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# AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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

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**01 Aeronautics** **1**

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**05 Aircraft Design, Testing and Performance** **5**

Includes aircraft simulation technology.

**06 Aircraft Instrumentation** **8**

Includes cockpit and cabin display devices; and flight instruments.

**07 Aircraft Propulsion and Power** **8**

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# Typical Report Citation and Abstract

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

## Key

1. Document ID Number; Corporate Source
2. Title
3. Author(s) and Affiliation(s)
4. Publication Date
5. Contract/Grant Number(s)
6. Report Number(s); Availability and Price Codes
7. Abstract
8. Abstract Author
9. Subject Terms

# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 351)*

JUNE 27, 1997

## 01
## AERONAUTICS

**19970017413** Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
**F-111 C Lower Wing Skin Bonded Composite Repair Substantiation Testing**
Boykett, R., Defence Science and Technology Organisation, Australia; Walker, K., Defence Science and Technology Organisation, Australia; Nov. 1996; 80p; In English
Report No.(s): DSTO-TR-0480; AR-010-110; Copyright; Avail: Issuing Activity (Aeronauticla and Maritime Research Lab., PO Box 4331, Melbourne Vic 3001, Australia), Hardcopy, Microfiche

Experimental testing was undertaken to verify a bonded composite repair to a crack in the primary structure of a F-111C aircraft of the Royal Australian Air Force. The flight safety was compromised by a crack in the lower wing skin reducing the structure residual strength below the Design Limit level. Two levels of representative specimens were designed to incorporate the complex local geometry in the lower wing skin. They were tested in several configurations (ambient, high and low temperature) under static and cyclic loads with, and without, repaired cracks. Extensive strain survey data was obtained for both types of specimens and their static residual strength was shown to be restored by the repair. Cyclic loading tests of specimens with the repair also demonstrated good durability and damage tolerance, with crack growth data providing a recommended inspection interval for remaining aircraft.
Author
*F-111 Aircraft; Wings; Dynamic Tests; Crack Propagation; Flight Safety; Maintenance*

## 02
## AERODYNAMICS

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

**19970017015** NASA Langley Research Center, Hampton, VA USA
**Surface-Pressure and Flow-Visualization Data at Mach Number of 1.60 for Three 65 deg Delta Wings Varying in Leading-Edge Radius and Camber**
McMillin, S. Naomi, NASA Langley Research Center, USA; Bryd, James E., Lockheed Engineering and Sciences Co., USA; Parmar, Devendra S., Old Dominion Univ., USA; Bezos-OConnor, Gaudy M., NASA Langley Research Center, USA; Forrest, Dana K., NASA Langley Research Center, USA; Bowen, Susan, Computer Sciences Corp., USA; Dec. 1996; 268p; In English; CD-ROM conforms to ISO 9660 standard.
Contract(s)/Grant(s): RTOP 505-59-53-05
Report No.(s): NASA-TM-4673; NAS 1.15:4673; NONP-NASA-CD-97-1997021249; L-17443; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

An experimental investigation of the effect of leading-edge radius, camber, Reynolds number, and boundary-layer state on the incipient separation of a delta wing at supersonic speeds was conducted at the Langley Unitary Plan Wind Tunnel at Mach number of 1.60 over a free-stream Reynolds number range of 1 x 106 to 5 x 106 ft-1. The three delta wing models examined had a 65 deg swept leading edge and varied in cross-sectional shape: a sharp wedge, a 20:1 ellipse, and a 20:1 ellipse with a -9.750 circular camber imposed across the span. The wings were tested with and without transition grit applied. Surface-pressure coefficient data and flow-visualization data indicated that by rounding the wing leading edge or cambering the wing in the spanwise direction, the onset of leading-edge separation on a delta wing can be raised to a higher angle of attack than that observed on a sharp-edged delta wing. The data also showed that the onset of leading-edge separation can be raised to a higher angle of attack

by forcing boundary-layer transition to occur closer to the wing leading edge by the application of grit or the increase in free-stream Reynolds number.
Author
*Delta Wings; Flow Visualization; Leading Edges; Camber; Pressure Ratio*

**19970017057** NASA Langley Research Center, Hampton, VA USA
**Computation of Sound Generated by Viscous Flow Over a Circular Cylinder**
Cox, Jared S., George Washington Univ., USA; Rumsey, Christopher L., NASA Langley Research Center, USA; Brentner, Kenneth S., NASA Langley Research Center, USA; Younis, Bassam A., City Univ., UK; Mar. 1997; 12p; In English
Contract(s)/Grant(s): RTOP 533-31-21-04
Report No.(s): NASA-TM-110339; NAS 1.15:110339; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
The Lighthill acoustic analogy approach combined with Reynolds-averaged Navier Stokes is used to predict the sound generated by unsteady viscous flow past a circular cylinder assuming a correlation length of 10 cylinder diameters. The two-dimensional unsteady flow field is computed using two Navier-Stokes codes at a low Mach number over a range of Reynolds numbers from 100 to 5 million. Both laminar flow as well as turbulent flow with a variety of eddy viscosity turbulence models are employed. Mean drag and Strouhal number are examined, and trends similar to experiments are observed. Computing the noise within the Reynolds number regime where transition to turbulence occurs near the separation point is problematic: laminar flow exhibits chaotic behavior and turbulent flow exhibits strong dependence on the turbulence model employed. Comparisons of far-field noise with experiment at a Reynolds number of 90,000, therefore, vary significantly, depending on the turbulence model. At a high Reynolds number outside this regime, three different turbulence models yield self-consistent results.
Author
*Viscous Flow; Lighthill Method; Navier-Stokes Equation; Unsteady Flow; Reynolds Number; Aerodynamic Noise; Aeroacoustics; Computational Fluid Dynamics; Noise Prediction; Circular Cylinders*

**19970017058** NASA Langley Research Center, Hampton, VA USA
**Subsonic Dynamics of Stardust Sample Return Capsule**
Mitcheltree, Robert A., NASA Langley Research Center, USA; Fremaux, Charles M., NASA Langley Research Center, USA; Mar. 1997; 22p; In English
Contract(s)/Grant(s): RTOP 242-80-01-01
Report No.(s): NASA-TM-110329; NAS 1.15:110329; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Subsonic dynamic stability tests performed in the NASA Langley 20-Foot Vertical Spin-Tunnel on a 0.238 scale model of the Stardust Sample Return Capsule are discussed. The tests reveal that the blunted 60 degree half-angle cone capsule is dynamically unstable at low subsonic conditions due to the aft location of the center-of-gravity (0.351 body diameters back from the nose). The divergent behavior of the capsule continued when the center-of-gravity was moved to 0.337 and 0.313 body diameters back from the nose. When the center-of-gravity was moved further forward to 0.290 body diameters back from the nose, the vehicle established itself in a limit cycle with amplitude around 10 degrees. Two afterbody modifications were examined which proved unsuccessful in alleviating the instability of the original design. Finally, the addition of different sized parachutes was examined as a means to stabilize the vehicle. The parachute tests indicate that a parachute with equivalent full scale drag area of at least 2.24 ft. is necessary to assure large perturbations are damped.
Author
*Dynamic Stability; Wind Tunnel Tests; Stability Tests; Atmospheric Entry; Space Capsules; Landing Modules; Aerodynamics; Subsonic Speed*

**19970017325** NASA Langley Research Center, Hampton, VA USA
**External Boundary Conditions for Three-Dimensional Problems of Computational Aerodynamics**
Tsynkov, Semyon V., NASA Langley Research Center, USA; Mar. 1997; 42p; In English
Contract(s)/Grant(s): RTOP 522-31-21-04
Report No.(s): NASA-TM-110337; NAS 1.15:110337; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
We consider an unbounded steady-state flow of viscous fluid over a three-dimensional finite body or configuration of bodies. For the purpose of solving this flow problem numerically, we discretize the governing equations (Navier-Stokes) on a finite-difference grid. The grid obviously cannot stretch from the body up to infinity, because the number of the discrete variables in that case would not be finite. Therefore, prior to the discretization we truncate the original unbounded flow domain by introducing some artificial computational boundary at a finite distance of the body. Typically, the artificial boundary is introduced in a natural way as the external boundary of the domain covered by the grid. The flow problem formulated only on the finite computational domain

rather than on the original infinite domain is clearly subdefinite unless some artificial boundary conditions (ABC's) are specified at the external computational boundary. Similarly, the discretized flow problem is subdefinite (i.e., lacks equations with respect to unknowns) unless a special closing procedure is implemented at this artificial boundary. The closing procedure in the discrete case is called the ABC's as well. In this paper, we present an innovative approach to constructing highly accurate ABC's for three-dimensional flow computations. The approach extends our previous technique developed for the two-dimensional case; it employs the finite-difference counterparts to Calderon's pseudodifferential boundary projections calculated in the framework of the difference potentials method (DPM) by Ryaben'kii. The resulting ABC's appear spatially nonlocal but particularly easy to implement along with the existing solvers. The new boundary conditions have been successfully combined with the NASA-developed production code TLNS3D and used for the analysis of wing-shaped configurations in subsonic (including incompressible limit) and transonic flow regimes. As demonstrated by the computational experiments and comparisons with the standard (local) methods, the DPM-based ABC's allow one to greatly reduce the size of the computational domain while still maintaining high accuracy of the numerical solution. Moreover, they may provide for a noticeable increase of the convergence rate of multigrid iterations.
Author
*Computational Fluid Dynamics; Navier-Stokes Equation; Viscous Fluids; Finite Difference Theory; Boundary Conditions; Three Dimensional Flow; Transonic Flow; Subsonic Flow*

**19970017370** NASA Langley Research Center, Hampton, VA USA
**An Application of the Difference Potentials Method to Solving External Problems in CFD**
Ryaben 'Kii, Victor S., Academy of Sciences (USSR), USSR; Tsynkov, Semyon V., NASA Langley Research Center, USA; Mar. 1997; 40p; In English
Contract(s)/Grant(s): RTOP 522-31-21-04
Report No.(s): NASA-TM-110338; NAS 1.15:110338; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Numerical solution of infinite-domain boundary-value problems requires some special techniques that would make the problem available for treatment on the computer. Indeed, the problem must be discretized in a way that the computer operates with only finite amount of information. Therefore, the original infinite-domain formulation must be altered and/or augmented so that on one hand the solution is not changed (or changed slightly) and on the other hand the finite discrete formulation becomes available. One widely used approach to constructing such discretizations consists of truncating the unbounded original domain and then setting the artificial boundary conditions (ABC's) at the newly formed external boundary. The role of the ABC's is to close the truncated problem and at the same time to ensure that the solution found inside the finite computational domain would be maximally close to (in the ideal case, exactly the same as) the corresponding fragment of the original infinite-domain solution. Let us emphasize that the proper treatment of artificial boundaries may have a profound impact on the overall quality and performance of numerical algorithms. The latter statement is corroborated by the numerous computational experiments and especially concerns the area of CFD, in which external problems present a wide class of practically important formulations. In this paper, we review some work that has been done over the recent years on constructing highly accurate nonlocal ABC's for calculation of compressible external flows. The approach is based on implementation of the generalized potentials and pseudodifferential boundary projection operators analogous to those proposed first by Calderon. The difference potentials method (DPM) by Ryaben'kii is used for the effective computation of the generalized potentials and projections. The resulting ABC's clearly outperform the existing methods from the standpoints of accuracy and robustness, in many cases noticeably speed up the multigrid convergence, and at the same time are quite comparable to other methods from the standpoints of geometric universality and simplicity of implementation.
Author
*Computational Fluid Dynamics; Compressible Flow; Boundary Value Problems; Navier-Stokes Equation; Difference Equations; Viscous Flow*

**19970017437** Toledo Univ., Dept. of Mechanical Engineering, OH USA
**User's Manual for DuctE3D: A Program for 3D Euler Unsteady Aerodynamic and Aeroelastic Analysis of Ducted Fans *Final Report***
Srivastava, R., Toledo Univ., USA; Reddy, T. S. R., Toledo Univ., USA; Apr. 1997; 52p; In English
Contract(s)/Grant(s): NAG3-1230; RTOP 538-06-13
Report No.(s): NASA-CR-202335; NAS 1.26:202335; E-10707; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche
The program DuctE3D is used for steady or unsteady aerodynamic and aeroelastic analysis of ducted fans. This guide describes the input data required and the output files generated, in using DuctE3D. The analysis solves three dimensional unsteady, compressible Euler equations to obtain the aerodynamic forces. A normal mode structural analysis is used to obtain the aeroelastic

equations, which are solved using either the time domain or the frequency domain solution method. Sample input and output files are included in this guide for steady aerodynamic analysis and aeroelastic analysis of an isolated fan row.
Author
*User Manuals (Computer Programs); Euler Equations of Motion; Aeroelasticity; Applications Programs (Computers); Aerospace Engineering*

**19970017671** NASA Lewis Research Center, Cleveland, OH USA
**Modern Airfoil Ice Accretions**
Addy, Harold E., Jr., NASA Lewis Research Center, USA; Potapczuk, Mark G., NASA Lewis Research Center, USA; Sheldon, David W., NASA Lewis Research Center, USA; Mar. 1997; 16p; In English; 35th; Aerospace Sciences, 6-10 Jan. 1997, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 505-68-1C
Report No.(s): NASA-TM-107423; NAS 1.15:107423; AIAA Paper 97-0174; E-10667; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report presents results from the first icing tests performed in the Modem Airfoils program. Two airfoils have been subjected to icing tests in the NASA Lewis Icing Research Tunnel (IRT). Both airfoils were two dimensional airfoils; one was representative of a commercial transport airfoil while the other was representative of a business jet airfoil. The icing test conditions were selected from the FAR Appendix C envelopes. Effects on aerodynamic performance are presented including the effects of varying amounts of glaze ice as well as the effects of approximately the same amounts of glaze, mixed, and rime ice. Actual ice shapes obtained in these tests are also presented for these cases. In addition, comparisons are shown between ice shapes from the tests and ice shapes predicted by the computer code, LEWICE for similar conditions. Significant results from the tests are that relatively small amounts of ice can have nearly as much effect on airfoil lift coefficient as much greater amounts of ice and that glaze ice usually has a more detrimental effect than either rime or mixed ice. LEWICE predictions of ice shapes, in general, compared reasonably well with ice shapes obtained in the IRT, although differences in details of the ice shapes were observed.
Author
*Airfoils; Aerodynamic Characteristics; Aerodynamic Coefficients; Ice Formation; Computer Programs*

**19970017825** Old Dominion Univ., Aerospace Engineering, Norfolk, VA USA
**Unsteady, Transonic Flow Around Delta Wings Undergoing Coupled and Natural Modes Response: A Multidisciplinary Problem**
Menzies, Margaret Anne, Old Dominion Univ., USA; May 1996; 6p; In English
Contract(s)/Grant(s): NAG1-648
Report No.(s): NASA-CR-203248; NAS 1.26:203248; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The unsteady, three-dimensional Navier-Stokes equations coupled with the Euler equations of rigid-body dynamics are sequentially solved to simulate and analyze the aerodynamic response of a high angle of attack delta wing undergoing oscillatory motion. The governing equations of fluid flow and dynamics of the multidisciplinary problem are solved using a time-accurate solution of the laminar, unsteady, compressible, full Navier- Stokes equations with the implicit, upwind, Roe flux-difference splitting, finite-volume scheme and a four-stage Runge-Kutta scheme, respectively. The primary model under consideration consists of a 65 deg swept, sharp-edged, cropped delta wing of zero thickness at 20 deg angle of attack. In a freestream of Mach 0.85 and Reynolds number of 3.23 x 10(exp 6), the flow over the upper surface of the wing develops a complex shock system which interacts with the leading-edge primary vortices producing vortex breakdown. The effect of the oscillatory motion of the wing on the vortex breakdown and overall aerodynamic response is detailed to provide insight to the complicated physics associated with unsteady flows and the phenomenon of wing rock. Forced sinusoidal single and coupled mode rolling and pitching motion is presented for the wing in a transonic freestream. The Reynolds number, frequency of oscillation, and the phase angle are varied. Comparison between the single and coupled mode forced rolling and pitching oscillation cases illustrate the effects of coupling the motion. This investigation shows that even when coupled, forced rolling oscillation at a reduced frequency of 2(pi) eliminates the vortex breakdown which results in an increase in lift. The coupling effect for in phase forced oscillations show that the lift coefficient of the pitching-alone case and the rolling-moment coefficient of the rolling-alone case dominate the resulting response. However, with a phase lead in the pitching motion, the coupled motion results in a non-periodic response of the rolling moment. The second class of problems involve releasing the wing in roll to respond to the flowfield. Two models of sharp-edged delta wings, the previous 65 deg swept model and an 80 deg swept, sharp-edged delta wing, are used to observe the aerodynamic response of a wing free to roll in a transonic and subsonic freestream, respectively. These cases demonstrate damped oscillations, self-sustained limit cycle oscillations, and divergent rolling oscillations. Ultimately, an active control model using a mass injection system was applied on the surface of the wing to suppress the self-sustained limit cycle oscillation known as wing rock. Comparisons with experimen-

tal investigations complete this study, validating the analysis and illustrating the complex details afforded by computational investigations.
Author
*Transonic Flow; Unsteady Flow; Delta Wings; Aerodynamic Coefficients; Navier-Stokes Equation; Angle of Attack; Flow Distribution; Flow Equations; Swept Wings; Leading Edges*

## 05
## AIRCRAFT DESIGN, TESTING AND PERFORMANCE

*Includes aircraft simulation technology.*

**19970016959** Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA USA
**Power Plant and Drive Train of the NPS Hummingbird Remotely Piloted Helicopter**
Conway, Robert E., Naval Postgraduate School, USA; Sep. 1996; 102p; In English
Report No.(s): AD-A320151; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

Originally designed as a target drone for the U.S. Army, the NPS Hummingbird has undergone several modifications to convert it into a reliable research platform. The 163 pound remotely piloted helicopter (RPH) is powered by a Weslake Aeromarine Engines Limited (WAEL) 342 two stroke, twin cylinder, 25 hp, gasoline engine. An engine failure due to cylinder overheating halted research efforts until investigation as to the cause and subsequent corrections could be made. Costing approximately $3000 per engine, another failure is unacceptable. The tasks undertaken in this thesis were to investigate the cause of the overheat failure and improve the engine cooling system. Cooling system corrections required total redesigns of the engine cooling and engine start systems. Additionally, research of the RPH's history revealed a need for a torsional shock absorber to be incorporated in the drive train to increase component life. The changes made to Hummingbird provide a decrease in empty weight, minimal center of gravity chang e and, most importantly, an increase in user safety finishing the Department of Aeronautics and Astronautics with a dependable vehicle for rotary wing research.
DTIC
*Helicopters; Remotely Piloted Vehicles; Cooling Systems; Drone Vehicles; Engine Failure; Internal Combustion Engines; Rotary Wings*

**19970016974** NASA Langley Research Center, Hampton, VA USA
**Stiffness Characteristics of Composite Rotor Blades With Elastic Couplings**
Piatak, David J., NASA Langley Research Center, USA; Nixon, Mark W., Army Research Lab., USA; Kosmatka, John B., California Univ., USA; Apr. 1997; 48p; In English
Contract(s)/Grant(s): RTOP 505-63-36-02
Report No.(s): NASA-TP-3641; NAS 1.60:3641; ARL-TR-1279; L-17442; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Recent studies on rotor aeroelastic response and stability have shown the beneficial effects of incorporating elastic couplings in composite rotor blades. However, none of these studies have clearly identified elastic coupling limits and the effects of elastic couplings on classical beam stiffnesses of representative rotor blades. Knowledge of these limits and effects would greatly enhance future aeroelastic studies involving composite rotor blades. The present study addresses these voids and provides a preliminary design database for investigators who may wish to study the effects of elastic couplings on representative blade designs. The results of the present study should provide a basis for estimating the potential benefits associated with incorporating elastic couplings without the need for first designing a blade cross section and then performing a cross-section analysis to obtain the required beam section properties as is customary in the usual one-dimensional beam-type approach.
Author
*Stiffness; Composite Materials; Couplings; Rotor Blades (Turbomachinery)*

**19970016982** Armstrong Lab., Logistics Research Div., Wright-Patterson AFB, OH USA
**Using a Neural Network and a Statistical Classifier for Aircraft Fault Diagnostics** ***Final Report, Mar. 1995 - Aug. 1996***
Chu, Shing P., Armstrong Lab., USA; Aug. 1996; 22p; In English
Contract(s)/Grant(s): AF Proj. 1710
Report No.(s): AD-A319499; AL/HR-TP-1996-0018; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

In recent years, several techniques have been developed to create intelligent diagnostic aiding systems. Most of these systems, including the current Integrated Maintenance Information System (IMIS) diagnostics module, involve modeling the systems to

be maintained. These systems have the disadvantage of requiring extensive efforts to develop them. A developing technology, neural networks, provides a promising alternative. Neural nets develop diagnostics strategies by learning from past experience with the system, and do not require extensive modeling. Neural networks are well suited to diagnostics applications. This paper presents: A detailed description of a neural network based diagnostic system; An explanation of a radial basis function (RBF) neural network architecture and its construction; An explanation of the construction of a statistical classifier; A description of data representation and method of system optimization; and Performance and experimental result.
DTIC
*Information Systems; Neural Nets*

**19970017054** Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
**A Lightweight Vibration Monitoring System for the S-70A-9 Black Hawk Transmission**
Blunt, D. M., Defence Science and Technology Organisation, Australia; Dutton, S. A., Defence Science and Technology Organisation, Australia; Nov. 1996; 62p; In English
Report No.(s): DSTO-TR-0336; AR-009-697; Copyright; Avail: Issuing Activity (Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne Vic 3001, Australia), Hardcopy, Microfiche

A lightweight carry-on/carry-off transmission vibration monitoring system has been developed for the Black Hawk helicopter. The system collects vibration data from accelerometers mounted on the transmission while in flight, and then post-processes the data on the ground using AMRL-developed fault detection algorithms. This report describes the systems, its installation and operation, and the results of a flight trial conducted by the RAAF Aircraft and Development Unit.
Author
*H-60 Helicopter; Vibration Measurement; Fault Detection; In-Flight Monitoring; Transmissions (Machine Elements); Helicopter Propeller Drive*

**19970017055** Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
**Effect of the Leading-Edge Extension (LEX) Fence on the Vortex Structure over the F/A-18**
Thompson, D. H., Defence Science and Technology Organisation, Australia; Feb. 1997; 63p; In English
Report No.(s): DSTO-TR-0489; AR-008-381; Copyright; Avail: Issuing Activity (Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne Vic 3001, Australia), Hardcopy, Microfiche

The effects of the Leading Edge Extension (LEX) fence on the vortex structure over the F/A-18 at moderate to high angles of attack were studied using a 1/9 scale wind tunnel model and a 1/48 scale water tunnel model. Measurements at the tip of one of the vertical fins of the wind tunnel model confirmed that the fence reduced fin vibration caused by vortex breakdown. Flow visualisation in the water tunnel and in the wind tunnel showed that the fence caused the formation of a second LEX vortex, of the same sense as the main LEX vortex, but originating on the LEX leading edge outboard of the fence. Visualization of the surface flow around the fence showed in detail how the fence caused the second LEX vortex. The effects on vortex breakdown and fin vibration of the interaction between the main and second LEX vortices are discussed.
Author
*Wind Tunnel Models; Wind Tunnel Tests; Scale Models; Leading Edges; Angle of Attack; Water Tunnel Tests*

**19970017364** NASA Langley Research Center, Hampton, VA USA
**Generic Airplane Model Concept and Four Specific Models Developed for Use in Piloted Simulation Studies**
Hoffler, Keith D., Vigyan Research Associates, Inc., USA; Fears, Scott P., Vigyan Research Associates, Inc., USA; Carzoo, Susan W., Unisys Corp., USA; Feb. 1997; 54p; In English
Contract(s)/Grant(s): NAS1-19672; NAS1-96014; NAS1-20454; RTOP 505-68-30-01
Report No.(s): NASA-CR-201651; NAS 1.26:201651; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

A generic airplane model concept was developed to allow configurations with various agility, performance, handling qualities, and pilot vehicle interface to be generated rapidly for piloted simulation studies. The simple concept allows stick shaping and various stick command types or modes to drive an airplane with both linear and nonlinear components. Output from the stick shaping goes to linear models or a series of linear models that can represent an entire flight envelope. The generic model also has provisions for control power limitations, a nonlinear feature. Therefore, departures from controlled flight are possible. Note that only loss of control is modeled, the generic airplane does not accurately model post departure phenomenon. The model concept is presented herein, along with four example airplanes. Agility was varied across the four example airplanes without altering spe-

cific excess energy or significantly altering handling qualities. A new feedback scheme to provide angle-of-attack cueing to the pilot, while using a pitch rate command system, was implemented and tested.
Author
*Aircraft Models; Flight Control; Flight Envelopes; Flight Simulation; Flight Optimization; Controllability*

**19970017596** Wright Lab., Flight Dynamics Directorate, Wright-Patterson AFB, OH USA
**FY97 Air Vehicles Technology Area Plan** ***Final Report, 1 Oct. 1996 - 30 Sep. 1997***
Aug. 1996; 42p; In English
Contract(s)/Grant(s): AF-Proj. 9993
Report No.(s): AD-A318708; WL-TR-97-3000; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Air vehicle technology spans multiple technical disciplines to provide the Air Force and our nation with innovative solutions to both near and far-term defense needs. Our scientists and researchers work in Integrated Product Terms (IPTs) that design, develop and provide optimum air combat capabilities. The IPTs, the TMP and the Mission Area Plans(MAPs), generated in coordination with the warfighter communities, ensure the emphasis of Research Development Test & Evaluation RDT&E) is focused on the areas of greatest need. Affordability is paramount and is given utmost consideration in all phases of RDT&E within the Air Vehicles Technology Area. During a time of declining budgets and resources, we are challenged to maintain and provide critical technologies, ensuring the nation's superior defense capabilities. We developed a strategic plan for Air Vehicles RDT&E to ensure we can maintain our leadership role, and to build a foundation for continuing excellence into the future
DTIC
*Military Aircraft; Coordination; Research and Development; Technologies; Management Planning*

**19970017777** Old Dominion Univ., Dept. of Mechanical Engineering, Norfolk, VA USA
**Variational Methods in Design Optimization and Sensitivity Analysis for Two-Dimensional Euler Equations**
Ibrahim, A. H., Old Dominion Univ., USA; Tiwari, S. N., Old Dominion Univ., USA; Smith, R. E., NASA Langley Research Center, USA; Apr. 1997; 54p; In English
Contract(s)/Grant(s): NCC1-232
Report No.(s): NASA-CR-204431; NAS 1.26:204431; ODU/ICAM-97-102; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Variational methods (VM) sensitivity analysis employed to derive the costate (adjoint) equations, the transversality conditions, and the functional sensitivity derivatives. In the derivation of the sensitivity equations, the variational methods use the generalized calculus of variations, in which the variable boundary is considered as the design function. The converged solution of the state equations together with the converged solution of the costate equations are integrated along the domain boundary to uniquely determine the functional sensitivity derivatives with respect to the design function. The application of the variational methods to aerodynamic shape optimization problems is demonstrated for internal flow problems at supersonic Mach number range. The study shows, that while maintaining the accuracy of the functional sensitivity derivatives within the reasonable range for engineering prediction purposes, the variational methods show a substantial gain in computational efficiency, i.e., computer time and memory, when compared with the finite difference sensitivity analysis.
Author
*Calculus of Variations; Derivation; Design Analysis; Differential Equations; Equations of State; Optimization; Prediction Analysis Techniques; Sensitivity*

**19970017831** Sandia National Labs., Albuquerque, NM USA
**Crack detection on HU-25 Guardian aircraft**
Moore, D. G., Sandia National Labs., USA; Jones, C. R., Sandia National Labs., USA; Mihelic, Joseph E., Coast Guard, USA; Dassler, Ed, Coast Guard, USA; Walizer, Jim, Coast Guard, USA; 1996; 5p; In English; Ndt - New Horizons on the Pacific, 14-18 Oct. 1996, Seattle, WA, USA
Contract(s)/Grant(s): DE-AC04-94AL-85000
Report No.(s): SAND-96-1930C; CONF-9610109-2; DE96-013389; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

An ultrasonic inspection method was developed at FAA's Airworthiness Assurance NDI Validation Center (AANC) to easily and rapidly detect hidden fatigue cracks in the copilot vertical windshield post on USCG (Coast Guard) HU-25 'Guardian' aircraft. The inspection procedure locates hidden cracks as small as 3.2 mm emanating from internal fastener holes and determines their

length. A test procedure was developed and a baseline assessment of the USCG fleet conducted. Inspection results on 41 aircraft revealed good correlation with results made during subsequent structural disassembly and visual inspection of selected aircraft. DOE

*Aircraft Reliability; Inspection; Holes (Mechanics); Cracks*

## 06
## AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices; and flight instruments.*

**19970017564** Wright Lab., Avionics Directorate, Wright-Patterson AFB, OH USA

**FY97 Avionics Technology Area Plan** ***Final Report, 1 Oct. 1996 - 30 Sep. 1997***

May 1996; 47p; In English

Contract(s)/Grant(s): AF-Proj. 9993

Report No.(s): AD-A318709; WL-TR-97-1000; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

On 15 February 1996, HQ USAF approved the merger of Wright Laboratory's (WL's) Solid State Electronics and Avionics Directorates. This 're-engineering' of the organizational structure for avionics technology development was pursued as one of three critical elements in the overall strategy for achievement of the Air Force vision for 21st Century Avionics. The Radio Frequency and Electro-Optical Technology Divisions develop targeting sensor, electronic warfare, and communication subsystems. The focus of the Combat Information Division is information fusion, the full scope of which is defined by the JDL/Reliance fusion model to include situation/threat determination and execution of an integrated offensive/defensive response. The System Concepts and Simulation Technology Division provides the open system-level architectures (hardware and software) and virtual prototyping for implementation of the full functionality of the avionics suite. The Electronic Devices Division supports efforts of the other Divisions by developing critical, enabling devices not available through commercial sources. The Mission Applications Division serves as the Directorate's primary interface to warfighter and acquisition customer communities and conducts advanced technology demonstrations as the last step to technology transition. Finally, the Technology Management Division provides centralized investment strategy and resource allocation planning in support of the entire Directorate. The resulting structure eliminates one layer of management, improves sharing of technical expertise across avionics functions, and establishes an enhanced environment for pursuit of multidivision development of open architecture, integrated avionics.

DTIC

*Avionics; Electronic Warfare; Electronic Equipment; Solid State Devices; Technologies; Management Planning*

## 07
## AIRCRAFT PROPULSION AND POWER

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

**19970017381** NASA Lewis Research Center, Cleveland, OH USA

**Evaluation of an Ejector Ramjet Based Propulsion System for Air-Breathing Hypersonic Flight**

Thomas, Scott R., NASA Lewis Research Center, USA; Perkins, H. Douglas, NASA Lewis Research Center, USA; Trefny, Charles J., NASA Lewis Research Center, USA; Mar. 1997; 14p; In English; 89th, 14-17 Apr. 1997, Palaiseau, France; Sponsored by North Atlantic Treaty Organization, Belgium

Contract(s)/Grant(s): RTOP 523-61-13

Report No.(s): NASA-TM-107422; NAS 1.15:107422; E-10665; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A Rocket Based Combined Cycle (RBCC) engine system is designed to combine the high thrust to weight ratio of a rocket along with the high specific impulse of a ramjet in a single, integrated propulsion system. This integrated, combined cycle propulsion system is designed to provide higher vehicle performance than that achievable with a separate rocket and ramjet. The RBCC engine system studied in the current program is the Aerojet strutjet engine concept, which is being developed jointly by a government-industry team as part of the Air Force HyTech program pre-PRDA activity. The strutjet is an ejector-ramjet engine in which small rocket chambers are embedded into the trailing edges of the inlet compression struts. The engine operates as an ejector-ramjet from take-off to slightly above Mach 3. Above Mach 3 the engine operates as a ramjet and transitions to a scramjet at high Mach numbers. For space launch applications the rockets would be re-ignited at a Mach number or altitude beyond which air-breathing propulsion alone becomes impractical. The focus of the present study is to develop and demonstrate a strutjet flowpath using

hydrocarbon fuel at up to Mach 7 conditions. Freejet tests of a candidate flowpath for this RBCC engine were conducted at the NASA Lewis Research Center's Hypersonic Tunnel Facility between July and September 1996. This paper describes the engine flowpath and installation, outlines the primary objectives of the program, and describes the overall results of this activity. Through this program 15 full duration tests, including 13 fueled tests were made. The first major achievement was the further demonstration of the HTF capability. The facility operated at conditions up to 1950 K and 7.34 MPa, simulating approximately Mach 6.6 flight. The initial tests were unfueled and focused on verifying both facility and engine starting. During these runs additional aerodynamic appliances were incorporated onto the facility diffuser to enhance starting. Both facility and engine starting were achieved. Further, the static pressure distributions compared well with the results previously obtained in a 40% subscale flowpath study conducted in the LERC 1X1 supersonic wind tunnel (SWT), as well as the results of CFD analysis. Fueled performance results were obtained for the engine at both simulated Mach 6 (1670 K) and Mach 6.6 (1950 K) conditions. For all these tests the primary fuel was liquid JP-10 with gaseous silane (a mixture of 20% SiH4 and 80% H2 by volume) as an ignitor/pilot. These tests verified performance of this engine flowpath in a freejet mode. High combustor pressures were reached and significant changes in axial force were achieved due to combustion. Future test plans include redistributing the fuel to improve mixing, and consequently performance, at higher equivalence ratios.
Author
*Integral Rocket Ramjets; Ejectors; Hydrocarbon Fuels; Wind Tunnel Tests; Supersonic Speed; Mach Number; Engine Tests; Propulsion System Performance; Flow Distribution*

**19970017382** NASA Lewis Research Center, Cleveland, OH USA
**Mixing of Multiple Jets With a Confined Subsonic Crossflow, Part 2, Opposed Rows of Orifices in Rectangular Ducts**
Holdeman, James D., NASA Lewis Research Center, USA; Liscinsky, David S., United Technologies Research Center, USA; Bain, Daniel B., CFD Research Corp., USA; May 1997; 18p; In English; 42nd; Gas Turbine and Aeroengine Congress, 2-5 Jun. 1997, Orlando, FL, USA; Sponsored by American Society of Mechanical Engineers, USA
Contract(s)/Grant(s): RTOP 537-02-20
Report No.(s): NASA-TM-107461; NAS 1.15:107461; E-10747; ASME-97-GT-439; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper summarizes experimental and computational results on the mixing of opposed rows of jets with a confined subsonic crossflow in rectangular ducts. The studies from which these results were excerpted investigated flow and geometric variations typical of the complex 3-D flowfield in the combustion chambers in gas turbine engines. The principal observation was that the momentum-flux ratio, J, and the orifice spacing, S/H, were the most significant flow and geometric variables. Jet penetration was critical, and penetration decreased as either momentum-flux ratio or orifice spacing decreased. It also appeared that jet penetration remained similar with variations in orifice size, shape, spacing, and momentum-flux ratio when the orifice spacing was inversely proportional to the square-root of the momentum-flux ratio. It was also seen that planar averages must be considered in context with the distributions. Note also that the mass-flow ratios and the offices investigated were often very large (jet-to-mainstream mass-flow ratio greater than 1 and the ratio of orifices-area-to-mainstream-cross-sectional-area up to 0.5 respectively), and the axial planes of interest were often just downstream of the orifice trailing edge. Three-dimensional flow was a key part of efficient mixing and was observed for all configurations.
Author
*Jet Mixing Flow; Three Dimensional Flow; Orifices; Mass Flow; Gas Turbine Engines; Ducted Flow; Combustion Chambers; Cross Flow*

**19970017403** NASA Lewis Research Center, Cleveland, OH USA
**Heat Transfer Computations of Internal Duct Flows With Combined Hydraulic and Thermal Developing Length**
Wang, C. R., NASA Lewis Research Center, USA; Towne, C. E., NASA Lewis Research Center, USA; Hippensteele, S. A., NASA Lewis Research Center, USA; Poinsatte, P. E., NASA Lewis Research Center, USA; May 1997; 22p; In English; 32nd; Thermophysics Conference, 23-25 Jun. 1997, Atlanta, GA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 523-26-13
Report No.(s): NASA-TM-107450; NAS 1.15:107450; E-10731; AIAA Paper 97-2486; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This study investigated the Navier-Stokes computations of the surface heat transfer coefficients of a transition duct flow. A transition duct from an axisymmetric cross section to a non-axisymmetric cross section, is usually used to connect the turbine exit to the nozzle. As the gas turbine inlet temperature increases, the transition duct is subjected to the high temperature at the gas turbine exit. The transition duct flow has combined development of hydraulic and thermal entry length. The design of the transition duct required accurate surface heat transfer coefficients. The Navier-Stokes computational method could be used to predict the

surface heat transfer coefficients of a transition duct flow. The Proteus three-dimensional Navier-Stokes numerical computational code was used in this study. The code was first studied for the computations of the turbulent developing flow properties within a circular duct and a square duct. The code was then used to compute the turbulent flow properties of a transition duct flow. The computational results of the surface pressure, the skin friction factor, and the surface heat transfer coefficient were described and compared with their values obtained from theoretical analyses or experiments. The comparison showed that the Navier-Stokes computation could predict approximately the surface heat transfer coefficients of a transition duct flow.
Author
*Heat Transfer; Turbulent Flow; Turbines; Navier-Stokes Equation; Internal Flow; Inlet Temperature; Heat Transfer Coefficients; Gas Turbines; Friction Factor; Flow Characteristics; Ducted Flow; Computational Fluid Dynamics*

**19970017415** Missouri Univ., Mechanical and Aerospace Engineering and Engineering Mechanics, Rolla, MO USA
**Improved Finite Element Modeling of the Turbofan Engine Inlet Radiation Problem**
Roy, Indranil Danda, Missouri Univ., USA; Eversman, Walter, Missouri Univ., USA; Meyer, H. D., United Technologies Corp., USA; Apr. 1993; 150p; In English
Contract(s)/Grant(s): NAS3-25952
Report No.(s): NASA-CR-204341; NAS 1.26:204341; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
Improvements have been made in the finite element model of the acoustic radiated field from a turbofan engine inlet in the presence of a mean flow. The problem of acoustic radiation from a turbofan engine inlet is difficult to model numerically because of the large domain and high frequencies involved. A numerical model with conventional finite elements in the near field and wave envelope elements in the far field has been constructed. by employing an irrotational mean flow assumption, both the mean flow and the acoustic perturbation problem have been posed in an axisymmetric formulation in terms of the velocity potential; thereby minimizing computer storage and time requirements. The finite element mesh has been altered in search of an improved solution. The mean flow problem has been reformulated with new boundary conditions to make it theoretically rigorous. The sound source at the fan face has been modeled as a combination of positive and negative propagating duct eigenfunctions. Therefore, a finite element duct eigenvalue problem has been solved on the fan face and the resulting modal matrix has been used to implement a source boundary condition on the fan face in the acoustic radiation problem. In the post processing of the solution, the acoustic pressure has been evaluated at Gauss points inside the elements and the nodal pressure values have been interpolated from them. This has significantly improved the results. The effect of the geometric position of the transition circle between conventional finite elements and wave envelope elements has been studied and it has been found that the transition can be made nearer to the inlet than previously assumed.
Author
*Finite Element Method; Sound Waves; Far Fields; Turbofan Engines; Engine Inlets; Mathematical Models; Digital Simulation; Computerized Simulation; Numerical Flow Visualization*

**19970017585** NASA Lewis Research Center, Cleveland, OH USA
**Numerical Flow Visualization in Basic- and Hyper-Cluster Spheres**
Hendricks, R. C., NASA Lewis Research Center, USA; Athavale, M. M., CFD Research Corp., USA; Braun, M. J., Akron Univ., USA; Lattime, S., B and C Engineering Associates, Inc., USA; Feb. 1997; 26p; In English; 1st; Flow Visualization and Image Processing, 23-26 Feb. 1997, Honolulu, HI, USA; Sponsored by Pacific Centre of Thermal Fluids Engineering, Singapore; Original contains color illustrations
Contract(s)/Grant(s): RTOP 233-1B-1B
Report No.(s): NASA-TM-107361; NAS 1.15:107361; E-10521-1; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Packed spherical particle beds have wide applications throughout the process industry and are usually analyzed using an appropriate combination of laminar and turbulent flows with empirically derived coefficients of which the Ergun (1952) relation is probably the best known. The 3-D complexity of the void distribution within the beds has precluded detailed studies of sphere clusters. Numerical modeling and flow vector visualization for the basic tetra- and hexa-sphere clusters and two hyper-sphere clusters are presented at two Reynolds numbers, 400 and 1200. Cutting planes are used to enable visualization of the complex flows generated within the sphere clusters and are discussed herein. The boundary conditions and flow fields for the simple clusters are also compared to the hyper-clusters with larger variations found for hexa-clusters.
Author
*Numerical Flow Visualization; Turbulent Flow; Laminar Flow; Flow Distribution; Computational Fluid Dynamics*

**19970017675** NASA Lewis Research Center, Cleveland, OH USA

**Comparison of Predicted Low Speed Fan Rotor/Stator Interaction Modes to Measured**

Sutliff, Daniel L., AYT Corp., USA; Bridges, James, NASA Lewis Research Center, USA; Envia, Edmane, NYMA, Inc., USA; May 1996; 26p; In English; 3rd; Aeroacoustic, 8-12 May 1997, Atlanta, GA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAS3-27571; NAS3-27186; RTOP 538-03-11

Report No.(s): NASA-TM-107462; NAS 1.15:107462; AIAA Paper 97-1609; E-10748; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The V072 Rotor Wake/Stator Interaction Code is widely used as a state-of-the-art prediction code. This paper validates the code by comparing experimentally measured mode levels to those predicted by V072. The experimental mode levels were measured by the Rotating Rake system installed on the 48 inch Active Noise Control Fan at NASA Lewis Research Center. V072 predicted mode levels by inputting the actual wake profiles of the ANCF rotor measured by a 2-component hotwire. The mode levels were also predicted from the V072 wake models. V072 reasonably predicts the mode levels within the design limits of the code.

Author

*Ducted Fans; Engine Noise; Aircraft Noise; Aeroacoustics; Rotors; Stators; Noise Reduction*

**19970017745** Wright Lab., Aeropropulsion and Power Directorate, Wright-Patterson AFB, OH USA

**FY 1997 Aero Propulsion and Power Technology Area Plan *Final Report***

Aug. 1996; 40p; In English

Contract(s)/Grant(s): AF Proj. 9993

Report No.(s): AD-A318710; WL-TR-97-2000; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Aero Propulsion and Power Technology Area is responsible for developing air breathing propulsion and power technology for Air Force use. Besides developing new technologies, product centers are supported by helping acquire systems and providing expertise to help solve developmental problems. Current research and development includes aircraft gas turbine engines (components, gas generators, technology demonstrator engines, fuels and lubricants), missile propulsion, (solid fuel ramjets, ducted rockets, and small turbine engines) , aircraft and missile power (electrical and mechanical power generation, conditioning and distribution, energy storage, and thermal management), and plasma physics. Work is conducted primarily under contract, although an aggressive in-house program exploits new opportunities, maintains technical expertise, and verifies contractor findings. Supporting this are two dozen major in-house R&D facilities and an annual budget of over $150 million.

DTIC

*Propulsion; Air Breathing Engines; Product Development; Engine Design*

**19970017837** NASA Lewis Research Center, Cleveland, OH USA

**Mixing of Pure Air Jets with a Reacting Fuel-Rich Crossflow**

Leong, M. Y., California Univ., USA; Samuelsen, G. S., California Univ., USA; Holdeman, J. D., NASA Lewis Research Center, USA; Apr. 1997; 30p; In English; Western States Section, 14-17 Apr. 1997, Livermore, CA, USA; Sponsored by Combustion Inst., USA; Original contains color illustrations

Contract(s)/Grant(s): RTOP 537-02-20

Report No.(s): NASA-TM-107430; E-10684; NAS 1.15:107430; WCC/CI Paper 97S-034; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Jets in a crossflow play an integral role in practical combustion systems such as can and annular gas turbine combustors in conventional systems, and the Rich-burn/Quick-mix/Lean-burn (RQL) combustor utilized in stationary applications and proposed for advanced subsonic and supersonic transports. The success of the RQL combustor rests with the performance of the quick-mixing section that bridges the rich and lean zones. The mixing of jet air with a rich crossflow to bring the reaction to completion in the lean zone must be performed rapidly and thoroughly in order to decrease the extent of near-stoichiometric fluid pocket formation. Fluid pockets at near-stoichiometric equivalence ratios are undesirable because the high temperatures attained accelerate pollutant formation kinetics associated with nitric oxide (NO). The present study develops a model experiment designed to reveal the processes that occur when jet air is introduced into hot effluent emanating from a fuel-rich reaction zone.

Author

*Air Jets; Cross Flow; High Temperature; Gas Turbines; Combustion; Stoichiometry*

## 08
## AIRCRAFT STABILITY AND CONTROL

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

**19970017343** Naval Postgraduate School, Monterey, CA USA
**Linear Modeling of Tiltrotor Aircraft (In Helicopter and Airplane Modes) for Stability Analysis and Preliminary Design**
Klein, Gary D., Naval Postgraduate School, USA; Jun. 1996; 222p; In English
Report No.(s): AD-A316795; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

This thesis investigates the linear state space modeling of a tiltrotor aircraft by modifying an existing MATLAB routine which is used for preliminary (helicopter) stability and control analysis. The modifications consist of changing existing script files along with adding new ones. The modifications result in having a routine that allows the input of tiltrotor characteristics and subsequently generates a state space model along with other stability and contr ol characteristics. The tiltrotor modeling is validated by the input of XV-15 characteristic data into the program and performing a eigenvalue comparison with a model of a similar tiltrotor, the V-22. A more extensive comparison is performed with another XV-15 model which has been extensively used and validated with wind tunnel and flight tests.
DTIC
*Software Engineering; Aerodynamic Stability; Tilt Rotor Aircraft*

**19970017380** NASA Ames Research Center, Moffett Field, CA USA
**Piloted Simulation Tests of Propulsion Control as Backup to Loss of Primary Flight Controls for a B747-400 Jet Transport**
Bull, John, Caelum Research Corp., USA; Mah, Robert, NASA Ames Research Center, USA; Hardy, Gordon, NASA Ames Research Center, USA; Sullivan, Barry, NASA Ames Research Center, USA; Jones, Jerry, NSI Technology Services Corp., USA; Williams, Diane, NSI Technology Services Corp., USA; Soukup, Paul, NSI Technology Services Corp., USA; Winters, Jose, DeAnza Coll., USA; Apr. 1997; 52p; In English
Report No.(s): NASA-TM-112191; A-976382; NAS 1.15:112191; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Partial failures of aircraft primary flight control systems and structural damages to aircraft during flight have led to catastrophic accidents with subsequent loss of lives (e.g. DC-10, B-747, C-5, B-52, and others). Following the DC-10 accident at Sioux City, Iowa in 1989, the National Transportation Safety Board recommended 'Encourage research and development of backup flight control systems for newly certified wide-body airplanes that utilize an alternate source of motive power separate from that source used for the conventional control system.' This report describes the concept of a propulsion controlled aircraft (PCA), discusses pilot controls, displays, and procedures; and presents the results of a PCA piloted simulation test and evaluation of the B747-400 airplane conducted at NASA Ames Research Center in December, 1996. The purpose of the test was to develop and evaluate propulsion control throughout the full flight envelope of the B747-400 including worst case scenarios of engine failures and out of trim moments. Pilot ratings of PCA performance ranged from adequate to satisfactory. PCA performed well in unusual attitude recoveries at 35,000 ft altitude, performed well in fully coupled ILS approaches, performed well in single engine failures, and performed well at aft cg. PCA performance was primarily limited by out-of-trim moments.
Author
*Flight Control; Aircraft Control; Jet Aircraft; Transport Aircraft; Engine Control; Aircraft Landing; Flight Simulation; Aircraft Safety*

**19970017810** Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA
**Effective Control of Computationally Simulated Wing Rock in Subsonic Flow**
Kandil, Osama A., Old Dominion Univ., USA; Menzies, Margaret A., Old Dominion Univ., USA; 1997; 11p; In English; 35th; Aerospace Sciences, 6-9 Jan. 1997, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAG1-648
Report No.(s): NASA-CR-203247; NAS 1.26:203247; AIAA Paper 97-0831; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

The unsteady compressible, full Navier-Stokes (NS) equations and the Euler equations of rigid-body dynamics are sequentially solved to simulate the delta wing rock phenomenon. The NS equations are solved time accurately, using the implicit, upwind, Roe flux-difference splitting, finite-volume scheme. The rigid-body dynamics equations are solved using a four-stage Runge-Kutta scheme. Once the wing reaches the limit-cycle response, an active control model using a mass injection system is applied from the wing surface to suppress the limit-cycle oscillation. The active control model is based on state feedback and the control law is established using pole placement techniques. The control law is based on the feedback of two states: the roll-angle and roll velocity. The primary model of the computational applications consists of a 80 deg swept, sharp edged, delta wing at 30 deg angle

of attack in a freestream of Mach number 0.1 and Reynolds number of 0.4 x 10(exp 6). With a limit-cycle roll amplitude of 41.1 deg, the control model is applied, and the results show that within one and one half cycles of oscillation, the wing roll amplitude and velocity are brought to zero.
Author
*Navier-Stokes Equation; Delta Wings; Rigid Structures; Difference Equations; Flux Difference Splitting; Control Theory; Active Control*

**19970017824** Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA
**Natural Rolling Responses of a Delta Wing in Transonic and Subsonic Flows**
Menzies, Margaret A., Old Dominion Univ., USA; Kandil, Osama A., Old Dominion Univ., USA; 1996; 12p; In English; Atmospheric Flight Mechanics, 29-31 Jul. 1996, San Diego, CA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Sponsored in part by Virginia Grant Consortium.
Contract(s)/Grant(s): NAG1-648
Report No.(s): NASA-CR-203246; NAS 1.26:203246; AIAA Paper 96-3391; Copyright Waived (NASA); Avail: CASI; A03, Hardcopy; A01, Microfiche

The unsteady, three-dimensional, full Navier-Stokes (NS) equations and the Euler equations of rigid-body dynamics are sequentially solved to simulate the natural rolling response of slender delta wings of zero thickness at moderate to high angles of attack, to transonic and subsonic flows. The governing equations of fluid flow and dynamics of the present multi-disciplinary problem are solved using the time-accurate solution of the NS equations with the implicit, upwind, Roe flux-difference splitting, finite-volume scheme and a four-stage Runge-Kutta scheme, respectively. The main focus is to analyze the effect of Mach number and angle of attack on the leading edge vortices and their breakdown, the resultant rolling motion, and overall aerodynamic response of the wing. Three cases demonstrate the natural response of a 65 deg swept, cropped delta wing in a transonic flow with breakdown of the leading edge vortices and an 80 deg swept delta wing in a subsonic flow undergoing either damped or self-excited limit-cycle rolling oscillations as a function of angle of attack. Comparisons with an experimental investigation completes this study, validating the analysis and illustrating the complex details afforded by computational investigations.
Author
*Navier-Stokes Equation; Swept Wings; Delta Wings; Rigid Structures; Slender Wings; Flow Equations; Transonic Flow; Subsonic Flow; Fluid Dynamics*

**19970017826** Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA
**Far-Field Turbulent Vortex-Wake/Exhaust Plume Interaction for Subsonic and HSCT Airplanes**
Kandil, Osama A., Old Dominion Univ., USA; Adam, Ihab, Old Dominion Univ., USA; Wong, Tin-Chee, Old Dominion Univ., USA; 1996; 14p; In English; 27th; Fluid Dynamics, 17-20 Jun. 1996, New Orleans, LA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAG1-994
Report No.(s): NASA-CR-203260; NAS 1.26:203260; AIAA Paper 96-1962; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Computational study of the far-field turbulent vortex-wake/exhaust plume interaction for subsonic and high speed civil transport (HSCT) airplanes is carried out. The Reynolds-averaged Navier-Stokes (NS) equations are solved using the implicit, upwind, Roe-flux-differencing, finite-volume scheme. The two-equation shear stress transport model of Menter is implemented with the NS solver for turbulent-flow calculation. For the far-field study, the computations of vortex-wake interaction with the exhaust plume of a single engine of a Boeing 727 wing in a holding condition and two engines of an HSCT in a cruise condition are carried out using overlapping zonal method for several miles downstream. These results are obtained using the computer code FTNS3D. The results of the subsonic flow of this code are compared with those of a parabolized NS solver known as the UNIWAKE code.
Author
*Turbulent Flow; Vortices; Navier-Stokes Equation; Supersonic Transports; Finite Difference Theory; Shear Stress; Turbulent Wakes*

## 09
## RESEARCH AND SUPPORT FACILITIES (AIR)

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

**19970017299** Stanford Univ., Dept. of Aeronautics and Astronautics, Stanford, CA USA
**Development of an Apparatus for Wind Tunnel Dynamic Experiments at High-alpha**
Pedreiro, Nelson, Stanford Univ., USA; Feb. 1997; 128p; In English
Contract(s)/Grant(s): NCC2-55
Report No.(s): NASA-CR-203760; NAS 1.26:203760; JIAA-TR-119; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

A unique experimental apparatus that allows a wind tunnel model two degrees of freedom has been designed and built. The apparatus was developed to investigate the use of new methods to augment aircraft control in the high angle of attack regime. The model support system provides a platform in which the roll-yaw coupling at high angles of attack can be studied in a controlled environment. Active cancellation of external effects is used to provide a system in which the dynamics are dominated by the aerodynamic loads acting on the wind tunnel model.
Author
*Wind Tunnel Tests; Aircraft Control; Aerodynamic Loads; Active Control; Wind Tunnel Stability Tests; Aerodynamic Stability*

**19970017473** Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA
**Application of Magnetic Suspension and Balance Systems to Ultra-High Reynolds Number Facilities**
Britcher, Colin P., Old Dominion Univ., USA; Jul. 1996; 13p; In English
Contract(s)/Grant(s): NAG1-1056
Report No.(s): NASA-CR-203236; NAS 1.26:203236; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The current status of wind tunnel magnetic suspension and balance system development is briefly reviewed. Technical work currently underway at NASA Langley Research Center is detailed, where it relates to the ultra-high Reynolds number application. The application itself is addressed, concluded to be quite feasible, and broad design recommendations given.
Author
*Wind Tunnels; Magnetic Suspension; Wind Tunnel Tests; Wind Tunnel Apparatus; Aerodynamic Balance*

**19970017800** Los Alamos National Lab., NM USA
**Fabrication and characterization of aluminum heavy liners for the pulse power systems of the high energy density physics program at Los Alamos**
Anderson, W. E., Los Alamos National Lab., USA; Day, R. D., Los Alamos National Lab., USA; Bartos, J. J., Los Alamos National Lab., USA; Garcia, F. P., Los Alamos National Lab., USA; Hatch, D. J., Los Alamos National Lab., USA; Hannah, P. R.; 1996; 19p; In English; Megagauss Magnetic Field Generation and Related Topics, 5-10 Aug. 1996, Sarov, Russian Federation
Contract(s)/Grant(s): W-7405-eng-36
Report No.(s): LA-UR-96-2706; CONF-9608132-8; DE96-014649; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Aluminum heavy liners of three basic types have been fabricated for Los Alamos pulse power experiments. The first fabrications used a conventional hand operated lathe with high speed steel cutting tools. More recent fabrications have used numerically controlled lathes with carbide insert cutting tools. A numerically controlled Pneumo lathe with an air bearing spindle and with air bearing cross slides has been used to fabricate the most recent examples of the 3.2 gm Pegasus Precision Liner that is normally accelerated to 3 mm/(micro)s for experiments at the Pegasus II pulse power facility. The basic dimensions, including wall thickness, of fourteen of these parts have been characterized by an automated inspection machine. Liner surface finishes are measured directly by stylus profilometer and by optical interferometric analysis of cast polymeric replicas. Statistics of these measurements will be presented. Plans for future fabrication of similar and larger liners with increasingly stringent specification of wall thickness and of surface finish are described along with corresponding plans for liner characterization improvements.
DOE
*Interferometry; Profilometers; Gas Bearings*

## 10
## ASTRONAUTICS

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

**19970017187** Oral Roberts Univ., Dept. of Engineering and Physics, Tulsa, OK USA
**Simulation Accuracy of an Apparatus to Test the Stability of Spinning Spacecraft Under Thrust**
Halsmer, Dominic M., Oral Roberts Univ., USA; Fetter, Amy R., Oral Roberts Univ., USA; Chidebelu-Eze, Maduka C., Oral Roberts Univ., USA; Flight Mechanics Symposium 1997; May 1997, pp. 1-15; In English; Also announced as 19970017186; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

An experimental laboratory apparatus is being developed to simulate the dynamics and control of spinning, thrusting spacecraft with internal mass motion. This is accomplished by floating a spacecraft model on a spherical air bearing which is accelerated along a circular path. The resultant of centrifugal and gravity forces is kept collinear with the thrust axis, hence serving as the (scaled) thrust force. Sensors provide instantaneous and continuous attitude tracking to determine the circular path characteristics for accurate modeling, and also provide cone angle growth/attenuation rates to determine stability. A spacecraft in space with rotational kinetic energy will spin about its instantaneous mass center. In general, the mass center will be moving relative to a spacecraft fixed frame due to the presence of internal mass motion and propellant usage. This effect is difficult to simulate in a ground based laboratory using an air bearing since the spacecraft model is constrained to spin about the center of curvature of the bearing surface. Simulation fidelity is optimized by collocating the center of curvature of the bearing and the nominal system mass center of the model. The dynamical equations of motion of a rigid, symmetric, thrusting, spinning body containing a radial mass-spring-damper are compared to those of a similar ground-based system supported by an air bearing being accelerated along a circular path. Conditions on path radius and velocity for near dynamic equivalence are obtained. Coning stability criteria for the two cases are compared. Stability regions plotted in a parameter space are found to be nearly identical for small damper masses. For a prolate spacecraft, the stability region for the laboratory simulation is a subset of the stability region for the space case. Thus, a laboratory simulation exhibiting coning stability for a prolate configuration implies stability for the actual spin-stabilized thrust maneuver. A quantitative comparison is made between an actual vehicle and a laboratory model.
Author
*Flight Characteristics; Flight Mechanics; Centrifugal Force; Dynamic Control; Equations of Motion; Flight Optimization; Orbital Mechanics; Thrust*

**19970017199** Maryland Univ., Flight Dynamics and Control Lab., College Park, MD USA
**A Comparative Study of the Flight Dynamics and Control Laboratory's Orbit Analysis System with the Goddard Trajectory Determination System (GTDS)**
McConnell, Charles, Maryland Univ., USA; Schmidt, David, Maryland Univ., USA; Flight Mechanics Symposium 1997; May 1997, pp. 151-161; In English; Also announced as 19970017186; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A comparison of the Flight Dynamics and Control Laboratory's (FDCL) orbit analysis software system and the Goddard Trajectory Determination System (GTDS) has been performed. The orbit analysis system is a component in the Spacecraft Mission Analysis System (SMAS) being developed by the FDCL in cooperation with NASA's Goddard Space Flight Center. Specifically investigated were the levels of agreement between the two systems in the areas of preprocessing raw tracking data, performing orbit determination, and performing orbit prediction. In preprocessing raw tracking data, results from the SMAS was generally found to agree with those from GTDS to within the published accuracy of Unified S-band (USB) range-rate measurements. The differences were on the order of expected corrections for ionospheric and tropospheric refraction. In performing orbit estimation, results from the SMAS were found to agree well with those from GTDS. The final estimation errors from the SMAS were comparable to those from GTDS and were well within the published measurement accuracy. In performing orbit prediction, results from the SMAS were found to agree with those from GTDS to within 2 kilometers in position over 28 days. Sensitivity analysis was also performed for both orbit estimation and orbit prediction, revealing the effects of bias in tracking data and of selected modeling and input parameters.
Author
*Dynamic Control; Flight Characteristics; Orbit Calculation; Computer Programs; Investigation*

**19970017211** Computer Sciences Corp., Lanham, MD USA
**The Earth Radiation Budget Satellite Tumble of 1987 Revisited: Magnetometer-Only Estimates of the Attitude and Rates**
Challa, M., Computer Sciences Corp., USA; Kotaru, S., Computer Sciences Corp., USA; Natanson, G., Computer Sciences Corp.,

USA; Flight Mechanics Symposium 1997; May 1997, pp. 279-292; In English; Also announced as 19970017186; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Earth Radiation Budget Satellite (ERBS) experienced an uncontrolled tumble on July 2, 1987, with spacecraft rates of the order of 2 deg/sec. During a substantial span of this contingency period of about 12 hours, the Sun and Earth sensor data were not useful and the gyro telemetry was saturated, so that the three-axis magnetometer (TAM) was the only reliable attitude sensor. ERBS attitude and rates for this period are estimated using TAMONLY (a recently developed system that estimates attitude and rates using a TAM and spacecraft dynamical models) after enhancing the system to include thruster torques in the spacecraft dynamics. It is shown that the spacecraft rates estimated by the Kalman filter and by the deterministic algorithm in TAMONLY agree closely, both algorithms confirming rates as high as 2 deg/sec. These rate estimates are also in close agreement with valid gyro data. Using TAM residuals, TAMONLY's attitude accuracies during the high-rate period are estimated to be 2.5 deg. The consistency of the results is demonstrated by their independence from a priori errors. The effects of models of thrusters, spacecraft mass properties, and TAM noise on the filter estimates are treated in detail. Enhancements stabilizing the deterministic solutions in high-rate situations are also described.

Author

*Attitude Indicators; Magnetometers; Solar Sensors; Satellite Attitude Control; Flight Instruments; Attitude (Inclination); Attitude Gyros; Satellite Orientation; Orbital Maneuvers*

**19970017525** National Aerospace Lab., Tokyo, Japan

**Technical Report of National Aerospace Laboratory**

Noda, Junichi, National Aerospace Lab., Japan; Tate, Atushi, National Aerospace Lab., Japan; Watanabe, Mitsunori, National Aerospace Lab., Japan; Sekine, Hideo, National Aerospace Lab., Japan; Yoshinaga, Takashi, National Aerospace Lab., Japan; Akimoto, Toshio, National Space Development Agency, Japan; 1996; ISSN 0389-2010; 34p; In Japanese

Report No.(s): NAL-TR-1300; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

To obtain the aerodynamic characteristics of the Orbital Reentry Experiment Vehicle (OREX) measurements of three force components of the OREX model and other modified models were carried out in the NAL supersonic wind tunnel (1 m x 1 m test cross-section) in the Mach number range 1.4 less than or equal to M(sub infinity) less than or equal to 4.0. The models have spherically blunted nose heads with the same radius. The effects of conical afterbody of 50 degree and 45 degree half-apex conical angles and four different radii of circumferential edges of 0 mm, 2 mm, 3.3 mm (OREX) and 10 mm were tested. The tests show that the models are statically stable for the pitching movement (vane-stable). The model with the edge of 3.3 mm shows larger recovering pitching moment than other models in low Mach number regions. The model with a sharp edge shows a larger drag coefficient than the one with a blunted edge.

Author

*Reentry Vehicles; Mach Number; Wind Tunnel Tests; Aerodynamic Drag; Blunt Bodies*

**19970017656** NASA Johnson Space Center, Houston, TX USA

**STS-82 Day 05 Highlights**

Feb. 15, 1997; In English; Videotape: 19 min. playing time, in color, with sound

Report No.(s): NASA-TM-112803; BRF-1405E; NONP-NASA-VT-1997026063; No Copyright; Avail: CASI; A02, Videotape-VHS; A22, Videotape-Beta

The fifth day of the STS-82 mission begins with the crew, Commander Kenneth D. Bowersox, Pilot Scott J. Horowitz, Payload Commander Mark C. Lee, and Mission Specialists Gregory J. Harbaugh, Steven L. Smith, Joseph R. Tanner, and Steven A. Hawley completing the checkout of spacesuits well ahead of schedule, allowing them to start the second spacewalk of the flight. Harbaugh and Tanner went right to work, replacing a degraded Fine Guidance Sensor and a failed Engineering and Science Tape Recorder with new spares. The astronauts also installed a new unit known as the Optical Control Electronics Enhancement Kit, which will further increase the capability of the new Fine Guidance Sensor. During the spacewalk, the astronauts and flight controllers took note of cracking and wear incurred by thermal insulation which protects several areas of the telescope.

CASI

*Space Transportation System; Space Transportation System Flights; Space Shuttle Missions; Flight Control; Guidance Sensors; Spacecrews; Thermal Insulation*

## 11
## CHEMISTRY AND MATERIALS

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

**19970017041** NYMA, Inc., Brook Park, OH USA
**SiC Recession Due to SiO2 Scale Volatility Under Combustor Conditions** ***Final Report***
Robinson, Raymond Craig, NYMA, Inc., USA; Mar. 1997; 102p; In English
Contract(s)/Grant(s): NAS3-27186; RTOP 537-04-22
Report No.(s): NASA-CR-202331; E-10685; NAS 1.26:202331; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

One of today's most important and challenging technological problems is the development of advanced materials and processes required to design and build a fleet of supersonic High Speed Civil Transport (HSCT) airliners, a follow-up to the Concorde SST. The innovative combustor designs required for HSCT engines will need high-temperature materials with long-term environmental stability. Higher combustor liner temperatures than today's engines and the need for lightweight materials will require the use of advanced ceramic-matrix composites (CMC's) in hot-section components. The HSCT is just one example being used to demonstrate the need for such materials. This thesis evaluates silicon carbide (SiC) as a potential base material for HSCT and other similar applications. Key issues are the environmental durability for the materials of interest. One of the leading combustor design schemes leads to an environment which will contain both oxidizing and reducing gas mixtures. The concern is that these environments may affect the stability of the silica (SiO2) scale on which SiC depends for environmental protection. A unique High Pressure Burner Rig (HPBR) was developed to simulate the combustor conditions of future gas turbine engines, and a series of tests were conducted on commercially available SiC material. These tests are intended as a feasibility study for the use of these materials in applications such as the HSCT. Linear weight loss and surface recession of the SiC is observed as a result of SiO2 volatility for both fuel-lean and fuel-rich gas mixtures. These observations are compared and agree well with thermogravimetric analysis (TGA) experiments. A strong Arrhenius-type temperature dependence exists. In addition, the secondary dependencies of pressure and gas velocity are defined. As a result, a model is developed to enable extrapolation to points outside the experimental space of the burner rig, and in particular, to potential gas turbine engine conditions.
Author
*Silicon Carbides; Silicon Dioxide; Combustion Chambers; Gas Turbine Engines; Test Stands; Temperature Effects; Pressure Effects; Experimentation*

## 12
## ENGINEERING

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

**19970017402** California Polytechnic State Univ., Dept. of Aeronautical Engineering, San Luis Obispo, CA USA
**Computational Investigation of Flap-Edges** ***Final Report***
Cummings, Russell M., California Polytechnic State Univ., USA; Apr. 1997; 15p; In English
Contract(s)/Grant(s): NCC2-857
Report No.(s): NASA-CR-204349; NAS 1.26:204349; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The current study expands the application of computational fluid dynamics to three-dimensional multi-element high-lift systems by investigating the flow dynamics created by a slat edge. Flow is computed over a three-element high-lift configuration using an incompressible Navier-Stokes solver with structured, overset grids processed assuming full turbulence with the one-equation Baldwin-Barth turbulence model. The geometry consists of an unswept wing, which spans the wind tunnel test section, a single element half-span Fowler flap, and a three-quarter span slat. Results are presented for the wing configured for landing with a chord based Reynolds number of 3.7 million. Results for the three-quarter span slat case are compared to the full-span slat and two-dimensional investigations.
Author
*Computational Fluid Dynamics; Turbulence Models; Navier-Stokes Equation; Structured Grids (Mathematics); Turbulent Flow; Incompressible Flow; Unswept Wings*

**19970017534** NASA Johnson Space Center, Houston, TX USA

**Rotary Blood Pump**

Bozeman, Richard J., Jr., Inventor, NASA Johnson Space Center, USA; Akkerman, James W., Inventor, NASA Johnson Space Center, USA; Aber, Gregory S., Inventor, NASA Johnson Space Center, USA; VanDamm, George A., Inventor, NASA Johnson Space Center, USA; Bacak, James W., Inventor, NASA Johnson Space Center, USA; Svejkovsky, Paul A., Inventor, NASA Johnson Space Center, USA; Benkowski, Robert J., Inventor, NASA Johnson Space Center, USA; Jun. 18, 1996; 20p; In English

Patent Info.: Filed 10 Nov. 1993; NASA-Case-MSC-22424-1; US-Patent-5,527,159; US-Patent-Appl-SN-153595; No Copyright; Avail: US Patent and Trademark Office, Hardcopy, Microfiche

A rotary blood pump includes a pump housing for receiving a flow straightener, a rotor mounted on rotor bearings and having an inducer portion and an impeller portion, and a diffuser. The entrance angle, outlet angle, axial and radial clearances of blades associated with the flow straightener, inducer portion, impeller portion and diffuser are optimized to minimize hemolysis while maintaining pump efficiency. The rotor bearing includes a bearing chamber that is filled with cross-linked blood or other bio-compatible material. A back emf integrated circuit regulates rotor operation and a microcomputer may be used to control one or more back emf integrated circuits. A plurality of magnets are disposed in each of a plurality of impeller blades with a small air gap. A stator may be axially adjusted on the pump housing to absorb bearing load and maximize pump efficiency.

Official Gazzette of the U.S. Patent and Trademark

*Blood Pumps; Integrated Circuits; Rotors; Diffusers; Axial Flow; Biotechnology*

**19970017836** NASA Dryden Flight Research Center, Edwards, CA USA

**Thermostructural Behavior of a Hypersonic Aircraft Sandwich Panel Subjected to Heating on One Side**

Ko, William L., NASA Dryden Flight Research Center, USA; Apr. 1997; 56p; In English

Contract(s)/Grant(s): RTOP 505-63-50

Report No.(s): NASA-TM-4769; H-2103; NAS 1.15:4769; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Thermostructural analysis was performed on a heated titanium honeycomb-core sandwich panel. The sandwich panel was supported at its four edges with spar-like substructures that acted as heat sinks, which are generally not considered in the classical analysis. One side of the panel was heated to high temperature to simulate aerodynamic heating during hypersonic flight. Two types of surface heating were considered: (1) flat-temperature profile, which ignores the effect of edge heat sinks, and (2) dome-shaped-temperature profile, which approximates the actual surface temperature distribution associated with the existence of edge heat sinks. The finite-element method was used to calculate the deformation field and thermal stress distributions in the face sheets and core of the sandwich panel. The detailed thermal stress distributions in the sandwich panel are presented, and critical stress regions are identified. The study shows how the magnitudes of those critical stresses and their locations change with different heating and edge conditions. This technical report presents comprehensive, three-dimensional graphical displays of thermal stress distributions in every part of a titanium honeycomb-core sandwich panel subjected to hypersonic heating on one side. The plots offer quick visualization of the structural response of the panel and are very useful for hot structures designers to identify the critical stress regions.

Author

*Aerodynamic Heating; Aircraft Structures; Structural Analysis; Temperature Effects; Heating; Heat Sinks; Honeycomb Cores; Thermal Stresses; Titanium; Surface Temperature; Hypersonic Aircraft; High Temperature*

## 14
## LIFE SCIENCES

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

**19970016965** Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

**Comparison of the Control Anticipation Parameter and the Bandwidth Criterion During the Landing Task**

Kivioja, David A., Air Force Inst. of Tech., USA; Mar. 1996; 167p; In English

Report No.(s): AD-A319509; AFIT/GAE/ENY/96M-2; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

Many handling qualities criteria have been developed which predict pilot opinion of landing aircraft. 'Flying Qualities of Piloted Aircraft' lists six different criteria. However, applying all six criteria to one aircraft can lead to conflicting results. The Air Force Institute of Technology (AFIT) along with the Flight Dynamics Laboratory have conducted research to evaluate differences among the handling qualities criteria. The overall objective of this thesis was to determine similarities and discrepancies between the Control Anticipation Parameter (CAP) and bandwidth criteria, and to evaluate the advantage of including a dropback criterion with the bandwidth criterion. Results of this research will be used to derive a more clear-cut, generally acceptable, com-

prehensive flying qualities criteria predicting pilot opinion for the next revision. Research was conducted in two phases. Phase 1 was conducted at AFIT. There the CAP domain was mapped onto the bandwidth and bandwidth with dropback criteria revealing where the criteria agreed and disagreed. Phase 2 was conducted at the USAF Test Pilot School. The test team used the Variable-Stability In-Flight Simulator Test Aircraft (VISTA) to simulate aircraft and obtain actual pilot opinion in the areas of agreement and conflict found in Phase 1.
DTIC
*Flight Characteristics; Aerodynamics; Test Pilots*

**19970017727** Army Research Inst., Behavioral and Social Sciences, Alexandria, VA USA
**Air Warrior Baseline Evaluation, Volume 1, Summary** ***Final Report, Jun. 1995 - Jul. 1996***
Wright, Robert H., Army Research Inst., USA; Hanson, Rande R., Army Research Inst., USA; Couch, Michael E., Anacapa Sciences, Inc., USA; Oct. 1996; 18p; In English
Contract(s)/Grant(s): DA Proj. 2O2-62785-A-791
Report No.(s): AD-A320909; ARI-RP-97-01-Vol-1; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Air Warrior is a U.S. Army program that has been initiated to improve the fighting capabilities of helicopter crews in contaminated combat environments. The Air Warrior baseline simulations were conducted to identify and quantify the effects on aircrew mission and task performance of wearing the current MOPP 4 protective and survival ensemble. Differences in performance and workload between the MOPP 4 ensemble and normal flying gear were obtained for AH-64 crews flying night missions and performing a set of daylight maneuvers and tasks. The MOPP 4 ensemble was found to cause major increases in workload and reduce performance on numerous aircrew tasks. Specific effects of the MOPP 4 ensemble on aircrew discomfort, pain, and task performance were obtained through detailed debriefings.
DTIC
*AH-64 Helicopter; Combat; Flight Crews; Helicopters*

## 16
## PHYSICS

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

**19970017414** United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT USA
**Fan Noise Prediction System Development: Source/Radiation Field Coupling and Workstation Conversion for the Acoustic Radiation Code**
Meyer, H. D., United Technologies Corp., USA; Apr. 1993; 48p; In English
Contract(s)/Grant(s): NAS3-25952
Report No.(s): NASA-CR-204340; NAS 1.26:204340; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
The Acoustic Radiation Code (ARC) is a finite element program used on the IBM mainframe to predict far-field acoustic radiation from a turbofan engine inlet. In this report, requirements for developers of internal aerodynamic codes regarding use of their program output an input for the ARC are discussed. More specifically, the particular input needed from the Bolt, Beranek and Newman/Pratt and Whitney (turbofan source noise generation) Code (BBN/PWC) is described. In a separate analysis, a method of coupling the source and radiation models, that recognizes waves crossing the interface in both directions, has been derived. A preliminary version of the coupled code has been developed and used for initial evaluation of coupling issues. Results thus far have shown that reflection from the inlet is sufficient to indicate that full coupling of the source and radiation fields is needed for accurate noise predictions ' Also, for this contract, the ARC has been modified for use on the Sun and Silicon Graphics Iris UNIX workstations. Changes and additions involved in this effort are described in an appendix.
Author
*Aerodynamic Noise; Engine Inlets; Finite Element Method; Acoustic Propagation; Applications Programs (Computers); Digital Simulation; Computerized Simulation; Far Fields; Fan Blades; Turbofan Engines*

**19970017613** NASA Lewis Research Center, Cleveland, OH USA
**Active Noise Control of Low Speed Fan Rotor-Stator Modes**
Sutliff, Daniel L., AYT Corp., USA; Hu, Ziqiang, General Electric Co., USA; Pla, Frederic G., General Electric Co., USA; Heidelberg, Laurence J., NASA Lewis Research Center, USA; May 1996; 26p; In English; 3rd; Aeroacoustic, 12-14 May 1997, Atlanta, Georgia, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAS3-27571; RTOP 538-03-11
Report No.(s): NASA-TM-107458; NAS 1.15:107458; AIAA Paper 97-1641; E-10744; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report describes the Active Noise Cancellation System designed by General Electric and tested in the NASA Lewis Research Center's 48 inch Active Noise Control Fan. The goal of this study was to assess the feasibility of using wall mounted secondary acoustic sources and sensors within the duct of a high bypass turbofan aircraft engine for active noise cancellation of fan tones. The control system is based on a modal control approach. A known acoustic mode propagating in the fan duct is cancelled using an array of flush-mounted compact sound sources. Controller inputs are signals from a shaft encoder and a microphone array which senses the residual acoustic mode in the duct. The canceling modal signal is generated by a modal controller. The key results are that the (6,0) mode was completely eliminated at 920 Hz and substantially reduced elsewhere. The total tone power was reduced 9.4 dB. Farfield 2BPF SPL reductions of 13 dB were obtained. The (4,0) and (4,1) modes were reduced simultaneously yielding a 15 dB modal PWL decrease. Global attenuation of PWL was obtained using an actuator and sensor system totally contained within the duct.
Author

*Shafts (Machine Elements); Acoustic Ducts; Ducts; Engine Noise; Noise Reduction; Rotors; Sound Generators; Turbofan Aircraft; Turbofan Engines*

# Subject Term Index


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