# The AERONAUTICAL Journal

# **Contents**

L. J. Johnston
Solution of the Reynolds averaged
Navier–Stokes equations for
transonic aerofoil flows.

A. W. Bloy, V. Trochalidis and M. G. West
The aerodynamic interference between a flapped tanker aircraft and a receiver aircraft during air-to-air

P. A. O. Soviero and J. B. V. Wanderley Jet inflow simulation and its downwash effects on lifting surfaces.

Library reviews, additions, patent applications and reports.

**Incorporating** 

The Aeronautical Quarterly

Volume 95 Number 948 October 1991

refuelling.

# 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.

# AERONAUTICA OUPNAI Incorporating the Aeronautical Quarterly



Editor: J. M. Ramsden

Production Editor: **David Moore** 

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 2 Luke Street, London EC2A 4NT Tel: 071-613 0717 Fax: 071-613 1108

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: £160 per annum, post free.

RAeS members: £18.00 per annum.

Single copies, including back numbers: £18.

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

Tel: 0732 770823. Fax: 0732 361708 ISSN: 0001-9240

**PUBLISHED MONTHLY EXCEPT JUNE AND AUGUST** 

# **Contents**

# 253

L. J. Johnston Solution of the Reynolds averaged Navier-Stokes equations for transonic aerofoil flows.

# 274

A. W. Bloy, V. Trochalidis and M. G. West

The aerodynamic interference between a flapped tanker aircraft and a receiver aircraft during air-to-air refuelling.

P. A. O. Soviero and J. B. V. Wanderlev Jet inflow simulation and its downwash effects on lifting surfaces.

# 289

Library reviews, additions, patent applications 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: Air Vice-Marshal: R. Noble. Hon. Secretary: R. D. BARKLA, CEng, MRAeS, 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, CEng, MRAeS, PO Box 3813, Wellington.

Southern Africa President: B. H. PRESCOTT, CEng, FRAeS. Hon. Secretary: N. A. H. BARRAUD, CEng, MRAeS, PO Box 630, Kelvin, 2054, Republic of South Africa.

Zimbabwe President: K. A. BOLT, IEng FRAeS. Hon. Secretary: H. W. SMITH, FRAeS, PO Box 1931, Harare.

# **Bedford**

edford President: L. O. HUDSON, CEng, MRAeS. Chairman: A. M. McVITIE, FRAeS. Hon. Secretary: R. BAILEY, MRAeS, College of Aeronautics, Cranfield, Bedford MK43 0AL. Tel: 0234 750111. Ex. 2171.

# Relfast

errast President: M. I. WILD, CEng, MRAeS. Chairman: D. J. GRENVILLE, AMRAeS. Hon. Secretary: R. R. PARSONS, AMRAeS, 27 Mande-ville 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.

ioscombe Down
President: Air Cdre D. L. BYWATER, FRAeS, RAF
Chairman: Dr D. W. Williams.
Hon. Secretary: Wg Cdr P. L. WOOD, CEng, MRAeS,
ATG, Armament Division, A&AEE Boscombe
Down, Salisbury SP4 0JF. Tel: 0980 623331. Ex. 2572.

President: C. H. GREEN, CEng, 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**

rough
President: R. I. HARESCEUGH, CEng, FRAeS.
Chairman: Dr J. A. H. PETRIE, MRAeS.
Hon. Secretary: Mrs A. L. FERGUSON, Student RAeS,
British Aerospace (Military Aircraft) Ltd, Brough,
North Humberside HU15 1EQ. Tel: Work — 0482 667121. Ex. 5679.

Cambridge
President: Professor M. GASTER, FRS, CEng, FRAeS.
Chairman: K. WESTLEY, AMRAeS.
Hon. Secretary: D. WHITEHEAD, CEng, MRAeS,
Marshall of Cambridge (Engineering) Ltd, Airport
Works, Cambridge CB5 8RX. Tel: 0223 61133. Ex.

President: S. A. E. DYKE, MRAeS.
Chairman: Dr J. E. D. CHARLES-JONES, Associate
RAeS.
Hon. Secretary: C. E. MANN, Technician RAeS, 3 Fir
Tree Avenue, Westminster Park, Chester CH4 70Y.
Tel: 0244 682607.

# Christchurch

hristchurch President: M. J. COBHAM, FRAeS. Chairman: P. E. COURSE, MRAeS. Hon. Secretary: R. W. SMILLIE, Associate RAeS, Penny & Giles Control Ltd, Somerford Road, Christ-church, Dorset BH23 3RS. Tel: 0425 278821. Ex. 210.

Coventry
President: J. B. ROBERTS, CEng, FRAeS.
Chairman: Dr. B. D. HOBSON, CEng, MRAeS.
Hon. Secretary: R. I. RATCLIFF, IEng, Technician
RAeS. 6 Erithway Rd, Green Lane, Coventry CV3
6JT. Tel: 0203 413779.

Franwell
President: Air Vice Marshal R. M. AUSTIN, AFC,
CEng, FRAeS, RAF.
Chairman: Wg Cdr A. J. PARSONS, RAF.
Hon. Secretary: Sqn Ldr J. E. MORTON, CEng,
MRAeS. RAF College, Cranwell, Sleaford, Lincs
NG34 8HB. Tel: 0400 61201. Ex. 7237.

President: J. O. KEIR, FRAeS.
Chairman: D. C. COOK, CEng, MRAeS.
Hon. Secretary: C. J. ROBINSON, CEng, MRAeS, do
Compressor Technology, Rolls-Royce pic, PO Box 31,
Derby DE2 8BJ. Tel: 0332 249017.

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

Gatwick
President: R. ASHFORD, CEng, FRAeS.
Chairman: A. G. SAYCE, CEng, 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.

ilasgow President: Dr A. W. BABISTER, CEng, MRAeS. Chairman: F. J. MULLEN. Hon. Secretary: S. J. CRUICKSHANK, Student RAeS. T/L 123 Deanston Drive, Showlands, Glasgow G41 3LJ. Tel: 03352 78668.

Gloucester and Cheltenham
President: J. R. LIGHTFOOT, CEng, FRAeS.
Chairman: J. W. LINDLEY, CEng, MRAeS.
Hon. Secretary: R. F. J. McCARTHY, CEng, FRAeS,
Dowty Aerospace Gloucester, Cheltenham Road,
Gloucester GL2 9QH. Tel: 0452 711428.

# Halton

President: Gp Capt R. BRUMPTON, MRAeS, RAF.
Chairman: Wg Cdr C. G. R. GREAVES, CEng,
MRAeS, RAF.

MINASO, NAT.

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.

atfield
President: C. B. G. MASEFIELD, CEng, FRAeS.
Chairman: L. BALTHAZOR, CEng, FRAeS.
Hon. Secretary: J. SAUNDERS, MRAES, Research
Dept., British Aerospace (Commercial Aircraft) Ltd,
Hatfield, Herts AL10 9TL. Tel: 0707 255098.

Heathrow
President: LORD KING of WARTNABY, Comp. RAeS.
Chairman: G. A. TAYLOR, CEng. MRAeS.
Hon. Secretary: R. KENNEDY, IEng. AMRAeS,
British Airways (S.1), PO Box 10, Heathrow Airport,
Hounslow, Middx TW6 2JA. Tel: 081-562 3366.

Isle of Wight
President: Vacant.
Chairman: R. L. WHEELER, CEng, FRAeS.
Hon. Secretary: P. J. CHIVERS, CEng, MRAeS, Westland Aerospace, Castle Street, East Cowes, Isle of Wight PO32 6RH. Tel: 0983 294101, Ex. 2016.

# Loughborough

President: Professor G. L. WILDE, OBE, CEng, FRAeS. Chairman: M. F. POCOCK, Student RAeS. Hon. Secretary: Prof. S. J. STEVENS, CEng, MRAeS, Transport Technology Dept, Loughborough University of Technology, Loughborough, Leics. LE11 3TU. Tel: 0509 223404.

uton
President: J. M. RAINBOW, CEng, FRAeS.
Chairman: C. TURNER, CEng, FRAeS.
Hon. Secretary: N. G. TOOMEY, IEng, MRAeS, c/o
Monarch Aircraft Engineering Ltd (Planning Dept.),
Luton International Airport, Luton, Beds LU2 9LX.
Tel: Work — 0582 398542. Home — 0234 54185.

lanchester
President: Professor J. L. LIVESEY, CEng, MIMechE.
Chairman: M. J. TAYLOR, CEng, FRAeS.
Hon. Secretary: J. C. DEAN, MRAeS, British Aerospace (Commercial Aircraft) Ltd, Woodford,
Cheshire SK7 1QR. Tel: 061 439 5050. Ex. 3951.

President: Gp Capt. G. E. STIRRUP.

Chairman: Wg Cdr D. N. WILLIAMS, CEng, MRAeS.

Hon. Secretary: Fit Sgt N. P. KING, AMRAeS, 617

Squadron, RAF Marham, Kings Lynn, Norfolk PE33

9NP. Tel: 0760 337261 Ex. 4423.

Medway
President: P. A. HEARNE, Hon. FRAeS.
Chairman: G. R. SLEIGHT, CEng. MRAeS.
Hon. Secretary: R. T. TWINE, MRAeS, c/o GEC
Avionics Ltd, Airport Works, Rochester, Kent ME1
2XX. Tel: 0634 844400 Ex. 3534.

Middle Wallop
President: G. M. McCOOMBE, OBE, CEng, FRAeS.
Chairman: D. J. WILLIAMS, Technician RAeS.
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

reston
President: D. GARDNER, CEng, FRAeS.
Chairman: M. MANSELL, FRAeS.
Hon. Secretary: C. N. BENT, AMRAES, British Aerospace, (Military Aircraft) Ltd, Warton Aerodrome,
Preston, Lancs PR4 1AX. Tel: 0772 852284.

Prestwick
President: Dr W. G. WATSON, FRAeS.
Chairman: D. R. SHEPHERD, CEng, MRAeS.
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, President: AIr Marshal SII E. DUNN, RBE, CB, BEIM, CEng, FRAS, RAF(Ret'd).
Chairman: C. A. FRY, FRAeS.
Hon. Secretary: G. R. RUSSELL, Grad RAeS, 18
Berkely Court, Hermes Place, Ilchester, Somerset
BA22 8JU. Tel: 0935 704231.

Southampton
President: Professor G. M. LILLEY, CEng, FRAeS.
Chairman: M. DRASDO, MRAeS.
Hon. Secretary: D. R. J. BAXTER, CEng, MRAeS, Dept
of Aeronautics and Astronautics, The University,
Southampton, Hants SO9 5NH. Tel: 0703 592326.

# Southend

Outnend
President: BARONESS PLATT of WRITTLE, CBE,
FEng, FRAeS.
Chairman: M. NICOLINI, MRAeS.
Hon. Secretary: G. GILLIGAN, Associate RAeS, 21
Sandleigh Road, Leigh-on-Sea, Essex SS9 1JT. Tel:
0268 883102.

# Stevenage

tevenage
President: J. A. HOLT, FEng, FRAeS.
Chairman: Dr J. M. YOUNG, MRAeS.
Hon. Secretary: A. C. K. CRESSWELL, CEng, MRAeS,
PB067 British Aerospace (Dynamics) Ltd, Six Hills
Way, Stevenage, Herts SG1 2DA. Tel: 0438 752027.

# Swindon

William President: Professor M. G. FARLEY, CEng, FRAeS. Chairman: Wing Cdr A. R. HILL. 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. J. DAVIES, CEng, MRAeS, Aerodynamics Department, British Aerospace, (Military
Aircraft) Ltd, Richmond Road, Kingston-uponThames KT2 5QS. Tel: 081-546 7741. Ex. 2895.

# Yeovil

eovii President: V. A. B. ROGERS, CBE, FEng, 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, MRAeS, 8 Georgiou Christodoulou, 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.

relaysta
Chairman: Brig. Gen. Dato' M. MUSLIM AYOB,
RMAF, CEng, FRAeS.
Hon. Secretary: Major LATIF, MRAF, Dept of the Air
Force, Ministry of Defence, Jalan Padang Tembak,
50634 Kuala Lumpur, Malaysia. Tel: 03-2354010.

Chairmar: S. AJAZ ALI, CEng, FRAeS. Hon. Secretary: Dr. S. A. HASAN, CEng, MRAeS, 4th Floor, IEP Building, 177/2 Liaquat Barracks, Karachi 75530, Pakistan. Tel: 92-7780233.

Toulouse
Chairman: S. G. CORPS, FRAeS.
Hon. Secretary: W. A. N. FORD, CEng, FRAeS,
Chresties, Avenue du Bouconne, Levignac 31530,
France. Tel: Work — (33) 6193 3560.
Home (33) 61 85 4258.

8/91