

ISSN 0001-9240



ROYAL  
AERONAUTICAL  
SOCIETY

2016 • CELEBRATING 150 YEARS

# THE AERONAUTICAL JOURNAL

Covering all aspects of aerospace

Volume 120

Number 1233

November 2016



CAMBRIDGE  
UNIVERSITY PRESS

# THE AERONAUTICAL JOURNAL

**Editor-in-Chief: Professor Peter Bearman**

## **Editorial Board**

**Chairman: Professor Mike Graham**

## **Editorial Board**

**Deputy Chairman: Professor Chris Atkin**

## **Editorial Board**

**Professor Christian Allen**  
University of Bristol

**Wg Cdr Mike Bratby**  
RAeS Air Power Group

**Professor Laurent Dala**  
University of Northumbria

**Professor Song Fu**  
Tsinghua University, China

**Professor Victor Giurgiutiu**  
University of South Carolina

**Professor Ismet Gursul**  
University of Bath

**Professor Michael Henshaw**  
Loughborough University

**Dr M R Nayak**  
National Aerospace Laboratories, India

**Professor Srinivasan Raghunathan**  
Queen's University, Belfast

**Professor Shahrokh Shahpar**  
Rolls-Royce, Derby

**Professor Constantinos Soutis**  
University of Manchester

**Professor Holger Babinsky**  
University of Cambridge

**Professor Jonathan Cooper**  
University of Bristol

**Professor Dimitris Drikakis**  
University of Strathclyde

**Professor Antonio Filippone**  
University of Manchester

**Dr Guy Gratton**  
Brunel University

**Professor Keith Hayward**  
Former Head of Research, RAeS

**Professor Konstantinos Kontis**  
University of Glasgow

**Professor Mark Price**  
Queen's University Belfast

**Professor Gareth Padfield**  
University of Liverpool

**Dr Arthur Richards**  
University of Bristol

**Professor Kenichi Rinoie**  
University of Tokyo

**Professor Howard Smith**  
Cranfield University

**Professor Constantinos Stavriniadis**  
European Space Agency

**Professor Rene de Borst**  
University of Sheffield

**Peter Curtis**  
Aircraft Research Association

**Professor Brian Falzon**  
Queen's University, Belfast

**Professor Ed Galea**  
Greenwich University

**Dr John Green**  
Consultant Chief Scientist, ARA

**Professor Li He**  
University of Oxford

**Professor Jim McQuirk**  
Loughborough University

**Dr Richard Markiewicz**  
DSTL

**Professor Ning Qin**  
University of Sheffield

**Carl Russell**  
NASA Ames, USA

**Professor Marilyn Smith**  
Georgia Institute of Technology, USA

**Professor Anthony Waas**  
University of Washington, USA

## **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. Topics covered in *The Aeronautical Journal* include:

Aircraft design, aerodynamics, air law, air power, air transport, air navigation, airworthiness and maintenance, aviation medicine, avionics and systems, composites, 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 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. Be assured that *The Aeronautical Journal* provides a renowned platform for refereeing and presenting your work to the broadest international audience.

Papers will be considered for publication in *The Aeronautical Journal* if they meet the terms and conditions listed in our instructions for authors available at: <http://journals.cambridge.org/AER>. 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.

Wayne J Davis, RAeS Production Editor at: [aerjournal@aerossociety.com](mailto:aerjournal@aerossociety.com). Subscription enquiries should be sent to: [journals@cambridge.org](mailto:journals@cambridge.org)

Papers should be submitted at: [www.edmgr.com/aeroi](http://www.edmgr.com/aeroi)