulae. Comparisons are made between the aerodynamics model, data from the latest Orbiter Operational Aerodynamic Design Data Book, applicable computer simulations, and wind-tunnel data.
Author
Aerodynamics; Rarefied Gas Dynamics; Spacecraft Reentry; Space Shuttle Orbiters; Mathematical Models; Hypersonic Flow; Transition Flow; Free Molecular Flow

19960023963; 96N26591 NASA Langley Research Center, Hampton,VA USA
Direct Monte Carlo Simulations of Hypersonic Viscous Interactions Including Separation
Moss, James N., NASA Langley Research Center, USA; Rault, Didier F. G., NASA Langley Research Center, USA; Price, Joseph M., NASA Langley Research Center, USA; 199316p; Repr. from Progress in Astronautics and Aeronautics. Rarefied Gas Dynamics: Space Science and Engineering (Washington, DC, AIAA), v. 160, 1993 p 209-220; In English
Report No.(s): NASA-TM-111528; NAS 1.15:111528; ISBN-1-56347-081-0; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

Results of calculations obtained using the direct simulation Monte Carlo method for Mach 25 flow over a control surface are presented. The numerical simulations are for a 35-deg compression ramp at a low-density wind-tunnel test condition. Calculations obtained using both two- and three-dimensional solutions are reviewed, and a qualitative comparison is made with the oil flow pictures highlight separation and three-dimensional flow structure.
Author
Monte Carlo Method; Viscous Flow; Hypersonic Flow; Separated Flow; Control Surfaces; Flow Visualization

03
AIR TRANSPORTATION AND SAFETY

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

19960018158; 96N23588 Princeton Univ., NJ USA
Longitudinal aircraft flight in microburst wind shear: Deterministic trajectory optimization and feedback control using nonlinear inverse dynamics
Mulgund, Sandeep Shriram, Princeton Univ., USA; 1994288p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9429155, Hardcopy, Microfiche

Severe low-altitude wind variability poses a significant hazard to aircraft in the terminal area. Longitudinal control strategies to improve flight safety in microburst wind shear are developed using deterministic trajectory optimization and feedback control based on the aircraft's nonlinear inverse dynamics (NID). Optimal state estimates are computed for feedback using Extended Kalman Filtering. The optimal trajectories provide a qualitative picture of the nature of an aborted-landing maneuver in wind shear, as well as an upper bound on the performance that may be expected from a feedback control law. The results demonstrate that optimal control strategies make it possible to transit an extremely severe microburst, suggesting that an aircraft's ability to deal with wind shear may depend as much upon control law design as on aircraft performance limits. The optimal trajectories exchange altitude for airspeed in a manner that is dependent on microburst severity: in weak-to-moderate microbursts, the aircraft smoothly shifts from glide slope tracking to an ascent at a target climb rate, while in severe microbursts the aircraft descends through some or all of the core region to prevent unsafe airspeed loss. Feedback control laws are developed using the aircraft's nonlinear inverse dynamics to approximate the optimal performance in real time. The effects of variable winds are included directly in the derivation of the inverting control laws. Nonlinear control designs do not suffer from the fundamental limitation of control laws designed using linearization assumptions, particularly in extreme unanticipated flight conditions. The NID control laws, together with a climb rate scheduling strategy, capture the essence of the optimal trajectories in that they also trade altitude for airspeed as a function of microburst strength. In order to make the NID control laws realizable, and Extended Kalman Filter (EKF) is developed to compute estimates of the aircraft state and wind inputs from realistic inertial and air-data measurements. Accurate estimates of the horizontal and vertical wind inputs are achieved using a simple integral-state model of wind dynamics. NID trajectories that employ the optimal estimates as the basis of the feedback closely match

those obtained using perfect state feedback. Estimator robustness with respect to uncertainty in the aerodynamic model is achieved using fictitious process noise, which treats the uncertainty as a random disturbance input. Simulations in turbulent wind shear yield insight into the tradeoffs associated with achieving satisfactory controller-estimator performance in the face of high-frequency disturbance inputs.
Dissert. Abstr.
Aerodynamic Characteristics; Aircraft Performance; Feedback Control; Flight Conditions; Microbursts (Meteorology); Optimal Control; Trajectory Optimization; Nonlinearity

19960018538; 96N23769 Civil Aviation Authority, London, UK
Enhanced warning and intervention strategies for the protection of rotor speed following power failure
Haddon, D. R., Westland Aircraft Ltd., UK; Hughes, T., Westland Aircraft Ltd., UK; Oct. 1995153p; In English; Document contains color illustrations
Report No.(s): CAA PAPER 95009; RP937 AT/AS4/1272; ISBN 0 86039 637 1; Copyright; Avail: Issuing Activity (European Space Agency (ESA)), Hardcopy, Microfiche

Aircraft accident investigations have shown that British civil helicopters often have crashed because of the combined failure to control rotor speed and power loss. The helicopter has a distinct advantage over a fixed wing aircraft in that it can autorotate its rotors. However, the pilot must continually maintain control of the rotor speed throughout the subsequent descent and landing. This report outlines the extent of the problem, current warnings and procedures, training, past and current work programs, scope for providing better/additional warnings, warnings and intervention strategies selected for assessment, piloted simulation trial, results of the piloted simulation trial, and limitations and further developments of the automatic intervention strategies.
CASI
Helicopters; Rotor Speed; Rotary Wings; Flight Safety; Warning Systems; Aircraft Safety

19960018539; 96N23770 Loughborough Univ. of Technology, Dept. of Aeronautical and Automotive Engineering and Transport Studies., UK
Ice detection for the turboprop aircraft
Remder, P. M., Loughborough Univ. of Technology, UK; Jenkinson, L. R., Loughborough Univ. of Technology, UK; Caves, R. E., Loughborough Univ. of Technology, UK; Pitfield, D. E., Loughborough Univ. of Technology, UK; Sep. 199568p; In English
Report No.(s): CAA PAPER 95007; ISBN 0 86039 631 2; Copyright; Avail: Issuing Activity (European Space Agency (ESA)), Hardcopy, Microfiche

The issues relating to ice detection systems on turboprop passenger aircraft are addressed. The capabilities of existing and proposed ice detection systems are described. Opinions of aircraft pilots and manufacturers and operators on ice detection and protection are summarized. The feasibility of conducting a safety/cost benefit analysis of ice detectors is assessed.
CASI
Turboprop Aircraft; Passenger Aircraft; Ice Formation; Aircraft Icing; Detection; Aircraft Safety; Cost Effectiveness; In-Flight Monitoring

19960020250; 96N23845 Northrop Grumman Corp., Los Angeles, CA USA
B-2 safety lessons learned
Crenshaw, Kent, Northrop Grumman Corp., USA; Cameron, Steven E., Department of the Air Force, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 208-223; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

It has been 6 years now, since the B-2A first entered flight test. During that time, the B-2 Combined Test Force has learned and revalidated many safety-related lessons learned. This paper will describe some unique features of the B-2 aircraft and program which affect safety planning, outline the key safety procedures in place on the program, and then recount some lessons learned.
Derived from text
B-2 Aircraft; Flight Tests; Safety Factors; Safety Management; Risk; Aircraft Safety

19960020251; 96N23846 Air Force Test Pilot School, Edwards AFB, CA USA
The AFFTC test safety review process: A tailored system safety approach
Lazerson, David A., Air Force Test Pilot School, USA; Reuter, Abigail L., Air Force Flight Test Center, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 224-243; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In June of 1978, an A-10 gunfire test resulted in a Class A mishap at the Air Force Flight Test Center (AFFTC). The investigation into that mishap led to changes at AFFTC including the establishment of what is now known as the Test System Safety Division. The charter of that division is to review the safety aspects of testing by implementing a test safety review process. This paper will introduce system safety basics, briefly describe the AFFTC Test System Safety Division, provide details of the test safety review process, and describe the AFFTC test safety database composition and benefits. Examples and lessons learned are provided through-

out the paper with future prospects described in the last paragraph of this report.
Author (revised)
Flight Tests; Safety Factors; Safety Management; Risk

19960020454; 96N24027 NASA Langley Research Center, Hampton,VA USA
Aircraft Vortex Spacing System (AVOSS) Conceptual Design
Hinton, David A., NASA Langley Research Center, USA; Aug. 199532p; In English
Contract(s)/Grant(s): RTOP 538-04-14-04
Report No.(s): NASA-TM-110184; NAS 1.15:110184; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A concept is presented for the development of a prototype Aircraft Vortex Spacing System (AVOSS). The AVOSS development is being performed by NASA Langley as an element of the Terminal Area Productivity (TAP) Program, and in support of the FAA Integrated Wake Vortex Program Plan. The purpose of the AVOSS is to provide dynamical, weather dependent wake vortex separation criteria to ATC facilities with adequate stability and lead time for use in runway 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. With the appropriate interface to planned ATC automation, spacing can be tailored to specific generator/follower aircraft types rather than several broad weight categories of aircraft. In a manual ATC environment, the AVOSS may be used to determine when reduced separation standards may be used. Work is currently underway to address the critical disciplines and knowledge needs to demonstrate a prototype AVOSS in the 1999 time frame. This document describes the concept and candidate form of an operational AVOSS system, system ground rules and requirements, research needs, and the development efforts being followed.
Author
Air Traffic Control; Vortices; Automatic Control; Aircraft Wakes; Aircraft Safety; Weather; Vortex Avoidance; Airline Operations

19960020799; 96N24322 National Academy of Sciences - National Research Council, Committee on Improved Fire- and Smoke-Resistant Materials for Commercial Aircraft Interiors., Washington, DC USA
Improved Fire- and Smoke-Resistant Materials for Commercial Aircraft Interiors: A proceedings
1995224p; In English; Also announced as 19960020799 through 1996002081
Contract(s)/Grant(s): FAA-93-G-033
Report No.(s): NMAB-477-2; LC-95-70653; ISBN-0-309-05336-6; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

The Federal Aviation Administration (FAA) has established an Advanced Fire Safety Materials Research Program to meet the requirements of the Aviation Safety Act of 1988. The FAA requested the National Research Council, through its National Materials Advisory Board, recommend research in promising areas based on projected technology. Towards this end, the National Research Council established the Committee on Fire and Smoke Resistant Materials for Commercial Aircraft Interiors. The committee hosted a conference on Fire and Smoke Resistant Materials held at the National Academy of Sciences on November 8-10, 1994. This conference report contains the 15 papers presented by the invited speakers and summaries of the workshop sessions that followed. The papers served as background for the workshop sessions, each of which addressed a specific topic: (1) toxicity issues; (2) fire performance parameters; (3) drivers for materials development; and (4) new materials technology.
Derived from text
Fires; Nonflammable Materials; Toxic Hazards; Aircraft Accidents; Aircraft Safety; Flight Safety; Commercial Aircraft; Aircraft Compartments; Conferences; Flammability; Aircraft Construction Materials; Toxicity; Materials Science; Flame Retardants; Aircraft Design

19960020800; 96N24323 Boeing Commercial Airplane Co., Airplane Safety Engineering., Seattle, WA USA
Airplane accidents and fires
Murray, Thomas M., Boeing Commercial Airplane Co., USA; Improved Fire- and Smoke-Resistant Materials for Commercial Aircraft Interiors: A proceedings; 1995, pp. 7-24; In English; Also announced as 19960020799; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Airplane fires prompt fear and concern for anyone associated with air transport. Those associated include the passengers and flight and cabin crews, as well as those who must eventually provide rescue functions and extinguish an airplane fire. Fortunately, the aviation community experiences few fires while in flight. Furthermore, those fires that do occur on the ground are typically preceded by another event: a hard landing ruptures a fuel tank; a long land prompts a runway overrun; a premature landing cause excessive airplane damage; a controlled flight into terrain shatters an airplane upon impact, etc. Due to the frequency of-and often repeated- preceding events, Boeing believes that the most effective safety strategy available today is to PREVENT ACCIDENTS. Many airplane accidents are preventable using current technology and preferred cockpit procedures. For instance, controlled-flight-into-terrain accidents are preventable through technology, the ground proximity warning systems, and an appropriate response to the warning. From reviewing multiple accident records, Boeing as well as others in the commercial airplane transportation industry have determined that rarely is an accident the result of only one event. Rather, most, if not all, accidents occur through a chain of events. Fire cer-

tainly fits with the realm of a multiple-cause process. The information in this review of aviation data with associated fires is broken into three parts. First, there is an examination of the commerical jet transport accidents from 1959 through 1993. This information is provided to offer a perspective regarding aviation accidents from a variety of causes. Then, the second part reviews how fire has influenced the accident record. Fire details are also provided to enhance understanding of airplane fire-related accidents. Finally, the third part examines some specific fire scenarios to illustrate the range of events that occur, since looking at the number of events often fails to illuminate the many parameters associated with an aspect of aviation accident data, such as fire-related events.
Derived from text
Air Transportation; Aircraft Accidents; Commercial Aircraft; Aircraft Safety; Fires; Fire Prevention; Case Histories; Assessments

19960020801; 96N24324 Federal Aviation Administration, Fire Safety Branch., Atlantic City, NJ USA
Heat exposure and burning behavior of cabin materials during an aircraft post-crash fuel fire
Sarkos, Constantine P., Federal Aviation Administration, USA; Improved Fire- and Smoke-Resistant Materials for Commercial Aircraft Interiors: A proceedings; 1995, pp. 25-36; In English; Also announced as 19960020799; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Federal Aviation Administration (FAA) has conducted numerous full-scale aircraft fire tests for the purpose of characterizing a post-crash cabin-fire environment and developing improved criteria for fire testing cabin materials. The tests subjected aircraft fuselages to an external fuel fire, usually adjacent to an opening in the fuselage. this paper reviews those tests. Emphasis is on the heating conditions experienced by the fuselage skin and cabin hazard development arising from the fuel fire; the important cabin phenomena related to survival, such as stratification of fire hazards and flashover; and hazard-time profiles and materials fire involvement.
Author
Fires; Aircraft Fuels; Cabin Atmospheres; Aircraft Accidents; Aircraft Compartments; Aircraft Safety; Combustion Physics; Fire Damage; Aircraft Construction Materials; Postflight Analysis; Crash Landing; Fuel Combustion

19960020811; 96N24334 Lufthansa German Airlines, Cabin and Cargo Systems., Frankfurt, Germany
In-service performance criteria for aircraft interiors
Betz, Hanns-Joerg, Lufthansa German Airlines, Germany; Improved Fire- and Smoke-Resistant Materials for Commercial Aircraft Interiors: A proceedings; 1995, pp. 197-202; In English; Also announced as 19960020799; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Besides flammability, toxicity, smoke emission, wear-resistance, and other technical requirements that are defined in detailed specifications by the aircraft manufacturers, special requirements out of the service experience had to be incorporated in the design of aircraft interiors. Often the specification requirements do not meet the 'in-service requirements criteria.' In order to create a comfortable feeling for the passenger the aircraft interior must provide durable performance while showing a clean, pleasing, and comfortable cabin without any visible damage.
Derived from text
Aircraft Compartments; Aircraft Design; Passenger Aircraft; Specifications; Criteria; Aircraft Construction Materials

19960021046; 96N24534 NASA Washington, Washington, DC USA
Safety Standard for Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation
Jan. 1996288p; In English
Report No.(s): NSS-1740.15; No Copyright; Avail: CASI; A13, Hardcopy; A03, Microfiche

NASA's standard for oxygen system design, materials selection, operation, and transportation is presented. Minimum guidelines applicable to NASA Headquarters and all NASA Field Installations are contained.
Derived from text
Oxygen Supply Equipment; Safety Factors; Standards; Transportation; Storage; High Pressure Oxygen; Standardization; Safety Management

19960022705; 96N25607 Civil Aeromedical Inst., Oklahoma City, OK USA
Dummy and Injury Criteria for Aircraft Crashworthiness *Final Report*
Marcus, Jeffrey H., Civil Aeromedical Inst., USA; Apr. 199612p; In English
Report No.(s): DOT/FAA/AM-96/11; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Since 1988, newly type-certificated aircraft are required to comply with stringent crashworthiness requirements. Central to these more stringent requirements is a dynamic test that assesses the potential for injury for someone exposed to similar conditions. In this report, the techniques and reference values used for measuring the impact protection offered by aircraft seating systems are reviewed. General requirements of a crash dummy are enumerated. The use and limitations of various designs of adult-sized front and side dummies are discussed, and relationships relating dynamic variables measured with a dummy to the probability of an injury are referenced.
Author
Crashworthiness; Aircraft Accidents; Flight Safety; Dummies; Injuries; Measuring Instruments

19960023130; 96N25929 Royal Air Force, High Wycombe, UK

The Flight Safety Officer's Perspective

Spiller, N. B., Royal Air Force, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, pp. 23-1 - 23-8; In English; Also announced as 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

RAF aircraft accidents in the last 2 years have included a Hercules in Scotland, where all 9 on board were killed, 2 Harriers, one on operations over Iraq and one on a training flight in England, and a Tornado F-3 and its crew off Cyprus. The RAF also suffered 2 mid-air collision accidents, one involving a Tornado GR-1 and a civilian helicopter and the other 2 Tornados in formadon over Canada. Human factors and the maintenance of situational awareness were a feature in all these accidents. This paper attempts to identify some of the human factors linking these accidents.

Author

Aircraft Accidents; Human Factors Engineering; Midair Collisions; Helicopters; Flight Safety

19960023624; 96N26316 Lockheed Aeronautical Systems Co., Marietta, GA USA

The future of very large subsonic transports

Justice, R. Steven, Lockheed Aeronautical Systems Co., USA; Hays, Anthony P., Lockheed Aeronautical Systems Co., USA; Parrott, Ed L., Lockheed Aeronautical Systems Co., USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 399-429; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Very Large Subsonic Transport (VLST) is a multi-use commercial passenger, commercial cargo, and military airlifter roughly 50% larger than the current Lockheed C-5 and Boeing 747. Due to the large size and cost of the VLST, it is unlikely that the commercial market can support more than one aircraft production line, while declining defense budgets will not support a dedicated military VLST. A successful VLST must therefore meet airline requirements for more passenger and cargo capacity on congested routes into slot-limited airports and also provide a cost effective heavy airlift capacity to support the overseas deployment of US military forces. A successful VLST must satisfy three key missions: commercial passenger service with nominal seating capacity at a minimum of 650 passengers with a range capability of 7,000 to 10,000 miles; commercial air cargo service for containerized cargo to support global manufacturing of high value added products, 'just-in-time' parts delivery, and the general globalization of trade; and military airlift with adequate capacity to load current weapon systems, with minimal break-down, over global ranges (7,000 to 10,000 miles) required to reach the operational theater without need of overseas bases and midair refueling. The development of the VLST poses some technical issues specific to large aircraft, but also key technologies applicable to a wide range of subsonic transport aircraft. Key issues and technologies unique to the VLST include: large composite structures; dynamic control of a large, flexible structure; aircraft noise requirements for aircraft over 850,000 pounds; and increased aircraft separation due to increased wake vortex generation. Other issues, while not unique to the VLST, will critically impact the ability to build an efficient and affordable aircraft include: active control systems: Fly-By-Light/Power-By-Wire (FBL/PBW); high lift systems; flight deck associate systems; laminar flow; emergency egress; and modular design. The VLST will encounter severe restrictions on weight, ground flotation, span, length, and door height to operate at current airports/bases, gates, and cargo loading systems. One option under consideration is for a sea-based VLST, either a conventional seaplane or Wing-In-Ground effect (WIG) vehicle, which would allow greater operational flexibility, while introducing other design challenges such as water impact loads and salt-water corrosion. Lockheed Martin is currently developing a floatplane version of the C-130 Hercules which will provide experience with a modern sea-based aircraft. In addition to its own ongoing research activities, Lockheed Martin is also participating in the NASA Advanced Subsonic Technology, High Speed Research (HSR), and other programs which address some of the technologies needed for the VLST. The VLST will require NASA and US aerospace companies to work together to develop new capabilities and technologies for make the VLST a viable part of transportation beyond 2000.

Author

Transport Aircraft; Aircraft Design; Subsonic Aircraft; Aircraft Production Costs; Aircraft Production; Air Transportation; Design to Cost

19960023626; 96N26318 NASA Ames Research Center, Moffett Field, CA USA

Large capacity oblique all-wing transport aircraft

Galloway, Thomas L., NASA Ames Research Center, USA; Phillips, James A., NASA Ames Research Center, USA; Kennelly, Robert A., Jr., NASA Ames Research Center, USA; Waters, Mark H., Eloret Corp., USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 461-489; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Dr. R. T. Jones first developed the theory for oblique wing aircraft in 1952, and in subsequent years numerous analytical and experimental projects conducted at NASA Ames and elsewhere have established that the Jones' oblique wing theory is correct. Until the late 1980's all proposed oblique wing configurations were wing/body aircraft with the wing mounted on a pivot. With the emerging requirement for commercial transports with very large payloads, 450-800 passen-

gers, Jones proposed a supersonic oblique flying wing in 1988. For such an aircraft all payload, fuel, and systems are carried within the wing, and the wing is designed with a variable sweep to maintain a fixed subsonic normal Mach number. Engines and vertical tails are mounted on pivots supported from the primary structure of the wing. The oblique flying wing transport has come to be known as the Oblique All-Wing (OAW) transport. This presentation gives the highlights of the OAW project that was to study the total concept of the OAW as a commercial transport.
Author
Aircraft Configurations; Body-Wing Configurations; Oblique Wings; Aircraft Design; Transport Aircraft; Feasibility Analysis

19960023627; 96N26319 Aeronautical Systems Corp.
A corporate supersonic transport
Greene, Randall, Aeronautical Systems Corp.; Seebass, Richard, Colorado Univ., USA; Transportation Beyond 2000: Technologies Needed for Engineering Design; Feb. 1996, pp. 491-508; In English; Also announced as 19960023610; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This talk address the market and technology for a corporate supersonic transport. It describes a candidate configuration. There seems to be a sufficient market for such an aircraft, even if restricted to supersonic operation over water. The candidate configuration's sonic boom overpressure may be small enough to allow overland operation as well.
Author
Supersonic Transports; Aircraft Design; Economic Analysis; General Aviation Aircraft

04
AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

19960018159; 96N23589 Mississippi State Univ., Mississippi State, MS USA
Tactical Inertial Measurement Unit (IMU) integrated with missile borne Global Positioning System (GPS) antenna and ground-based receiver electronics
Killen, Albert Kevin, Mississippi State Univ., USA; 199496p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9428849, Hardcopy, Microfiche

Much of the recent developments involving the Global Positioning System (GPS) involves the integration of GPS and Inertial Navigation Systems (INS). These developments have been focused around manned platforms which have operator assisted capabilities such as aircraft and ground vehicles. The issues surrounding missile borne GPS/INS integrated systems differ in several important ways including time-of-flight, proximity, and orientation to a jamming environment, flight dynamics, shadowing due to missile body/terrain/battlefield obstacles as well as systems considerations such as size, weight, and power. The purpose of this research is to design, implement, and evaluate the sub-optimal integration filter formulated to accommodate a missile borne GPS antenna and ground based receiver electronics in a highly dynamic environment with tactical quality inertial instruments. Linear covariance simulation analysis will utilized to predict system performance. The goal is to improve accuracy at the transition point between cruise and terminal homing and identify the trade-offs between sensor accuracy and loss of GPS.
Dissert. Abstr.
Global Positioning System; Inertial Navigation; Systems Integration; Missiles; Airborne Equipment; Antennas; Radio Receivers; Ground Support Equipment; Tacan

19960018303; 96N23631 New South Wales Univ., Kensington, Australia
Efficient and effective handling of cycle slips in Global Positioning System data
Chu, Ching-Mei, New South Wales Univ., Australia; 19941p; In English; No Copyright; Avail: Univ. Microfilms, Hardcopy, Microfiche

A prerequisite for high precision GPS-based geodesy is the reliable detection and correction of cycle slips in the carrier phase data. Without reliable data editing, further processing of GPS data is compromised. The detection and repair of cycle slips can, however, be a labor intensive and time consuming procedure, particularly if the data is noisy, if there are gaps in the data series and there are many slips on more than one satellite at the same time. In this research, the possibility of performing efficient and effective cycle slip editing of GPS carrier phase signal was studied and a polynomial solution technique was developed. The technique was designed to operate in either a single-station mode or multi-station mode, but was used in the single-station mode for most investigations. There are a number of advantages in such a-procedure including: (1) it can be used on site, shortly after data has been collected, and (2) it permits cycle slips to be detected and repaired in the raw one-way data, a significant boon if phase data is to be processed in the undifferenced (as opposed to the double-differenced) mode. Today a number of software packages are available to process GPS observations for high precision, scientific applications. They all provide a number of different options for data processing. Solutions can therefore differ due to a number of factors, such as the algorithms themselves, the frequencies or frequency combinations used, cut-off angle selected, etc. Often there is no standardized procedure -- just precedent the analyst has a variety of data processing strategies from which to choose reasonable, appropriate and justifiable alternatives -- to obtain the 'best' solution: Do different solutions and software agree with each

other? And how accurate are the results? We used GAMIT, a well established GPS program, to verify the technique of cycle slip editing. The technique has been shown to be capable of editing cycle slips reliably and quickly. Solutions using two processing methods (GAMIT and our own scientific software) were compared. Comparisons were also made between solutions in which cycle slip detection and repair were carried out within two programs. Significant differences were detected between using two 'clean' data sets. The impact of undetected cycle slips on a GPS network solution has also been studied in this research. The simulation of cycle slip was done to study the effect of leaving undetected cycle slips. The results confirmed that, for the highest precision, all cycle slips must be removed from the data thoroughly before a solution is carried out.
Dissert. Abstr.
Global Positioning System; Data Processing; Signal Processing; Phase Deviation; Position Errors

19960020469; 96N24041 Cincinnati Univ., Dept. of Aerospace Engineering and Engineering Mechanics., OH USA
Evaluation of Scheduling Methods for Multiple Runways *Final Report*
Bolender, Michael A., Cincinnati Univ., USA; Slater, G. L., Cincinnati Univ., USA; Apr. 199625p; In English
Contract(s)/Grant(s): NCC2-669
Report No.(s): NASA-CR-200886; NAS 1.26:200886; AIAA Paper 96-3719; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Several scheduling strategies are analyzed in order to determine the most efficient means of scheduling aircraft when multiple runways are operational and the airport is operating at different utilization rates. The study compares simulation data for two and three runway scenarios to results from queuing theory for an M/D/n queue. The direction taken, however, is not to do a steady-state, or equilibrium, analysis since this is not the case during a rush period at a typical airport. Instead, a transient analysis of the delay per aircraft is performed. It is shown that the scheduling strategy that reduces the delay depends upon the density of the arrival traffic. For light traffic, scheduling aircraft to their preferred runways is sufficient; however, as the arrival rate increases, it becomes more important to separate traffic by weight class. Significant delay reduction is realized when aircraft that belong to the heavy and small weight classes are sent to separate runways with large aircraft put into the 'best' landing slot.
Author
Scheduling; Airports; Slots; Runways; Queueing Theory

19960020550; 96N24099 NASA Johnson Space Center, Houston,TX USA
Evaluation of Two Computational Techniques of Calculating Multipath Using Global Positioning System Carrier Phase Measurements
Gomez, Susan F., NASA Johnson Space Center, USA; Hood, Laura, NASA Johnson Space Center, USA; Panneton, Robert J., NASA Johnson Space Center, USA; Saunders, Penny E., NASA Johnson Space Center, USA; Adkins, Antha, Lockheed Martin Engineering and Sciences Co., USA; Hwu, Shian U., Lockheed Martin Engineering and Sciences Co., USA; Lu, Ba P., Lockheed Martin Engineering and Sciences Co., USA; Mar. 1996136p; In English
Report No.(s): NASA-TM-104816; NAS 1.15:104816; S-804; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Two computational techniques are used to calculate differential phase errors on Global Positioning System (GPS) carrier war phase measurements due to certain multipath-producing objects. The two computational techniques are a rigorous computati electromagnetics technique called Geometric Theory of Diffraction (GTD) and the other is a simple ray tracing method. The GTD technique has been used successfully to predict microwave propagation characteristics by taking into account the dominant multipath components due to reflections and diffractions from scattering structures. The ray tracing technique only solves for reflected signals. The results from the two techniques are compared to GPS differential carrier phase ns taken on the ground using a GPS receiver in the presence of typical International Space Station (ISS) interference structures. The calculations produced using the GTD code compared to the measured results better than the ray tracing technique. The agreement was good, demonstrating that the phase errors due to multipath can be modeled and characterized using the GTD technique and characterized to a lesser fidelity using the DECAT technique. However, some discrepancies were observed. Most of the discrepancies occurred at lower devations and were either due to phase center deviations of the antenna, the background multipath environment, or the receiver itself. Selected measured and predicted differential carrier phase error results are presented and compared. Results indicate that reflections and diffractions caused by the multipath producers, located near the GPS antennas, can produce phase shifts of greater than 10 mm, and as high as 95 mm. It should be noted tl the field test configuration was meant to simulate typical ISS structures, but the two environments are not identical. The GZ and DECAT techniques have been used to calculate phase errors due to multipath o the ISS configuration to quantify the expected attitude determination errors.
Author
Global Positioning System; Multipath Transmission; Phase Error; Scattering; Receivers

19960021758; 96N25033 NASA Johnson Space Center, Houston,TX USA
Multi-Flight-Phase GPS Navigation Filter Applications to Terrestrial Vehicle Navigation and Positioning
Park, Young W., McDonnell-Douglas Aerospace, USA; Montez, Moises N., NASA Johnson Space Center, USA;

Dual-Use Space Technology Transfer Conference and Exhibition; May 1994; vol. Volume 1, pp. 159-166; In English; Also announced as 19960021743; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A candidate onboard space navigation filter demonstrated excellent performance (less than 8 meter level RMS semi-major axis accuracy) in performing orbit determination of a low-Earth orbit Explorer satellite using single-frequency real GPS data. This performance is significantly better than predicted by other simulation studies using dual-frequency GPS data. The study results revealed the significance of two new modeling approaches evaluated in the work. One approach introduces a single-frequency ionospheric correction through pseudo-range and phase range averaging implementation. The other approach demonstrates a precise axis-dependent characterization of dynamic sample space uncertainty to compute a more accurate Kalman filter gain. Additionally, this navigation filter demonstrates a flexibility to accommodate both perturbational dynamic and observational biases required for multi-flight phase and inhomogeneous application environments. This paper reviews the potential application of these methods and the filter structure to terrestrial vehicle and positioning applications. Both the single-frequency ionospheric correction method and the axis-dependent state noise modeling approach offer valuable contributions in cost and accuracy improvements for terrestrial GPS receivers. With a modular design approach to either 'plug-in' or 'unplug' various force models, this multi-flight phase navigation filter design structure also provides a versatile GPS navigation software engine for both atmospheric and exo-atmospheric navigation or positioning use, thereby streamlining the flight phase or application-dependent software requirements. Thus, a standardized GPS navigation software engine that can reduce the development and maintenance cost of commercial GPS receivers is now possible.

Author

Global Positioning System; Onboard Equipment; Space Navigation; Rendezvous Guidance; Orbit Calculation; Spacecraft Guidance; Kalman Filters; Systems Integration; Trajectory Analysis; Applications Programs (Computers)

19960022249; 96N25282 Science Applications International Corp., Arlington, VA USA

Measurements of GPS and LORAN Performance in an Urban Environment

Miller, Lance C., Science Applications International Corp., USA; Vaurio, David, Science Applications International Corp., USA; Giambalvo, Albert, Science Applications International Corp., USA; Karp, Sherman, Science Applications International Corp., USA; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 199610p; In English; Also announced as 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

During the summer of 1994, the Advanced Research Projects Agency funded an experiment to collect extensive radionavigation data in the New York City area. The participants are listed under the Acknowledgments. The data includes the accuracy and availability of the Global Positioning System (GPS) and LORAN-C, the increased availability of both GPS and LORAN by adding a precise oscillator input to the receivers, and a comparison of electric field (E-field) and magnetic field (H-field) LORAN signal availabilities. Analysis of the data shows: (I) in the deep urban canyons of Wall Street, the availability of LORAN (either E or H field) is higher than that of GPS; (2) in almost all scenarios, the LORAN magnetic field signal is easily detectable and has repeatable phase characteristics. In contrast, the LORAN electric field signal strength is frequently attenuated and undetectable, especially in the Wall Street area and under the elevated train tracks in the Bronx; (3) when corrected for propagation anomalies, the inherent repeatable accuracy of LORAN is 7-10 meters rms with under 100 meters rms potentially obtainable in an operational differential mode; and (4) the availability of radionavigation fixes can be enhanced in these urban areas by the integration of LORAN and GPS navigation information and by the use of a precise oscillator which allows a geographic fix to be made by receiving as few u two time of arrival broadcasts, e.g. one GPS satellite and one LORAN station.

Author

Global Positioning System; Loran C; Loran; Navigation Satellites; Electric Field Strength; Radio Navigation; Magnetic Fields

19960022250; 96N25283 Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Euskirchen, Germany

Susceptibility Measurements on GPS Receivers

Braun, Ch., Fraunhofer-Inst. fuer Naturwissenschaftlich-Technische Trendanalysen, Germany; Guidi, P., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Schmidt, H. U., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 199610p; In English; Also announced as 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper describes our low power microwave coupling measurements on hand-held GPS (Global Positioning System) receivers in the frequency range between 0.3...2 GHz. The plane wave excitation experiments have been carried out mainly in our field coupling facility, which consists of an asymmetric triplate transmission line with maximum CW field levels of up to 120 V/m at the test position. As test objects we examined four Standard Positioning Service (SPS) C/A-code GPS receivers of different manufacturers. The test objects were positioned in the simulator in three orthogonal orientations with respect to the external field. to maintain a

high-integrity navigation, the GPS receiver must maintain lock on the satellite signal and read the data. A three dimensional position (latitude, longitude and altitude) at least requires four satellites to be in view. Failure is defined when this 3 D fix is lost. It turned out that the GPS were most susceptible to CW fields with its internal antenna. They were less susceptible if the receiver and the GPS antenna were placed separately and linked together via a cable. Worst case effects caused GPS switch off, but no damage occurred at field strengths below 100 V/m at out-of-band frequencies. Pulse testing (width = 20 microns) the GPS always required much higher fields to cause upsets depending strongly on frequency and test object. In some cases pulsed fields of more than 2 kV/m were necessary.
Author
Global Positioning System; Receivers; Field Strength; Frequencies; Plane Waves

19960022272; 96N25299 Cincinnati Univ., Dept. of Aerospace Engineering and Engineering Mechanics., OH USA
Evaluation of Scheduling Methods for Multiple Runways *Final Report*
Bolender, Michael A., Cincinnati Univ., USA; Slater, G. L., Cincinnati Univ., USA; Apr. 19, 199625p; In English
Contract(s)/Grant(s): NCC2-669
Report No.(s): NASA-CR-200949; NAS1.26:200949; AIAA Paper 96-3719; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Several scheduling strategies are analyzed in order to determine the most efficient means of scheduling aircraft when multiple runways are operational and the airport is operating at different utilization rates. The study compares simulation data for two and three runway scenarios to results from queuing theory for an M/D/n queue. The direction taken, however, is not to do a steady-state, or equilibrium, analysis since this is not the case during a rush period at a typical airport. Instead, a transient analysis of the delay per aircraft is performed. It is shown that the scheduling strategy that reduces the delay depends upon the density of the arrival traffic. For light traffic, scheduling aircraft to their preferred runways is sufficient; however, as the arrival rate increases, it becomes more important to separate traffic by weight class. Significant delay reduction is realized when aircraft that belong to the heavy and small weight classes are sent to separate runways with large aircraft put into the 'best' landing slot.
Author
Runways; Scheduling; Airports; Air Traffic; Queueing Theory

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

19960018307; 96N23635 Rensselaer Polytechnic Inst., Troy, NY USA
A nonlinear dynamic analysis of rotor blades in forward flight
Cho, Yeon, Rensselaer Polytechnic Inst., USA; 1993260p; In English; No Copyright; Avail: Univ. Microfilms Order No. DA9405663, Hardcopy, Microfiche

The stability analyses of both a rigid blade and a flexible blade in forward flight are presented. Two perturbation techniques based on the method of multiple time scales have been implemented to analyze the flap-lag stability of a rigid helicopter blade using a centrally hinged spring restrained model. The perturbation methodology that is presented here is valid both for hover and for forward flight since a bookkeeping parameter is used instead of the advanced ratio as a perturbation parameter as has been done previously. This methodology is not only numerically efficient but is also useful in understanding the stability mechanism of a rotor blade in forward flight. The stability analysis was performed in the neighborhood of lines which represent the resonances, omega(sub beta) approx. equal to omega(sub zeta) and omega(sub zeta) approx. equal to omega(sub beta) + 1, where omega(sub beta) and omega(sub zeta) represent the flap and lead-lag frequencies respectively. The nonlinear dynamic response and the stability of the flexible rotor blade were also studied. The investigations presented here are based on the full nonlinear differential equations of motion, instead of on a set of equations that are obtained by expanding the original equations about a state that is not an equilibrium state. The periodic solution to the full nonlinear equations were obtained by by a combination of numerical methods and the method of harmonic balance. The trim condition is imposed on the periodic solution through an iteration procedure. The stability of the motion about the trimmed periodic solution was then analyzed using a modal reduction technique and Floquet theory with substantial use of symbolic computation. The effect of the weight coefficient, Lock number, and torsional flexibility on the stability of rotor blade motion were also examined.
Dissert. Abstr.
Rotor Blades (Turbomachinery); Dynamic Response; Nonlinearity; Equations of Motion; Floquet Theorem

19960018389; 96N23715 Rensselaer Polytechnic Inst., Troy, NY USA
Minimization of helicopter rotor blade loads using formal optimization and adjustable masses
Lee, Ming-Ru, Rensselaer Polytechnic Inst., USA; 1993234p; In English; No Copyright; Avail: Univ. Micro-

films Order No. DA9405681, Hardcopy, Microfiche

This study focuses on the minimization of vibratory loads in helicopter rotors. In the first phase, a modal-based method was used for reducing vibratory loads in composite helicopter rotor blades. The thicknesses of composite material layers and nonstructural masses were chosen as design variables. From this study, the following optimization procedure is suggested. First, blade natural frequencies are placed at desired values with respect to the n per/rev lines. Second, minimum vibration design is obtained using a vibration index approach. Various optimum solutions can then be obtained by placing the frequencies in various relations to the n per/rev lines. The mechanism for the reduction of vibratory loads is found to be modal shaping, i.e., the blade's mode shapes are made orthogonal to the excitation forces. As a result, the optimal design is shown to be very sensitive to the distribution of aerodynamic forces. In the second phase, the potential of active vibration reduction devices for helicopter blades was investigated. The device consists of a small number of non-structural masses whose positions are adjustable along the blade span. The position of the masses could be adjusted in flight using an automatic controller. The validity of this concept was tested by using formal optimization techniques to find the best configuration of the adjustable masses for a given aerodynamic loading. The process is repeated for various approximations to the aerodynamic loading to verify that an optimum configuration can be found within the allowable travel of each mass. Reduction of vibratory hub loads is obtained for a range of flight conditions using a simple mass representing 12% of the blade's structural mass. In the third phase, the potential of these adjustable masses as a means of reducing the one per revolution loads resulting from rotor imbalance is explored. Results show that the adjustable masses are most effective on reducing the in-plane l per/rev hub loads. Adjusting the average pitch length for individual blades was also found to be an effective means of reducing vertical shear loads due to aerodynamic dissimilarities. Tracking of the dissimilar blade does not necessarily correspond to minimum 1 per/rev loads.

Dissert. Abstr.

Helicopters; Rotary Wings; Rotors; Aerodynamic Loads; Vibration Damping

19960020236; 96N23831 Society of Experimental Test Pilots, Lancaster, CA USA

Report to the Aerospace Profession: 39th SETP Symposium

Sep. 1995; ISSN 0742-3705469p; In English; Also announced as 19960020236 through 1996002026; Copyright Waived (NASA); Avail: CASI; A20, Hardcopy; A04, Microfiche

The objectives of The Society of Experimental Test Pilots (SETP) are to: promote air safety by presenting the pilot's opinions; strengthen the influence of the test pilot on aeronautical progress; continuously evaluate the adequacy of flight equipment; exchange information for the development of improved testing techniques; exchange ideas, experiences, and information concerning techniques of escape and survival; Discuss newly experienced phenomena in the relm of flight; further professional advancement through lecture and displays; stimulate interest in aviation of the world; and broaden professional and fraternal relationship. Topics addressed at the 39th SETP Symposium were: the Boeing 777- progress to the plan; B-2A flight test progress report; U-2S engine flight test program; F/A-18E/F road to first flight lessons learned; B-1B flight test update; F-111C Virtual bombing; flight test of a civilian R&D aircraft; U.S. Navy T-45A departure and spin evaluation; handling qualities flight testing of helicopters at extreme lateral center of gravity; Handling clearance of jaguar lateral asymmetric stores configurations; flight test techniques to ensure proper rigging of highly augmented aircraft and the importance of rigging in developing departure demonstration test program; keep eagle: F-15E high angle of attack testing; safety and flight test; B-2 safety lessons learned; the AFFTC test safety review process, a tailored system safety approach; test safety considerations for F-16C high angle of attack testing with LANTIRN and HTS pods; flight test planning and execution in the frequency domain, rotary-wing flight test lessons learned; weapons flight test safety, a CBU-97 sensor fuzed weapon perspective; EH-101 icing trails; taking an X-airplane to the Paris airshow; First flight test results of the simpled aid for EVA rescue (SAFER) propulsion unit; stork missile development and test; flight testing of airships for military roles; stratos 2 flight test program; V/STOL systems research aircraft- a tool for cockpit integration; the first space shuttle to MIR docking mission; optimization of the terrian following radar; F-14A Helmet mounted cueing and display system; and the ANVIS head-up display: an analysis of its application to naval helicopters.

Derived from text

Aircraft Safety; V/STOL Aircraft; F-14 Aircraft; Helicopters; Flight Safety; Flight Tests; Rescue Operations; Research Aircraft; Safety Factors; Test Pilots

19960020237; 96N23832 Boeing Commercial Airplane Co., Seattle, WA USA

Boeing 777: Progress to the plan

Cashman, John E., Boeing Commercial Airplane Co., USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 4-16; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The 777 airplane flew its first flight on June 12, 1994, and received its FAA/JAA type design approval for the Pratt & Whitney engine in April 1995 and early Extended range Twin-engine OPerationS (ETOPS) approval in May 1995. A review of the principle design features, the flight test plan and lessons learned from the first 4,000 hours of flight test are

discussed. A view of the changing role of the test pilot in the design and testing of complex transport aircraft is included.
Author
Boeing 777 Aircraft; Flight Tests; Jet Engines; Flight Characteristics

19960020238; 96N23833 Northrop Grumman Corp., Los Angeles, CA USA
B-2A flight test *Progress Report*
Weiss, Donald L., Northrop Grumman Corp., USA; Dunn, James C., Air Force Operational Test and Evaluation Center, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 17-33; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The B-2A is a four engine, long range, strategic bomber, with significant conventional capability. It combines advanced technologies in materials and processes to produce outstanding high altitude cruise performance and low altitude, night, all weather penetration capability with low observable characteristics an all wing airframe. It has a maximum takeoff gross weight of approximately 370,000 lb. It can carry up to 40,000 lb of ordnance in combination with over 160,000 lb of fuel. The aircraft is powered by four General Electric F-118-GE-100 engines and employs a 'glass' cockpit and a large number of embedded computers to allow a two-person crew to accomplish all missions. The B-2 combined test force has accomplished a great deal of work over the last six years. Despite the obvious differences between the B-2 and most other aircraft, the problems being experienced by the government-contractor test team are little different than those found on other programs. Software and hardware deliveries, are the big schedule drivers for the program.
Derived from text
B-2 Aircraft; Aircraft Configurations; Flight Characteristics; Avionics

19960020239; 96N23834 Lockheed Martin Corp., Skunk Works., Burbank, CA USA
U-2S Engine Flight Test Program
Pugh, Thomas S., Lockheed Martin Corp., USA; Kerzie, Dave, Lockheed Martin Corp., USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 34-46; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

It is the author's intent to present an overview of the U-2S Engine Flight Test Program. This paper will provide some background information regarding the General Electric F118-GE-101 turbo-fan engine and an aircraft whose legacy began 40 years ago in Lockheed's well known Skunk Works (Registered Trademark).
Author
U-2 Aircraft; Turbofan Engines; Aircraft Performance

19960020240; 96N23835 Naval Air Station, Patuxent River, MD USA
F/A-18E/F road to first flight lessons learned
Madenwald, Fred, Naval Air Station, USA; Sandberg, Jim, Naval Air Station, USA; Niewoehner, Rob, Naval Air Station, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 47-54; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Navy determined that a follow-on design of the very successful F/A-18 aircraft was needed to accomplish current and additional mission requirements well into the next century. So the new F/A-18 E/F was born and it was required to exhibit the following specific capabilities; increased mission radius, payload flexibility and increased payload recovery at the carrier, and system growth margin. Furthermore, it was desirable to make any improvements to existing systems that really made sense to increase safety and improve survivability. Also the performance of the F/A-18 E/F is required to match or be better than the existing F/A-18 C/D aircraft. These requirements have driven the design of the F/A-18 E/F to be a larger platform as compared to the F/A-18 C/D, and produced special challenges in all areas of design. This paper proposes to offer some lessons learned while on the road to first flight dealing with: flight control development; engine control and performance; and Iron Bird.
Derived from text
F-18 Aircraft; Control Surfaces; Flight Control; Aircraft Design

19960020243; 96N23838 Mississippi State Univ., Raspet Flight Research Lab., Starkville, MS USA
Flight test of a civilian R/D aircraft
Wilson, Grady W., Mississippi State Univ., USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 95-113; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper begins with a short history of a very unique flight test facility and continues with what we believe is a one-of-a-kind aircraft development and flight test program. Honda R&D, Wako Research Center, approached Mississippi State University (MSU) in the mid 80's requesting technical guidance and oversight for their endeavor into the aviation arena, leading to a partnership which lasted a decade. The major objectives were to develop aircraft design and composite manufacturing capabilities within the Honda R&D organization. The MH-02 HondaJet is an 8000 lb, twin turbofan, carbon-fiber research and development aircraft. The design incorporates a high-wing with a 12 degree forward sweep and zero geometric dihedral, triple-slotted Fowler flaps, and four-panel leading edge slats. The benefits of the partnership have far outweighed the problems, and the program which resulted has produced a highly viable flight research vehicle and

greatly enhanced the technical capabilities of both Honda and MSU.
Derived from text
Flight Tests; Research Aircraft; Turbofan Aircraft; Light Aircraft; General Aviation Aircraft; Passenger Aircraft; Composite Structures

19960020244; 96N23839 Naval Air Warfare Center, Naval Strike Aircraft Test Squadron., Patuxent River, MD USA
US Navy T-45A departure and spin evaluation
Mortensen, Joseph A., Naval Air Warfare Center, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 114-131; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

U.S. Navy T-45A departure and spin evaluation was conducted from 8 July to 30 September 1994. The initial T-45A flight manual departure and spin recovery procedures evaluated proved unsatisfactory in providing consistent recoveries from inverted spin modes. Specifically, the procedures allowed the rudder to blowout in the pro-spin direction during recovery, resulting in spin mode transitions and delayed recoveries. Furthermore, a third sustained inverted spin mode was discovered during flight tests. The initial flight manual procedures were successfully modified to reduce the occurrence of rudder blow-out during recovery attempts and provided more consistent recovery characteristics. There were no spins that could be used as out-of-control flight training maneuvers due to the susceptibility of inverted spins, inconsistent inverted spin recoveries, and engine flame-outs.
Author
Flight Tests; Training Aircraft; Aircraft Spin; Turbofan Aircraft; Single Engine Aircraft; Controllability

19960020245; 96N23840 Army Aviation Systems Command, Airworthiness Qualification Test Directorate., Edwards AFB, CA USA
Handling qualities flight testing of helicopters at extreme lateral center of gravity
Reed, Donald E., Army Aviation Systems Command, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 132-153; In English; Also announced as 19960020236; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper addresses the handling qualities of the UH-60A Black Hawk helicopter at several lateral centers of gravity that could result from asymmetrical external fuel loading with the Extended Stores Support System (ESSS) installed. The primary test objective was to determine if normal aircraft operations could be conducted at or below 100,000 in-lbs lateral moment (maximum lateral moment for normal operations) without exceeding the aircraft flight envelope or applying additional flight limitations and restrictions. Additionally, if the maximum lateral moment for normal operations were exceeded, would the pilot be aware of exceeding this limit and what pilot actions would be required to prevent loss of aircraft control? The test consisted of 25 flights with the ESSS configured with 230-gallon external fuel tanks mounted on the outboard vertical support pylons. The aircraft was ballasted for nine different lateral moments ranging from near-mid to 191,000 in-lbs, which is equivalent to an asymmetrical jettison of full outboard 230-gallon external fuel tanks. Tests were conducted in both forward flight at mission relatable airspeeds and low-speed flight at different azimuths. Aircraft parameters affecting lateral control margins that were of primary interest were airspeed, power, load factor, and aircraft gross weight. Test results revealed that in forward, descending, ball-centered flight at low airspeed and minimal power with a right-lateral imbalance, the sideslip limits of the aircraft could easily be exceeded. This was the only limit exceeded while operating at or below the maximum lateral moment for normal operations. At larger than normal lateral moments (150,000 in-lbs, 174,000 in-lbs, and 191,000 in-lbs), five conditions tested resulted in control margin less than 10%. While attempting to stabilize on one test point, a handling qualities rating (HQR) of 10 (aircraft uncontrollable) was assigned. Additionally, during low-speed flight and cross-slope landings, the control stop/limiter was contacted several times.
Author
Helicopter Control; Center of Gravity; Controllability; External Tanks; Flight Tests; Fuel Tanks; Uh-60A Helicopter; Lateral Control; Loading Moments; Rolling Moments

19960020247; 96N23842 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD USA
Developing flight test techniques to ensure proper rigging of highly augmented aircraft
Traven, Ricardo, Naval Air Warfare Center, USA; Frazier, F. Alan, McDonnell-Douglas Aerospace, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 171-179; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Uncommanded rolling moments have been considered a natural part of the aging process of some F/A-18 airplanes. These rolling moments can range from an annoyance requiring constant trimming to a serious degradation in handling qualities which can cause premature departures during maneuvering flight. Uncommanded rolling moments in flight can generally be eliminated with rigging if the surface which is causing the roll is known. Due to the highly augmented flight control architecture of the F/A-18, it is very difficult to isolate the actual control surface that is causing the uncommanded rolling moment since so many surfaces are active. NAWC-AD has developed techniques to identify the flight control surface causing uncommanded rolling moments. These techniques have been used successfully on four F/A-18

airplanes to identify which flight control surface was causing uncommanded roll rates. Additional flight tests are planned to further refine the techniques described in this paper. These techniques have been demonstrated to reduce uncommanded rolling moments in the F/A-18 and can be applied to all aircraft.
Author
Rolling Moments; Flight Tests; Control Surfaces; Rigging; Aging (Materials); Flight Control; F-18 Aircraft; Aircraft Performance

19960020248; 96N23843 Department of the Air Force, Edwards AFB, CA USA
Keep Eagle: F-15E high angle of attack testing
Felock, Joe, Department of the Air Force, USA; Habig, Chris, Department of the Air Force, USA; Hancock, Regis, Department of the Air Force, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 180-191; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The KEEP EAGLE program began in late 1992 to enhance the high angle-of-attack (AOA) flying qualities of the F-15E Strike Eagle following the loss of two aircraft from departures and subsequent spins. After those losses, Air Combat Command (ACC) placed a 20 degree AOA limit on aircraft configured with Conformal Fuel Tanks (CFT's). Since this was the normal configuration for the dual role F-15E, the limit drastically reduced the aircraft's air-to-air combat capability. At high AOA the F-I5E now has better departure resistance than the original F-15A, greatly enhanced spin recovery control power, and no AOA limitations for CFT or LANTIRN configurations. In short, it has significantly increased combat capability. by virtue of a thorough wind tunnel and other analytical tools, we were able to validate those improvements in flight test, ahead of schedule, under budget, and without ever having to use the spin chute.
Derived from text
F-15 Aircraft; Angle of Attack; Flight Control; Flight Tests; In-Flight Monitoring

19960020249; 96N23844 National Test Pilot School, Mojave, CA USA
Safety and flight test
Shawler, Wendell H., National Test Pilot School, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 197-207; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The goal of any flight test program is to acquire all the necessary test data to determine if the requirements have been met, and to clear an aircraft for operational use for the life of the system and to do so without a mishap. The hazards of flight test have been minimized over the years due to better predictions, better simulation and improved design and technology. Many steps are required to achieve the stated goals. One of the first is to accomplish good test planning, then have complete technical and safety reviews, and finally, to use competent and professional testers. Some points to consider are to review the lessons learned from previous or similar tests, insure quality flight test data is obtained; do not eliminate tests simply because they are hazardous, define how much testing should be completed, and finally, and most important, assemble a test team that is well trained, experienced, and has the ability to work as a team to provide mutual support during all phases of the flight test program. This last point includes the test pilots, flight test engineers, telemetry room personnel, instrumentation people, data reduction personnel, designers, managers, safety experts, and others as needed. The Flight Test Safety Committee (FTSC) is providing a method for flight testers world wide to receive information and lessons learned on previous test programs. The FTSC was formed by the Society of Experimental Test Pilots (SETP), the Society of Flight Test Engineers (SFTE), and the Flight Test Technical Committee of the American Institute of Aeronautics and Astronautics (AIAA). The results and data acquired by the FTSC can be obtained through the INTERNET.
Author
Flight Tests; Safety Factors; Safety Management; Risk; Resources Management; Flight Crews; Aircraft Safety

19960020253; 96N23848 Army Aviation Systems Command, Airworthiness Qualification Test Directorate., Edwards AFB, CA USA
Flight test planning and execution in the frequency domain: Rotary wing flight test lessons-learned
Williams, Jeffrey N., Army Aviation Systems Command, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 255-269; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

One of the primary objectives of experimental and engineering flight testing is the identification of the dynamic characteristics of an aircraft system. Applications of that objective, known as system identification, are many. They include flying qualities studies, flight control system design and verification, simulation validation, aeroelastic and vibration studies, and specification compliance. Frequency domain system identification applications for rotary-wing aircraft have been developed over the past decade. The frequency domain approach takes time-domain flight data, such as frequency sweeps, and converts them to the frequency-domain. Extensive documentation has been published for the various applications of that data, but very little exists for the flight test planning and execution process. Lessons-learned illustrate the importance of defining the discipline and methodology of frequency domain flight testing, both for meeting data requirements and for flight safety. This paper provides an overview of the flight test planning and execution methodol-

ogy, with emphasis on lessons-learned, flight test techniques to meet data requirements, risk management, and flight safety. Author

Flight Tests; Mission Planning; Rotary Wing Aircraft; Dynamic Characteristics; Flight Characteristics; System Identification; Frequency Modulation

19960020255; 96N23850 Westland Helicopters Ltd., Hayes, UK

EH101 icing trials

Tracy, Jeremy P., Westland Helicopters Ltd., UK; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 281-291; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper covers the icing trials on the EH101 and the research work that preceded these trials. The EH101 is a medium size 32,000 lb helicopter, equipped with a single main rotor, tail rotor, and powered by three General Electric CT7-6 engines or the more powerful RTM 322 engine. The aircraft is designed for use in the maritime, utility, and civil roles. The 1993/94 trial resulted in the confidence to go forward to further trials without any significant change to the aircraft. The Authorities require further icing encounters prior to a full icing release. The aircraft performance in icing was as predicted and served to validate much of the work that had previously been undertaken in environmental chambers and rigs.

Derived from text

Helicopters; Aircraft Configurations; Aircraft Icing; Flight Tests; Aircraft Equipment; Heating Equipment; Rotor Blades (Turbomachinery)

19960020256; 96N23851 North American Rockwell Corp., Aircraft Div., Palmdale, CA USA

Taking an X-airplane to the Paris Air Show

Knox, Fred D., North American Rockwell Corp., USA; Santangelo, Thomas C., Naval Air Warfare Center, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 292-307; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

During the eight air shows and four practice sessions at Paris, the X-31 was the 'star' of the air show and dramatically demonstrated integrated multi-axis thrust vectoring. The flight demonstration showed that multi-axis thrust vectoring provides a new design dimension, has matured, and is ready for operational development. PST maneuvers had never been demonstrated at these altitudes and included the following firsts: (1) 70 deg AOA down to 500 ft AGL; (2) fully controlled and stabilized flight at 70 KIAS, above 50 deg AOA at 500 ft AGL; and (3) high rate velocity vector rolls at 70 deg AOA.

Derived from text

X-31 Aircraft; Flight Tests; Performance Tests; Aircraft Design; Automatic Flight Control; Thrust Vector Control

19960020259; 96N23854 Royal Air Force, London, UK

Flight testing of airships for military roles

Prior, Mark R., Royal Air Force, UK; Hall, Robert C., Army Air Corps, UK; Thornton, Kevin B., Ministry of Defence, UK; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 350-367; In English; Also announced as 19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Since 1993 the UK Ministry of Defence (Procurement Executive) has been engaged in an Airship Feasibility Study which has been looking at the suitability of airships for military roles. Some of the possible roles are Airborne Early Warning, Command, Control and Communication (C3) and Fishery Protection Patrols. The Feasibility Study is very broad-based and has involved research work carried out by the Defence Research Agency (DRA) in parallel with practical fight tests conducted mainly on the Skyship 600-01 at the Defence Test and Evaluation Organization (DTEO) Boscombe Down. This Airship was initially built to the standard certificated by the Civil Aviation Authority, this allowed the contractor to fly the airship under civil rules whilst initial pilot training was undertaken. Following the completion of the initial pilot training the mechanical flight control system was removed and a prototype simplex fly-by-light (FBL) flight control system (FCS) was installed. The requirement to fit the FBL FCS was as a result of an earlier preview of a Skyship 500 airship which concluded that pilot workload was significant and needed reducing; it was considered that the FBL FCS would overcome the workload deficiency. This paper will describe some of the practical flight testing conducted by DTEO Boscombe Down. The Feasibility Study was aimed at answering the following questions: (a) Can current airships regularly take-off and land safely in surface windspeeds up to 30 kn? (b) Can airships be flown safely in Instrument Meteorological Conditions (IMC)? (c) Can airships operate safely in typical UK weather conditions, including snow and icing conditions? and (d) Can airships provide a satisfactory platform for the mounting of radars and electro-optical sensors?

Derived from text

Airships; Command and Control; Flight Mechanics; Flight Tests; Fly by Light Control

19960020260; 96N23855 NASA Ames Research Center, Moffett Field, CA USA

V/STOL systems research aircraft: A tool for cockpit integration

Stortz, Michael W., NASA Ames Research Center, USA; ODonoghue, Dennis P., NASA Lewis Research Center, USA; Report to the Aerospace Profession: 39th SETP Symposium; Sep. 1995, pp. 368-385; In English; Also announced as

19960020236; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The next generation ASTOVL aircraft will have a complicated propulsion system. The configuration choices include Direct Lift, Lift-Fan and Lift + Lift/Cruise but the aircraft must also have supersonic performance and low-observable characteristics. The propulsion system may have features such as flow blockers, vectoring nozzles and flow transfer schemes. The flight control system will necessarily fully integrate the aerodynamic surfaces and the propulsive elements. With a fully integrated, fly-by-wire flight/propulsion control system, the options for cockpit integration are interesting and varied. It is possible to de-couple longitudinal and vertical responses allowing the pilot to close the loop on flightpath and flightpath acceleration directly. In the hover, the pilot can control the translational rate directly without having to stabilize the inner rate and attitude loops. The benefit of this approach, reduced workload and increased precision, has previously been demonstrated through several motion-based simulations. In order to prove the results in flight, the V/STOL System Research Aircraft (VSRA) was developed at the NASA Ames Research Center. The VSRA is the YAV-8B Prototype modified with a research flight control system using a series-parallel servo configuration in all the longitudinal degrees of freedom (including thrust and thrust vector angle) to provide an integrated flight and propulsion control system in a limited envelope. Development of the system has been completed and flight evaluations of the response types have been performed. In this paper we will discuss the development of the VSRA, the evolution of the flightpath command and translational rate command response types and the Guest Pilot evaluations of the system. Pilot evaluation results are used to draw conclusions regarding the suitability of the system to satisfy V/STOL requirements.

Author

Aerodynamics; Control Surfaces; Flight Tests; Fly by Wire Control; V/STOL Aircraft; Propulsion; Aircraft Control

19960020398; 96N23976 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France

AGARD Flight Test Techniques Series., Volume 14, Introduction to Flight Test Engineering *Introduction a la technique dessais en vol*

Stoliker, F. N., Stoliker (F. N.), USA; Sep. 1995458p; In English

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This is the Introductory Volume to the Flight Test Techniques Series. It is a general introduction to the various activities and aspects of Flight Test Engineering that must be considered when planning, conducting, and reporting a flight test program. Its main intent is to provide a broad overview to the novice engineer or to other people who have a need to interface with specialists within the flight test community. The first two Sections provide some insight into the question of why flight test and give a short history of flight test engineering. Sections 3 through 10 deal with the preparation for flight testing. They provide guidance on the preliminary factors that must be considered; the composition of the test team; the logistic support requirements; the instrumentation and data processing requirements; the flight test plan; the associated preliminary ground tests; and last, but by no means least, discuss safety aspects. Sections 11 through 27 describe the various types of flight tests that are usually conducted during the development and certification of a new or modified aircraft type. Each Section offers a brief introduction to the topic under consideration, and the nature and the objectives of the tests to be conducted. It lists the test instrumentation (and, where appropriate, other test equipment and facilities) required, describes the test maneuvers to be executed, and indicates the way in which the test data is selected, analyzed, and presented. The various activities that should take place between test flights are presented next. Items that are covered are: who to debrief; what type of reports to send where: types of data analysis required for next flight; review of test data to make a comparison to predicted data and some courses of action if there is not good agreement; and comments on selecting the next test flight. The activities that must take place upon completion of the test program are presented. The types of reports and briefings that should take place and a discussion of some of the uses of the flight test data are covered. A brief forecast is presented of where present trends may be leading.

Author

Flight Tests; Flight Safety; Test Equipment; Project Management

19960020447; 96N24020 NASA Ames Research Center, Moffett Field,CA USA

Future Carrier-Based Tactical Aircraft Study

Samuels, Jeffrey J., NASA Ames Research Center, USA; Hahn, Andrew S., NASA Ames Research Center, USA; Schleicher, David R., NASA Ames Research Center, USA; Wilson, Samuel B., III, NASA Ames Research Center, USA; Carbajal, Kevin B., NASA Ames Research Center, USA; Gelhausen, Paul A., NASA Ames Research Center, USA; Mar. 1996204p; In English

Contract(s)/Grant(s): RTOP 505-59-30

Report No.(s): NASA-TM-110388; A-961330; NAS 1.15:110388; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

This report describes an aircraft database which was developed to identify technology trends for several classes of tactical naval aircraft, including subsonic attack, supersonic fighter, and supersonic multimission aircraft classes. This study used an approach that was internally consistent among designs, whereas most comparative studies require 'normalizing' aircraft that are developed by different design groups

using different methods and databases. All aircraft were evaluated in two technology timeframes and were sized with consistent methods which allow the aircraft to be directly compared in operational utility or cost analysis trends. The multimission aircraft were compared to evaluate the effect of technology and mission requirements. This comparison highlights the effect of changing technology and mission requirements on the Short Takeoff and Vertical Landing (STOVL) aircraft and addresses the impact of aircraft navalization. The subsonic attack aircraft evaluation compared flying wing to conventional designs, one- versus two-place crew, two versus four bombs, and internal versus external weapon carriage.
Author
Aircraft Design; Data Bases; Military Aircraft; Stovl Aircraft; Trends

19960020450; 96N24023 NASA Ames Research Center, Moffett Field,CA USA
Dynamic Calibration of the NASA Ames Rotor Test Apparatus Steady/Dynamic Rotor Balance
Peterson, Randall L., NASA Ames Research Center, USA; vanAken, Johannes M., Sterling Federal Systems, Inc., USA; Apr. 1996114p; In English
Contract(s)/Grant(s): RTOP 505-59-36
Report No.(s): NASA-TM-110393; A-961452; NAS 1.15:110393; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

The NASA Ames Rotor Test Apparatus was modified to include a Steady/Dynamic Rotor Balance. The dynamic calibration procedures and configurations are discussed. Random excitation was applied at the rotor hub, and vibratory force and moment responses were measured on the steady/dynamic rotor balance. Transfer functions were computed using the load cell data and the vibratory force and moment responses from the rotor balance. Calibration results showing the influence of frequency bandwidth, hub mass, rotor RPM, thrust preload, and dynamic loads through the stationary push rods are presented and discussed.
Author
Calibrating; Rotor Dynamics; Rotors; Dynamic Loads; Aerodynamic Balance; Dynamic Response; Moments of Inertia; Stability Derivatives

19960020611; 96N24153 Army Research Lab., Watertown, MA USA
Evaluation of Spectra Airlift Sling Systems Subjected to Asymmetric Fatigue Loading
Dooley, Robert B., Army Research Lab., USA; Pasternak, Robert E., Army Research Lab., USA; Pergantis, Charles, Army Research Lab., USA; Dr. Mead J.L., Army Research Lab., USA; Jun. 199536p; In English
Report No.(s): ARL-TR-757; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The contents of this report describe the results and observations of experimental activities focused on evaluating the performance of SPECTRA(TM) Airlift Sling Systems in support of an External Airlift Transportation (EAT) failure investigation. One of two legs of the twin leg SPECTRA sling system was subjected to fatigue loading in an asymmetric test configuration (four sling systems fatigued). Ultimate strength tests were performed on the fatigued legs to determine reduced strength. An additional two slings were reserved to identify virgin (non-fatigued) ultimate strength. Test parameters including cable gender loading (i.e. male versus female sling leg), splice coatings, and the effects of heat and degradation of strength by fatigue were examined. Attempts were made to identify the most influential test parameters. Correlations between ultimate strength and the test parameters were established.
Author
Fatigue (Materials); Failure Analysis; Load Carrying Capacity; Cables (Ropes); Helicopters; Air Cargo; Heavy Lift Helicopters

19960020736; 96N24259 Advisory Group for Aerospace Research and Development, Structures and Materials Panel., Neuilly-Sur-Seine, France
Widespread Fatigue Damage in Military Aircraft *LEndommagement en Fatigue des Avions Militaires*
Dec. 1995224p; In English; 80th Meeting of the AGARD Structures and Materials Panel, 10-11 May 1995, Rotterdam, Netherlands; Also announced as 19960013191 through 1996001320; Original contains 2 color illustrations
Report No.(s): AGARD-CP-568; ISBN-92-836-1021-0; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

Several countries have been experiencing aging aircraft related problems in their military fleets, particularly among their military transport aircraft. The most troubling aging aircraft structure-related issue is widespread fatigue damage (WFD), sometimes termed as multiple site damage, whose onset due to fatigue causes a dramatic structural strength reduction. Invariably, when WFD occurs, the affected model in the fleet is subjected to an extensive modification program which is almost always expensive and time-consuming. A Specialists' Meeting on the subject was held in order to explore ways and means to quantitatively predict structural degradation on account of WFD as a function of usage and when WFD is likely to occur.
Author
Fatigue (Materials); Degradation; Structural Analysis; Aircraft Structures; Aircraft Maintenance; Fatigue Life; Conferences

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