

The AERONAUTICAL Journal



Contents

WING TIP FLOWS AND WING DEVICES (SYMPOSIUM)

J. H. B. Smith

Introductory remarks

J. J. Spillman

Wing tip sails; progress to date and future developments

A. C. Willmer, R. V. Barrett and J. D. Coleman

The tip flow of a part span slotted flap

H. P. Horton and X. M. Xenophontos

Experimental studies of viscous regions near streamlined wing tips (Synopsis)

Hamdi T. Hemdan

A first order theory for Newtonian flow over two-dimensional airfoils

H. B. Tou and G. J. Hancock

Inviscid theory of two-dimensional aerofoil/spoiler configurations at low speed —

Part V: Steady and oscillatory aerofoil-spoiler flap characteristics

Part VI: The rapid deployment of a spoiler on a two-dimensional aerofoil

Library reviews, additions and reports

Index

Incorporating

The Aeronautical Quarterly

Volume 91 Number 910 December 1987

NOTES ON THE PREPARATION OF PAPERS FOR PUBLICATION IN THE AERONAUTICAL JOURNAL

All papers submitted for publication are sent to two referees.

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

A list of all 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 so on, over symbols, or the use of dots as multiplication signs and bars for brackets should be avoided. Suffixes and indices must be clearly indicated and complicated suffixes avoided.

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 reference — eg, author(s), title of contribution, title of periodical, year of publication, volume 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.

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 person or his 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.

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

Incorporating the Aeronautical Quarterly

Volume 91 Number 910 December 1987



Managing Editor:
John B. Groves, TEng, FRAeS

Production Editor:
Bernard F. Baldwin,

Associate Editors:
Professor L. F. Crabtree,
PhD, CEng, FRAeS
Mr D. H. Peckham,
BSc(Eng), CEng, MRAeS

Grey Tiles, Kingston Hill, Kingston
upon Thames, Surrey KT2 7LW
Tel: 01-546 1843/3249
Fax: 01-546 3192

Advertisements:
Brian R. Harris — Jackson-Rudd
& Associates (London) Limited
Oldebourne House, 46-47
Chancery Lane, London WC2A 1JB
Tel: 01-405 3611/2
01-405 7308/9
Telex: 8811725 Jackson-Rudd
Fax: 01 831 8030

Reproduction of any of the papers
published in this journal is not
permitted without the written
consent 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: £122 per annum,
post free.

RAeS members: £11.00 per
annum.

Single copies, including back
numbers: £12.

All foreign currency rates on
application.

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

ISSN: 0001-9240

**PUBLISHED MONTHLY
EXCEPT JUNE AND
AUGUST**

Contents

443 WING TIP FLOWS AND WING DEVICES (SYMPOSIUM)

J. H. B. Smith
Introductory remarks

J. J. Spillman
Wing tip sails; progress to date and
future developments

**A. C. Willmer, R. V. Barrett and J. D.
Coleman**
The tip flow of a part span slotted
flap

H. P. Horton and X. M. Xenophontos
Experimental studies of viscous
regions near streamlined wing tips
(Synopsis)

471
Hamdi T. Hemdan
A first order theory for Newtonian
flow over two-dimensional airfoils

479
H. B. Tou and G. J. Hancock
Inviscid theory of two-dimensional
airfoil/spoiler configurations at low
speed —

Part V: Steady and oscillatory
airfoil/spoiler flap characteristics
Part VI: The rapid deployment of a
spoiler on a two-dimensional
airfoil

499
**Library reviews, additions and
reports**

502
Index

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: Air Marshal I. T. SUTHERLAND, CEng, FRAeS. Hon. Secretary: R. D. BARKLA, PO Box 573, Mascot, NSW 2020.

Zimbabwe Branches at: Bulawayo, Gweru and Harare.

President: Wg. Cdr. F. R. SIMMONDS, CEng, MRAeS. Private Bag 6003, Harare Airport.

New Zealand Branches at: Auckland, Blenheim, Christchurch, Hamilton, Palmerston North and Wellington.

President: Wg. Cdr. G. MURRAY, CEng, MRAeS. Hon. Secretary: P. J. GAUNT, PO Box 3813, Wellington.

Southern Africa President: B. H. PRESCOTT, CEng, MRAeS. Hon. Secretary: N. A. H. BARRAUD, MRAeS, PO Box 16608, Atlasville, Republic of South Africa, 1465.

Bedford

President: Professor D. HOWE, CEng, FRAeS.
Chairman: G. I. PAULEY, CEng, FRAeS.
Hon. Secretary: I. G. HACKER, Aircraft Research Association Ltd, Manton Lane, Bedford MK41 7PF. Tel: 0234 50681.

Belfast

President: Sir PHILIP FOREMAN, CBE, FRAeS.
Chairman: D. J. GRENVILLE, AMRAeS.
Hon. Secretary: W. GORDON, MRAeS, College of Technology, College Square East, Belfast BT1 6DJ. Tel: Work — 0232 327244. Home — 0232 710370.

Birmingham and Wolverhampton

President: R. G. HILTON, MA
Chairman: W. G. MORRIS, AMRAeS.
Hon. Secretary: M. FIDDLER, Student RAeS, 12 Engleton Lane, Brewdog, Stafford ST19 9DZ. Tel: Work — 0785 23331. Home — 0902 850522.

Boscombe Down

President: Air Cdre. P. D. L. GOVER, AFC, FRAeS, RAF.
Chairman: B. W. CHILDES, FRAeS.
Hon. Secretary: Major (ret'd), N. C. GRAYSON, CEng, MRAeS, A&EE Boscombe Down, Salisbury SP4 0JF. Tel: 0980 23331. Ex. 3255.

Bristol

President: D. G. ATKIN, FRAeS.
Chairman: M. H. BEANLAND, FRAeS.
Hon. Secretary: D. C. GREENMAN, MRAeS, Aerodynamics Dept. No 7 Drawing Office, British Aerospace plc, Civil Aircraft Div., Filton House, Bristol BS99 7AR. Tel: 0272 693831. Ex. 4911.

Brough

President: M. EDWARDS, CEng, FRAeS.
Chairman: S. W. FIELD, FRAeS.
Hon. Secretary: J. P. NEWTON, AMRAeS, Flight Test Department, British Aerospace, Weybridge Division, Brough, North Humberside HU15 1EQ. Tel: Work — 0482 667121. Ex. 5821. Home — 0405 83893.

Cambridge

President: Professor W. A. MAIR, CBE, FRAeS.
Chairman: K. WESTLEY.
Hon. Secretary: T. W. CARTER, AMRAeS, Marshall of Cambridge (Engineering) Ltd, Airport Works, Cambridge CB5 8RX. Tel: 0223 61133. Ex. 232 or 434.

Chester

President: R. GRIFFITHS, FRAeS.
Chairman: R. A. HUGHES, CEng, MRAeS.
Hon. Secretary: J. R. YOUNG, AMRAeS, British Aerospace, Civil Aircraft Division, Chester Road, Broughton, Chester CH4 0DR. Tel: 0244 535333.

Christchurch

President: M. J. COBHAM, FRAeS.
Chairman: P. E. COURSE, MRAeS.
Hon. Secretary: C. CRUDDAS, FRAeS, Flight Refuelling Ltd, Wimborne, Dorset BH21 2BJ. Tel: 0202 882121. Ex. 2654.

Coventry

President: J. B. ROBERTS, FRAeS.
Chairman: T. W. HARPER, FRAeS.
Hon. Secretary: R. I. RATCLIFF, Assoc. Member RAeS, 6 Erithway Rd, Green Lane, Coventry CV3 6JT. Tel: 0203 413779. Work — 0203 624000. Ex. 23141.

Cranwell

President: Air Vice Marshal R. H. WOOD, OBE, RAF.
Chairman: Wg. Cdr. T. H. BUSH, MRAeS.
Hon. Secretary: Sqn. Ldr. G. J. COPSEY, CEng, MRAeS, RAF College, Cranwell, Sleaford, Lincs NG34 8HB. Tel: 0400 61201. Ex. 7303.

Derby

President: J. O. KEIR, FRAeS.
Chairman: J. F. BUSH, FRAeS.
Hon. Secretary: C. J. ROBINSON, c/o Compressor Research Dept., Rolls-Royce Ltd, PO Box 31, Derby DE2 8BJ. Tel: 0332 42424. Ex. 719.

Dublin

President: R. W. O'SULLIVAN FRAeS.
Chairman: Lt. Col. J. L. MOORE, MRAeS.
Hon. Secretary: J. CONNERNEY, Eng. Wing, Air Corps, Baldonnel, Co. Dublin. Tel: 592493. Ex. 28.

Gatwick

President: A. T. PUGH, FRAeS.
Chairman: T. J. PATRICK, MRAeS.
Hon. Secretary: A. G. SAYCE, MRAeS, Mayfield, Meath Green Lane, Horley, Surrey RH6 8JA.

Glasgow

President: Dr. A. W. BABISTER, MRAeS.
Chairman: C. SNOWDON, AMRAeS.
Hon. Secretary: F. J. MULLEN, 275 Fenwick Rd, Giffnock, Glasgow G46 6JX. Tel: 041-638 3236.

Gloucester and Cheltenham

President: M. H. SPENCE, CEng.
Chairman: K. BEST, FRAeS.
Hon. Secretary: N. E. LANGSTONE, CEng, MRAeS, Smiths Industries Aerospace & Defence Systems Ltd, Bishops Cleeve, Cheltenham, Glos GL52 4SF. Tel: 0242 673333.

Halton

President: Gp. Capt. S. M. D. WILLIAMSON-NOBLE, MRAeS, RAF.
Chairman: Wg. Cdr. C. J. ROWLAND, 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. 5014.

Hatfield

President: C. B. G. MASEFIELD, FRAeS.
Chairman: F. W. VANN, FRAeS.
Hon. Secretary: J. SAUNDERS, MRAeS, Research Dept., Civil Aircraft Division, British Aerospace, Hatfield, Herts. Tel: 07072 62345.

Heathrow

President: LORD KING OF WARTNABY, Comp. RAeS.
Chairman: M. J. J. PERRY, MRAeS.
Hon. Secretary: J. D. BROWN, MRAeS, H2TBAS383, British Airways, PO Box 10, London (Heathrow) Airport, Hounslow, Middx TW6 2JA. Tel: 01-562 5958.

Isle of Wight

President: R. STANTON-JONES, FEng, MRAeS.
Chairman: R. L. WHEELER, MRAeS.
Hon. Secretary: R. J. PERRY, Stress Office, Westland Aerospace, East Cowes, Isle of Wight. Tel: 0983 294121. Ex. 2025.

Loughborough

President: Professor G. L. WILDE, OBE, FRAeS.
Chairman: S. J. RAYNER, Student RAeS.
Hon. Secretary: Dr. J. B. OLLERHEAD, MRAeS, Transport Technology Dept, Loughborough University of Technology, Loughborough, Leics. LE11 3TU. Tel: 0509 223406.

Luton

President: J. M. RAINBOW, CEng, FRAeS.
Hon. Secretary: N. G. TOOMEY, TEng, AMRAeS, c/o Monarch Aircraft Engineering Ltd (Planning Dept.), Luton International Airport, Luton, Beds. Tel: Work — 0582 424211. Ex. 226. Home — 0234 54185.

Manchester

President: Prof J. L. LIVESEY, CEng, MIMechE.
Chairman: J. TAYLOR, CEng, MRAeS.
Hon. Secretary: J. A. SHIMMIN, CEng, MRAeS, 26 Denison Road, Hazel Grove, Stockport, Cheshire. Tel: 061-439 5050. Ex. 3953.

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. Tel: 0634 44400.

Middle Wallop

President: Col. B. D. PORTER, CEng, MRAeS.
Chairman: D. J. WILLIAMS, Eng Tech.
Secretary: B. V. ADDISON, TEng, AMRAeS, 119 Bury Hill Close, Andover, Hants SP11 7NA. Tel: 0264 53352.

Preston

President: M. D. PARRY, FRAeS.
Chairman: A. G. BARNES, FRAeS.
Hon. Secretary: J. R. HUNTINGTON, MRAeS, British Aerospace plc, Military Aircraft Div, Warton Aerodrome, Preston, Lancs PR4 1AX. Tel: 0772 633333. Ex. 2282.

Prestwick

President: R. McINTYRE, FRAeS.
Chairman: J. THOMAS, MRAeS.
Hon. Secretary: R. FROST, AMRAeS, 5 Burnside Road, Monkton, Ayrshire KA9 2RL.

Sherborne

President: Air Marshal Sir E. DUNN, KBE, CB, BEM, CEng, FRAeS, RAF(Ret'd).
Chairman: J. L. MAYGER, TEng, AMRAeS.
Hon. Secretary: C. A. FRY, FRAeS, 46 Yew Tree Close, Yeovil, Somerset BA20 2PD. Tel: Work — 0935 702158. Home — 0935 74033.

Southampton

President: Professor G. M. LILLEY, FRAeS.
Chairman: B. W. MUDDLE, MRAeS.
Hon. Secretary: D. R. J. BAXTER, CEng, MRAeS, Dept of Aeronautics and Astronautics, The University, Southampton, Hants SO9 5NH. Tel: 0703 559122.

Southend

President: Vacant
Chairman: E. B. GOLDSPINK, Assoc. RAeS.
Hon. Secretary: D. M. GLADSTONE, MRAeS, 36 Brooke House, Town Square, Basildon, Essex SS14 1HX. Tel: 0268 284621; Work: 0268 22861. Ex. 207.

Stevenage

President: H. METCALFE, FEng, FRAeS.
Chairman: N. MUIR, CEng, FRAeS.
Hon. Secretary: J. M. SMITH, BAe Space & Communications Div., Argyle Way, Stevenage, Herts. SG1 2AS. Tel: 0438 313456. Ex. 6464.

Swindon

President: W. GILLESPIE, CEng, MRAeS.
Chairman: Sqn. Ldr. J. J. D. RICHARDSON, CEng, MRAeS.
Hon. Secretary: V. SIMON, 20 Hawkswood, Covington Park, Swindon, Wilts. Tel: 0793 25350.

Weybridge

President: N. V. BARBER, BA, MSc, FRAeS.
Chairman: B. W. PAYNE, CEng, FRAeS.
Hon. Secretary: K. J. DAVIES, CEng, MRAeS and Mrs. R. D. HARPER, MIPM, (Correspondence), British Aerospace plc, Military Aircraft Div., Richmond Road, Kingston-upon-Thames, KT2 5QS. Tel: 0932 45522. Ex. 6945.

Yeovil

President: V. A. B. ROGERS, 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

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: Lt. Col. Yeoh Kiat BOON, CEng, MRAeS.
Hon. Secretary: Capt. Koh Chen TIEN, AIROD, SDN. BHD, Locked Bag 4004, Pejabat Pos Kg Tunku, 47309 Petaling Jaya, Malaysia.

Pakistan

Chairman: M. M. SALIM, FRAeS.
Hon. Secretary: Dr. S. A. HASAN, MRAeS, PAF, College of Aeronautical Engineering, Korangi Creek, Karachi 2002, Pakistan.