

THE AERONAUTICAL JOURNAL

Covering all aspects of Aerospace

Volume 111 Number 1119

May 2007



THE AERONAUTICAL JOURNAL

Editor-in-chief: Prof Peter Bearman

Associate Editors

Chairman: Prof Mike Graham

Dr Holger Babinsky
Cambridge University

Dr Trevor Birch
Dstl

Prof Rene de Borst
Delft University

Wg Cdr Mike Bratby
RAeS Air Power Group

Mr Tim Cansdale
Dstl

Dr Jon Carrotte
Loughborough University

Dr Graham Coleman
Dstl

Prof Jonathan Cooper
Manchester University

Mr Anthony Cross
BAE Systems Warton

Prof Richard Crowther
Rutherford Appleton Lab

Prof Glyn Davies
Imperial College, London

Dr Olivier Dessens
Cambridge University

Prof Dimitris Drikakis
Cranfield University

Mr Chris Fielding
BAE Systems, Warton

Professor John Fielding
Cranfield University

Professor Nabil Gindy
University of Nottingham

Prof Ismet Gursul
University of Bath

Prof Keith Hayward
RAeS Head of Research

Dr Michael J de C Henshaw
Loughborough University

Prof Richard Hillier
Imperial College, London

Prof Howard Hodson
University of Cambridge

Mr Julian Lea-Jones
Systems Consultant

Prof Ken Morgan
University of Wales, Swansea

Dr Ravi Nayak
National Aerospace Laboratories, India

Prof Gareth Padfield
Liverpool University

Dr Shahrokh Shahpar
Rolls-Royce

Prof Constantinos Soutis
University of Sheffield

Prof John Stollery
Cranfield University

Prof Anthony Waas
University of Michigan

Aims and scope

The aims and scope of *The Aeronautical Journal* are intended to reflect the objectives of the Royal Aeronautical Society as expressed in its Charter of Incorporation. Briefly, these are to encourage and foster the advancement of all aspects of aeronautical and space science. Thus the topics of *The Aeronautical Journal* include most of those covered by the various Specialist Groups of the Society, which include:

Aircraft design, aerodynamics, air law, air power, air transport, air navigation, airworthiness and maintenance, aviation medicine, avionics and systems, environmental issues, flight operations, flight simulation, fluid dynamics, fluid mechanics, general aviation, guided flight, human factors, human powered flight, light aviation, management studies, propulsion, rotorcraft, safety, space, structures and materials, structural mechanics, systems and test procedures and UAVs.

Papers are therefore solicited on all aspects of research, design and development, construction and operation of aircraft and space vehicles. Papers are also welcomed which review, comprehensively, the results of recent research developments in any of the above topics.

We recognise the inhibiting pressures of time and confidentiality and acknowledge that many of the design testing, manufacturing and operational problems that industry has to solve contain important information for the whole aerospace community. *The Aeronautical Journal* provides a platform for refereeing and presenting your work to an international audience.

Papers will be considered for publication in *The Aeronautical Journal* if they meet the terms and conditions listed in The Instructions for authors. If these are not met, the Editor reserves the right to withdraw the paper without redress, which may be at any time up to publication.

Papers should be sent to: Prof Peter Bearman, Royal Aeronautical Society, 4 Hamilton Place, London W1J 7BQ, United Kingdom.

Subscriptions

Non-members

Annual subscription (12 issues) £360, Single copies, including back issues £36; *Non-member subscription orders are available from:* Royal Aeronautical Society, Publications Subscriptions Department, Dovetail Services Ltd, 800 Guillat Avenue, Kent Science Park, Sittingbourne, Kent ME9 8GU, UK.

Tel: +44 (0)870 442 0915, Fax: +44 (0)870 220 0290, email: ras@cisubs.co.uk

RAeS members

Annual subscription (12 issues) £55, Single copies, including back issues £6; *member subscription orders are available from:* Membership Department, Royal Aeronautical Society, 4 Hamilton Place, London W1J 7BQ, UK. Tel: +44 (0)20 7670 4300, Fax: +44 (0)20 7670 4309, email: membership@raes.org.uk

RAeS Conference Proceedings

Details, price and availability of Royal Aeronautical Society Conference Proceedings can be obtained from: RAeS Conference and Events Department, 4 Hamilton Place, London W1J 7BQ, UK. Tel: +44 (0)20 7670 4300, email: conference@raes.org.uk or via www.aerosociety.com/proceedings



CONTENTS

Volume 111 Number 1119

Reproduction of any of the papers published in this journal is not permitted without the written consent of the Editor.

Editor-in-Chief

Professor P W Bearman FREng, FCGI, FRAeS

Managing Editor

C S C Male BSc(Eng) MRAeS

Production Editor

W J Davis BA

Production

W I I Read MA(Econ)

Production

T C Robinson BA

Book Review Editor

B L Riddle BLib

Publisher

Royal Aeronautical Society (RAeS)
4 Hamilton Place
London W1J 7BQ, UK
Tel: +44 (0)20 7670 4300
Fax: +44 (0)20 7670 4359
e-mail: publications@raes.org.uk
raes@raes.org.uk

<http://www.aerosociety.com>

The Royal Aeronautical Society
is a registered charity: No 313708

RAeS Chief Executive

K D R Mans BA FRAeS

The content does not necessarily express the opinion of the Council of the Royal Aeronautical Society.

Advertisement Sales

David Lancaster, Group Sales Manager
Ten Alps Publishing
9 Savoy Street
London WC2E 7HR, UK
Tel: +44 (0)20 7878 2316
Fax: +44 (0)20 7379 7118/7155
email: david.lancaster@tenalpspublishing.com

Printer

Manor Creative Limited
7 and 8 Edison Road
Eastbourne
East Sussex
BN23 6PT
United Kingdom
ISSN: 0001-9240

Published monthly

All papers are available to view free of charge for subscribers and to purchase by others at:
www.aerosociety.com

- | | |
|--|-----|
| O. Song, H.D. Kwon and L. Librescu
Modelling and vibration of a non-classical tilt-rotor wing system | 285 |
| D. Riggins, T. Taylor, L. Terhune and D. Moorhouse
Methods for the design of energy efficient high speed aerospace vehicles | 297 |
| O. Dessens, H.L. Rogers and J.A. Pyle
A change in the calculated impact of supersonic aircraft NOx emissions on the atmosphere | 311 |
| P. Cosyn and J. Vierendeels
Design of fixed wing micro air vehicles | 315 |
| D. Pritchard and A. MacPherson
Strategic destruction of the Western commercial aircraft sector: Implications of systems integration and international risk-sharing business models | 327 |
| G. Radice and M. Casasco
On different parameterisation methods to analyse spacecraft attitude manoeuvres in the presence of attitude constraints | 335 |

Front Cover: An AgustaWestland BA609-08.