

The **AERONAUTICAL** Journal

The seal of the Royal Aeronautical Society is a circular emblem. It features a central figure of a winged figure, possibly a personification of flight or a deity, holding a staff or scepter. The figure is surrounded by a circular border containing the text 'ROYAL AERONAUTICAL SOCIETY' and the year '1866'. The seal is rendered in a light blue color against the dark blue background of the cover.

Contents

E. Greff

The development and design integration of a variable camber wing for long/medium range aircraft.

M. R. Wisnom

Prediction of penetration of curved metal stiffened panels due to birdstrike.

P. Berry

North Atlantic air traffic control.

Library reviews, additions and reports

Incorporating
The Aeronautical Quarterly

Volume 94 Number 939 November 1990

THE AERONAUTICAL JOURNAL

Aims and scope

The aims and scope of *The Aeronautical Journal* are intended to reflect the objectives of the Society as expressed in the 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 Journal include all those which are covered by the various Sections and Groups of the Society such as fluid mechanics and aerodynamics, propulsion, structures and materials, rotorcraft, astronautics and guided flight, dynamics and control, aeromarine technology, aviation medicine, air transport, test flying, flight simulation, air law, management studies, history of aviation and manpowered aircraft. Thus 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.

Notes on the preparation of papers

Acceptance of a submitted paper will depend on the results of rigorous technical review by at least two referees and on the judgement of the Editors as to the importance of the paper to readers of the Journal.

Three clear copies of the manuscript, each complete with illustrations, should be submitted. Papers should be typed in double spacing and should preferably not exceed 10 000 words. Handwritten manuscripts cannot be accepted.

A list of symbols used, both in the illustrations and in the text, should be given in alphabetical order at the beginning of the paper whether or not they are standard. All unfamiliar terms must be explained.

Symbols and formulae should be typewritten if possible. The use of dots, bars, and similar characters over symbols, or the use of dots as multiplication signs and bars for brackets should be avoided. Suffixes (subscripts) and indices (superscripts) must be clearly indicated. Complicated suffixes and indices also should be avoided where possible.

References should be numbered in the text where they occur, and a complete list of references given at the end of the paper. *The Aeronautical Journal* uses the BSI Numeric System for references — e.g. author(s), title of contribution, title of periodical, year of publication, volume number, issue number, page numbers.

Illustrations should be kept to a minimum. When the paper is first submitted they can be clear prints or graphs, sketches or photographs. If the paper is accepted, authors are asked to provide the original drawings if possible, and clear, glossy, black-and-white photographs. All diagrams should be produced to the same scale.

Manuscripts should be read critically, for example by a colleague, before submission, in order to avoid small errors which might otherwise prolong the refereeing process.

Conditions of publication

An author must obtain consent, where necessary, to use any material in a paper which is copyright or the property of any other persons and of his/her or their employers.

Security clearance, if appropriate, must be obtained by the author before the paper is submitted.

The copyright of papers printed in *The Aeronautical Journal* is the property of The Royal Aeronautical Society. Permission to reprint or to use any paper will not be refused unreasonably.

Following the acceptance of a submitted paper, publication of the paper will not be unreasonably delayed.

Authors are entitled to 50 complimentary reprints of their papers. Authors may order any number of additional reprints at the time of printing and quotations can be provided.

The AERONAUTICAL Journal

Volume 94 Number 939 November 1990

Incorporating the Aeronautical Quarterly



Editor:

J. M. Ramsden

Production Editor:

David Moore

Associate Editor:

Mr D. H. Peckham,
BSc(Eng), CEng, MRAS

Published by

The Royal Aeronautical Society,
4 Hamilton Place, London W1V 0BQ.

Tel: 071-499 3515

Cables: Didaskalos, London W1

Telex: 262826 RAESOC

Fax: 071-499 6230

Advertisements:

Brian R. Harriss — Jackson-Rudd
& Associates (London) Limited
Oldebourne House, 46-47 Chan-
cery Lane, London WC2A 1JB
Tel: 071-405 3611/2
071-405 7308/9

Telex: 8811725 Jackson-Rudd
Fax: 071-831 8030

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

None of the papers or paragraphs
must be taken as expressing the
opinion of the Council unless
otherwise stated.

Printed by

Manor Park Press Ltd.
Unit 7, Highfield Industrial Estate,
Edison Road, Hampden Park,
Eastbourne.

Subscriptions: £145 per annum,
post free.

RAeS members: £16.00 per
annum.

Single copies, including back
numbers: £16.

Non-member subscriptions from
The Royal Aeronautical Society
Publications Subscriptions Depart-
ment, PO Box 139, Tonbridge,
Kent TN9 1EW, UK.

Tel: 0732 770823. Fax: 0732
361708

USA and Canada subscriptions from
The Aeronautical Journal
Fulfillment Office, PO Box 11806,
Birmingham, AL35202, USA

ISSN: 0001-9240

**PUBLISHED MONTHLY
EXCEPT JUNE AND
AUGUST**

Contents

301

E. Greff

The development and design
integration of a variable camber
wing for long/medium range aircraft.

313

M. R. Wisnom

Prediction of penetration of curved
metal stiffened panels due to
birdstrike.

318

P. Berry

North Atlantic air traffic control.

324

**Library reviews, additions and
reports**

Incorporating the Journals of The
Institution of Aeronautical Engineers and
The Helicopter Association of Great
Britain

DIVISIONS AND BRANCHES OF

THE ROYAL AERONAUTICAL SOCIETY

Australia Branches at: Adelaide, Canberra, Melbourne and Sydney.

President: Captain A. I. TERRELL, MRAeS. *Hon. Secretary:* R. D. BARKLA, PO Box 573, Mascot, NSW 2020.

New Zealand Branches at: Auckland, Blenheim, Canterbury, Hamilton, Otago, Palmerston North and Wellington.
President: I. J. DIAMOND, Associate Member. *Hon. Secretary:* J. H. MOUNCE, MRAeS, PO Box 3813, Wellington.

Southern Africa *President:* Prof. E. A. BUNT, CEng, FRAeS. *Hon. Secretary:* N. A. H. BARRAUD, MRAeS, PO Box 630, Kelvin, 2054, Republic of South Africa.

Zimbabwe *President:* M. E. McCORMACK, Eng Tech, Technician RAeS. *Hon. Secretary:* H. W. SMITH, FRAeS, P.O. Box 1931, Harare, Zimbabwe. *Tel:* 4-731781.

Bedford

President: Air Cdre. P. D. CLARK, BA.
Chairman: A. M. McVITIE, FRAeS.
Hon. Secretary: Dr M. A. PARKER, CEng, MRAeS, 8 West Road, Wharley End, Cranfield, Bedford MK43 0SZ. *Tel:* 0234 750111 Ex. 3489.

Belfast

President: M. I. WILD, MRAeS.
Chairman: D. J. GRENVILLE, AMRAeS.
Hon. Secretary: R. R. PARSONS, 27 Mandeville Avenue, Stratheden Heights, Newtownards BT23 3XA. *Tel:* 0247 818191.

Birmingham and Wolverhampton

President: C. I. HUGHES, CEng, MRAeS.
Chairman: G. P. HARRIS, CEng, MRAeS.
Hon. Secretary: A. R. BANBURY, CEng, MIPROdE, 13 Grasmere Close, Tettenhall, Wolverhampton WV6 9DP. *Tel:* 0902 745957.

Boscombe Down

President: Air Cdre. D. L. BYWATER, FRAeS, FBIM, RAF
Chairman: R. W. NOADES, MA, MRAeS.
Hon. Secretary: Wg. Cdr. M. C. BROOKE, MRAeS, HQ Flying Division, A&AEE Boscombe Down, Salisbury SP4 0JF. *Tel:* 0980 623331. Ex. 2572.

Bristol

President: P. J. ALLARD, FRAeS.
Chairman: R. STEPHENSON, CEng, FRAeS.
Hon. Secretary: D. C. GREENMAN, CEng, MRAeS, Technical Training Manager, British Aerospace (Commercial Aircraft) Ltd, Airbus Division, Filton House, Bristol BS99 7AR. *Tel:* 0272 362057. BAe Int 2057.

Brough

President: M. EDWARDS, CEng, FRAeS.
Chairman: Dr J. A. H. PETRIE.
Hon. Secretary: S. J. BLEE, MRAeS, British Aerospace (Military Aircraft) Ltd, Brough, North Humberside HU15 1EQ. *Tel:* Work — 0482 667121. Ex. 5435. Home — 0482 666553.

Cambridge

President: Professor M. GASTER, FRS, CEng, FRAeS.
Chairman: K. WESTLEY, AMRAeS.
Hon. Secretary: T. W. CARTER, AMRAeS, Aircraft Design Office, Marshall of Cambridge (Engineering) Ltd, Airport Works, Cambridge CB5 8RX. *Tel:* 0223 61133. Ex. 3232 or 3434.

Chester

President: S. A. E. DYKE.
Chairman: R. A. HUGHES, CEng, MRAeS.
Hon. Secretary: C. E. MANN, Associate RAeS, 3 Fir Tree Avenue, Westminster Park, Chester CH4 7QY. *Tel:* 0244 672607.

Christchurch

President: M. J. COBHAM, FRAeS.
Chairman: C. CRUDDAS, FRAeS.
Hon. Secretary: R. W. SMILLIE, AMRAeS, Penny & Giles Control Ltd, Somerford Road, Christchurch, Dorset BH23 3RS. *Tel:* 0425 278821. Ex. 210.

Coventry

President: J. B. ROBERTS, FRAeS.
Chairman: Dr. B. D. HOBSON, PhD, BSc(Eng), CEng, MIMechE, MRAeS.
Hon. Secretary: R. I. RATCLIFF, IEng, Technician RAeS, 6 Erithway Rd, Green Lane, Coventry CV3 6JT. *Tel:* 0203 413779. Work — 0203 623141.

Cranwell

President: Air Vice Marshal R. M. AUSTIN, AFC, RAF.
Chairman: Wg. Cdr. C. T. HARROW, CEng, MRAeS, RAF.
Hon. Secretary: Sqn. Ldr. T. WINSTANLEY, RAF College, Cranwell, Sleaford, Lincs NG34 8HB. *Tel:* 0400 61201. Ex. 7237.

Derby

President: J. O. KEIR, FRAeS.
Chairman: J. F. BUSH, FRAeS.
Hon. Secretary: C. J. ROBINSON, CEng, MRAeS, c/o Compressor Technology, Rolls-Royce plc, PO Box 31, Derby DE2 8BJ. *Tel:* 0332 249855.

Dublin

President: R. W. O'SULLIVAN FRAeS.
Chairman: J. TOWERS, MRAeS.
Hon. Secretary: J. CONERNEY, Eng. Wing, Air Corps, Baldonnel, Co. Dublin. *Tel:* 592493. Ex. 6633.

Gatwick

President: A. T. PUGH, FRAeS.
Chairman: A. G. SAYCE, MRAeS.
Hon. Secretary: S. A. WITTS, MRAeS, Civil Aviation Authority, Transport Aeroplane Group, Aviation House, Gatwick RH6 0YR. *Tel:* Work — 0293 573285. Home — 0293 573285.

Glasgow

President: Dr. A. W. BABISTER, MRAeS.
Chairman: F. J. MULLEN.
Hon. Secretary: A. REID, 42 Burntbroom Drive, Baillieston, Glasgow G69 7XN. *Tel:* 041 554 1800.

Gloucester and Cheltenham

President: M. H. SPENCE, CEng.
Chairman: J. W. LINDLEY, MRAeS.
Hon. Secretary: R. F. J. MCCARTHY, CEng, FRAeS, Dowty Aerospace Gloucester, Cheltenham Road, Gloucester GL2 9QH. *Tel:* 0452 711428.

Halton

President: Gp. Capt. I. R. BLUNT, RAF.
Chairman: Wg. Cdr. C. G. R. GREAVES, CEng, MRAeS, RAF.
Secretary: Sqn. Ldr. A. W. DEBUSE, CEng, MRAeS, RAF, O/C Aerodynamics Flight, No. 1 School of Technical Training, RAF Halton, Aylesbury, Bucks HP22 5PG. *Tel:* 0296 623535. Ex. 303.

Hatfield

President: C. B. G. MASEFIELD, FRAeS.
Chairman: L. BALTHAZOR, MRAeS.
Hon. Secretary: J. SAUNDERS, MRAeS, Research Dept., British Aerospace (Commercial Aircraft) Ltd, Hatfield, Herts AL10 9TL. *Tel:* 07072 62345. Ex. 5098.

Heathrow

President: LORD KING of WARTNABY, Comp. RAeS.
Chairman: J. D. BROWN, MRAeS.
Hon. Secretary: R. KENNEDY, IEng, AMRAeS, British Airways, PO Box 10, Heathrow Airport, Hounslow, Middx TW6 2JA. *Tel:* 081-562 3366.

Isle of Wight

President: R. STANTON-JONES, FEng, MRAeS.
Chairman: R. L. WHEELER, FRAeS.
Hon. Secretary: R. J. PERRY, Engineering Office, Westland Aerospace, Castle Street, East Cowes, Isle of Wight, PO32 6RH. *Tel:* 0983 294101, Ex. 2025.

Loughborough

President: Professor G. L. WILDE, OBE, FRAeS.
Chairman: A. R. LITTLE, Stud RAeS.
Hon. Secretary: Prof. S. J. STEVENS, MRAeS, Transport Technology Dept, Loughborough University of Technology, Loughborough, Leics. LE11 3TU. *Tel:* 0509 223425.

Luton

President: J. M. RAINBOW, CEng, FRAeS.
Chairman: C. TURNER, CEng, FRAeS.
Hon. Secretary: N. G. TOOMEY, IEng, AMRAeS, c/o Monarch Aircraft Engineering Ltd (Planning Dept.), Luton International Airport, Luton, Beds LU2 9LX. *Tel:* Work — 0582 424211, Ex. 2542. Home — 0234 54185.

Manchester

President: Prof J. L. LIVESEY, CEng, MIMechE.
Chairman: M. J. TAYLOR, CEng, MRAeS.
Hon. Secretary: G. G. CODNER, Grad RAeS, 19 Lorna Road, Cheadle Hulme, Cheshire SK8 5BJ. *Tel:* 061-439 5050, Ex. 3617.

Medway

President: P. A. HEARNE, FRAeS.
Chairman: R. T. TWINE, CEng, MRAeS.
Hon. Secretary: G. E. SIM, AMRAeS, c/o GEC Avionics Ltd, Airport Works, Rochester, Kent ME1 2XX. *Tel:* 0634 682720.

Middle Wallop

President: Col. T. I. COURTNELL, CEng, MRAeS.
Chairman: D. J. WILLIAMS, Eng Tech.
Secretary: Staff Sgt M. A. PARKER, Validation Section, School of Aeronautical Engineering, Army Air Corps Centre, Middle Wallop, Stockbridge, Hampshire, SO20 8DY. *Tel:* 0264 384264

Preston

President: D. GARDNER, FRAeS.
Chairman: M. MANSELL, FRAeS.
Hon. Secretary: I. G. JAMES, MRAeS, Systems Engineering Dept — W354D, British Aerospace, (Military Aircraft) Ltd, Warton Aerodrome, Preston, Lancs PR4 1AX. *Tel:* 0772 633333. Ex. 54896.

Prestwick

President: Dr. W. G. WATSON, FRAeS.
Chairman: I. J. McDONNELL, AMRAeS.
Hon. Secretary: A. R. FROST, AMRAeS, 21 Fullerton Road, Prestwick KA9 2BU. *Tel:* 0292 78204.

Sherborne

President: Air Marshal Sir E. DUNN, KBE, CB, BEM, CEng, FRAeS, RAF(Ret'd).
Chairman: C. A. FRY, FRAeS.
Hon. Secretary: G. R. RUSSELL, Grad RAeS, 18 Berkely Court, Hermes Place, Ichester, Somerset BA22 8JU. *Tel:* 0935 704231.

Southampton

President: Professor G. M. LILLEY, FRAeS.
Chairman: M. DRASDO, Associate RAeS.
Hon. Secretary: D. R. J. BAXTER, CEng, MRAeS, Dept of Aeronautics and Astronautics, The University, Southampton, Hants SO9 5NH. *Tel:* 0703 595000. Ex. 2326.

Southend

President: BARONESS PLATT of WRITTELE, CBE, FEng, FRAeS.
Chairman: M. NICOLINI, AMRAeS.
Hon. Secretary: G. GILLIGAN, 21 Sandleigh Road, Leigh-on-Sea, Essex SS9 1JT. *Tel:* 0702 713365.

Stevenage

President: J. A. HOLT, FRAeS.
Chairman: N. MUIR, CEng, FRAeS.
Hon. Secretary: A. C. K. CRESSWELL, PB256 British Aerospace (Dynamics) Ltd, Six Hills Way, Stevenage, Herts SG1 2DA. *Tel:* 0438 752027.

Swindon

President: Vacant.
Chairman: Wing Cdr. P. GILBERT.
Hon. Secretary: V. A. SIMON, 20 Hawkswood, Covingham Park, Swindon, Wilts. *Tel:* 0793 525350.

Weybridge

President: I. R. YATES, CBE, FEng, FRAeS.
Chairman: Miss J. M. GULLAND, CEng, MRAeS.
Hon. Secretary: K. D. DAVIES, CEng, MRAeS, Aerodynamics Department, British Aerospace, (Military Aircraft) Ltd, Richmond Road, Kingston-upon-Thames, Surrey KT2 5QS. *Tel:* 081-546 7741. Ex. 2895.

Yeovil

President: V. A. B. ROGERS, CBE, FRAeS.
Chairman: R. I. CASE, CEng, FRAeS.
Hon. Secretary: F. N. R. BALLAM, CEng, MRAeS, Box 269, Westland Helicopters Ltd, Yeovil, Somerset BA20 2YB. *Tel:* 0935 703779.

OVERSEAS BRANCHES

Cyprus

Chairman: Air Vice-Marshal G. A. WHITE, CB, AFC, FRAeS.
Hon. Secretary: C. PERICLEOUS, AMRAeS, 8 Georgiou Christodolou, Acropolis, Nicosia, Cyprus.

Hong Kong

Chairman: S. M. JOHN, FRAeS.
Hon. Secretary: M. J. POMFRET, MRAeS, MME Dept, HK Polytechnic, Kowloon, Hong Kong. *Tel:* Office: 3-638344. Ex. 765. Home: 3-7213732.

Malaysia

Chairman: Brig. Gen. Dato' M. MUSLIM AYOB, RMAF, CEng, MRAeS.
Hon. Secretary: Lt. Col. CHEE ENG BOON, RMAF, CEng, MRAeS, Dept of the Air Force, Ministry of Defence, Jalan Padang Tembak, 50634 Kuala Lumpur, Malaysia. *Tel:* 03-2354010.

Pakistan

Chairman: S. AJAZ ALI, CEng, FRAeS.
Hon. Secretary: Dr. S. A. HASAN, CEng, MRAeS, PIA Training Centre, Karachi Airport-75200, Pakistan.