NASA SP-7037 (357)
September 19, 1997

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and
Space Administration
Langley Research Center

**Scientific and Technical
Information Program Office**

The NASA STI Program Office . . . in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.

- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.

- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.

- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.

- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.

- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at ***http://www.sti.nasa.gov***

- E-mail your question via the Internet to help@sti.nasa.gov

- Fax your question to the NASA Access Help Desk at (301) 621-0134

- Telephone the NASA Access Help Desk at (301) 621-0390

- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  800 Elkridge Landing Road
  Linthicum Heights, MD 21090-2934

Introduction

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

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

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

The NASA CASI price code table, addresses of organizations, and document availability information are included before the abstract section.

Two indexes—subject and author are included after the abstract section.

SCAN Goes Electronic!

If you have electronic mail or if you can access the Internet, you can view biweekly issues of *SCAN* from your desktop absolutely free!

Electronic SCAN takes advantage of computer technology to inform you of the latest worldwide, aerospace-related, scientific and technical information that has been published.

No more waiting while the paper copy is printed and mailed to you. You can view *Electronic SCAN* the same day it is released—up to 191 topics to browse at your leisure. When you locate a publication of interest, you can print the announcement. You can also go back to the *Electronic SCAN* home page and follow the ordering instructions to quickly receive the full document.

Start your access to *Electronic SCAN* today. Over 1,000 announcements of new reports, books, conference proceedings, journal articles...and more—available to your computer every two weeks.

Timely Flexible Complete FREE!

For Internet access to *E-SCAN*, use any of the following addresses:

http://www.sti.nasa.gov
ftp.sti.nasa.gov
gopher.sti.nasa.gov

To receive a free subscription, send e-mail for complete information about the service first. Enter **scan@sti.nasa.gov** on the address line. Leave the subject and message areas blank and send. You will receive a reply in minutes.

Then simply determine the SCAN topics you wish to receive and send a second e-mail to **listserve@sti.nasa.gov**. Leave the subject line blank and enter a subscribe command in the message area formatted as follows:

Subscribe <desired list> <Your name>

For additional information, e-mail a message to **help@sti.nasa.gov**.

Phone: (301) 621-0390

Fax: (301) 621-0134

Write: NASA Access Help Desk
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

Looking just for *Aerospace Medicine and Biology* reports?

Although hard copy distribution has been discontinued, you can still receive these vital announcements through your *E-SCAN* subscription. Just **subscribe SCAN-AEROMED** in the message area of your e-mail to **listserve@sti.nasa.gov**.

Table of Contents

Records are arranged in categories 1 through 19, the first nine coming from the Aeronautics division of *STAR*, followed by the remaining division titles. Selecting a category will link you to the collection of records cited in this issue pertaining to that category.

Indexes

Two indexes are available. You may use the find command under the tools menu while viewing the PDF file for direct match searching on any text string. You may also view the indexes provided, for searching on *NASA Thesaurus* subject terms and author names.

Selecting an index above will link you to that comprehensive listing.

Document Availability

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

The New NASA Video Catalog is Here

Free!

To order your copy,
call the NASA Access Help Desk at
(301) 621-0390,
fax to
(301) 621-0134,
e-mail to
help@sti.nasa.gov,
or visit the NASA STI Program
homepage at
http://www.sti.nasa.gov/STI-homepage.html

(Select STI Program Bibliographic Announcements)

Explore the Universe!

Document Availability Information

The mission of the NASA Scientific and Technical (STI) Program Office is to quickly, efficiently, and cost-effectively provide the NASA community with desktop access to STI produced by NASA and the world's aerospace industry and academia. In addition, we will provide the aerospace industry, academia, and the taxpayer access to the intellectual scientific and technical output and achievements of NASA.

Eligibility and Registration for NASA STI Products and Services

The NASA STI Program offers a wide variety of products and services to achieve its mission. Your affiliation with NASA determines the level and type of services provided by the NASA STI Program. To assure that appropriate level of services are provided, NASA STI users are requested to register at the NASA Center for AeroSpace Information (CASI). Please contact NASA CASI in one of the following ways:

E-mail:	help@sti.nasa.gov
Fax:	301-621-0134
Phone:	301-621-0390
Mail:	ATTN: Registration Services NASA Center for AeroSpace Information 800 Elkridge Landing Road Linthicum Heights, MD 21090-2934

Limited Reproducibility

In the database citations, a note of limited reproducibility appears if there are factors affecting the reproducibility of more than 20 percent of the document. These factors include faint or broken type, color photographs, black and white photographs, foldouts, dot matrix print, or some other factor that limits the reproducibility of the document. This notation also appears on the microfiche header.

NASA Patents and Patent Applications

Patents and patent applications owned by NASA are announced in the STI Database. Printed copies of patents (which are not microfiched) are available for purchase from the U.S. Patent and Trademark Office.

When ordering patents, the U.S. Patent Number should be used, and payment must be remitted in advance, by money order or check payable to the Commissioner of Patents and Trademarks. Prepaid purchase coupons for ordering are also available from the U.S. Patent and Trademark Office.

NASA patent application specifications are sold in both paper copy and microfiche by the NASA Center for AeroSpace Information (CASI). The document ID number should be used in ordering either paper copy or microfiche from CASI.

The patents and patent applications announced in the STI Database are owned by NASA and are available for royalty-free licensing. Requests for licensing terms and further information should be addressed to:

National Aeronautics and Space Administration
Associate General Counsel for Intellectual Property
Code GP
Washington, DC 20546-0001

Sources for Documents

One or more sources from which a document announced in the STI Database is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below, with an Addresses of Organizations list near the back of this section. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source.

Avail: NASA CASI. Sold by the NASA Center for AeroSpace Information. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code following the letters HC or MF in the citation. Current values are given in the NASA CASI Price Code Table near the end of this section.

Note on Ordering Documents: When ordering publications from NASA CASI, use the document ID number or other report number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy.

Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)

Avail: DOE Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Department of Energy reports, usually in microfiche form, are listed in Energy Research Abstracts. Services available from the DOE and its depositories are described in a booklet, *DOE Technical Information Center—Its Functions and Services* (TID-4660), which may be obtained without charge from the DOE Technical Information Center.

Avail: ESDU. Pricing information on specific data, computer programs, and details on ESDU International topic categories can be obtained from ESDU International.

Avail: Fachinformationszentrum Karlsruhe. Gesellschaft für wissenschaftlich-technische Information mbH 76344 Eggenstein-Leopoldshafen, Germany.

Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, CA. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.

Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration (JBD-4), Public Documents Room (Room 1H23), Washington, DC 20546-0001, or public document rooms located at NASA installations, and the NASA Pasadena Office at the Jet Propulsion Laboratory.

Avail: NTIS. Sold by the National Technical Information Service. Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) are available. For information concerning this service, consult the NTIS Subscription Section, Springfield, VA 22161.

Avail: Univ. Microfilms. Documents so indicated are dissertations selected from Dissertation Abstracts and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.

Avail: US Patent and Trademark Office. Sold by Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, at the standard price of $1.50 each, postage free.

Avail: (US Sales Only). These foreign documents are available to users within the United States from the National Technical Information Service (NTIS). They are available to users outside the United States through the International Nuclear Information Service (INlS) representative in their country, or by applying directly to the issuing organization.

Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed on the Addresses of Organizations page. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.

Addresses of Organizations

British Library Lending Division
Boston Spa, Wetherby, Yorkshire
England

Commissioner of Patents and Trademarks
U.S. Patent and Trademark Office
Washington, DC 20231

Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

European Space Agency–
Information Retrieval Service ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

ESDU International
27 Corsham Street
London
N1 6UA
England

Fachinformationszentrum Karlsruhe
Gesellschaft für wissenschaftlich–technische
Information mbH
76344 Eggenstein–Leopoldshafen, Germany

Her Majesty's Stationery Office
P.O. Box 569, S.E. 1
London, England

NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090–2934

(NASA STI Lead Center)
National Aeronautics and Space Administration
Scientific and Technical Information Program Office
Langley Research Center – MS157
Hampton, VA 23681

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Pendragon House, Inc.
899 Broadway Avenue
Redwood City, CA 94063

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, MI 48106

University Microfilms, Ltd.
Tylers Green
London, England

U.S. Geological Survey Library National Center
MS 950
12201 Sunrise Valley Drive
Reston, VA 22092

U.S. Geological Survey Library
2255 North Gemini Drive
Flagstaff, AZ 86001

U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

U.S. Geological Survey Library
Box 25046
Denver Federal Center, MS914
Denver, CO 80225

NASA CASI Price Code Table

(Effective July 1, 1996)

CASI PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
A01	$ 6.50	$ 13.00
A02	10.00	20.00
A03	19.50	39.00
A04-A05	21.50	43.00
A06	25.00	50.00
A07	28.00	56.00
A08	31.00	62.00
A09	35.00	70.00
A10	38.00	76.00
A11	41.00	82.00
A12	44.00	88.00
A13	47.00	94.00
A14-A17	49.00	98.00
A18-A21	57.00	114.00
A22-A25	67.00	134.00
A99	Call For Price	Call For Price

Important Notice

The $1.50 domestic and $9.00 foreign shipping and handling fee currently being charged will remain the same. Foreign airmail is $27.00 for the first 1-3 items, $9.00 for each additional item. Additionally, a new processing fee of $2.00 per each video ordered will be assessed.

For users registered at the NASA CASI, document orders may be invoiced at the end of the month, charged against a deposit account, or paid by check or credit card. NASA CASI accepts American Express, Diners' Club, MasterCard, and VISA credit cards. There are no shipping and handling charges. To register at the NASA CASI, please request a registration form through the NASA Access Help Desk at the numbers or addresses below.

Return Policy

The NASA Center for AeroSpace Information will gladly replace or make full refund on items you have requested if we have made an error in your order, if the item is defective, or if it was received in damaged condition and you contact us within 30 days of your original request. Just contact our NASA Access Help Desk at the numbers or addresses listed below.

NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

E-mail: help@sti.nasa.gov
Fax: (301) 621-0134
Phone: (301) 621-0390

Rev. 6/96

Federal Depository Library Program

In order to provide the general public with greater access to U.S. Government publications, Congress established the Federal Depository Library Program under the Government Printing Office (GPO), with 53 regional depositories responsible for permanent retention of material, inter-library loan, and reference services. At least one copy of nearly every NASA and NASA-sponsored publication, either in printed or microfiche format, is received and retained by the 53 regional depositories. A list of the Federal Regional Depository Libraries, arranged alphabetically by state, appears at the very end of this section. These libraries are not sales outlets. A local library can contact a regional depository to help locate specific reports, or direct contact may be made by an individual.

Public Collection of NASA Documents

An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in the STI Database. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents FIZ–Fachinformation Karlsruhe–Bibliographic Service, D-76344 Eggenstein-Leopoldshafen, Germany and TIB–Technische Informationsbibliothek, P.O. Box 60 80, D-30080 Hannover, Germany.

Submitting Documents

All users of this abstract service are urged to forward reports to be considered for announcement in the STI Database. This will aid NASA in its efforts to provide the fullest possible coverage of all scientific and technical publications that might support aeronautics and space research and development. If you have prepared relevant reports (other than those you will transmit to NASA, DOD, or DOE through the usual contract- or grant-reporting channels), please send them for consideration to:

ATTN: Acquisitions Specialist
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934.

Reprints of journal articles, book chapters, and conference papers are also welcome.

You may specify a particular source to be included in a report announcement if you wish; otherwise the report will be placed on a public sale at the NASA Center for AeroSpace Information. Copyrighted publications will be announced but not distributed or sold.

Federal Regional Depository Libraries

ALABAMA

AUBURN UNIV. AT MONTGOMERY LIBRARY
Documents Dept.
7300 University Dr.
Montgomery, AL 36117–3596
(205) 244–3650 Fax: (205) 244–0678

UNIV. OF ALABAMA
Amelia Gayle Gorgas Library
Govt. Documents
P.O. Box 870266
Tuscaloosa, AL 35487–0266
(205) 348–6046 Fax: (205) 348–0760

ARIZONA

DEPT. OF LIBRARY, ARCHIVES, AND PUBLIC RECORDS
Research Division
Third Floor, State Capitol
1700 West Washington
Phoenix, AZ 85007
(602) 542–3701 Fax: (602) 542–4400

ARKANSAS

ARKANSAS STATE LIBRARY
State Library Service Section
Documents Service Section
One Capitol Mall
Little Rock, AR 72201–1014
(501) 682–2053 Fax: (501) 682–1529

CALIFORNIA

CALIFORNIA STATE LIBRARY
Govt. Publications Section
P.O. Box 942837 – 914 Capitol Mall
Sacramento, CA 94337–0091
(916) 654–0069 Fax: (916) 654–0241

COLORADO

UNIV. OF COLORADO – BOULDER
Libraries – Govt. Publications
Campus Box 184
Boulder, CO 80309–0184
(303) 492–8834 Fax: (303) 492–1881

DENVER PUBLIC LIBRARY
Govt. Publications Dept. BSG
1357 Broadway
Denver, CO 80203–2165
(303) 640–8846 Fax: (303) 640–8817

CONNECTICUT

CONNECTICUT STATE LIBRARY
231 Capitol Avenue
Hartford, CT 06106
(203) 566–4971 Fax: (203) 566–3322

FLORIDA

UNIV. OF FLORIDA LIBRARIES
Documents Dept.
240 Library West
Gainesville, FL 32611–2048
(904) 392–0366 Fax: (904) 392–7251

GEORGIA

UNIV. OF GEORGIA LIBRARIES
Govt. Documents Dept.
Jackson Street
Athens, GA 30602–1645
(706) 542–8949 Fax: (706) 542–4144

HAWAII

UNIV. OF HAWAII
Hamilton Library
Govt. Documents Collection
2550 The Mall
Honolulu, HI 96822
(808) 948–8230 Fax: (808) 956–5968

IDAHO

UNIV. OF IDAHO LIBRARY
Documents Section
Rayburn Street
Moscow, ID 83844–2353
(208) 885–6344 Fax: (208) 885–6817

ILLINOIS

ILLINOIS STATE LIBRARY
Federal Documents Dept.
300 South Second Street
Springfield, IL 62701–1796
(217) 782–7596 Fax: (217) 782–6437

INDIANA

INDIANA STATE LIBRARY
Serials/Documents Section
140 North Senate Avenue
Indianapolis, IN 46204–2296
(317) 232–3679 Fax: (317) 232–3728

IOWA

UNIV. OF IOWA LIBRARIES
Govt. Publications
Washington & Madison Streets
Iowa City, IA 52242–1166
(319) 335–5926 Fax: (319) 335–5900

KANSAS

UNIV. OF KANSAS
Govt. Documents & Maps Library
6001 Malott Hall
Lawrence, KS 66045–2800
(913) 864–4660 Fax: (913) 864–3855

KENTUCKY

UNIV. OF KENTUCKY
King Library South
Govt. Publications/Maps Dept.
Patterson Drive
Lexington, KY 40506–0039
(606) 257–3139 Fax: (606) 257–3139

LOUISIANA

LOUISIANA STATE UNIV.
Middleton Library
Govt. Documents Dept.
Baton Rouge, LA 70803–3312
(504) 388–2570 Fax: (504) 388–6992

LOUISIANA TECHNICAL UNIV.
Prescott Memorial Library
Govt. Documents Dept.
Ruston, LA 71272–0046
(318) 257–4962 Fax: (318) 257–2447

MAINE

UNIV. OF MAINE
Raymond H. Fogler Library
Govt. Documents Dept.
Orono, ME 04469–5729
(207) 581–1673 Fax: (207) 581–1653

MARYLAND

UNIV. OF MARYLAND – COLLEGE PARK
McKeldin Library
Govt. Documents/Maps Unit
College Park, MD 20742
(301) 405–9165 Fax: (301) 314–9416

MASSACHUSETTS

BOSTON PUBLIC LIBRARY
Govt. Documents
666 Boylston Street
Boston, MA 02117–0286
(617) 536–5400, ext. 226
Fax: (617) 536–7758

MICHIGAN

DETROIT PUBLIC LIBRARY
5201 Woodward Avenue
Detroit, MI 48202–4093
(313) 833–1025 Fax: (313) 833–0156

LIBRARY OF MICHIGAN
Govt. Documents Unit
P.O. Box 30007
717 West Allegan Street
Lansing, MI 48909
(517) 373–1300 Fax: (517) 373–3381

MINNESOTA

UNIV. OF MINNESOTA
Govt. Publications
409 Wilson Library
309 19th Avenue South
Minneapolis, MN 55455
(612) 624–5073 Fax: (612) 626–9353

MISSISSIPPI

UNIV. OF MISSISSIPPI
J.D. Williams Library
106 Old Gym Bldg.
University, MS 38677
(601) 232–5857 Fax: (601) 232–7465

MISSOURI

UNIV. OF MISSOURI – COLUMBIA
106B Ellis Library
Govt. Documents Sect.
Columbia, MO 65201–5149
(314) 882–6733 Fax: (314) 882–8044

MONTANA

UNIV. OF MONTANA
Mansfield Library
Documents Division
Missoula, MT 59812–1195
(406) 243–6700 Fax: (406) 243–2060

NEBRASKA

UNIV. OF NEBRASKA – LINCOLN
D.L. Love Memorial Library
Lincoln, NE 68588–0410
(402) 472–2562 Fax: (402) 472–5131

NEVADA

THE UNIV. OF NEVADA LIBRARIES
Business and Govt. Information Center
Reno, NV 89557–0044
(702) 784–6579 Fax: (702) 784–1751

NEW JERSEY

NEWARK PUBLIC LIBRARY
Science Div. – Public Access
P.O. Box 630
Five Washington Street
Newark, NJ 07101–7812
(201) 733–7782 Fax: (201) 733–5648

NEW MEXICO

UNIV. OF NEW MEXICO
General Library
Govt. Information Dept.
Albuquerque, NM 87131–1466
(505) 277–5441 Fax: (505) 277–6019

NEW MEXICO STATE LIBRARY
325 Don Gaspar Avenue
Santa Fe, NM 87503
(505) 827–3824 Fax: (505) 827–3888

NEW YORK

NEW YORK STATE LIBRARY
Cultural Education Center
Documents/Gift & Exchange Section
Empire State Plaza
Albany, NY 12230–0001
(518) 474–5355 Fax: (518) 474–5786

NORTH CAROLINA

UNIV. OF NORTH CAROLINA – CHAPEL HILL
Walter Royal Davis Library
CB 3912, Reference Dept.
Chapel Hill, NC 27514–8890
(919) 962–1151 Fax: (919) 962–4451

NORTH DAKOTA

NORTH DAKOTA STATE UNIV. LIB.
Documents
P.O. Box 5599
Fargo, ND 58105–5599
(701) 237–8886 Fax: (701) 237–7138

UNIV. OF NORTH DAKOTA
Chester Fritz Library
University Station
P.O. Box 9000 – Centennial and University Avenue
Grand Forks, ND 58202–9000
(701) 777–4632 Fax: (701) 777–3319

OHIO

STATE LIBRARY OF OHIO
Documents Dept.
65 South Front Street
Columbus, OH 43215–4163
(614) 644–7051 Fax: (614) 752–9178

OKLAHOMA

OKLAHOMA DEPT. OF LIBRARIES
U.S. Govt. Information Division
200 Northeast 18th Street
Oklahoma City, OK 73105–3298
(405) 521–2502, ext. 253
Fax: (405) 525–7804

OKLAHOMA STATE UNIV.
Edmon Low Library
Stillwater, OK 74078–0375
(405) 744–6546 Fax: (405) 744–5183

OREGON

PORTLAND STATE UNIV.
Branford P. Millar Library
934 Southwest Harrison
Portland, OR 97207–1151
(503) 725–4123 Fax: (503) 725–4524

PENNSYLVANIA

STATE LIBRARY OF PENN.
Govt. Publications Section
116 Walnut & Commonwealth Ave.
Harrisburg, PA 17105–1601
(717) 787–3752 Fax: (717) 783–2070

SOUTH CAROLINA

CLEMSON UNIV.
Robert Muldrow Cooper Library
Public Documents Unit
P.O. Box 343001
Clemson, SC 29634–3001
(803) 656–5174 Fax: (803) 656–3025

UNIV. OF SOUTH CAROLINA
Thomas Cooper Library
Green and Sumter Streets
Columbia, SC 29208
(803) 777–4841 Fax: (803) 777–9503

TENNESSEE

UNIV. OF MEMPHIS LIBRARIES
Govt. Publications Dept.
Memphis, TN 38152–0001
(901) 678–2206 Fax: (901) 678–2511

TEXAS

TEXAS STATE LIBRARY
United States Documents
P.O. Box 12927 – 1201 Brazos
Austin, TX 78701–0001
(512) 463–5455 Fax: (512) 463–5436

TEXAS TECH. UNIV. LIBRARIES
Documents Dept.
Lubbock, TX 79409–0002
(806) 742–2282 Fax: (806) 742–1920

UTAH

UTAH STATE UNIV.
Merrill Library Documents Dept.
Logan, UT 84322–3000
(801) 797–2678 Fax: (801) 797–2677

VIRGINIA

UNIV. OF VIRGINIA
Alderman Library
Govt. Documents
University Ave. & McCormick Rd.
Charlottesville, VA 22903–2498
(804) 824–3133 Fax: (804) 924–4337

WASHINGTON

WASHINGTON STATE LIBRARY
Govt. Publications
P.O. Box 42478
16th and Water Streets
Olympia, WA 98504–2478
(206) 753–4027 Fax: (206) 586–7575

WEST VIRGINIA

WEST VIRGINIA UNIV. LIBRARY
Govt. Documents Section
P.O. Box 6069 – 1549 University Ave.
Morgantown, WV 26506–6069
(304) 293–3051 Fax: (304) 293–6638

WISCONSIN

ST. HIST. SOC. OF WISCONSIN LIBRARY
Govt. Publication Section
816 State Street
Madison, WI 53706
(608) 264–6525 Fax: (608) 264–6520

MILWAUKEE PUBLIC LIBRARY
Documents Division
814 West Wisconsin Avenue
Milwaukee, WI 53233
(414) 286–3073 Fax: (414) 286–8074

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. 357)

SEPTEMBER 19, 1997

01
AERONAUTICS

19970025651 NASA Dryden Flight Research Center, Edwards, CA USA

A Summary of Numerous Strain-Gage Load Calibrations on Aircraft Wings and Tails in a Technological Format

Jenkins, Jerald M., NASA Dryden Flight Research Center, USA; DeAngelis, V. Michael, NASA Dryden Flight Research Center, USA; Jul. 1997; 146p; In English

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

Report No.(s): NASA-TM-4804; NAS 1.15:4804; H-2154; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Fifteen aircraft structures that were calibrated for flight loads using strain gages are examined. The primary purpose of this paper is to document important examples of load calibrations on airplanes during the past four decades. The emphasis is placed on studying the physical procedures of calibrating strain-gaged structures and all the supporting analyses and computational techniques that have been used. The results and experiences obtained from actual data from 14 structures (on 13 airplanes and 1 laboratory test structure) are presented. This group of structures includes fins, tails, and wings with a wide variety of aspect ratios. Straight- wing, swept-wing, and delta-wing configurations are studied. Some of the structures have skin-dominant construction; others are spar-dominant. Anisotropic materials, heat shields, corrugated components, nonorthogonal primary structures, and truss-type structures are particular characteristics that are included.

Author

Anisotropy; Aerodynamic Loads; Aircraft Structures; Aspect Ratio; Loads (Forces); Swept Wings; Strain Gages

02
AERODYNAMICS

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

19970025373 Michigan Technological Univ., Mechanical Engineering Dept., Houghton, MI USA

Fundamentals of Laminar-Turbulent Transition on Oscillating Airfoils

Trevino, George, Michigan Technological Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 94; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

It is well known that a laminar flow will become turbulent when the flow Reynolds number (Re) achieves some critical value. In understanding the nature of laminar-turbulent transition it is important to recognize that theoretical results can predict only the point of instability (i.e. that point where the instabilities which eventually lead to the onset of turbulence first begin to appear), while the actual point of transition from laminar to turbulent remains at issue. The precise distance between the point of transition and the point of instability depends, among other things, on the rate of amplification of the unstable disturbances and on the intensity of the turbulence in the free stream. The rate of amplification, in turn, is strongly influenced by the pressure gradient. If the airfoil is some angle of attack other than zero, transition from laminar to turbulent has been studied extensively by Bussman and Ulrich for the case of symmetric Zhukovskii airfoils. These results, however, are all for steady state flows. The case where the airfoil is itself oscillating about some fixed angle of attack has not been reported, although the effect of an oscillating free stream on flat plate laminar-turbulent transition has been studied. In these investigations the free stream oscillates in a direction parallel to the plate. The essential results of those efforts are: (a) the critical Re at the start of transition depends only on the amplitude of the external fluctuations; (b) the dimensionless transition length depends only on the frequency of the external oscillations. Transition in the case where the airfoil oscillates can potentially be modeled by taking the oncoming flow to be composed of a constant U(sub

infinity) and a second component, say W(t)=W(sub infinity) + Delta Wcos(wt), where the fixed angle of attack is given by (W(sub infinity/U(sub infinity). This approach should ideally lead to a result consistent with the analyses of airfoils to transient loads such as gusts, where the lift on an airfoil due to a sinusoidal gust is defined by Sears function. The dependence of the point of instability and the point of transition on the lift coefficient is described.
Author
Turbulent Boundary Layer; Boundary Layer Transition; Aerodynamic Coefficients; Airfoils; Angle of Attack; Laminar Flow; Lift; Reynolds Number

19970025561 Defence Science and Technology Organisation, Air Operations Div., Canberra, 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; 64p; In English
Report No.(s): AD-A324125; DSTO-TR-0489; DODA-AR-008-381; No Copyright; Avail: CASI; A04, Hardcopy; A01, 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. Visualisation 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.
DTIC
Water Tunnel Tests; Wind Tunnel Tests; Flow Visualization; Fins; Leading Edges; Vortex Breakdown; F-18 Aircraft; Aerodynamic Configurations

19970025578 Clarkson Univ., Dept. of Mechanical and Aeronautical Engineering, Potsdam, NY USA
Structure Identification Within a Transitioning Swept-Wing Boundary Layer ***Final Report***
Chapman, Keith, Clarkson Univ., USA; Glauser, Mark, Clarkson Univ., USA; Dec. 1996; 252p; In English
Contract(s)/Grant(s): NCC4-110; NAG2-724
Report No.(s): NASA-CR-205181; NAS 1.26:205181; MAE-319; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

Extensive measurements are made in a transitioning swept-wing boundary layer using hot-film, hot-wire and cross-wire anemometry. The crossflow-dominated flow contains stationary vortices that breakdown near mid-chord. The most amplified vortex wavelength is forced by the use of artificial roughness elements near the leading edge. Two-component velocity and spanwise surface shear-stress correlation measurements are made at two constant chord locations, before and after transition. Streamwise surface shear stresses are also measured through the entire transition region. Correlation techniques are used to identify stationary structures in the laminar regime and coherent structures in the turbulent regime. Basic techniques include observation of the spatial correlations and the spatially distributed auto-spectra. The primary and secondary instability mechanisms are identified in the spectra in all measured fields. The primary mechanism is seen to grow, cause transition and produce large-scale turbulence. The secondary mechanism grows through the entire transition region and produces the small-scale turbulence. Advanced techniques use Linear Stochastic Estimation (LSE) and Proper Orthogonal Decomposition (POD) to identify the spatio-temporal evolutions of structures in the boundary layer. LSE is used to estimate the instantaneous velocity fields using temporal data from just two spatial locations and the spatial correlations. Reference locations are selected using maximum RMS values to provide the best available estimates. POD is used to objectively determine modes characteristic of the measured flow based on energy. The stationary vortices are identified in the first laminar modes of each velocity component and shear component. Experimental evidence suggests that neighboring vortices interact and produce large coherent structures with spanwise periodicity at double the stationary vortex wavelength. An objective transition region detection method is developed using streamwise spatial POD solutions which isolate the growth of the primary and secondary instability mechanisms in the first and second modes, respectively. Temporal evolutions of dominant POD modes in all measured fields are calculated. These scalar POD coefficients contain the integrated characteristics of the entire field, greatly reducing the amount of data to characterize the instantaneous field. These modes may then be used to train future flow control algorithms based on neural networks.
Author
Boundary Layers; Friction Measurement; Flow Measurement; Velocity Measurement; Velocity Distribution

19970025696 Mississippi State Univ., Engineering Research Center for Computational Field Simulation, Mississippi State, MS USA

Simulation of Massively Separated Flow Around a Missile at Angle of Attack Using Solution-Adaptive Re-Meshing ***Final Report***

Soni, Bharat K., Mississippi State Univ., USA; Apr. 15, 1997; 87p; In English

Contract(s)/Grant(s): DAAH04-95-I-0040

Report No.(s): AD-A324828; ARO-33958.1-EG; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Simulation of massively separated flow around a missile at various angle of attack using solution adaptive remeshing is performed. These simulations are exercised in support of the KTA2-12 program which is designed to evaluate computational technology for predicting highly separated flow fields for missile configurations. A new weight function using Boolean sum of pertinent solution gradient and curvature terms with appropriate scaling and normalization is developed. The n ew weight function is applicable to wide range of grid adaptive problems with no user input. The adaptive algorithms have been cast into a parallel multiblock adaptive grid system using MPI. The improvement in the convergence level and better agreement of flow solutions with experimental force and moment coefficients with flow solutions have been demonstrated by using the adaptive process. The computer codes NPARC and CFL3D are utilized for respective flow field simulations.

DTIC

Missile Configurations; Missiles; Force Distribution; Computer Programs; Computational Grids; Angle of Attack; Aerodynamic Configurations

03
AIR TRANSPORTATION AND SAFETY

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

19970025124 Naval Research Lab., Monterey, CA USA

Aircraft Icing Algorithms Applied to U. S. Navy Numerical Model Data: A Verification Study ***Final Report***

Vogel, G. N., Naval Research Lab., USA; Feb. 1997; 94p; In English

Report No.(s): AD-A324028; NRL/MR/7543--97-7228; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The results from a verification with pilot reports of four aircraft icing algorithms applied to Navy global numerical model data are presented. Significant differences in forecast performance among algorithms are closely related to differences in temperature and moisture thresholds utilized to infer icing. Near 850 mb (-5000 ft), three of the icing routines correctly forecast over 70% of observed icing occurrences, and obtained Hanssen and Kuipers skill scores (difference between hits and false alarms) in excess of 0.5 (0, random performance; 1, perfect skill). Statistical tests indicated that differences in skill scores as a function of forecast lead time (0 to 24 hr) were generally not significant. The use of higher vertical resolution data was found very important for enhanced icing prediction performance. Overall results indicate that the ability of icing routines to differentiate icing type and intensity based on temperature, moisture and stability criteria is clearly limited. In terms of forecast skill and computational efficiency, algorithm comparisons indicate that the icing routine currently used as operational guidance at the National Centers for Environmental Prediction Aviation Weather Center would be a good selection for the Naval Research Laboratory's aviation support product suite.

DTIC

Aircraft Icing; Algorithms; Mathematical Models; Statistical Tests; Navy; Research; Flight Safety

19970025438 NASA Johnson Space Center, Houston, TX USA

Development of Methods to Evaluate Safer Flight Characteristics ***Final Report***

Basciano, Thomas E., Jr., Cincinnati Univ., USA; Erickson, Jon D., NASA Johnson Space Center, USA; National Aeronautics and Space Administration (NASA) /American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Jun. 1997; Volume 1, pp. 3.1-3.12; In English; Also announced as 19970025435

Contract(s)/Grant(s): NAG9-867; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The goal of the proposed research is to begin development of a simulation that models the flight characteristics of the Simplified Aid For EVA Rescue (SAFER) pack. Development of such a simulation was initiated to ultimately study the effect an Orbital Replacement Unit (ORU) has on SAFER dynamics. A major function of this program will be to calculate fuel consumption for many ORUs with different masses and locations. This will ultimately determine the maximum ORU mass an astronaut can carry and still perform a self-rescue without jettisoning the unit. A second primary goal is to eventually simulate relative motion (vibration) between the ORU and astronaut. After relative motion is accurately modeled it will be possible to evaluate the robustness

of the control system and optimize performance as needed. The first stage in developing the simulation is the ability to model a standardized, total, self-rescue scenario, making it possible to accurately compare different program runs. In orbit an astronaut has only limited data and will not be able to follow the most fuel efficient trajectory; therefore, it is important to correctly model the procedures an astronaut would use in orbit so that good fuel consumption data can be obtained. Once this part of the program is well tested and verified, the vibration (relative motion) of the ORU with respect to the astronaut can be studied.
Author
Extravehicular Activity; Rescue Operations; Astronaut Locomotion; Extravehicular Mobility Units; Manned Space Flight; Astronaut Maneuvering Equipment

19970026027 Ohio State Univ., Columbus, OH USA
A New Approach to Aeronautical Decision-Making: The Expertise Method ***Final Report***
Kochan, Janeen A., Ohio State Univ., USA; Jensen, Richard S., Ohio State Univ., USA; Chubb, Gerald P., Ohio State Univ., USA; Hunter, David R., Federal Aviation Administration, USA; Mar. 1997; 43p; In English
Contract(s)/Grant(s): DTFA-01-93-C-00041
Report No.(s): AD-A323793; DOT/FAA/AM-97/6; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Four studies of pilot decision-making were conducted to formulate a general model of the expert pilot that might be applied to novice pilots in order to increase their decision-making skills and reduce their risk of accident involvement. This set of studies began with a series of unstructured interviews of pilots to identify and compile characteristics of the expert pilot. Each succeeding study, then, became more structured in its approach as the characteristics of an expert pilot were more closely defined. From structured interviews conducted as part of the second study, a preliminary definition was obtained that stressed motivation, confidence, superior learning and performance skills, and an intuitive decision-making style. The third study evaluated these characteristics as they were possessed by pilots of three types of relatively high-performance general aviation aircraft. In the final study, experienced pilots were presented with a plausible general aviation flight scenario using a verbal protocol methodology. The responses of the pilots to this table-top simulation were recorded and analyzed. These data suggest that, when compared to competent pilots, expert pilots tend to (1) seek more quality information in a more timely manner; (2) make more progressive decisions to solve problems; and, (3) communicate more readily with all available resources.
DTIC
Aircraft Pilots; Decision Making; Flight Safety; General Aviation Aircraft; Stress (Psychology); Flight Simulation

04
AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

19970025125 Nebraska Univ., Lincoln, NE USA
Millimeter-Wave Backscatter Measurements in Support of Surface Navigation Applications
Snuttjer, Brett R., Nebraska Univ., USA; Apr. 18, 1997; 121p; In English
Report No.(s): AD-A324004; AFIT-97-024; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

Millimeter wave (MMW) short range radar systems have unique advantages in surface navigation applications, such as military vehicle mobility in inclement conditions, aircraft landing assistance, and missile guidance. MMW radars systems have recently become commercially affordable, and are being developed for automobile collision avoidance applications. Two types of radar cross section (RCS) measurements were performed at 95 GHz. Grazing angle clutter data were obtained from common surfaces. The RCS of objects, commonly encountered by automobiles on the road, was also measured. In addition the received power statistics were investigated for both types of RCS measurements. Surface clutter from several surfaces, including asphalt, grass and snow, was measured at 7.5 and 5.0 deg grazing angles. The average normalized RCS values are presented for each surface. The received clutter power is compared to Rayleigh and Weibull probability distributions. For all distributed surfaces, the received power cumulative distribution function (CDF) best matches the Rayleigh assumption. The azimuthal RCS profile was measured and plotted for several roadside objects. These objects included both metal and wood sign posts and a section of guard rail. An average RCS value was also calculated for each object. The received power CDF was compared to the Rayleigh and Weibull distributions. The uniformly shaped targets, e.g., a round wood pole, best match the Rayleigh distribution. The majority of odd shaped objects best follow the Weibull assumption.
DTIC
Millimeter Waves; Radar Cross Sections; Collision Avoidance; Surface Navigation; Backscattering; Rayleigh Distribution

19970025220 Ohio State Univ., Cognitive Systems Engineering Lab., Columbus, OH USA

Human-Centered Technologies and Procedures for Future Air Traffic Management ***Progress Report***

Smith, Philip, Ohio State Univ., USA; Woods, David, Ohio State Univ., USA; McCoy, Elaine, Ohio Univ., USA; Billings, Charles, Ohio State Univ., USA; Sarter, Nadine, Illinois Univ., USA; Denning, Rebecca, Ohio State Univ., USA; Dekker, Sidney, Ohio State Univ., USA; Jan. 31, 1997; 162p; In English

Contract(s)/Grant(s): NAG2-995

Report No.(s): NASA-CR-205087; NAS 1.26:205087; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The use of various methodologies to predict the impact of future Air Traffic Management (ATM) concepts and technologies is explored. The emphasis has been on the importance of modeling coordination and cooperation among multiple agents within this system, and on understanding how the interactions among these agents will be influenced as new roles, responsibilities, procedures and technologies are introduced. to accomplish this, we have been collecting data on performance under the current air traffic management system, identifying critical problem areas and looking for examples suggestive of general approaches for solving such problems. Using the results of these field studies, we have developed a set of concrete scenarios centered around future designs, and have studied performance in these scenarios with a set of 40 controllers, dispatchers, pilots and traffic managers. Derived from text

Air Traffic Control; Controllers; Management Planning; Management Systems; Data Acquisition; Coordination

19970025549 National Academy of Sciences - National Research Council, Washington, DC USA

Flight to the Future: Human Factors in Air Traffic Control

Wickens, Christopher D., Editor, Illinois Univ., USA; Mavor, Anne S., Editor, National Academy of Sciences - National Research Council, USA; McGee, James P., Editor, National Academy of Sciences - National Research Council, USA; 1997; 386p; In English

Contract(s)/Grant(s): FAA-94-G-042; ISBN-0-309-05637-3; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche

The nation's air traffic control system, which is part of the national airspace system, is responsible for managing a complex mixture of air traffic from commercial, general, corporate, and military aviation. Despite the strong safety record achieved over the last several decades, the system does suffer occasional serious disruption, often the result of outdated and failed equipment. When equipment failures occur, system safety relies on the skills of controllers and pilots. Under these circumstances, safety is maintained by reducing the number of aircraft in the air. Pressures to provide the capacity to handle a greater number of flights in the future and to maintain high levels of safety and efficiency have led to proposals to provide more reliable and powerful equipment and at the same time increase the level of automation in air traffic control facilities-that is, to use advances in technology to take over tasks that are currently performed by humans. Such proposals have raised concern from members of the Subcommittee on Aviation of the Public Works and Transportation Committee of the U.S. House of Representatives that automation not compromise the safety or efficiency of the system by marginalizing the human controller's ability to provide the necessary backup when disruptions occur. As a result, the Panel on Human Factors in Air Traffic Control Automation was convened at the request of the Federal Aviation Administration (FAA) for the purposes of gaining an understanding of, and providing recommendations on, the human factors characteristics of the current air traffic control system, the national airspace system, and future automation alternatives in terms of the human's role in the system. The panel's charge divides the tasks into two phases. The first focuses on the current system and its development as a means to: (1) understand the complexities of and problems with the current air traffic control system that automation is intended to address; (2) describe the manner in which some levels of automation have already been implemented; and (3) pro- vide a baseline of human factors knowledge as it relates to the functions of the air traffic controller in the system. The second phase is to assess future automation alternatives and the role of the human operator in ensuring safety and efficiency in the air traffic control system. This report provides the results of the panel's work during the first phase. Derived from text

Air Traffic Control; Air Traffic Controllers (Personnel); Safety Factors; National Airspace System; Human Factors Engineering

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

19970025162 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel Working Group 16, Neuilly-Sur-Seine, France

Cooperative Programme on Dynamic Wind Tunnel Experiments for Manoeuvring Aircraft ***Programme en Cooperation sur l'Experimentation Dynamique en Soufflerie pour la Manoeuvrabilite de l'Avion***

Oct. 1996; 248p; In English; Original contains color illustrations
Report No.(s): AGARD-AR-305; ISBN-92-836-1043-1; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

This report describes a multinational cooperative program in response to the continuing interest among the NATO countries in dynamic wind tunnel testing. The program consisted of a series of dynamic experiments on models of a schematic combat aircraft configuration and of two generic aircraft forebodies. Ten wind tunnels in seven countries were involved. The dynamic tests included oscillatory, and in one case oscillatory-coning experiments. In several facilities, this was complemented by static and, in some cases, also dynamic flow visualization experiments in water tunnels. The forebody experiments included extensive surface pressure measurements under rotary conditions, carried out in a pressurized wind tunnel. The reliability of current test techniques was examined; and an expanded data base for dynamic data at high angles of attack is presented.
Author (revised)
Wind Tunnel Tests; Dynamic Tests; Angle of Attack; Fighter Aircraft; Flow Visualization; Pressure Measurement; Reynolds Number

19970025239 Carnegie-Mellon Univ., School of Computer Science, Pittsburgh, PA USA
Subtyping for Distributed Object Stores (Extended Abstract)
Wing, Jeannette M., Carnegie-Mellon Univ., USA; Apr. 1997; 11p; In English
Contract(s)/Grant(s): F30602-93-I-1330; NSF CCR-95-23972
Report No.(s): AD-A324565; CMU-CS-97-121; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The author reviewed the Liskov and Wing subtype definition that takes into consideration the problem of subtyping in the presence of mutable objects. She then shows how this notion of subtyping is relevant to the design of the TOM object repository whose main application today is a data type conversion service accessible through the Web.
DTIC
Distributed Processing; Object-Oriented Programming

19970025346 Old Dominion Univ., Dept. of Mechanical Engineering, Norfolk, VA USA
Identification of the Strut Characteristics of an A-6 Landing Gear
Bawab, Sebastian, Old Dominion Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 60; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

The objective of this research is to assist in designing an active control strut of the nose landing gear of the High Speed Civil Transport and analyzing its performance. This is achieved by experimentally studying the characteristics of an A-6 aircraft landing gear and analytically modeling it to further enhance its performance by controlling the critical parameters. The parameters include active changes to the characteristics of the strut such as the stiffness, the damping, or the addition of external energy sources in a hydraulic form. Once the system is well understood and the analytical model conforms with the physical model, the results are documented and different control schemes can then be implemented to the analytical strut where they can be verified experimentally.
Derived from text
A-6 Aircraft; Struts; Landing Gear; Stiffness; Active Control

19970025367 Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA
Modeling and Control of Forward Vanes for HSR
Newman, Brett, Old Dominion Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 85; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

The High-Speed Civil Transport (HSCT) is projected to have a pitch divergence due to the relaxation of static stability at subsonic speeds. Further, significant interaction between rigid-body and aeroelastic degrees of freedom is expected. Objectives of the inner most loops of the flight control system (FCS) for HSCT will be to artificially supply the stability inherently lacking in the airframe, augment the key responses with crisp, well damped behavior, and to suppress, or lessen, aeroelastic motions in the rigid-body responses. Attainment of multiple, conflicting closed-loop objectives inherently requires a dexterous FCS architecture, which can sense key motions and apply critical forces/moments at selected points distributed throughout the vehicle. Here, the overall objective is to explore the FCS related benefits from an additional, small, forward aerodynamic control surface applicable to preliminary HSCT concepts. The study is conducted at a rudimentary level to provide rapid progress through the modeling phase, in order to allow sufficient time for the flight control phase and evaluation of benefits. Use of existing dynamic models and flight control architectures for HSCT is given priority. The current HSCT concept does not allow forward force/moment gen-

eration capability, and inclusion of such capability in existing models is the initial activity. A component build-up modeling procedure is used to incorporate the dynamic stability and control power characteristics arising from forward vanes on existing HSCT math models. Vane 'angle of attack' is generated by the following motion: rigid plunge rate, rigid pitch rate, structural deflection, structural deflection rate, and control surface rotation. The additional forces/moments generated by the vanes are inserted into the governing rigid and structural equations of motion. The technique makes use of rigid empirical lifting surface predictions and structural vibration characteristics. Comparison of open-loop residues for the vane and wing trailing edge flap reveals nearly an order of magnitude effectiveness increase upon the first structural mode, as well coordination with elevator/relaxed static stability mode relationships. This extra control power does not come free, the price is further destabilization in the static margin. Utilization of the forward surface in previous FCS milestones is the second activity. These earlier studies considered wing trailing edge flaps as secondary pitch surfaces in a two-loop FCS architecture. However, flaps were found to be ineffective due to their positioning on the vehicle. The analysis revisited the two-loop FCS architecture with forward vanes substituted for flaps and comparisons were made. For the aeroelastic suppression loop, the vane-to-nearby-rate-gyro proved more effective in damping augmentation of the structural modes. An increase in the damping-to-loop-gain sensitivity is observed, as well as a higher upper limit for the achievable closed-loop structural damping ratios. An elevator-to-vane cross channel provided aeroelastic suppression through tailoring of the closed-loop cockpit numerator characteristics. Finally, the rigid pitch augmentation loop, driven by the elevator, stabilized the relaxed stability mode. In this loop, the upper limits of the handling performance were increased. These FCS benefits are a direct result of separating the pitch augmentation and aeroelastic suppression functions into separate loops. HSCT flight control design activities face hard constraints and challenging hurdles. Useful design freedoms, possibly created with a forward pair of small, aerodynamic control surfaces, are highly sought. Conclusions and data from this study indicate new design space is available with a pair of small, forward aerodynamic control vanes.
Author
Aerodynamics; Airframes; Angle of Attack; X-30 Vehicle; Flight Control; Flapping; Dynamic Structural Analysis; Wing Flaps; Trailing Edge Flaps; Supersonic Transports

19970025403 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
Advances in Rotorcraft Technology ***Les Avancees en Technologies pour Aeronefs a Voilure Tournante***
Advances in Rotorcraft Technology; Apr. 1997; 392p; In English; In French, 27-30 May 1996, Ottawa, Canada; Also announced as 19970025404 through 19970025434
Report No.(s): AGARD-CP-592; ISBN-92-836-0038-X; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche
The last half of the twentieth century has seen the rotorcraft come in to prominence as a combat system. Rotorcraft have proven their worth in all environments and in all domains of conflict. They will continue to provide essential military capabilities for the Alliance well into the next century. The objective of this symposium was to capture the current situation in the rapidly changing field of rotorcraft technology. The symposium met its objective. Different parts of this Conference Proceedings should be valuable to anyone currently designing or developing rotorcraft, or doing basic research in rotorcraft technology. Special emphasis in the programme was placed upon the following subjects: (1) the impact of the increasing use of commercial off-the-shelf technology in military helicopter development and use; (2) the increasing acceptance and expanded use of Aeronautical Design Standard ADS-33; and (3) the issue of rotorcraft flight safety. This symposium provided an excellent forum for a varied program of technical presentations. It specifically provided information on the Bell 230, the Tiger, Eurocopter EC 135, the V-22, and the RAH Comanche. The knowledge gained and exchanged at this symposium should assist the attendees in helping to provide NATO with the future affordable combat rotorcraft it will need to maintain our current technological lead.
Author
Conferences; Flight Safety; Helicopter Design; Standardization; Helicopter Performance; Rotary Wing Aircraft

19970025404 Textron Bell Helicopter, Mirabel, Quebec Canada
Certification of Model 230 Helicopter for Category A Elevated Helipad Operations
Goldenberg, Joachim, Textron Bell Helicopter, Canada; Meslin, L., Textron Bell Helicopter, Canada; Blondino, M., Textron Bell Helicopter, USA; Williams, D., Textron Bell Helicopter, USA; Advances in Rotorcraft Technology; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche
A flight test program leading to the certification of Model 230 helicopter for Category A elevated heliport operations was conducted. This paper discusses the development of the TakeOff and Landing profiles for Transport Helicopters operating from elevated helipads. The development included simulation, ground level helipad tests, and elevated helipad testing. Also presented

are the demonstrated helicopter performances for this type of operations. The developed procedures will enable operators to plan for Category A operations from elevated heliports.
Author
Helicopters; Aircraft Reliability; Flight Safety; Certification; Takeoff; Aircraft Landing; Helicopter Performance; Helicopter Design

19970025405 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, UK
The Use of Simulation to Develop an Improved Understanding of Helicopter Tail Rotor Failures and Develop Aircrew Emergency Advice
Martyn, A. W., Defence Research Agency, UK; Phipps, P., Westland Helicopters Ltd., UK; Mustard, E., Westland Helicopters Ltd., UK; Apr. 1997; 18p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper reviews the use of simulation in recent UK programmes to improve our understanding of helicopter tail rotor failures, and develop the handling advice for aircrew following a tail rotor (TR) malfunction. The paper discusses the original motivation for the work and in particular the research work that has been carried out by the Defence Research Agency (DRA) and Westland Helicopters Ltd (WHL) under UK Ministry of Defence (MOD) funded programmes. This research has included flight trials conducted on the DRA Aeromechanics Lynx Control and Agility Testbed (ALYCAT) to develop Lynx TR control failure handling advice, and simulation trials on the DRA Bedford Advanced Flight Simulator (AFS) to develop Lynx TR drive failure handling advice. The AFS was also used to investigate the influence of helicopter design parameters on a pilot's ability to recover from a TR failure. Also described are off-line simulation and model development activities. The paper concludes with a review of lessons learnt.
Author
Helicopter Tail Rotors; Helicopter Design; Helicopters; System Failures; Failure Analysis; Simulation; Flight Hazards; Accident Prevention

19970025406 NASA Ames Research Center, Moffett Field, CA USA
Optimal Trajectories for the Helicopter in One-Engine-Inoperative Terminal-Area Operations
Chen, Robert T. N., NASA Ames Research Center, USA; Zhao, Yi-Yuan, Minnesota Univ., USA; Apr. 1997; 28p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents a summary of a series of recent analytical studies conducted to investigate one-engine-inoperative (OEI) optimal control strategies and the associated optimal trajectories for a twin engine helicopter in Category-A terminal-area operations. These studies also examine the associated heliport size requirements and the maximum gross weight capability of the helicopter. Using an eight states, two controls, augmented point-mass model representative of the study helicopter, continued takeoff (CTO), rejected takeoff (RTO), balked landing (BL), and continued landing (CL) are investigated for both vertical-takeoff-and-landing (VTOL) and short-takeoff-and-landing (STOL) terminal-area operations. The formulation of the non-linear optimal control problems with considerations for realistic constraints, solution methods for the two-point boundary-value problem, a new real-time generation method for the optimal OEI trajectories, and the main results of this series of trajector optimization studies are presented. In particular, a new balanced-weight concept for determining the takeoff decision point for VTOL Category-A operations is proposed, extending the balanced-field length concept used for STOL operations.
Author
Helicopter Engines; Optimal Control; Engine Failure; Helicopter Performance; Boundary Value Problems; Real Time Operation; Flight Hazards; Helicopter Control; Trajectory Optimization; Helicopters

19970025407 Atlantis Aerospace Corp., Brampton, Ontario Canada
An Investigation of Primary Flight Control Failure in a Piloted Helicopter
Gibbard, Scott R., Atlantis Aerospace Corp., Canada; Reid, L. D., Toronto Univ., Canada; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The application of fly-by-wire techniques to helicopters allows for a number of advanced control schemes that can be used to enhance performance and safety. An experiment has been carried out in a manned helicopter simulator to evaluate the possibility of making use of such a system to allow the pilot to retain control over the helicopter following catastrophic failure of the lateral cyclic primary control. It was demonstrated that a pilot can switch to pedals as the lateral control input provided that the tail rotor

is controlled by an autopilot mode. The feasibility of this process has been evaluated for a range of system configurations and the corresponding handling qualities ratings are reported.
Author
Helicopters; Flight Control; System Failures; Flight Safety; Fly by Wire Control; Lateral Control; Helicopter Control; Controllability; Pilot Performance; Flight Hazards; Manual Control

19970025408 Centre d'Essais en Vol, Section et Simulation, Istres, France
Mission Simulation for TIGRE (Protection Support Version) ***Simulation de mission pour le TIGRE (version appui protection)***
Rigal, J. F., Centre d'Essais en Vol, France; Colas, G., Centre d'Essais en Vol, France; Advances in Rotorcraft Technology; Apr. 1997; 10p; In French; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As part of the development of the support-protection helicopter version of the TIGRE helicopter, an evaluation of the specifications of the mission system was performed. The prior phases made it possible to tackle aspects pertaining to the crew-system interface, as well as the symbols and procedures relating to piloting, navigation, and employment of armament, including degraded modes and the integration of specific equipment units into the support-protection version within the basic TIGRE system. This developmental phase made it possible to perform mission simulations, thus ensuring the overall check on the crew workload under conditions as close as possible to real-life missions.
Transl. by SCITRAN
Helicopters; Flight Simulation; Flight Crews; Helicopter Design; Air Navigation

19970025409 CAE Electronics G.m.b.H., Stolberg, Germany
Modular Roll-On/Roll-Off Design Concept of a Rotorcraft Simulation Center
Niessen, Klaus, CAE Electronics G.m.b.H., Germany; Apr. 1997; 6p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

It must be the objective of the army aviation corps flight training to enable helicopter pilots to use their weapon system safely and efficiently by using the technical equipment and possibilities: at day and night, in air mobile combat of combined arms, and under almost all possible weather conditions. This is done in the so-called training equipment compound where the adequate training equipment is assigned to the respective training objective. Partial skills are learned by means of simple procedure trainers and handling models before complex simulators and finally the original device, the helicopter, are used to merge the partial skills. This training equipment compound allows to reduce costs and at the same time to reach those training objectives which will be demanded in the future. Training equipment essentially consists of the following: (1) CBT is an interactive computer based training equipment which is used for interactive learning of flight theoretical and technical aircraft knowledge, navigation training and radio communications. (2) Part Task Trainers are used for hands-on training of partial capabilities. They are corresponding to the respective system in design, layout and operation. (3) Flight Simulators and Combat Mission Simulators will be treated in detail during the further explanations. (4) The close-in combat simulator (AGDUS) corresponds to the common equipment of the army. (5) SIRA, the common equipment for combat simulation, must be extended to allow for the command and control of operations of air-mobile forces. (6) The basic training helicopter (SHS) is an indispensable equipment for the basic and advanced training of aircrews. The helicopter is not replaceable - especially with regard to affect training objectives.
Author
Rotary Wing Aircraft; Flight Simulators; Flight Training; Flight Crews; Helicopter Control; Helicopter Design; Air Navigation; Training Devices; Roll

19970025410 Centre d'Essais en Vol, Istres, France
Evaluation of Transport Helicopter Piloting Capacity, Using In-Flight Tests of the ADS-33C Type: Formal Establishment of the Test Methodology and Instrumentation ***Evaluation de la Pilotabilite des Helicopteres de Transport en Utilisant les Essais en Vol de Type ADS-33C: Formalisation de la Methodologie et de l'Instrumentation d'Essais***
Fournier, D., Centre d'Essais en Vol, France; Papillier, D., Centre d'Essais en Vol, France; Apr. 1997; 12p; In French; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Flight tests, of the type of those proposed by ADS033, are performed to evaluate piloting capacity during the developing and testing of transport helicopter. Based on the results of an experiment conducted on SA332 Super Puma MK 2 helicopter, this document attempts to present a methodology and the resources for the necessary tests.
Transl. by SCITRAN
Helicopter Design; Flight Tests; Helicopters; Pilots (Personnel); Helicopter Control; Maneuverability

19970025411 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Mechanics, Brunswick, Germany
ADS-33 Flight Testing: Lessons Learned
Ockier, Carl J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Gollnick, Volker, Bundesamt fuer Wehrtechnik und Beschaffung, Germany; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A comprehensive evaluation of the ADS-33D handling qualities specification for military rotorcraft was completed with the BO 105 helicopter. The evaluation addressed both the quantitative and qualitative ADS-33 criteria. The evaluation of the quantitative or open-loop criteria in hover and in forward flight directly addressed applicability and repeatability of the criteria. The evaluation of the qualitative criteria or ADS-33 flight test maneuvers in the good visual environment addressed applicability and validity issues. This paper presents some of the major results of the quantitative and qualitative evaluations and extracts some lessons from the comparison of the results of both evaluations.
Author
Rotary Wing Aircraft; Flight Tests; Helicopter Performance; Helicopter Control; Aerodynamic Stability; Helicopter Design

19970025412 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
ONERA and DLR Cooperation on the Smart Helicopter Concept: Handling Qualities Data Base for Hover and Low Speed Flight
Bouwer, G., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Taghizad, A., Office National d'Etudes et de Recherches Aerospatiales, France; Moedden, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 8p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The handling qualities of a helicopter in the hover / low speed range were investigated with a lateral tracking task. The desired behaviour of decoupled rate command / attitude hold and attitude command systems were programmed in conceptual models with numerous sets of bandwidth / phase delay configurations. In a first step, the task was flown in a fixed base simulator. Then selected configurations were investigated in flight on a helicopter in-flight simulator. In the ground simulator, the pilots clearly preferred attitude command systems. In the flight tests, none of the attitude command systems was rated Level 1. For rate command / attitude hold systems, the configurations were rated with Level 1 and Level 2 with a clear boundary at a bandwidth of 2.5 rad/sec.
Author
Helicopter Design; Helicopter Control; Attitude Control; Controllability; Flight Tests; Command Guidance; Roll; Data Bases

19970025413 National Defence Headquarters, Air Vehicles Research Sector, Ottawa, Ontario Canada
Development of a Tactical Helicopter Infrared Signature Suppression (IRSS) System
Sully, P. R., National Defence Headquarters, Canada; VanDam, D., Davis (W. R.) Engineering Ltd., Canada; Bird, J., Institute for Aerospace Research, Canada; Luisi, D., Department of National Defence, Canada; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The world-wide availability of increasingly sophisticated but light weight infrared missile systems is presenting a serious threat to tactical helicopters in regional and peace-keeping operations. Part of the response to this threat lies in reducing as much as possible the infra-red signature of these helicopters. This paper briefly describes the nature of the threat presented by such missiles. The design and development of countermeasures in the form of IR suppression systems to reduce the engine exhaust produced signature is detailed. The results of experimental investigations and trials completed to date are described, along with the estimated potential for improving survivability. Future programmes and plans are summarized.
Author
Helicopter Design; Countermeasures; Infrared Signatures; Infrared Suppression; Missiles; Aircraft Detection; Jet Exhaust

19970025414 Textron Bell Helicopter, Mirabel, Quebec Canada
Model 412 Composite Tailboom
Mussett, G., Textron Bell Helicopter, Canada; Fews, R., Textron Bell Helicopter, Canada; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Bell Helicopter Textron is developing a technology demonstrator in the form of a Composite Tailboom for the Model 412 and 212 helicopters, to potentially replace the existing metallic design. The composite tailboom has been designed for producibility and low cost whilst maintaining the capability to withstand the operating environment of the Model 412 and 212 helicopters. During the development of the tailboom, concurrent engineering philosophies were used so that manufacturing and tooling considerations were recognized in the design concept stage resulting in a very economical and producible design. Additionally the composite tailboom has been designed for fatigue with a high degree of redundancy in critical areas making it very tolerant to

in service damage.This has been proven by an extensive material qualification and structural test program at Bell Helicopter. The composite tailboom is scheduled for flight test and FAA certification in 1996.
Author
Bell Aircraft; Helicopters; Manufacturing; Helicopter Design; Flight Tests; Composite Materials; Aircraft Construction Materials; Tail Assemblies

19970025415 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Structures and Design, Stuttgart, Germany
Crash Resistant Composite Subfloor Structures for Helicopters
Johnson, A. F., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kindevater, C. M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Thuis, H. G. S. J., National Aerospace Lab., Netherlands; Wiggenraad, J. F. M., National Aerospace Lab., Netherlands; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper describes the application of composite materials to the design of crash resistant beam and frame elements for helicopter subfloor structures, and discusses alternative fabrication technologies for these structural elements. These elements require a dual function structural concept with load carrying capability under flight loads and energy absorption under crash loads. The realization of this dual function by innovative design with fibre reinforced composite materials is described. In order to utilize these lightweight structural concepts in helicopters, cost effective technologies for series production of composite components are required. The paper discusses three fabrication methods based on autoclave technology, resin transfer moulding (RTM) and thermoforming, taking a sine-wave floor beam as a demonstrator component for the technologies.
Author
Fiber Composites; Helicopter Design; Aircraft Structures; Structural Design; Composite Structures; Resin Transfer Molding; Crashworthiness; Fabrication; Aircraft Construction Materials; Floors

19970025416 Lockheed Martin Corp., Electronics and Missiles, Orlando, FL USA
Introduction of Beryllium Aluminum Castings in the RAH-66 Comanche EOSS Program
Seinberg, J. P., Lockheed Martin Corp., USA; Tetz, D. P., Lockheed Martin Corp., USA; Raftery, K. R., Nuclear Metals, Inc., USA; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Beryllium aluminum alloys, containing greater than 60 weight percent beryllium, are very attractive materials for lightweight and high-stiffness applications. However, due to the inherent problems associated with casting these alloys, processing of beryllium aluminum has generally been restricted to rolling and extrusion of pre-alloyed powder metal compacts. Nuclear Metals, Inc. (NMI), with technical and financial support from the Lockheed Martin Electronics and Missiles (LMEM) RAH-66 Comanche Electro-Optical Sensor System (EOSS) program, has recently developed a family of castable beryllium aluminum alloys suited for production using state-of-the-technology investment casting processes. These new alloys, identified as Beralcast(R), yield a fine grain homogenous microstructure with attractive mechanical, physical and thermal properties. The problems associated with producing beryllium aluminum castings, including molten metal reactivity and a wide solidification range, have been resolved by NMI and LMEM. As a result of the efforts to date, over fifty different Comanche EOSS components of various sizes and complexities will be produced using Beralcast(R) alloys. In certain cases, where designs are being modified to take full advantage of the Beralcast(R) properties, component weight savings of up to 50% over conventional materials can be achieved. Current focus is on the optimization of both casting and associated secondary support processes, material characterization, non-destructive testing, and cost reduction. Developmental program goals, over the next eighteen months, being addressed in a series of programs funded by NMI, LMEM and the Army Aviation Research and Development Center, will provide the technology for the fabrication of large, complex precision investment castings. As a result of these efforts, Beralcast(R) investment castings will be available in time to support the RAH-66 Comanche EOSS demonstration/validation (Dem/Val) flight hardware program.
Author
Beryllium Alloys; Aluminum Alloys; Casting; Fabrication; Helicopter Design; Aircraft Construction Materials; Metal Powder; Optical Measuring Instruments; Mechanical Properties; Helicopters

19970025418 Textron Bell Helicopter, Fort Worth, TX USA
Ducted Tail Rotor Designs for Rotorcraft and their Low Noise Features
Edwards, Bryan, Textron Bell Helicopter, USA; Andrews, Jim, Textron Bell Helicopter, USA; Rahnke, Chris, Textron Bell Helicopter, USA; Apr. 1997; 16p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

During the development of an advanced ducted tail rotor (DTR) design, a concentrated and successful effort was made to research and incorporate the low noise features of a DTR suitable for intermediate size rotorcraft. The design, whirl stand testing,

and flight evaluations of this DTR configuration are described. Results of noise testing are presented for multiple design configurations to study the parametric effects of blade spacing, tip shape, rotational speed, and inflow turbulence. The acoustic effects of each parameter are presented, and measured noise reductions are identified. Isolated model ducted-rotor configurations are described, leading to additive noise level reductions of more than ten decibels for the DTR design. Installed on a Bell Model 222U helicopter, the DTR reduces total noise during hover and forward flight by an average of 2 to 6 dBA compared to the Model 222U configured with a standard tail rotor. A dramatic improvement in sound quality was found in subjective comparison tests. The performance and handling qualities of the test helicopter with the DTR prove to be similar to those characterizing a standard tail rotor. Component loads are well within design limits. These design qualities are discussed and substantiating test data are presented.
Author
Helicopter Design; Rotary Wing Aircraft; Tail Rotors; Noise Reduction; Flight Tests; Bell Aircraft; Ducted Bodies; Structural Design

19970025419 Office National d'Etudes et de Recherches Aerospatiales, Direction des Structures, Paris, France
In-Flight Measurements and Prediction of Internal Noise of ECUREUIL Helicopter ***Mesures en vol et prevision du Bruit Interne d'un Helicoptere ECUREUIL***
Morvan, A., Office National d'Etudes et de Recherches Aerospatiales, France; David, J.-M., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1997; 8p; In French; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In order to characterize the potential sources of noise in a helicopter cabin and to validate a model of the cabin based on the SEA (Statistical Energy Analysis) method used as a predictive method, measurements were made by the ONERA Structures Department vibroacoustical team at EUROCOPTER FRANCE in Marignane while the SEA modeling was being carried out. Experimental equipment used in the single-engine helicopter ECUREUIL, data recording and analysis procedures are described and results are analyzed for different flight speeds. The SEA model of helicopter cabin is then presented and the way to take into account the different sources of excitation in this model. A model of aerodynamic excitation (due to turbulent boundary layer) is based on a simplified numerical approach. Finally, a comparison between measurements and computation for vibration response of structural parts and acoustical pressure in the cabin is presented.
Author
Helicopter Design; Noise Reduction; Aircraft Compartments; Aircraft Models; Noise Prediction (Aircraft); Flight Tests; Structural Vibration; Statistical Analysis

19970025420 Technische Hogeschool, Faculty of Aerospace Engineering, Delft, Netherlands
Upgrading of Classical Lifting-Line Theory to Obtain Accurate Flight Mechanical Helicopter Models: Improved Correction for Sweep Effects
vanHolten, T., Technische Hogeschool, Netherlands; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the usual analysis of the helicopter rotor, models and concepts are used which originate from classical lifting line theory. A theory, strictly valid for the analysis of straight high aspect ratio wings in steady flow. In the case of a helicopter rotor blade, the validity of these models is questionable since its sections encounter unsteady and yawed flow. Asymptotic theory shows how in this case more correct models may be synthesized. The present paper deals with an improved correction for the effect of sweep on the tilt of the rotor's tip path plane. Its application to a simple test case shows that the prediction of its lateral tilt is considerably affected. The new model for sweep effects might thus explain the often observed peak of the lateral tilt at small flight velocities.
Author
Helicopters; Rotors; Rotary Wings; Sweep Effect; Unsteady Flow; Rotor Blades; Rotor Aerodynamics; Asymptotic Series; Helicopter Design

19970025422 Army Aviation Systems Command, Aeroflightdynamics Directorate, Moffett Field, CA USA
An Empirical Correction Method for Improving Off-Axes Response Prediction in Component Type Flight Mechanics Helicopter Models
Mansur, M. Hossein, Army Aviation Systems Command, USA; Tischler, Mark B., Army Aviation Systems Command, USA; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Historically, component-type flight mechanics simulation models of helicopters have been unable to satisfactorily predict the roll response to pitch stick input and the pitch response to roll stick input off-axes responses. In the study presented here, simple first-order low-pass filtering of the elemental lift and drag forces was considered as a means of improving the correlation. The

method was applied to a blade-element model of the AH-64 Apache, and responses of the modified model were compared with flight data in hover and forward flight. Results indicate that significant improvement in the off-axes responses can be achieved in hover. In forward flight, however, the best correlation in the longitudinal and lateral off-axes responses required different values of the filter time constant for each axis. A compromise value was selected and was shown to result in good overall improvement in the off-axes responses. The paper describes both the method and the model used for its implementation, and presents results obtained at hover and in forward flight.
Author
AH-64 Helicopter; Aerodynamic Drag; Helicopter Control; Aircraft Models; Helicopter Design; Flight Control; Aerodynamics; Lift

19970025423 Politecnico di Torino, Dipt. di Ingegneria Aeronautica e Spaziale, Torino, Italy
Effect of Propulsion System Dynamics on Rotorcraft Aeromechanical Stability in Straight and Turning Flight
Guglieri, Giorgio, Politecnico di Torino, Italy; Celi, Roberto, Maryland Univ., USA; Quagliotti, Fulvia, Politecnico di Torino, Italy; Apr. 1997; 8p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years there has been growing interest in improving the fidelity of mathematical models of helicopter fight dynamics through a more accurate representation of the main rotor dynamics. The main objective of this paper is to study the effect of several parameters of the propulsion system on the aeromechanical characteristics of a hingeless rotor helicopter, both in straight flight and in coordinated turns. The effects of these parameters on the handling qualities of the aircraft will also be examined (pitch and roll frequency response).
Author
Propulsion; Propulsion System Performance; Rotary Wing Aircraft

19970025424 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
Aerodynamic and Acoustics of Rotorcraft: A Survey of the 75th Fluid Dynamics Panel Symposium, Berlin
Koerner, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pahlke, K., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 18p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A survey of the 75th Fluid Dynamics Panel Symposium is given. The paper concentrates on dynamic stall, experimental investigations on helicopter rotors, 3D aerodynamic prediction methods and acoustic prediction methods. CFD methods were applied to dynamic stall on oscillating airfoils. The agreement with experimental data is acceptable for light and medium stall if appropriate turbulence models are used and the transition is fixed. None of the methods was able to accurately predict deep dynamic stall. A large effort was spent for the investigation of the Blade Vortex Interaction (BVI) noise. New national and multi-national experimental campaigns were conducted. Several researchers worked on the development and validation of aerodynamic and acoustic prediction methods for BVI. The efficiency of Higher Harmonic Control and of Individual Blade Control inputs for the reduction of BVI noise were investigated. The blade vortex miss distance was found to be the most important parameter for BVI noise. Methods for the prediction of high speed impulsive noise have been developed and encouraging results were presented.
Author
Rotary Wing Aircraft; Acoustics; Aerodynamic Stalling; Conferences

19970025425 Westland Helicopters Ltd., Yeovil, UK
The Integrated Development of a Medium Lift Military/Civil Helicopter
Graham, J. P., Westland Helicopters Ltd., UK; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The EH industries EH101 medium sized rotorcraft is the first of its kind to achieve production status that has been designed from the outset as a vehicle able to meet, without significant compromise, all appropriate civil and military regulatory requirements. Now that the design and development programme is nearing completion it is an appropriate time to review the success of the joint civil/military programme strategies which were implemented by EH Industries from the outset and which have significantly shaped both the product of the programme (EH101) and the programme design process.
Author
Product Development; Military Helicopters

19970025426 Westland Helicopters Ltd., Advanced Projects Dept., Yeovil, UK

Compound Interest: A Dividend for the Future?

Humpherson, D. V., Westland Helicopters Ltd., UK; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper seeks to explore the application of thrust and lift compounding as a cost efficient development of the traditional helicopter. The principal deficiencies of the edgewise rotor are examined and the use of compounding to overcome these limitations and enhance rotorcraft capabilities, is developed. Potential missions suitable for the various types of compounding and the concept of a family of vehicles to cover a wide variety of applications are discussed. A possible technology demonstrator, based on a Lynx airframe and its build standard are described. Finally a list of overall conclusions are drawn.
Author

Rotary Wing Aircraft; Costs; Airframes; Product Development

19970025427 Sikorsky Aircraft, Trumbull, CT USA

RAH-66 Comanche Program Status

Linden, Arthur W., Sikorsky Aircraft, USA; Stieglitz, Martin H., Sikorsky Aircraft, USA; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In an era of ever changing threats and declining defense budgets, the U.S. Army strategy is to procure systems that incorporate new technology and that leverage existing battlefield systems to fix war fighting deficiencies. The RAH-66 Comanche exemplifies this strategy. Developed through an evolutionary series of analyses, simulations, tests and demonstrations, the Comanche weapon system integrates war fighting capability to provide battlefield overmatch, while minimizing the cost of ownership to the Army. Comanche is an integrated advanced weapons system designed to operate and survive on the combined arms digital battlefield. Its Low-Observable (LO) characteristics protect the element of surprise and reduce the detectability of the aircraft, thus increasing survivability. Comanche's advanced sensor suite provides the aircraft effective standoff while allowing it to remain undetected by the enemy and still operate within onboard armament system range. This capability allows the pilot to correctly identify targets and can effectively reduce fratricide under nonlinear operations. The Comanche's advanced digital communication system makes Comanche the targeting element for the Army's long-range advanced shooters like the Multiple Launch Rocket System (MLRS) and the Army Tactical Missile System (ATACMS). This paper provides an update to the development status of the RAH-66 Comanche helicopter. Section 2 reviews key technologies that form the heart of Comanche. Section 3 explains the Comanche design affords rapid deployability and low-cost supportability. The extensive use of simulation throughout Comanche development is described in Section 4. The success of the Comanche program rests in large part on the successful taswork that is integral to all program activities. Section 5 explains the Team Comanche approach. Finally, Section 6 describes the plan to field the Army's 21st century reconnaissance attack helicopter in 2006.
Author

Helicopters; Helicopter Performance; Design Analysis; Product Development; Low Cost

19970025429 Boeing Defense and Space Group, Helicopter Div., Philadelphia, PA USA

V-22 Technical Challenges

Glusman, Steven I., Boeing Defense and Space Group, USA; Hyland, Robert A., Boeing Defense and Space Group, USA; Marr, Roger L., ITT Corp., USA; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Bell-Boeing V-22 Osprey Tiltrotor is an unique aircraft capable of landing vertically like a helicopter, flying at speeds in excess of 300 KTAS like a turboprop, with the added feature of folding the rotor/wing for deployment from shipboard for US Navy/Marines operations. During the development of the V-22 and subsequent 1000+ hours of flight testing, many technical challenges were encountered and overcome. These challenges included aerodynamic characteristics of the wing, tail buffet, hover performance, hover downwash, structural loads limiting, vibration reduction, landing gear fatigue life, and control law design/Handling Qualities. This paper presents an overview of many of these challenges, discusses the techniques used to perform analysis and fight test, and presents results of the relevant portions of the test program.
Author

V-22 Aircraft; Aerodynamic Characteristics; Fatigue Life; Flight Tests

19970025430 Institute for Aerospace Research, Flight Research Lab., Ottawa, Ontario Canada

Cockpit Technologies Research at the Flight Research Laboratory of the National Research Council of Canada

Morgan, J. Murray, Institute for Aerospace Research, Canada; Baillie, Stewart W., Institute for Aerospace Research, Canada; Apr. 1997; 8p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Flight Research Laboratory of the Institute for Aerospace Research (FRL) has been involved, under the advice and with the support of the Department of Defence Chief of Research and Development, in examining the use of current and emerging technologies in the helicopter cockpit, and examinations of how these can be used to reduce pilot workload or improve situational awareness for the crew. This paper will describe work at the pilot/machine interface, rather than manipulation of the machine itself. Three on-going segments of this program will be described, Direct Voice Input, Helmet Mounted Displays and advanced Head Down Displays.
Author
Helicopters; Cockpits; Helmet Mounted Displays; Head-Up Displays

19970025434 Auburn Univ., Adaptive Aerostructures Lab., AL USA
The Solid State Adaptive Rotor: Design, Development and Implications for Future Rotorcraft
Barrett, Ron, Auburn Univ., USA; Stutts, James, Auburn Univ., USA; Apr. 1997; 8p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years, numerous studies have been centered on a novel class of materials which are capable of changing their shapes, imparting forces and generating moments as a function of applied electrical signals. This study is centered on one application of these 'adaptive' materials to achieve rotor flight control. A pair of twist-active directionally attached piezoelectric (DAP) torque-plates constructed from PZT-5H piezoceramic sheets laid up on an aluminum substrate were bonded rigidly to a rotor shaft.
Derived from text
Solid State; Rotors; Rotary Wing Aircraft; Piezoelectricity; Piezoelectric Ceramics

19970025518 Army Aviation Systems Command, Aeroflightdynamics Directorate, Hampton, VA USA
Rotor-Fuselage Interaction: Analysis and Validation with Experiment
Berry, John D., Army Aviation Systems Command, USA; Bettschart, Nicolas, Office National d'Etudes et de Recherches Aerospatiales, France; May 1997; 27p; In English; 53rd; American Helicopter Society Annual Forum, 29 Apr. - 1 May 1997, Virginia Beach, VA, USA
Contract(s)/Grant(s): RTOP-581-10-11-01
Report No.(s): NASA-TM-112859; ATCOM-TR-97-A-007; NAS 1.15:112859; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The problem of rotor-fuselage aerodynamic interaction has to be considered in industry applications from various aspects. First, in order to increase helicopter speed and reduce operational costs, rotorcraft tend to be more and more compact, with a main rotor closer to the fuselage surface. This creates significant perturbations both on the main rotor and on the fuselage, including steady and unsteady effects due to blade and wake passage and perturbed inflow at the rotor disk. Furthermore,the main rotor wake affects the tail boom, empennage and anti-torque system. This has important consequences for helicopter control and vibrations at low speeds and also on tail rotor acoustics (main rotor wake-tail rotor interactions). This report describes the US Army-France MOD cooperative work on this problem from both the theoretical and experimental aspects. Using experimental 3D velocity field and fuselage surface pressure measurements, three codes that model the interactions of a helicopter rotor with a fuselage are compared. These comparisons demonstrate some of the strengths and weaknesses of current models for the combined rotor-fuselage analysis.
Author
Rotary Wing Aircraft; Fuselages; Interactional Aerodynamics; Experimentation; Proving

19970025525 Defence Science and Technology Organisation, Airframes and Engines Div., Canberra, Australia
Static and Fatigue Test Loading Development for an F-111 Bonded Composite Repair Substantiation
Walker, K., Defence Science and Technology Organisation, Australia; Swanton, G., Defence Science and Technology Organisation, Australia; Nov. 1996; 24p; In English
Report No.(s): AD-A324136; DSTO-TN-0063; DODA-AR-009-918; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Substantiation of a bonded composite repair to an F-111 lower wing skin required the development of representative loads for specimen testing. This report describes the development of representative static and fatigue spectrum loads to be applied during the testing. The spectrum was based on a known representative Wing Pivot Bending Moment spectrum. Full scale static wing testing and the manufacturer's original stress analysis reports were used to convert this spectrum to be representative of the stress at the region of interest in the outboard section of the lower wing skin. The spectrum (representing 199 flights or 499.1 flying hours) was expressed in both blocked and cycle by cycle form. Truncation was performed to reduce the total number of cycles to a manageable level and this was evaluated both analytically (for the blocked spectrum) and experimentally (for the cycle by

cycle spectrum) to ensure that damaging cycles were retained. The blocked spectrum was found to give highly conservative results and this approach is recommended only where no further information about the cycle history is known. The implications of the present results for realistic spectrum truncation are briefly discussed.
DTIC
Static Tests; Fatigue Tests; F-111 Aircraft; Stress Analysis; Airframes; Wings; Epoxy Matrix Composites; Aircraft Maintenance

19970025627 Defence Science and Technology Organisation, Airframes and Engines Div., Canberra, Australia
A Validated Finite Element Model of an F-111 Lower Wing Skin Structural Detail at Forward Auxilliary Spar Station (FASS) 281.28
Keeley, D., Defence Science and Technology Organisation, Australia; Callinan, R., Defence Science and Technology Organisation, Australia; Sanderson, S., Defence Science and Technology Organisation, Australia; Jun. 1996; 35p; In English
Report No.(s): AD-A324121; DSTO-TN-0046; DODA-AR-009-759; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report describes an AMRL developed and validated Finite Element model of the F-111A lower wing skin (Serial Number A-10-824) at Forward Auxiliary Spar Station (FASS) 281.28 and constitutes part of an extensive AMRL bonded composite repair substantiation program initiated by the RAAF following the discovery of fatigue cracking at FASS 281.28 in an F-111C aircraft Strain data from the FE model is compared with measured strain gauge data from an F-111A static test wing under Cold Proof Loading Test (CPLT) or limit conditions. A relationship between nominal section stress at FASS 281.28 and local bending moment is established. The FE model will be further developed to include the fatigue crack, the adhesive and the boron epoxy patch.
DTIC
Structural Analysis; Mathematical Models; Finite Element Method; F-111 Aircraft; Wings; Fatigue (Materials); Wing Loading; Aircraft Maintenance; Composite Materials; Cracks

19970025636 Defence Science and Technology Organisation, Airframes and Engines Div., Canberra, 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): AD-A324123; DSTO-TR-0336; DODA-AR-009-697; No Copyright; Avail: CASI; A04, Hardcopy; A01, 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 system, its installation and operation, and the results of a flight trial conducted by the RAAF Aircraft Research and Development Unit.
DTIC
Aircraft Equipment; Flight Tests; Accelerometers; Vibration; Helicopters; Transmissions (Machine Elements)

19970025702 Defence Science and Technology Organisation, Air Operations Div., Canberra, Australia
Australian Airborne Trials of the Sikorsky S-70B-2 Helicopter, Part 1, Performance Measurements
Arney, A. M., Defence Science and Technology Organisation, Australia; Fieldhouse, I., Defence Science and Technology Organisation, Australia; Jan. 1997; 73p; In English
Report No.(s): AD-A324116; DSTO-TR-0463-Pt-1; DODA-AR-009-955-Pt-1; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Airborne tests have been conducted using an instrumented Sikorsky S-7OB-2 helicopter. These tests were flown by a Royal Australian Navy Test Pilot and were primarily aimed at establishing limits for the S-7OB-2 when operating from an
DTIC
Helicopters; Flight Tests; Helicopter Design; Aircraft Instruments

19970025711 Defence Science and Technology Organisation, Airframes and Engines Div., Canberra, Australia
The Static Testing of a Lockheed P-3 Orion Wing Leading Edge Centre Section
Wong, Albert K., Defence Science and Technology Organisation, Australia; Luke, Glenn, Defence Science and Technology Organisation, Australia; Nov. 1996; 80p; In English
Report No.(s): AD-A324110; DSTO-TR-0423; DODA-AR-009-899; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report documents the design of the test rig and the results of the static test of the Lockheed P-3 Orion Wing Leading Edge centre section structure. The test comprised of two parts, viz., the validation of the structural integrity of the structure under design load conditions, and the determination of the static strength of the structure for the local transonic flight regime within which the RAAF Orion A9-754 had evidently failed. The test clearly showed that the structure meets its design specifications and had an adequate margin of safety even for the high speed regime. However, it is pointed out that this margin can be quickly eroded if the material thickness is below specification, as was reported for the case of Orion A9-754, and it is recommended that this aspect be investigated for the RAAF Orion fleet.
DTIC
Leading Edges; Static Tests; P-3 Aircraft; Aircraft Design; Transonic Flight; Structural Design; Wings

06
AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

19970025167 NASA Lewis Research Center, Cleveland, OH USA
Microfabricated Ice-Detection Sensor
DeAnna, Russell G., Army Research Lab., USA; Mehregany, Mehran, Case Western Reserve Univ., USA; Roy, Shuvo, Case Western Reserve Univ., USA; Zakar, Eugene, Army Research Lab., USA; Jun. 1997; 14p; In English; Smart Structures and Materials, 2-6 Mar. 1997, San Diego, CA, USA; Sponsored by International Society for Optical Engineering, USA
Contract(s)/Grant(s): DAAL03-91-C-0034; DAAH04-95-10097; RTOP 523-26-13; DA Proj. 1L1-61102-AH-45
Report No.(s): NASA-TM-107432; NAS 1.15:107432; ARL-TR-1355; E-10690; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Knowledge of ice conditions on important aircraft lift and control surfaces is critical for safe operation. These conditions can be determined with conventional ice-detection sensors, but these sensors are often expensive, require elaborate installation procedures, and interrupt the airflow. A micromachined, silicon-based, flush-mounted sensor which generates no internal heat has been designed, batch fabricated, packaged, and tested. The sensor is capable of distinguishing between an ice-covered and a clean surface. It employs a bulk micromachined wafer with a 7 micrometer-thick, boron-doped, silicon diaphragm which serves as one plate of a parallel-plate capacitor. This is bonded to a second silicon wafer which contains the fixed electrodes, one to drive the diaphragm by application of a voltage, the other to measure the deflection by a change in capacitance. The diaphragm sizes ranged from 1x1 mm to 3x3 mm, and the gap between parallel-plate capacitors is 2 micrometers. A 200 V d.c. was applied to the driving electrode which caused the capacitance to increase approximately 0.6pf, from a nominal capacitance of 0.6pf, when the surface was ice free. After the sensor was cooled below the freezing point of water, the same voltage range was applied to the drive electrode. The capacitance increased by the same amount. Then a drop of water was placed over the diaphragm and allowed to freeze. This created an approximately 2mm-thick ice layer. The applied 200V d.c. produced no change in capacitance, confirming that the diaphragm was locked to the ice layer. Since the sensor uses capacitive actuation, it uses very little power and is an ideal candidate for inclusion in a wireless sensing system.
Author
Ice; Control Surfaces; Lift; Freezing; Air Flow; Sensors; Wafers; Detection

19970025207 Texas A&M Univ., College Station, TX USA
Automated Safety and Training Avionics for General Aviation Aircraft
Trang, Jeffrey A., Texas A&M Univ., USA; May 1997; 180p; In English
Report No.(s): AD-A324504; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

The past decade has seen the U.S. general aviation community plagued by substantial cost increases while operating in an increasingly complex and crowded air traffic control structure. Unfortunately, there has been a corresponding rise in accident rates involving these aircraft. In an attempt to improve safety factors and training programs for this aviation sector, researchers at Texas A&M University are investigating 'smart cockpit systems.' This research program is titled Automated Safety and Training Avionics (ASTRA). ASTRA research is focused on integrating low cost, yet sophisticated, computing technology into general aviation aircraft. The system architecture includes a Flight Mode Interpreter (FMI), which provides real time identification of the aircraft operational maneuvering mode, through interpretation by fuzzy logic of aircraft state variables. This inference controls a Head Up Display to automatically present a unique display format appropriate to the operational situation. The FMI also drives a rule based Pilot Advisor for generation of alarms and piloting advice. The pilot communicates with ASTRA through the Head-Down

Display (HDD), which is configured similarly to the Multi-Function Displays found in many 'glass cockpit' aircraft. This configuration permits the pilot to readily access, edit, and display a wide variety of information.
DTIC
Safety Factors; Training Devices; Flight Training; Aircraft Maneuvers; Maneuverability

19970025633 NASA Dryden Flight Research Center, Edwards, CA USA
Comparative Optical Measurements of Airspeed and Aerosols on a DC-8 Aircraft
Bogue, Rodney, NASA Dryden Flight Research Center, USA; McGann, Rick, Boeing Defense and Space Group, USA; Wagener, Thomas, Honeywell Systems and Research Center, USA; Abbiss, John, Singular Systems, USA; Smart, Anthony, Titan Spectron Div., USA; Jul. 1997, pp. 1-24; In English; 16th; International Congress on Instrumentation in Aerospace Simulation Facilities, 17-21 Jul. 1995, Dayton, OH, USA
Contract(s)/Grant(s): RTOP 529-50-24
Report No.(s): NASA-TM-113083; NAS 1.15:113083; H-2189; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

NASA Dryden supported a cooperative flight test program on the NASA DC-8 aircraft in November 1993. This program evaluated optical airspeed and aerosol measurement techniques. Three brassboard optical systems were tested. Two were laser Doppler systems designed to measure free-stream-referenced airspeed. The third system was designed to characterize the natural aerosol statistics and airspeed. These systems relied on optical backscatter from natural aerosols for operation. The DC-8 aircraft carried instrumentation that provided real-time flight situation information and reference data on the aerosol environment. This test is believed to be the first to include multiple optical airspeed systems on the same carrier aircraft, so performance could be directly compared. During 23 hr of flight, a broad range of atmospheric conditions was encountered, including aerosol-rich layers, visible clouds, and unusually clean (aerosol-poor) regions. Substantial amounts of data were obtained. Important insights regarding the use of laser-based systems of this type in an aircraft environment were gained. This paper describes the sensors used and flight operations conducted to support the experiments. The paper also briefly describes the general results of the experiments.
Author
Aerosols; Airspeed; Flight Tests; DC 8 Aircraft; Optical Measurement; Aircraft Performance

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.

19970025153 NASA Lewis Research Center, Cleveland, OH USA
Nonlinear Performance Seeking Control using Fuzzy Model Reference Learning Control and the Method of Steepest Descent
Kopasakis, George, NASA Lewis Research Center, USA; May 1997; 12p; In English; 33rd; Jet Propulsion, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 538-06-AR
Report No.(s): NASA-TM-107454; NAS 1.15:107454; E-10739; AIAA Paper 97-3362; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Performance Seeking Control (PSC) attempts to find and control the process at the operating condition that will generate maximum performance. In this paper a nonlinear multivariable PSC methodology will be developed, utilizing the Fuzzy Model Reference Learning Control (FMRLC) and the method of Steepest Descent or Gradient (SDG). This PSC control methodology employs the SDG method to find the operating condition that will generate maximum performance. This operating condition is in turn passed to the FMRLC controller as a set point for the control of the process. The conventional SDG algorithm is modified in this paper in order for convergence to occur monotonically. For the FMRLC control, the conventional fuzzy model reference learning control methodology is utilized, with guidelines generated here for effective tuning of the FMRLC controller.
Author
Controllers; Algorithms; Gradients; Convergence; Steepest Descent Method; Fuzzy Systems

19970025160 NASA Lewis Research Center, Cleveland, OH USA
Aerodynamic Synthesis of a Centrifugal Impeller Using CFD and Measurements
Larosiliere, L. M., Army Research Lab., USA; Skoch, G. J., Army Research Lab., USA; Prahst, P. S., NYMA, Inc., USA; Jul. 1997; 28p; In English; 33rd; Joint Propulsion Conference and Exhibit, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American

Inst. of Aeronautics and Astronautics, USA; Original contains color illustrations
Contract(s)/Grant(s): RTOP 523-22-13
Report No.(s): NASA-TM-107515; NAS 1.15:107515; E-10818; AIAA Paper 97-2878; ARL-TR-1461; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The performance and flow structure in an unshrouded impeller of approximately 4:1 pressure ratio is synthesized on the basis of a detailed analysis of 3D viscous CFD results and aerodynamic measurements. A good data match was obtained between CFD and measurements using laser anemometry and pneumatic probes. This solidified the role of the CFD model as a reliable representation of the impeller internal flow structure and integrated performance. Results are presented showing the loss production and secondary flow structure in the impeller. The results indicate that while the overall impeller efficiency is high, the impeller shroud static pressure recovery potential is underdeveloped leading to a performance degradation in the downstream diffusing element. Thus, a case is made for a follow-on impeller parametric design study to improve the flow quality. A strategy for aerodynamic performance enhancement is outlined and an estimate of the gain in overall impeller efficiency that might be realized through improvements to the relative diffusion process is provided.
Author
Aerodynamic Characteristics; Impellers; Computational Fluid Dynamics; Laser Anemometers; Internal Flow; Secondary Flow

19970025199 National Academy of Sciences - National Research Council, Cleveland, OH USA
Numerical Study of Stratified Charge Combustion in Wave Rotors
Nalim, M. Razi, National Academy of Sciences - National Research Council, USA; Jul. 1997; 16p; In English; 33rd; Joint Propulsion Conference and Exhibit, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 505-26-33
Report No.(s): NASA-TM-107513; AIAA Paper 97-3141; E-10815; NAS 1.15:107513; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A wave rotor may be used as a pressure-gain combustor effecting non-steady flow, and intermittent, confined combustion to enhance gas turbine engine performance. It will be more compact and probably lighter than an equivalent pressure-exchange wave rotor, yet will have similar thermodynamic and mechanical characteristics. Because the allowable turbine blade temperature limits overall fuel/air ratio to sub-flammable values, premixed stratification techniques are necessary to burn hydrocarbon fuels in small engines with compressor discharge temperature well below autoignition conditions. One-dimensional, unsteady numerical simulations of stratified-charge combustion are performed using an eddy-diffusivity turbulence model and a simple reaction model incorporating a flammability limit temperature. For good combustion efficiency, a stratification strategy is developed which concentrates fuel at the leading and trailing edges of the inlet port. Rotor and exhaust temperature profiles and performance predictions are presented at three representative operating conditions of the engine: full design load, 40% load, and idle. The results indicate that peak local gas temperatures will result in excessive temperatures within the rotor housing unless additional cooling methods are used. The rotor itself will have acceptable temperatures, but the pattern factor presented to the turbine may be of concern, depending on exhaust duct design and duct-rotor interaction.
Author
Gas Turbine Engines; Flammability; Turbulence Models; Computational Fluid Dynamics; Combustion Chambers; Temperature Profiles; Performance Prediction; Rotors; Turbulent Combustion; Channel Flow

19970025214 NYMA, Inc., Brook Park, OH USA
Design of the NASA Lewis 4-Port Wave Rotor Experiment
Wilson, Jack, NYMA, Inc., USA; Jun. 1997; 10p; In English; 33rd; Joint Propulsion Conference, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAS3-27186; RTOP 505-26-33
Report No.(s): NASA-CR-202351; AIAA Paper 97-3139; E-10774; NAS 1.26:202351; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Pressure exchange wave rotors, used in a topping stage, are currently being considered as a possible means of increasing the specific power, and reducing the specific fuel consumption of gas turbine engines. Despite this interest, there is very little information on the performance of a wave rotor operating on the cycle (i.e., set of waves) appropriate for use in a topping stage. One such cycle, which has the advantage of being relatively easy to incorporate into an engine, is the four-port cycle. Consequently, an experiment to measure the performance of a four-port wave rotor for temperature ratios relevant to application as a topping cycle

for a gas turbine engine has been designed and built at NASA Lewis. The design of the wave rotor is described, together with the constraints on the experiment.
Author
Rotors; Experiment Design

19970025512 NASA Lewis Research Center, Cleveland, OH USA
Adaptive Performance Seeking Control Using Fuzzy Model Reference Learning Control and Positive Gradient Control
Kopasakis, George, NASA Lewis Research Center, USA; May 1997; 12p; In English; 33rd; Joint Propulsion, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 538-06-AR
Report No.(s): NASA-TM-107455; AIAA Paper 97-3191; E-10740; NAS 1.15:107455; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Performance Seeking Control attempts to find the operating condition that will generate optimal performance and control the plant at that operating condition. In this paper a nonlinear multivariable Adaptive Performance Seeking Control (APSC) methodology will be developed and it will be demonstrated on a nonlinear system. The APSC is comprised of the Positive Gradient Control (PGC) and the Fuzzy Model Reference Learning Control (FMRLC). The PGC computes the positive gradients of the desired performance function with respect to the control inputs in order to drive the plant set points to the operating point that will produce optimal performance. The PGC approach will be derived in this paper. The feedback control of the plant is performed by the FMRLC. For the FMRLC, the conventional fuzzy model reference learning control methodology is utilized, with guidelines generated here for the effective tuning of the FMRLC controller.
Author
Adaptive Control; Fuzzy Systems; Gradients; Optimal Control; Multivariable Control; Nonlinear Systems

19970025571 NASA Lewis Research Center, Cleveland, OH USA
Joint US/Russia TU-144 Engine Ground Tests
Acosta, Waldo A., Army Research Lab., USA; Balser, Jeffrey S., NASA Lewis Research Center, USA; McCartney, Timothy P., NASA Lewis Research Center, USA; Richter, Charles A., NASA Lewis Research Center, USA; Woike, Mark R., NASA Lewis Research Center, USA; Jun. 1997; 42p; In English; 33rd; Joint Propulsion Conference and Exhibit, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Original contains color illustrations
Contract(s)/Grant(s): RTOP 537-05-22
Report No.(s): NASA-TM-107516; NAS 1.15:107516; E-10820; ARL-TR-1390; AIAA Paper 97-2928; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Two engine research experiments were recently completed in Moscow, Russia using an engine from the TU-144 supersonic transport airplane. This was a joint project between the USA and Russia. Personnel from the NASA Lewis Research Center, General Electric Aircraft Engines, Pratt & Whitney, the Tupolev Design Bureau, and EBP Aircraft LTD worked together as a team to overcome the many technical and cultural challenges. The objective was to obtain large scale inlet data that could be used in the development of a supersonic inlet system for a future High Speed Civil Transport (HSCT). The-first experiment studied the impact of typical inlet structures that have trailing edges in close proximity to the inlet/engine interface plane on the flow characteristics at that plane. The inlet structure simulated the subsonic diffuser of a supersonic inlet using a bifurcated splitter design. The centerbody maximum diameter was designed to permit choking and slightly supercritical operation. The second experiment measured the reflective characteristics of the engine face to incoming perturbations of pressure amplitude. The basic test rig from the first experiment was used with a longer spacer equipped with fast actuated doors. All the objectives set forth at the beginning of the project were met.
Author
Aircraft Engines; Engine Tests; Flow Characteristics; Supersonic Inlets; Supersonic Transports; TU-144 Aircraft

19970025575 Southwest Research Inst., Army TARDEC Fuels and Lubricants Research Facility, San Antonio, TX USA
Thermal Stability of Jet Fuels: Kinetics of Forming Deposit Precursors
Naegeli, David W., Southwest Research Inst., USA; Jun. 1997; 50p; In English
Contract(s)/Grant(s): NAG3-1739; RTOP 538-06-12
Report No.(s): NASA-CR-202340; NAS 1.26:202340; E-10720; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The focus of this study was on the autoxidation kinetics of deposit precursor formation in jet fuels. The objectives were: (1) to demonstrate that laser-induced fluorescence is a viable kinetic tool for measuring rates of deposit precursor formation in jet fuels; (2) to determine global rate expressions for the formation of thermal deposit precursors in jet fuels; and (3) to better under-

stand the chemical mechanism of thermal stability. The fuels were isothermally stressed in small glass ampules in the 120 to 180 C range. Concentrations of deposit precursor, hydroperoxide and oxygen consumption were measured over time in the thermally stressed fuels. Deposit precursors were measured using laser-induced fluorescence (LIF), hydroperoxides using a spectrophotometric technique, and oxygen consumption by the pressure loss in the ampule. The expressions, I.P. = 1.278 x 10(exp -11)exp(28,517.9/RT) and R(sub dp) = 2.382 x 10(exp 17)exp(-34,369.2/RT) for the induction period, I.P. and rate of deposit precursor formation R(sub dp), were determined for Jet A fuel. The results of the study support a new theory of deposit formation in jet fuels, which suggest that acid catalyzed ionic reactions compete with free radical reactions to form deposit precursors. The results indicate that deposit precursors form only when aromatics are present in the fuel. Traces of sulfur reduce the rate of autoxidation but increase the yield of deposit precursor. Free radical chemistry is responsible for hydroperoxide formation and the oxidation of sulfur compounds to sulfonic acids. Phenols are then formed by the acid catalyzed decomposition of benzylic hydroperoxides, and deposit precursors are produced by the reaction of phenols with aldehydes, which forms a polymer similar to Bakelite. Deposit precursors appear to have a phenolic resin-like structure because the LIF spectra of the deposit precursors were similar to that of phenolic resin dissolved in TAM.
Author
Jet Engine Fuels; Thermal Stability; Deposits; Isothermal Processes; Laser Induced Fluorescence; Reaction Kinetics; Spectrophotometry

19970025576 NASA Lewis Research Center, Cleveland, OH USA
Combustion Noise at Elevated Pressures in a Liquid-Fueled Premixed Combustor
Darling, Douglas, NASA Lewis Research Center, USA; Radhakrishnan, Krishnan, NYMA, Inc., USA; Oyediran, Ayo, AYT Corp., USA; Jun. 1997; 10p; In English; Turbo-Expo 1997, 2-5 Jun. 1997, Orlando, FL, USA; Sponsored by American Society of Mechanical Engineers, USA
Contract(s)/Grant(s): RTOP 537-02-21
Report No.(s): NASA-TM-107481; NAS 1.15:107481; E-10773; ASME-97-GT-308; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Noise generated in gas turbine combustors can exist in several forms-broadband noise, sharp resonant peaks, and regular or intermittent nonlinear pulsing. In the present study, dynamic pressure measurements were made in several JP-5-fueled combustor configurations, at various mean pressures and temperatures. The fluctuating pressure was measured at mean pressures from 6 to 14 atm and inlet temperatures from 550 K to 850 K. The goal of the present work was to study the effect of changes in mean flow conditions on combustor noise: both broadband noise and sharp tones were considered. In general, the shape of the broadband noise spectrum was consistent from one configuration to another. The shape of the spectrum was influenced by the acoustic filtering of the combustion zone. This filtering ensured the basic consistency of the spectra. In general, the trends in broadband noise observed at low mean pressures were also seen at high mean pressures; that is, the total sound level decreased with both increasing equivalence ratio and increasing inlet temperature. The combustor configurations without a central pilot experienced higher broadband noise levels and were more susceptible to narrow peak resonances than configurations with a central pilot. The sharp peaks were more sensitive to the mean flow than was the broadband noise, and the effects were not always the same. In some situations, increasing the equivalence ratio made the sharp peaks grow, while at other conditions, increasing the equivalence ratio made the sharp peaks shrink. Thus, it was difficult to predict when resonances would occur; however, they were reproducible. Acoustic coupling between the upstream and downstream regions of the combustor may play a role in the sharp-peaked oscillations. Noise was also observed near lean blow out. As with other types of noise, lean blow out noise was affected by the combustion chamber acoustics, which apparently maintains the fluctuations at a uniform frequency. However, the actual conditions when this type of noise was experienced appeared to simply follow the lean blow out limit as it varied with mean temperature and pressure.
Author
Combustion Stability; Combustion; Broadband; Gas Turbines; Premixing

19970025615 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Numerical Analysis of Two and Three Dimensional Recessed Flame Holders for Scramjet Applications
Davis, Douglas L., Air Force Inst. of Tech., USA; Sep. 1996; 239p; In English; Sponsored in part by the Dayton Area Graduate Schools Inst.
Report No.(s): AD-A324246; AFIT/DS/ENY/96-12; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

This study investigated the flame holding properties of recessed cavities in supersonic flow using numerical analysis techniques. A simplified analytical model indicated that an important property for flame holding was the lower residence time. Several chemical kinetic rate models for hydrogen and hydrocarbon combustion were compared. The perfectly stirred reactor model also indicated that trace species diffusion should increase flame spreading rate, and that heat loss reduces flame holding limits. After

nonreacting calibration, two-dimensional simulations confirmed the perfectly stirred reactor results for blowout limits. Also, the effect of trace species diffusion on flame spreading was shown to be negligible, and the reduced flammability with heat loss was confirmed. Lowering the temperature of the inflow boundary layer was shown to reduce the flammability limits. Three-dimensional cavities were shown to generate axial vorticity and slightly enhance flame spreading. The methodology developed in this research provides a design guide for the size of cavity required to provide flame holding for a scramjet combustor. Also, reduction of heat losses was shown to be a method to improve flame holding performance without increasing the cavity size.
DTIC
Supersonic Combustion Ramjet Engines; Flame Holders; Numerical Analysis; Mathematical Models; Two Dimensional Models; Three Dimensional Models

19970025646 NYMA, Inc., Brook Park, OH USA
IPAC-Inlet Performance Analysis Code ***Final Report***
Barnhart, Paul J., NYMA, Inc., USA; Jul. 1997; 168p; In English
Contract(s)/Grant(s): NAS3-27186; RTOP 522-41-43
Report No.(s): NASA-CR-204130; NAS 1.26:204130; E-10800; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche
A series of analyses have been developed which permit the calculation of the performance of common inlet designs. The methods presented are useful for determining the inlet weight flows, total pressure recovery, and aerodynamic drag coefficients for given inlet geometric designs. Limited geometric input data is required to use this inlet performance prediction methodology. The analyses presented here may also be used to perform inlet preliminary design studies. The calculated inlet performance parameters may be used in subsequent engine cycle analyses or installed engine performance calculations for existing uninstalled engine data.
Author
Aerodynamic Drag; Pressure Recovery; Inlet Flow; Engine Inlets; Reliability Analysis; Aerodynamic Coefficients

19970025648 NASA Lewis Research Center, Cleveland, OH USA
An Overview of Three Approaches to Multidisciplinary Aeropropulsion Simulations
Lawrence, Charles, NASA Lewis Research Center, USA; May 1997; 14p; In English; Supported in part by General Electric AE & CRD, and Allied Signal Aircraft Engines
Contract(s)/Grant(s): RTOP 509-10-11
Report No.(s): NASA-TM-107443; NAS 1.15:107443; E-10713; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
The broad scope of aeropropulsion multidisciplinary applications necessitates that a collection of approaches, with distinct capabilities, be developed. Three general approaches to multidisciplinary simulations have been identified. The three approaches; loosely coupled, coupled process, and multiphysics, provide a comprehensive collection of capabilities for multidisciplinary aeropropulsion analysis. At the data access level, or loosely coupled approach of coupling, existing disciplinary simulations are run, data is generated, and made available and used for subsequent analysis. The data must be in the correct format for implementation by the subsequent analysis but the subsequent code need not directly communicate with the previous code. At the process level, or coupled process approach of coupling, individual disciplinary codes are used, similarly to the loosely coupled approach, however, in the coupled process approach the disciplinary codes need to run concurrently with each other. The system of equation coupled approach, or multiphysics approach, addresses those applications whose characteristics require that the disciplines be coupled at the fundamental equation level to accurately, or more efficiently, capture the multidisciplinary physics of the problem. No one of these approaches, by itself, addresses all of the community needs in this area. However, collectively the three approaches encompass all of the multidisciplinary applications which have been identified thus far. Multiple approaches to multidisciplinary simulations will be needed as long as the applications and their requirements remain as diverse as they currently are today.
Author
Aircraft; Aerodynamics; Propulsion

19970025652 NASA Lewis Research Center, Cleveland, OH USA
JTAGG II Brush Seal Test Results
Arora, Gul K., Garrett Turbine Engine Co., USA; Proctor, Margaret P., NASA Lewis Research Center, USA; Jul. 1997; 18p; In English; 33rd; Joint Propulsion, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 242-70-0J; DA Proj. 1L1-61102-AH-45; DA Proj. 1L1-62211-A-47-A
Report No.(s): NASA-TM-107448; AIAA Paper 97-2632; ARL-TR-1397; E-10725; NAS 1.15:107448; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Tri-services JTAGG 2 engine uses two identical brush seals, in tandem, located aft of the high pressure compressor. The engine operating conditions, at intermediate rated power (IRP), for this seal are estimated to be 50,000 rpm (899 ft/sec) speed, 175 psid air to air pressure differential and 1200 F air temperature. The testing was comprised of static air leakage, performance, seal offset, rotor run out tests and a 50 hr endurance test in the NASA Lewis seal rig. Based on the test results, it is concluded that the brush seal design should be able to meet the air leakage flow factor goal of less than 0.004 for the engine IRP operating conditions. For the 4.12 in. i.d. labyrinth seal, 0.005 in. typical radial clearance, at the JTAGG 2 operating conditions, the leakage flow factor is 0.007. The long term seal life can not be predicted accurately due to the limited endurance testing of 50 hr. However, based on the excellent condition of the test seal and rotor after 50 hr of testing, it is anticipated that the seals should easily meet the JTAGG 2 engine test requirement.
Author
Brush Seals; High Pressure; Engine Tests; Air Flow; Compressors; Leakage

08
AIRCRAFT STABILITY AND CONTROL

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

19970025365 Alaska Univ., Aviation Technology Dept., Anchorage, AK USA
Verification of Fault Tolerant Design of Flight Critical Digital Systems
Miller, Thomas P., Alaska Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 83; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

Many design and manufacturing procedures are currently employed to avoid the introduction of hardware and software faults into flight critical digital systems. These are followed by analyses designed to determine the level of risk of system failure and assure that it falls below a given threshold. During design, construction and analysis there are many assumptions made regarding the probability of arrival and the severity of effects of many types of internal and external disturbances. These assumptions must be tested in order to truly determine the level of risk associated with flight control using these systems. Since the operational state space is so large there is no way to test every parameter during every conceivable environmental condition. Laboratory tests are therefore directed to investigate given classes of disturbances on realistically modeled full systems that are identified as likely threats by system analyses and operational data. These tests should be supplemented by a much improved and expanded flight and ground operations data base that is suitable for extended analysis. Among these methods assumptions can be verified, confidence can be built in these systems, and developmental needs can be clearly identified. The Assessment Technology Branch of the Flight Electronics Technology Division has experts in both hardware and software for airborne applications who promote design methods that avoid faulty implementation of desired system behaviors, and who test existing airborne digital equipment in harsh operating environments. The goals of this research is to characterize conditions that cause upset of critical systems and to determine the effectiveness of design or operational methods employed to eliminate them, and to identify new or more capable methods to assure system integrity.
Author
Airborne Equipment; Applications Programs (Computers); Computer Programs; Fault Tolerance

19970025431 Westland Helicopters Ltd., Avionics and Systems Technology, Yeovil, UK
Advances in Helicopter Carefree Handling and Control Augmentation
Massey, C. P., Westland Helicopters Ltd., UK; Howitt, J., Defence Research Agency, UK; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes research being undertaken by GKN Westland Helicopters and the UK Defence Research Agency (DRA) to examine enhanced augmentation of helicopter flight control systems. Current research is targeted at mechanical primary flight control systems with limited authority automatic flight control systems (AFCS) with a view towards early application as a retrofit to in-service helicopters or new versions of existing helicopters.
Author
Helicopter Control; Helicopters; Automatic Flight Control; Flight Control

19970025432 Eurocopter France, Marignane, France
Active Control of Aeromechanical Stability
Krysinski, Tomasz, Eurocopter France, France; Apr. 1997; 26p; In English; Also announced as 19970025403; Copyright Waived;

Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents the active control of aeromechanical stability as a powerful means of simplifying rotor design in future helicopters. The mathematical simulation model is presented and the results are compared to flight test data. The active control of ground resonance was fully validated with flight tests in the Super Puma Mk2 helicopter which behaved in a highly efficient and robust manner. An active control strategy is suggested for air resonance and drive train stability; a validation with flight tests is forecast in the near future. The proposed controls are simple and easy to integrate in a conventional Flight Control System (FCS). The actuators available in the current FCS are sufficient as far bandwidth required for active control of aeromechanical stability is concerned.

Author

Aerodynamic Stability; Helicopters; Control Stability; Active Control; Aerodynamic Characteristics

19970025912 Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

Practical Implementation of Multiple Model Adaptive Estimation Using Neyman-Pearson Based Hypothesis Testing and Spectral Estimation Tools

Hanlon, Peter D., Air Force Inst. of Tech., USA; Sep. 1996; 198p; In English

Report No.(s): AD-A324108; AFIT/DS/ENG/96-07; No Copyright; Avail: CASI; A09, Hardcopy; A03, Microfiche

This study investigates and develops various modifications to the Multiple Model Adaptive Estimation (MMAE) algorithm. The standard MMAE uses a bank of Kalman filters, each based on a different model of the system. Each of the filters predict the system response, based on its system model, to a given input and form the residual difference between the prediction and sensor measurements of the system response. Model differences in the input matrix, output matrix, and state transition matrix, which respectively correspond to an actuator failure, sensor failure, and an incorrectly modeled flight condition for a flight control failure application, were investigated in this research. An alternative filter bank structure is developed that uses a linear transform on the residual from a single Kalman filter to produce the equivalent residuals of the other Kalman filters in the standard MMAE. A Neyman Pearson based hypothesis testing algorithm is developed that results in significant improvement in failure detection performance when compared to the standard hypothesis testing algorithm. Hypothesis testing using spectral estimation techniques is also developed which provides superior failure identification performance at extremely small input levels.

DTIC

Algorithms; Kalman Filters; Signal Processing; Flight Control; Detection

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.

19970025344 Turabo Univ., Gurabo, Puerto Rico

NASA 8-foot High Temperature Tunnel: Combustor Internal Flow Conditioning

Altaii, Karim, Turabo Univ., Puerto Rico; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 56; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

The objective of this study was to reduce or eliminate the velocity deficit downstream of the fuel flanges. Fluid flow simulation inside the combustor was conducted using computational fluid dynamics (CFD) codes (Fluent and Fluent/UNS). Two-dimensional flow simulation was conducted for three geometries: (1) the original flange geometry, (2) streamlined flanges 'downstream fairing' and (3) streamlined flanges 'upstream and downstream fairings'. The results of this simulation showed that streamlining the flanges, both upstream and downstream, improves the velocity field downstream considerably. This streamlining will also improve the temperature field in the test section.

Derived from text

Test Chambers; Temperature Profiles; Hypersonic Flight; Computational Fluid Dynamics; Convergent Nozzles; Divergent Nozzles; Fluid Flow; Fuel-Air Ratio; High Temperature; Internal Flow

19970025631 Air Force Inst. of Tech., Graduate School of Engineering, Wright-Patterson AFB, OH USA

Modeling and Analyzing the Effect of Ground Refueling Capacity on Airfield Throughput ***Final Report***

Rushing, W. Heath, Air Force Inst. of Tech., USA; Mar. 1997; 130p; In English

Report No.(s): AD-A324169; AFIT/GOR/ENS/97M-19; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

This thesis develops five analytical models to understand the current ground refueling process, to optimize the airfield configuration and to determine the refueling policy which maximizes throughput, the primary measure of airfield efficiency. This study models the airfield refueling process as a continuous time Markov process to adequately represent the inherent stochastic nature of the transitory ground refueling system and provide an analytical evaluation of various airfield configurations. Also, the study provides an optimal refueling policy to minimize the number of aircraft on the ground which in turn minimizes the average amount of time aircraft spend on the ground in a fifth model, a Markov decision process solved by a linear program. By accomplishing this, higher throughput rates can be achieved by allowing a higher aircraft arrival rate into the airfield.
DTIC
Refueling; Mathematical Models; Stochastic Processes; Markov Processes; Airports

19970026023 Science Applications International Corp., Arlington, VA USA
Heliport/Vertiport Implementation Process: Case Studies ***Final Report***
Peisen, Deborah J., Science Applications International Corp., USA; Berardo, Stephen V., Hoyle, Tanner and Associates, USA; Ludders, J. R., Hoyle, Tanner and Associates, USA; Ferguson, Samuel W., EMA, USA; Winick, Robert M., Winick (Robert M.), USA; Aug. 1996; 87p; In English
Contract(s)/Grant(s): DTFA01-93-C-00030
Report No.(s): AD-A324104; DOT/FAA/ND-96/1; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Attempts to build public-use facilities have often failed, primarily at the local government level. On the other hand, a few public-use heliports and vertiports have been built and operated successfully. This raises the question of why some heliports are approved and built while others are rejected? The study attempts to provide some answers to that question and to identify more effective approaches to the public approval processes for vertical flight facilities. This study analyzes the approval process three ways. First, through the investigation of the nature of the public approval/implementation process that presents two approaches to heliport implementation. One is the Systematic Development of Informed Consent (SDIC) and the second is based on t he results of a workshop held with persons experienced with heliport implementation. Next, six case studies of actual heliport approval processes are presented to promote an understanding of critical elements and procedures significant in determining the success or failure of heliport/vertiport projects during the approval process. Case study locations are: Dallas; Portland; Miami; Pittsburgh; Washington, DC; and San Francisco. The final section of this study provides information and offers strategies to assist heliport proposers in counteracting influences that often frustrate the implementation process.
DTIC
Vertical Flight; Heliports

19970026035 NASA Dryden Flight Research Center, Edwards, CA USA
A Technique for Transient Thermal Testing of Thick Structures
Horn, Thomas J., NASA Dryden Flight Research Center, USA; Richards, W. Lance, NASA Dryden Flight Research Center, USA; Gong, Leslie, NASA Dryden Flight Research Center, USA; 1997; 22p; In English; International Society for Optical Engineers Annual Meeting, 27 Jul. - 1 Aug. 1997, San Diego, CA, USA; Sponsored by International Society for Optical Engineering, USA
Contract(s)/Grant(s): RTOP 529-60-24-00-17
Report No.(s): NASA-TM-4803; NAS 1.15:4803; H-2188; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A new open-loop heat flux control technique has been developed to conduct transient thermal testing of thick, thermally-conductive aerospace structures. This technique uses calibration of the radiant heater system power level as a function of heat flux, predicted aerodynamic heat flux, and the properties of an instrumented test article. An iterative process was used to generate open-loop heater power profiles prior to each transient thermal test. Differences between the measured and predicted surface temperatures were used to refine the heater power level command profiles through the iteration process. This iteration process has reduced the effects of environmental and test system design factors, which are normally compensated for by closed-loop temperature control, to acceptable levels. The final revised heater power profiles resulted in measured temperature time histories which deviated less than 25 F from the predicted surface temperatures.
Author
Aircraft Structures; Surface Temperature; Heat Flux; Heat Transfer; Radiant Heating; Aerodynamic Heating

19970026045 Boeing Co., Seattle, WA USA
National Wind Tunnel Complex (NWTC) ***Final Report***
Jun. 07, 1996; 114p; In English; CD-ROM conforms to the ISO 9660 standard
Contract(s)/Grant(s): NAS3-27330
Report No.(s): NASA-CR-198491; E-10279; NAS 1.26:198491; NONP-NASA-CD-1997030132; No Copyright; Avail: CASI;

A06, Hardcopy; A02, Microfiche; CD-ROM or HC/CD-ROM Set A99; CD-ROM or HC/CD-ROM Set A99

The National Wind Tunnel Complex (NWTC) Final Report summarizes the work carried out by a unique Government/Industry partnership during the period of June 1994 through May 1996. The objective of this partnership was to plan, design, build and activate 'world class' wind tunnel facilities for the development of future-generation commercial and military aircraft. The basis of this effort was a set of performance goals defined by the National Facilities Study (NFS) Task Group on Aeronautical Research and Development Facilities which established two critical measures of improved wind tunnel performance; namely, higher Reynolds number capability and greater productivity. Initial activities focused upon two high-performance tunnels (low-speed and transonic). This effort was later descoped to a single multipurpose tunnel. Beginning in June 1994, the NWTC Project Office defined specific performance requirements, planned site evaluation activities, performed a series of technical/cost trade studies, and completed preliminary engineering to support a proposed conceptual design. Due to budget uncertainties within the Federal government, the NWTC project office was directed to conduct an orderly closure following the Systems Design Review in March 1996. This report provides a top-level status of the project at that time. Additional details of all work performed have been archived and are available for future reference.

Author

Wind Tunnels; Research Facilities; Government/Industry Relations

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.

19970025227 NASA Ames Research Center, Moffett Field, CA USA

Aerothermal Performance Constraints for Hypervelocity Small Radius Unswept Leading Edges and Nosetips

Kolodziej, Paul, NASA Ames Research Center, USA; Jul. 1997; 18p; In English

Contract(s)/Grant(s): RTOP 242-72-01

Report No.(s): NASA-TM-112204; NAS 1.15:112204; A-976832; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Small radius leading edges and nosetips were utilized to minimize wave drag in early hypervelocity vehicle concepts until further analysis demonstrated that extreme aerothermodynamic heating would cause severe ablation or blunting of the available thermal protection system materials. Recent studies indicate that ultrahigh temperature ceramic (UHTC) materials are shape stable at temperatures approaching 3033 K and will be available for use as sharp UHTC leading edge components in the near future. Aerothermal performance constraints for sharp components made from these materials are presented in this work to demonstrate the effects of convective blocking, surface catalycity, surface emissivity, and rarefied flow effects on steady state operation at altitudes from sea level to 90 km. These components are capable of steady state operation at velocities up to 7.9 km/s at attitudes near 90 km.

Author

Aerothermodynamics; Leading Edges; Nose Tips; Wave Drag; Heating; Ablation; Thermal Protection; Ceramics

19970025582 NASA Langley Research Center, Hampton, VA USA

Autonomous Modal Identification of the Space Shuttle Tail Rudder

Pappa, Richard S., NASA Langley Research Center, USA; James, George H., III, Houston Univ., USA; Zimmerman, David C., Houston Univ., USA; Jun. 1997; 14p; In English; 16th; Mechanical Vibration and Noise, 14-17 Sep. 1997, Sacramento, CA, USA; Sponsored by American Society of Mechanical Engineers, USA

Contract(s)/Grant(s): RTOP 963-89-00-01

Report No.(s): NASA-TM-112866; NAS 1.15:112866; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Autonomous modal identification automates the calculation of natural vibration frequencies, damping, and mode shapes of a structure from experimental data. This technology complements damage detection techniques that use continuous or periodic monitoring of vibration characteristics. The approach shown in the paper incorporates the Eigensystem Realization Algorithm (ERA) as a data analysis engine and an autonomous supervisor to condense multiple estimates of modal parameters using ERA's Consistent-Mode Indicator and correlation of mode shapes. The procedure was applied to free-decay responses of a Space Shuttle

tail rudder and successfully identified the seven modes of the structure below 250 Hz. The final modal parameters are a condensed set of results for 87 individual ERA cases requiring approximately five minutes of CPU time on a DEC Alpha computer.
Author
Vibration Damping; Space Shuttles; Rudders; Algorithms; Autonomy; Vibration Mode

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.

19970025595 Innovative Scientific Solutions, Inc., Beavercreek, OH USA
Advanced Diagnostic Techniques Development for Supersonic and Subsonic Combusting Flowfields ***Final Report, 15 Apr. - 14 Oct. 1996***
Gross, L. P., Innovative Scientific Solutions, Inc., USA; Nov. 13, 1996; 72p; In English; Original contains color plates
Contract(s)/Grant(s): F33615-96-C-2638; AF Proj. 3005
Report No.(s): AD-A322830; WL-TR-96-2144; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The goal of this program was to address instrumentation problems associated with studying unsteady supersonic and subsonic combustion flows by extending the Particle Imaging Velocimetry (PIV) technique and developing surface techniques capable of pressure, temperature, and heat transfer measurements. Optical-based non-intrusive instrumentation was designed and demonstrated in the Supersonic Combustion Tunnel at Wright Laboratory. The following tasks were accomplished: (1) Significant improvements in PIV analysis software included a new 2D-FFT correlator, a new graphic user interface, increased capacity to read the Kodak color camera files directly, and enhancement of postprocessing routines. (2) New and improved pressure and temperature paints were developed, allowing--for the first time--measurements in diverse, high temperature environments. The temperature range of the pressure paints was significantly increased to 160 deg C. (3) New pressure and temperature paints were applied in the Supersonic Combustion Facility for studying fuel injectors in a Mach 2 flowfield. (4) The design of a lifetime based pressure and temperature instrument was finalized and preliminary experiments conducted. (5) An optical heat flux sensor based on thermographic phosphors was developed and evaluated in a back ward facing step test apparatus. Potential applications of these techniques include testing and evaluation in the aerospace, automotive, industrial processing, and architectural industries.
DTIC
Product Development; Supersonic Combustion; Supersonic Speed; Diagnosis; Flow Distribution

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.

19970025315 Stanford Univ., High Temperature Gasdynamics Lab., Stanford, CA USA
Research on Supersonic Reacting Flows ***Final Report, 15 Feb. 1994 - 14 Feb. 1997***
Bowman, C. T., Stanford Univ., USA; Hanson, R. K., Stanford Univ., USA; Mungal, M. G., Stanford Univ., USA; Reynolds, W. C., Stanford Univ., USA; Feb. 14, 1997; 49p; In English
Contract(s)/Grant(s): F49620-94-I-0152; AF Proj. 2308
Report No.(s): AD-A324327; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An experimental and computational investigation of supersonic combustion flows was carried out. The principal objective of the research was to gain a more fundamental understanding of mixing and chemical reaction in supersonic flows. The research effort comprised three interrelated elements: (1) stability analyses and numerical simulations of compressible reacting flows; (2) development of laser induced fluorescence techniques for time resolved multidimensional imaging of species concentration, temperature, velocity and pressure; and (3) an experimental study of mixing and combustion in a supersonic plane mixing layer with the additional development of simple mixing enhancements. The specific objectives and results of the research of each of these program elements have been summarized in this report. New results include: (1) a detailed stability map for reacting, compressible

shear layers; (2) new PLIF techniques for transient facilities; (3) new measurements of mixing efficiency in compressible flows; and (4) demonstration of simple mixing enhancement techniques with low pressure drop.
DTIC
Supersonic Flow; Chemical Reactions; Supersonic Combustion; Mixing Layers (Fluids); Reacting Flow; Laser Induced Fluorescence; Computational Fluid Dynamics; Turbulent Flow; Compressible Flow; Combustion Stability; Hypersonic Flight; Supersonic Inlets; Jet Mixing Flow

19970025355 Iowa State Univ. of Science and Technology, Dept. of Space Engineering, Ames, IA USA
Nonequilibrium Boundary Layer Effects on Aerodynamic Heating Analyses of X-33
Inger, George R., Iowa State Univ. of Science and Technology, USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 72; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

NASA has laid the groundwork for the next generation space transportation system via the Reusable Launch Vehicle (RLV), X-33 program. The main goal of the RLV is to substantially reduce the cost of payloads to Earth orbit. Envisioned is a family of fully reusable robust rocket vehicles that operate like commercial aircraft with a ten-fold reduction in life cycle cost compared to the Space Shuttle Orbiter. Because of the advantages of this concept, a substantial effort was undertaken to assess and optimize the aerodynamic performance from entry to landing and to determine aeroheating characteristics for design of the thermal protection system. The Aerothermodynamics Branch at Langley had already shown that computational fluid dynamics (CFD) provides accurate predictions of vehicle heating over the Shuttle Orbiter through the proper modeling of the reacting gas chemistry in the flowfield and its interaction with the surface material. Such CFD analyses are particularly helpful when predicting heating in localized surface areas of topological complexity or in regions with rapid changes in surface properties. Although historically the Shuttle Orbiter has operated well within the limits of it's thermal protection system (TPS), the operational demands of the next generation RLV will require an even more thorough knowledge of the thermal environment. This new class of vehicle is also more complex and hence may see local surface temperatures several hundred degrees higher than the Orbiter. The present work is a case in point: it deals with an aerodynamic heating problem occurring in the regime of nonequilibrium-dissociated flow with finite surface catalycity. In particular, it describes an approach for combining a new boundary-layer analytical method with comprehensive (but time intensive) CFD flowfield solutions of the thin-layer Navier-Stokes equations. The approach extracts CFD-derived quantities for inclusion in a post-processing boundary layer analysis. It allows a designer at a workstation, using a single; CFD solution, to determine the change in heating across the interface of two different thermal protection materials due to a jump in catalytic efficiency. This is particularly important, because abrupt changes from low to high. catalytic efficiency can lead to localized increase in heating which exceeds usually conservative estimates. For a given trajectory point, the approach uses a single baseline CFD solution with changes in heating levels calculated as a function of the catalytic jump using the boundary layer analytical solution. This provides a stand-alone post-processing tool which can be used in preliminary design of thermal protection systems (TPS), involving only a small number of CFD runs. Improved physical insight and 100-fold reduced computational costs are thereby attained.
Author
X-33 Reusable Launch Vehicle; Aerothermodynamics; Aerodynamic Characteristics; Aerodynamic Heating; Boundary Layers; Flow Distribution; Navier-Stokes Equation; Nonequilibrium Flow; Rocket Vehicles; Surface Properties; Thermal Environments; Thermal Protection

19970025357 Elizabeth City State Univ., Dept. of Technology, NC USA
Process for Making Adhesiveless Flex Circuits Using Langley Research Center Soluble Imide (LaRC-SI)
Lawrence, Ellis E., Elizabeth City State Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 74; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

The avionics industry, an area where space and weight is a premium concern, is constantly trying to produce efficient, lighter, smaller systems. The electronics industry has offered flexible-circuits as one means of fulfilling this goal. However, there are disadvantages or concerns with flex circuits. The traditional flex circuits use an adhesive-based laminate to join the copper or conductors to the substrate or dielectric. Often it is the adhesive's flexing ability that limits or reduces the flexing of a circuit. The solution to this problem is to find a material that reduces or eliminates the need for adhesives. NASA/LaRC has developed a new dielectric material, Langley Research Center Soluble Imide (LaRC-SI) which is self-bonding. This polymer is now being researched to determine its place in electronics. LARC-SI is a wholly aromatic high performance thermoplastic polyimide that is a self-bonding/non-curing resin that is made from commercially available monomers. This polyimide possess superior electrical properties and an extensive range of processing choices which allow it to serve as both a dielectric innerlayer, substrate coating or the substrate.

LaRC-SI film is made by casting or spraying a solution consisting of xylene, N-methyl- pyrrolidinone (NMP) and LaRC-SI powder. At different drying temperatures, various amounts of solvent are removed. One drawback is that the NMP (the major solvent) is hydroscopic in nature requiring that care must be taken to insure that any absorbed water is removed during drying. The presence of moisture can adversely effect the electrical performance by reducing the dielectric strength, increasing the dielectric constant and forming voids upon vaporization which would lead to blistering and delamination. Hence, developing a drying schedule which eliminates the water and other solvents while allowing for rapid processing and repair are essential. Research has shown approximately 2.7% NMP retention in LaRC-SI film dried at 200 C. Therefore, a range between 150 C and 210 C at different times was investigated to determine the point where the least amount of NMP was retained.
Author
Avionics; Thermoplasticity; Flexing; Imides; Adhesives; Circuits; Dielectrics; Electronic Equipment

19970025522 Virginia Univ., Dept. of Mechanical, Aerospace and Nuclear Engineering, Charlottesville, VA USA
High Performance Magnetic Bearings for Aero Applications ***Final Report***
Allaire, P. E., Virginia Univ., USA; Knospe, C. R., Virginia Univ., USA; Williams, R. D., Virginia Univ., USA; Lewis, D. W., Virginia Univ., USA; Barrett, L. E., Virginia Univ., USA; Maslen, E. H., Virginia Univ., USA; Humphris, R. R., Virginia Univ., USA; Feb. 1997; 37p; In English
Contract(s)/Grant(s): NAG3-1334
Report No.(s): NASA-CR-203487; NAS 1.26:203487; SEAS-Rept-UVA/528425/MANE97/101; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Several previous annual reports were written and numerous papers published on the topics for this grant. That work is not repeated here in this final report. Only the work completed in the final year of the grant is presented in this final report. This final year effort concentrated on power loss measurements in magnetic bearing rotors. The effect of rotor power losses in magnetic bearings are very important for many applications. In some cases, these losses must be minimized to maximize the length of time the rotating machine can operate on a fixed energy or power supply. Examples include aircraft gas turbine engines, space devices, or energy storage flywheels. In other applications, the heating caused by the magnetic bearing must be removed. Excessive heating can be a significant problem in machines as diverse as large compressors, electric motors, textile spindles, and artificial heart pumps.
Derived from text
Magnetic Bearings; Aircraft Engines; Electric Motors; Energy Storage; Relativistic Effects; Rotors; Textiles
Sonic Nozzles for Mass Flow Measurement and Reference Nozzles for Thrust Verification
Jun. 1997; 86p; In English
Report No.(s): AGARD-AR-321; ISBN 92-836-1056-3; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report presents the results of a multinational effort to reflect the state-of-the-art for the accurate measurement of mass-flow and thrust. The accurate measurements of these quantities is essential to the success of windtunnel tests supporting engine-airframe aerodynamic integration studies. It is concluded that the measurement of gaseous mass flows with +/-0.1% or better is still very difficult. For most test cases, however, with reasonable care, bias and random errors can be kept within +/-0.1% respectively. For thrust measurements, these values must typically be doubled. This report presents the results of work conducted by Working Group 19 of the AGARD Fluid Dynamics Panel.
Author

19970025626 Georgia Inst. of Tech., Woodruff School of Mechanical Engineering, Atlanta, GA USA
Integrated Diagnostics ***Annual Report, 1 Mar. 1996 - 28 Feb. 1997***
Cowan, Richard S., Georgia Inst. of Tech., USA; Winer, Ward O., Georgia Inst. of Tech., USA; Feb. 28, 1997; 272p; In English
Contract(s)/Grant(s): N00014-95-I-0539
Report No.(s): AD-A324130; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

This document summarizes performance activity regarding basic research being conducted in the area of Integrated Diagnostics, a term associated with the technologies and methodologies used to determine how mechanical failures occur, and how they can be detected, predicted, and diagnosed in real-time. Objectives, set forth through the Department of Defense Multidisciplinary Research Program of the University Research Initiative (M-URI), are being addressed by faculty and staff from the Georgia Institute of Technology, Northwestern University, and the University of Minnesota. This activity is funded through the Office of Naval Research for a basic period of three years, with a potential for two additional years. Second year accomplishments, plans, and technology transfer actions are reported upon. During this reporting period, experiments based on material, load, and vibration information from critical rotorcraft components have been designed and conducted so as to collect data of relevance in understanding the mechanisms of failure for use in developing failure models. These models can serve as a guide in the selection and develop-

ment of sensors to detect faults and pending failures. Effort has been placed on microsensor development, and achieving the means to analyze and correlate reliable sensor output for operator use. Organizationally, this activity is being accomplished through (16) projects, categorized by three thrust areas.
DTIC
Rotary Wing Aircraft; Failure; Fault Detection; Performance Prediction; Real Time Operation; Failure Analysis

13
GEOSCIENCES

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

19970025642 Wisconsin Univ., Cooperative Inst. for Meteorological Satellite Studies, Madison, WI USA
Investigation of Cloud Properties and Atmospheric Profiles with MODIS ***Semiannual Report, Jan. - Jun. 1997***
Menzel, Paul, Wisconsin Univ., USA; Ackerman, Steve, Wisconsin Univ., USA; Moeller, Chris, Wisconsin Univ., USA; Gumley, Liam, Wisconsin Univ., USA; Strabala, Kathy, Wisconsin Univ., USA; Frey, Richard, Wisconsin Univ., USA; Prins, Elaine, Wisconsin Univ., USA; LaPorte, Dan, Wisconsin Univ., USA; Wolf, Walter, Wisconsin Univ., USA; 1997; 23p; In English; Original contains color illustrations
Contract(s)/Grant(s): NAS5-31367
Report No.(s): NASA-CR-205072; NAS 1.26:205072; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The WINter Cloud Experiment (WINCE) was directed and supported by personnel from the University of Wisconsin in January and February. Data sets of good quality were collected by the MODIS Airborne Simulator (MAS) and other instruments on the NASA ER2; they will be used to develop and validate cloud detection and cloud property retrievals over winter scenes (especially over snow). Software development focused on utilities needed for all of the UW product executables; preparations for Version 2 software deliveries were almost completed. A significant effort was made, in cooperation with SBRS and MCST, in characterizing and understanding MODIS PFM thermal infrared performance; crosstalk in the longwave infrared channels continues to get considerable attention.
Author
Cloud Physics; Flight Simulators; Software Engineering; Imaging Spectrometers; Infrared Radiation; Flight Tests

14
LIFE SCIENCES

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

19970025421 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
Rotorcraft-Pilot Coupling: A Critical Issue for Highly Augmented Helicopters?
Hamel, Peter G., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Rotorcraft-pilot coupling (RPC) has became a critical issue for flight safety. Based on experience in the field of aircraft-pilot coupling (APC), definitions and limited prediction opportunities of three RPC categories are discussed. Time delay, rate-limiting elements and pilot manipulators of full-authority FbW/L flight control systems provide new potentials of unfavorable rotorcraft-pilot coupling phenomena. Some limited RPC flight test experience at AFDD and DLR is presented. Research requirements for soliciting RPV prevention methodologies and technologies are laid down. New flight test techniques prediction tools and advanced technologies are proposed to improve RPC immunity.
Author
Pilot Induced Oscillation; Aircraft Pilots; Flight Tests; Flight Control; Helicopters

19970025594 Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA
Requirements, Design, and Development of a Rapidly Reconfigurable, Photo-Realistic, Virtual Cockpit Prototype
Adams, Terry A., Air Force Inst. of Tech., USA; Dec. 1996; 136p; In English
Report No.(s): AD-A323143; AFIT/GCS/ENG/96D-02; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The USA Air Force uses aircraft flight simulators for pilot training and mission rehearsal. They use a variety of simulators for this task ranging with prices ranging from $400,000 to $30,000,000. These simulators have specialized hardware that restricts reuse of their components and increases maintenance costs. Air Education and Training Command wants to reduce simulators cost and improve availability to the operational commands by supporting research in virtual reality flight simulators. This thesis looks at the development of a reconfigurable virtual cockpit in a distributed virtual environment that can be used for different aircraft as well as training scenarios. The thesis effort builds on a F-15 virtual cockpit previously developed at AFIT by creating a F-16. The Rapidly Reconfigurable Virtual Cockpit (RRVC) allows users to switch between an F-15 and F-16 during live simulation. All software models and aircraft geometry files are updated to reflect the current aircraft. The ability of a distributed virtual environment to support two unique aircraft flight simulators in a single application is encouraging. With the development of more aircraft, a single application can be provided to the operational pilot community that would support many aircraft at a fraction of the cost of today's flight simulators.
DTIC
Design Analysis; Product Development; Cockpits; Flight Simulators; Fighter Aircraft; Virtual Reality; Computerized Simulation

19970026046 Oregon State Univ., Dept. of Industrial and Manufacturing Engineering, Corvallis, OR USA
An Agent-Based Cockpit Task Management System ***Final Report***
Funk, Ken, Oregon State Univ., USA; Jun. 30, 1997; 78p; In English
Contract(s)/Grant(s): NAG2-875
Report No.(s): NASA-CR-205043; NAS 1.26:205043; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche
An agent-based program to facilitate Cockpit Task Management (CTM) in commercial transport aircraft is developed and evaluated. The agent-based program called the AgendaManager (AMgr) is described and evaluated in a part-task simulator study using airline pilots.
Derived from text
Management Systems; Cockpits; Commercial Aircraft; Transport Aircraft; Pilot Performance

15
MATHEMATICAL AND COMPUTER SCIENCES

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

19970025147 Armstrong Lab., Human Resources Directorate, Wright-Patterson AFB, OH USA
A Bayesian Classifier Based on a Deterministic Annealing Neural Network for Aircraft Fault Classification ***Final Report***
Wang, Jun, North Dakota Univ., USA; Chu, Shing P., Armstrong Lab., USA; Jan. 1997; 15p; In English
Contract(s)/Grant(s): F49620-93-C-0063; AF Proj. 1710
Report No.(s): AD-A323742; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
A Bayesian classifier based on a recurrent neural network was developed for aircraft fault classification. From historical maintenance data the posterior probabilities of fault classification based on given fault indicators are estimated and derived using the Bayes' rule. Based on Bayesian decision theory, the fault classification problem is formulated as a linear integer programming problem to minimize an expected loss function using the posterior probabilities. The linear integer programming problem is then converted equivalently to a standard linear programming problem. A two layer recurrent neural network is used to carry out the computation task for fault classification by solving the formulated linear programming problem. The simulation results of a pilot study based on the synthetic data on the fire control radar system in F-16 aircraft show that the neu ral network approach is capable of real-time aircraft fault classification.
DTIC
Bayes Theorem; Annealing; Neural Nets; Aircraft Maintenance; Computer Aided Design

19970025115 Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA
Analysis of Aircraft Sortie Generation with Concurrent Maintenance and General Service Times
Hackman, Daniel V., Air Force Inst. of Tech., USA; Feb. 1997; 86p; In English
Report No.(s): AD-A324093; AFIT/GOR/ENS/97M-11; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche
The primary objective of this study was to develop an analytical methodology for evaluating an aircraft sortie generation process. The process is modeled as a closed network of general service queues with a fork join node to model concurrent servicing. The model uses the Mean Value Analysis (MVA) algorithm and general queueing network analysis by decomposition to approxi-

mate network performance measures including resource utilization and the overall sortie generation rate. The results of the study show that the analytical approximation's accuracy decreases as server utilization increases. However, when server utilization is kept in realistic ranges, the approximation is very accurate. When applied to a closed system of single server queues and delay stations, the approximation performs significantly better than a pure MVA-based approach. For closed or capacitated open systems with multiserver queues, the approximation can still be applied to provide upper and lower bounds on system p erformance.
DTIC
Queueing Theory; Aircraft Maintenance; Services; Combat

19970025319 Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA
Modeling Diminishing Marginal Returns: An Application to the Aircraft Availability Model
Zorn, Wayne L., Air Force Inst. of Tech., USA; Mar. 1996; 133p; In English
Report No.(s): AD-A324311; AFIT/GOA/ENS/96M-10; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The Aircraft Availability Model (AAM) provides the Air Force with a worldwide peacetime requirement for reparable spare parts. This research models AAM methodology as it relates to the concept of diminishing marginal returns in resource application. Three separate modeling techniques are investigated with the goal of reformulating the AAM as a mathematical programming model that provides a comparable solution and a capable tool for the conduct of sensitivity analysis. The general formulations presented here are continuous non-linear, continuous linear, and piecewise linear discrete/continuous models. Two formulations of the piecewise linear discrete/continuous model are presented. The piecewise linear model based on AAM sort values shows the dominance of an optimization routine relative to the AAM shopping list greedy heuristic. The piecewise linear model based on availability rates provides the capability to maximize the mission design series (MDS) availability level. It has the potential to obtain the highest possible MDS availability relative to reparable spares inventory levels. This mathematical model is discussed in complete detail as a robust platform for conducting extensive post-optimality analysis.
DTIC
Aircraft Models; Mathematical Programming; Mathematical Models; Heuristic Methods; Spare Parts

19970025428 Defence Research Agency, Systems Integration Dept., Farnborough, UK
The Application of Helicopter Mission Simulation to System Trade-Off Issues
Tatlock, N., Defence Research Agency, UK; Silvester, C., Defence Research Agency, UK; Birkett, P., Defence Research Agency, UK; Apr. 1997; 4p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper discusses the use of simulation for understanding some of the system trade-offs and integration issues associated with the next generation of battlefield helicopters. The HOVERS helicopter mission simulator at DRA Farnborough is discussed and examples of the types of benefits provided by its use are described.
Author
Helicopter Design; Fighter Aircraft; Tradeoffs

19970025433 Institute for Aerospace Research, Flight Research Lab., Ottawa, Ontario Canada
Helicopters and Night Vision Goggles: A Synopsis of Current Research on Helicopter Handling Qualities during Flight in Degraded Visual Environments
Baillie, Stewart W., Institute for Aerospace Research, Canada; Morgan, J. Murray, Institute for Aerospace Research, Canada; Apr. 1997; 10p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The role of the helicopter in military operations often involves flight in adverse weather conditions and the execution of flight maneuvers designed to maintain minimal exposure to the enemy. This translates into a requirement for helicopters to fly very low level, nap-of-the-earth, at night or in bad weather. This type of flying places a high demand on the pilot to accurately perceive the environment and to precisely control the flight path of the aircraft.
Derived from text
Goggles; Night Vision; Nap-Of-The-Earth Navigation; Military Operations; Helicopter Control; Flight Conditions; Controllability

19970025562 Air Force Inst. of Tech., Graduate School of Engineering, Wright-Patterson AFB, OH USA
Applying Tabu Heuristic to Wind Influenced, Minimum Risk and Maximum Expected Coverage Routes
Sisson, Mark R., Air Force Inst. of Tech., USA; Feb. 1997; 83p; In English
Report No.(s): AD-A324146; AFIT/GOR/ENS/97-06; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The purpose of this thesis is to provide Air Combat Command a method for determining the number of predator unmanned aerial vehicles (UAVs) required to cover a pre-selected target. Extending previous research that employs reactive TABU search methods for deterministic vehicle routing problems, this thesis incorporates wind effects that can significantly alter the travel times for any given scenario. Additionally, it accounts for possible attrition by introducing minimum risk route and expected number of target covered to the objective function. The results of the TABU search and subsequent Monte-Carlo simulation: gives the number of predator's required to cover a target set, identifies 'robust' routes, and suggests routes that increase expected number of targets covered while reducing losses.
DTIC
Monte Carlo Method; Heuristic Methods; Pilotless Aircraft; Wind Effects; Combat; Traveling Salesman Problem

19970026016 Air Warfare Center, Nellis AFB, NV USA
OC-135B Open Skies ***Final Report, 9-16 Dec. 1996***
Palumbo, Gary E., Air Warfare Center, USA; DeMonbrun, Nancy B., Air Warfare Center, USA; Mar. 1997; 47p; In English
Contract(s)/Grant(s): ACC Proj. 95-079T
Report No.(s): AD-A323802; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
The purpose of the QOT&E was to evaluate the operational effectiveness and suitability of the modified OC-135B aircraft systems and subsystems to support Open Skies missions. The results of this QOT&E will be used in the fielding decision process and to refine the operational concept.
DTIC
Observation Aircraft; System Effectiveness; Aircraft Performance; Aircraft Maintenance

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.

19970025345 Old Dominion Univ., Academic Television Services, Norfolk, VA USA
Assessment System Aircraft Noise (ASAN): A Training Course for the USA Air Force
Aspillaga, Macarena, Old Dominion Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 57; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only
This project came as the result of a needs assessment performed by Langley's Air Force Base Environmental Office. The goal set by the Air Force for the ASAN system is to have a more efficient and effective teaching tool for the instructor. Environmental officers decided to put ASAN on-line to increase efficiency. This was accomplished through the use of PowerPoint presentations. The course was reviewed and designed according to its audience. The first step was reorganizing its content according to its overall importance within the subject matter, degree of difficulty, learning type, instructional strategies, instructional objectives, and assessment. After looking carefully at the way ASAN was being taught and presented through a training manual, or team found that the course in its initial state lacked: instructional objectives, overall organization, visualization of ASAN screen. In addition, each class was missing: objectives, organization, examples, practice items, interaction between instructor and learners, and acronyms'definition. The manual made by handouts did not have clarity, color, arrows or clip-part, explanation for accessing screen dumps, and page numbers for reference. The lab was also missing the objectives, clarity, interaction between instructor and learners, and examples relevant to the learner's daily activities.
Derived from text
Aircraft Noise; Education; Engine Noise; Jet Aircraft; Noise Prediction (Aircraft)

19970025364 Christopher Newport Coll., Dept. of Mathematics, Newport News, VA USA
A Computational Investigation of Flap Side-Edge Flow Noise
Martin, James E., Christopher Newport Coll., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 82; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only
During flight, high speed air flow about the side edges of an airfoil's Raps becomes one of the most intense sources of non-propulsive noise. The significance of this noise source began to be recognized in the late 1970's. Studies showed that the flap side edges were more efficient noise radiators than the trailing edge source, which had been considered to dominate wing-produced

noise up to that time. Recently, Sen of the Boeing Company proposed a physical mechanism for the flap-edge noise source and a two-dimensional model to illustrate it. Sen's model suggests that the vortex which forms off the edge of the flap can be excited into periodic oscillations as it is perturbed by a small secondary vortex or turbulent eddy. Such periodic oscillations of the flap edge vortex would provide a possible explanation for the intense noise producing capabilities of the flap side-edge region. Sen's model has several intriguing mathematical aspects and also appears to have physical plausibility based upon flow visualization tests carried out at NASA Langley Research Center. In the present study, the two-dimensional flap side-edge flow model developed by Sen is analyzed to reveal the noise production potential of the proposed mechanism. In our study, the flap is taken to be a rectangular slab of finite thickness in the presence of which there exists a potential flow as well as a point vortex to represent the flap-edge vortex. Using conformal mapping techniques, the region exterior to the slab is transformed into the upper half plane. Trajectories of the vortex are determined in the transform plane and then mapped back to the physical plane through the conformal map. For a limited range of the governing flow parameter, closed periodic trajectories of the flap edge vortex occur. For any given value within this range, there exists an equilibrium point of the vortex where the upwash potential flow velocity is just balanced by the image vortex induced velocity. If the vortex is perturbed slightly away from the equilibrium point, it will then follow a closed trajectory. For values of the governing flow parameter for which the tip vortex performs periodic oscillation, periodic noise will be produced. The resulting sound radiation at locations in the far field is determined by numerically integrating the Ffowcs Williams-Hawkings equation. Although the flow model itself is purely two-dimensional, the noise field is calculated three-dimensionally by taking the flap to have a finite chord. The Ffowcs Williams-Hawkings equation provides the acoustic pressure at any location in the far field based upon the time dependent surface pressures, evaluated at a retarded time. The intensive storage requirements necessary for the retarded time evaluation often leads investigators to ignore the retarded time effect in acoustic calculations. As a part of this investigation, the effect of neglecting the retarded time differences is considered. Extensive acoustic calculations have been carried out for various values of the governing flow parameter, vortex initial positions, and observer locations. For cases in which the vortex performs periodic oscillation, periodic dipole sound containing the fundamental frequency and several nonnegligible harmonics is produced. Results from this study, suggest that the intensity of sound can be reduced by reducing the chord or increasing the thickness of the flap. Currently, a similar investigation of an analogous three-dimensional version of Sen's flow model has begun. In particular, a numerical study is being conducted in which the point vortex representation of the flap edge vortex is replaced by a fully three-dimensional vortex filament.
Author

Aerodynamic Noise; Aeroacoustics; Airfoils; Flow Visualization; Noise Generators; Sound Waves; Wing Flaps; Vortex Flaps; Vortex Filaments; Two Dimensional Models; Two Dimensional Flow

19970025417 Eurocopter Deutschland G.m.b.H., Munich, Germany

Reduction of the Noise Signature of the Eurocopter EC 135

Niesl, G., Eurocopter Deutschland G.m.b.H., Germany; Arnaud, G., Eurocopter France, France; Apr. 1997; 12p; In English; Also announced as 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper presents an overview of the acoustic design of the EUROCOPTER EC 135 helicopter. The layout of the different noise relevant components were supported by measurements on the test bench and in the wind tunnel. The experimental and theoretical investigations were accompanied by acoustic measurement on the BO 105 and the BO 108. The results are discussed with respect to neighbourhood noise emission and acoustic detectability aspects. The low noise design of the fan-in-fin tail rotor (FENESTRON(R)) and the positive effect on the improved noise signature of the EC 135 is presented and compared to BO 105 and BO 108 with a conventional tail rotor. The main rotor of the EC 135 shows a reduced noise signature especially at higher Mach number due to the reduced blade thickness at the tip region, the introduction of a new airfoil generation, and an advanced blade shape. The low noise concept of the EC 135 is proved by noise measurements with ground based microphones.
Author

Military Helicopters; Noise Reduction; Noise Measurement; Helicopter Design; Aerodynamic Noise; Aircraft Noise; Acoustics

19970026029 NASA Lewis Research Center, Cleveland, OH USA

Azimuthal Directivity of Fan Tones Containing Multiple Modes

Heidelberg, Laurence J., NASA Lewis Research Center, USA; Sutliff, Daniel L., AYT Corp., USA; Nallasamy, M., NYMA, Inc., USA; May 1997; 18p; In English; 3rd; Aeroacoustics, 12-14 May 1997, Atlanta, GA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 538-03-11

Report No.(s): NASA-TM-107464; NAS 1.15:107464; E-10750; AIAA Paper 97-1587; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The directivity of fan tone noise is generally measured and plotted in the sideline or flyover plane and it is assumed that this curve is the same for all azimuthal angles. When two or more circumferential (m-order) modes of the same tone are present in the fan duct, an interference pattern develops in the azimuthal direction both in the duct and in the farfield. In this investigation two m-order modes of similar power were generated in a large low speed fan. Farfield measurements and a finite element propagation code both show substantial variations in the azimuthal direction. Induct mode measurement were made and used as input to the code. Although these tests may represent a worst case scenario, the validity of the current practice of assuming axisymmetry should be questioned.
Author
Aerodynamic Noise; Azimuth; Ducts; Aircraft Models; Frequencies

17
SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

19970025351 Old Dominion Univ., Dept. of Engineering Management, Norfolk, VA USA
A Benefit Analysis of a NASA Research Project: The Integrated Wing Design Project
Fernandez, Abel A., Old Dominion Univ., USA; 1996 NASA-Hampton University American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Dec. 1996, pp. 66; In English; Also announced as 19970025341; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche; Abstract Only; Abstract Only

Assessing the projected benefits of NASA's research projects is an indispensable first step towards effective management decision making. The results of such studies can be used as a basis for resource allocation, project management trade-offs and other similar decision analysis problems. Although conceptually simple, estimating the economic impact of a public sector research project often times poses significant modeling challenges. The present analysis examines the potential market and socio-economic impacts from the Integrated Wing Design (IWD) element of NASA's Advanced Subsonic Technology program.
Derived from text
Aircraft Design; Wings; Project Management; Aeronautical Engineering

19970025444 NASA Johnson Space Center, Houston, TX USA
Inherit Space *Final Report*
Giarratano, Joseph C., Houston Univ., USA; Jenks, K. C., NASA Johnson Space Center, USA; National Aeronautics and Space Administration (NASA) /American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program; Jun. 1997; Volume 1, pp. 11.1-11.11; In English; Also announced as 19970025435
Contract(s)/Grant(s): NAG9-867; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The objective of the proposed research was to begin development of a unique educational tool targeted at educating and inspiring young people 12-16 years old about NASA and the Space Program. Since these young people are the future engineers, scientists and space pioneers, the nurturing of their enthusiasm and interest is of critical importance to the Nation. This summer the basic infrastructure of the tool was developed in the context of an educational game paradigm. The game paradigm has achieved remarkable success in maintaining the interest of young people in a self-paced, student-directed learning environment. This type of environment encourages student exploration and curiosity which are exactly the traits that future space pioneers need to develop to prepare for the unexpected. The Inherit Space Educational Tool is an open-ended learning environment consisting of a finite-state machine classic adventure game paradigm. As the young person explores this world, different obstacles must be overcome. Rewards will be offered such as using the flight simulator to fly around and explore Titan. This simulator was modeled on conventional Earth flight simulators but has been considerably enhanced to add texture mapping of Titan's atmosphere utilizing the latest information from the NASA Galileo Space Probe. Additional scenery was added to provide color VGA graphics of a futuristic research station on Titan as well as an interesting story to keep the youngster's attention. This summer the game infrastructure has been developed as well as the Titan Flight Simulator. A number of other enhancements are planned.
Author
Flight Simulators; Computer Graphics; Education; Titan; Students

19
GENERAL

19970025183 Wright Lab., Plans and Programs Directorate, Wright-Patterson AFB, OH USA
Wright Laboratory Success Stories: A Review of 1996 ***Final Report, 1 Jan. - 1 Dec. 1996***
Apr. 1997; 203p; In English
Report No.(s): AD-A323748; WL-TR-97-6002; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

Success stories from 1996 that recognize the accomplishments and combined efforts of Wright Laboratory Scientists and Engineers. Stories have been selected from the following categories: (1) Technology Transition, technology that has achieved application on a DoD system in development or operation; (2) Technology Transfer, technology transferred from the laboratory to the private sector; (3) Technical Advancement, major innovative technological advancements that offer significant potential for existing & future AF systems, and, (4) Peer Recognition, external awards or recognitions by the scientific community at large, concerning advancements in Technology Transition, Transfer, or Technical Achievement.
DTIC
Technology Transfer; Flight Control; Aircraft Design; Turbofan Engines

19970025538 NASA Washington, Washington, DC USA
Hugh L. Dryden's Career in Aviation and Space, No. 5, Monographs in Aerospace History
Gorn, Michael H., NASA Washington, USA; 1996; 144p; In English
Report No.(s): NASA-TM-112843; NAS 1.15:112843; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Hugh Latimer Dryden led a life rich in paradox. Born in obsurity, he attained international prominence. Indifferent to self-advancement, he nonetheless rose to the pinnacle of the aeronautics profession and subsequently assumed a pivotal role in the initial period of space exploration. Although a research scientist of the first order, he nurtured within himself a profoundly spiritual outlook.
Author
Space Exploration; Aeronautics; Histories

Subject Term Index

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Personal Author Index

N

O

P

Q

R

S

T

V

W

Z

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7037 (357)		

4. Title and Subtitle	5. Report Date
Aeronautical Engineering A Continuing Bibliography (Supplement 357)	September 19, 1997
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address	
NASA Scientific and Technical Information Program Office	11. Contract or Grant No.

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics and Space Administration Langley Research Center Hampton, VA 23681	Special Publication
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report lists reports, articles and other documents recently announced in the NASA STI Database.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Aeronautical Engineering Aeronautics Bibliographies	Unclassified – Unlimited Subject Category – 01

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	59	A04/HC

For sale by the NASA Center for AeroSpace Information, 800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934