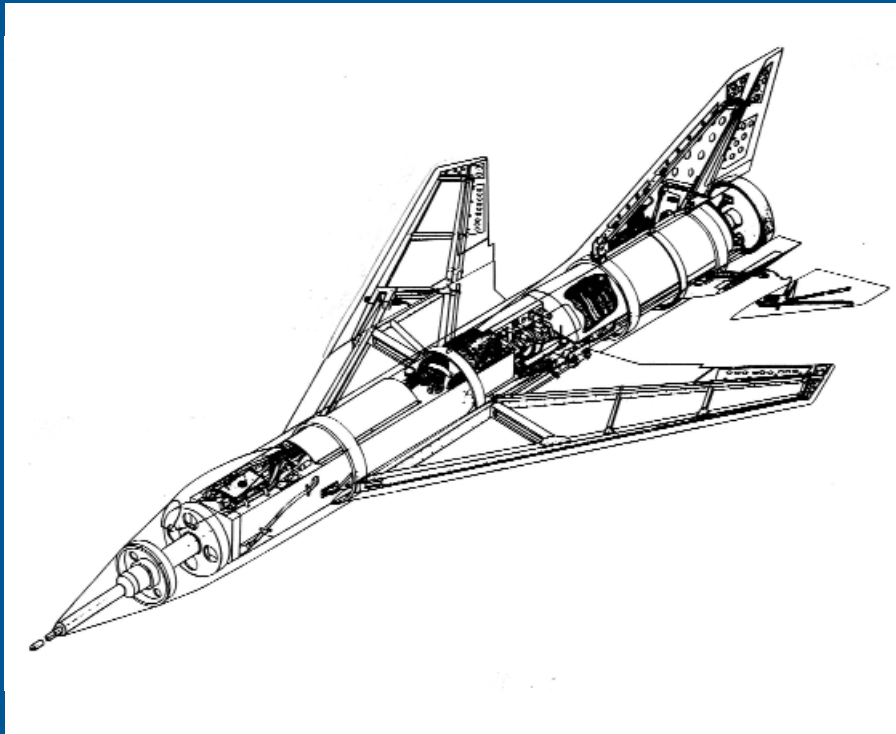




The
**AERONAUTICAL
JOURNAL**



Volume 109, Number 1091

January 2005

The AERONAUTICAL JOURNAL

Editor-in-chief: Prof John Stollery

Associate Editors

Chairman: Prof Peter Bearman

Dr Holgar Babinsky
Cambridge University

Dr Trevor Birch
Dstl

Prof Tim Cansdale
Dstl

Dr Graham Coleman
Dstl

Prof Jonathan Cooper
Manchester University

Mr Anthony Cross
BAE Systems Warton

Prof Glyn Davies
Imperial College, London

Prof Rene de Borst
Delft University

Dr Olivier Dessens
Cambridge University

Prof Dimitris Drikakis
Cranfield University

Mr Chris Fielding
BAE Systems, Warton

Prof Ismet Gursul
University of Bath

Dr Michael J de C Henshaw
BAE Systems, Brough

Prof Richard Hillier
Imperial College, London

Mr Julian Lea-Jones
ERA Technology

Prof Ken Morgan
University of Wales, Swansea

Prof Gareth Padfield
Liverpool University

Dr Shahrokh Shahpor
Rolls-Royce

Prof Constantinos Soutis
University of Sheffield

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 John Stollery, The Royal Aeronautical Society, 4 Hamilton Place, London W1J 7BQ, United Kingdom.

Subscriptions

Non-members

Annual subscription (12 issues) £350, Single copies, including back issues £35; *Non-member subscription orders are available from;* Royal Aeronautical Society, Publications Subscriptions Department, Cary Court, Bancombe Trading Estate, Somerton, Somerset TA11 6TB, UK. Tel: +44 (0)870 442 0915, Fax: +44 (0)1458 271146, e-mail: 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, e-mail: Membership@raes.org.uk

RAeS Conference Proceedings

Details, price and availability of Royal Aeronautical Society Conference Proceedings can be obtained from; Eurospan, 3 Henrietta Street, Covent Garden London WC2E 8LU, UK. Tel: +44 (0)20 7240 0856



Contents

Volume 109, Number 1091

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

Editor-in-Chief

Professor J L Stollery CBE DSc(Eng) FRAeS
HonFRSA

Managing Editor

C S C Male BSc(Eng) MRAeS

Production Editor

W I I Read MA(Econ)

News Editor

T C Robinson BA

Production Co-ordinator

W J Davis BA

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 Holmes, Advertisement Sales Director
The Media Centre
East Rudham
King's Lynn
Norfolk PE31 8RD
United Kingdom
Tel: +44 (0)1485 528020
Fax: +44 (0)1485 528022
e-mail: mcentre@aol.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
at: www.aerosociety.com**

- | | |
|---|----|
| R. Hosman, S. Advani and N. Haeck
Integrated design of flight simulator motion cueing systems | 1 |
| M. Mokry
The vortex merger factor in aircraft wake turbulence | 13 |
| S. Tizzi
Polynomial series expansion for optimisation of wing plane structures in idealised critical flutter conditions | 23 |
| S.C. Liddle and N.J. Wood
Investigation into clustering of synthetic jet actuators | 35 |
| S. Sadovnychiy, A. Ryzhenko and A. Betin
Flight control system damage simulation using freely flying models | 45 |

Front cover: Diagram of a DSM structure.



RAeS Aerospace Aerodynamics Conference (14-15 September 2004)

In coming months *The Aeronautical Journal* will be publishing papers first presented at the 2004 Aerospace Aerodynamics Conference held at The Royal Aeronautical Society's Mayfair headquarters. Michael J. de C. Henshaw gives an overview of the Conference.

The 2004 Aerospace Aerodynamics Conference took place amid an atmosphere of speculation about the status and role of UK aerodynamics, engendered in part by current discussions about aerodynamics networks. It was appropriate, therefore, that the first session featured papers that described large-scale collaborative ventures. Brian Timmins (ARA)⁽¹⁾ described the formation of the European Windtunnel Association; an EU-funded network of excellence that will share expertise and capabilities to strengthen the European research area through cost reduction, faster implementation of new technologies and better informed industrial end-users. Continuing the theme of collaborative windtunnel activity, Wolfgang Burgsmüller (ETW)⁽²⁾ presented a summary of the first ten years of operation of the European Transonic Windtunnel, demonstrating its importance with respect to design knowledge at flight Reynolds numbers and outlining future plans for improved measurement techniques, aeroelastic effects and engine simulation. The third paper invited for the first session focused on a different sort of network; Neil McDougall (Cranfield University) described the FLAVIIR⁽³⁾ project, jointly sponsored by BAE Systems and the EPSRC, in which ten UK universities collaborate on an interdisciplinary research programme into UAV technologies. The main aerodynamic content is associated with flow control technologies.

Two sessions were devoted to presentations from the aerodynamic DARPs⁽⁴⁾, PUMA⁽⁵⁾ (unsteady aerodynamics) and MSTTAR⁽⁶⁾ (turbulence and transition). These collaborations are industrially-led academic research programmes sponsored by DTI, EPSRC, MoD and industry. The presentations covered both the academic research highlights and the industry exploitation activities.

The RAeS and AIAA operate an exchange of 'best in conference' papers which afforded two sessions of very interesting papers from the 42nd Aerospace Sciences conference. Kevin Jones (NPS)⁽⁷⁾, Monterey) conducted perhaps the first flight test in the lecture theatre itself, demonstrating the exceptionally good control capabilities of a flapping-wing propelled MAV at the end of his presentation. His paper gives a good overview of the contending approaches to MAV flight and describes the use of COTS (Commercial off the shelf) components (including cell-phone batteries, motors and voltage converters) to build the vehicle which completed several circuits of the lecture theatre without significantly threatening any of the audience!

As usual, the conference featured a mixture of experimental and CFD research papers. Edward Tinoco (Boeing) analysed the impact of CFD on the overall aeroplane development process. He concluded that its benefit has been restricted mainly to high-speed cruise design, with little application to the majority of the aerodynamic development effort (high lift, certification, stability and control). The paper considered the combined role of CFD and wind tunnel and identified the key factors, associated with timeliness, technical and cultural challenges, that prevent extension of use of CFD in product development, despite significant increases in its applicability across the flight envelope.

Many of the conference papers were of an applied nature, addressing such diverse issues as improved wind-tunnel measurements and analysis, aeroelastic analysis techniques, and fire zone ventilation in turbofans. The themes of collaborative research across the industry-academic boundary and of the realisation of research outputs as practical engineering tools were well represented at the conference and are surely a strength of the meeting. Under the chairmanship of Norman Wood (Manchester University) the delegates considered the question of how the conference might be improved in future years and attract larger audiences. The importance of attracting international participation while, at the same time, providing an opportunity to showcase UK aerodynamics was emphasised, as was promotion of the conference to senior and influential members of the UK aerodynamics community. Next year's conference will be held in Bremen, Germany, in collaboration with CEAS (Confederation of European Aerospace Societies); this will hopefully provide an opportunity to address these challenges.

Michael J. de C. Henshaw
BAE Systems

⁽¹⁾Aircraft Research Association

⁽²⁾European Transonic Windtunnel

⁽³⁾FLapless Air Vehicle Integrated Industry Research

⁽⁴⁾Defence and Aerospace Research Partnership

⁽⁵⁾Partnership in Unsteady Methods for Aerodynamics

⁽⁶⁾Modelling and Simulation of Turbulence and Transition for AeRspace

⁽⁷⁾Naval Postgraduate School