

The JOURNAL of NAVIGATION

VOL. 42 NO. 1

JANUARY

1989

Precise Navigation, Guidance and Control Services within the Agricultural Community	1
R. J. PALMER	
A Brief History of Ancient Chinese Sailing Directions	11
SUN GUANG-QI	
The 'Automatic Gun Laying System' – A Quantum Enhancement for the Royal Artillery	31
G. B. SYMONDS	
Aircraft Automatic Landing Systems Using GPS	47
B. W. PARKINSON AND K. T. FITZGIBBON	
The Ship's Wheelhouse of the Nineties: the Navigation Performance and Mental Workload of the Officer of the Watch	60
H. SCHUFFEL, J. P. A. BOER AND L. VAN BREDA	
Air Navigation Systems	73
J. E. D. WILLIAMS	
Automatic Conflict Detection Logic for Future Air Traffic Control	92
S. RATCLIFFE	
Knowledge-based Collision Avoidance	107
F. P. COENEN, G. P. SMEATON AND A. G. BOLE	
ARPA Accuracy Testing	117
A. S. LENART	
Benefits of 'Area Navigation' in Regional Aviation	124
D. M. WALLACE	
Navigating Along Geodesic Paths on the Surface of a Spheroid	129
R. WILLIAMS AND J. E. PHYTHIAN	
A New Suncompass: Orientation Independent of Clock Time	137
J. A. F. DE RIJK	
Aspects of de Wit's Equations Governing the Apparent Spontaneous Yaw of a Ship	144
J. O. FLOWER	
'The Distribution of Navigational Errors'	151
A. W. F. EDWARDS	
The Author Replies	151
P. ČUMBELIĆ	
Record	152
Reviews	155

THE ROYAL INSTITUTE OF NAVIGATION
OXFORD UNIVERSITY PRESS

THE ROYAL INSTITUTE OF NAVIGATION

Patron

HRH THE PRINCE PHILIP DUKE OF EDINBURGH, KG, KT, OM

*OFFICERS AND COUNCIL 1988-9**President*

Sir John Charnley, CB

Vice Presidents

N. B. Dahl

Rear Admiral A. F. R. Weir, CB

Treasurer

J. H. Beattie

Chairman of the Technical Committee

Air Cdre D. F. H. Grocott, CBE, AFC, RAF

Chairman of the Membership & Fellowship Committee

Wg Cdr E. E. Eatwell, RAF

Other Members of Council

H. J. Agnew

J. C. Bell

B. D'Oliviera

Air Marshal Sir Barry Duxbury, KBE, CBE, RAF

Captain B. S. Greive

Rear Admiral R. O. Morris

D. Halliwell

L. Lee

R. D. Pike

S. G. Smith

 Director Rear Admiral R. M. Burgoyne, CB

THE JOURNAL OF NAVIGATION

The *Journal* is published three times a year by Oxford University Press and is edited by Professor J. F. Kemp. It contains original papers contributing to the science of navigation, including those presented at the meetings of the Institute together with the ensuing discussion. In addition the *Journal* includes a record of current navigational work, reviews of important books, and other matters of concern to those interested in navigation. The views expressed in the *Journal* are not necessarily those of the Institute, or of any organization or department to which the authors may belong. Crown Copyright may be reserved. Any facts stated or opinions expressed in this *Journal* are the sole responsibility of the contributors. Neither the Royal Institute of Navigation, the Editor nor the Publishers can be held responsible for any injury or loss sustained in reliance thereon.

The *Journal* (ISSN 0373-4633) is issued free to all Members of the Institute. The subscription price to non-members for Volume 42, 1989, is £65 (US \$110 in N. America, £52 in the UK); single parts are available at £23 (US \$40 in N. America, £19 in the UK). Prices include postage by surface mail or, for subscribers in the USA, Canada, Japan, Australia and New Zealand, by Air Speeded Post. Airmail rates are available on request. Back issues are sold at the current single issue rate. Please send orders and requests for sample copies to the Journals Subscriptions Dept, Oxford University Press, Walton Street, Oxford OX2 6DP, UK. Telex 837330 OXPRESG. Payment is required with all orders and subscriptions are accepted and entered by the volume.

Enquiries for advertising space should be addressed to the Journals Advertising Coordinator, Journals Production Dept., Oxford University Press at the address given above.

The postal address of the Institute is The Royal Institute of Navigation, at The Royal Geographical Society, 1 Kensington Gore, London SW7 2AT (Telephone: 01-589 5021).