

range, which are as a rule final and irrevocable; a typical encounter involves two autonomous agents with conflicting or at least diverging interests and incomplete information further accentuates the crisis. The appropriate mathematical theory for an analysis of conflict is the theory of games, in particular differential games dealing with systems changing continuously with time. The dilemmas and predicaments facing the mariner forced to execute an anti-collision manoeuvre are discussed in the light of results obtained by the application of the theory of differential games.

MATHEMATICAL MODELLING OF SHIP MANŒUVRING, by A. D. Gill.

This paper describes the results of work carried out at the National Maritime Institute on the representation of ship manoeuvring behaviour by mathematical models. The choice of equations and determination of coefficient values are discussed. Two particular non-linear models are described, a general model which provides a close approximation of the complicated motion of a vessel under a wide range of helm and engine orders and a simpler special model with a more limited range of validity. Solutions of the equations to obtain the steady turning characteristics and dynamic stability characteristics are also included.

A PROGRAM FOR COLLISION AVOIDANCE AND TRACK KEEPING, by J. Kearon.

An investigation into the feasibility of having a periodically unmanned navigational bridge was carried out at Liverpool Polytechnic. The computer program developed took into account collision avoidance manoeuvres in accordance with the 1972 Collision Regulations and navigational aspects such as track keeping, position fixing, regaining a planned track and allowing for set and drift. The programs, exemplifying the readiness of an experienced mariner, might be used directly or with minor adjustments in mathematical models of traffic in convergence zones or coastal routes.

AN ANALYSIS OF THE DANGERS OF SHIPS OVERTAKING, by R. G. Curtis.

This paper describes a theoretical model of a ship being overtaken by another vessel on a parallel track. It is assumed that the overtaken vessel may make a course alteration across the track of the overtaking vessel. Predictions of collision time and minimum safe overtaking distance are made for various situations. The collision risk time, risk exposure time, and probability of collisions are examined. The model predicts that many ships are running a risk of collision by overtaking too close.

SHIPPING OPERATIONS IN THE SUEZ CANAL, by J. D. Griffiths and E. Hassan.

Published in this issue.

Armando Zusarte Cortesão

MEMBERS of the Institute will be sad to learn of the passing of its celebrated Honorary Member Professor Dr. Armando Cortesão: his death occurred at the advanced age of 86 in Portugal in November 1977.

Professor Cortesão was an eminent Portuguese man of letters and an international and respected figure in the field of the history of cartography. For many years, up to the time of his death, he occupied the Chair of Maritime History at the University of Coimbra. During his long and fruitful life his numerous contributions to the history of the early period of the Golden Age of the Discovery of the Sea have added fresh lustre in particular to the Portuguese cosmographers and mariners who were inspired by Prince Henry the Navigator, and to the Portuguese nation in general. For it must be remembered that it was the Portuguese nation, numbering fewer than two million people who, in the sixteenth century, by opening up the world to oceanic trade, set the stage on which the subsequent history of mankind has been so significantly conditioned. The history of the Portuguese discoveries and the associated histories of navigation and cartography, have been, for more than a century, of major interest to Portuguese historians, and Armando Cortesão has stood as a giant among many. He was the author of numerous papers and works on the subject to which, with unflagging energy and untiring zeal, he devoted many decades of his life. Among his major works are *Cartografia e Cartógrafos Portugueses dos Séculos XV e XVI*, published in Lisbon in 1935; *Cartografi a Portuguesa Antiga*, published in Coimbra in 1960; and, with Captain Avelino Texeira da Mota of the Portuguese Navy, the monumental work, published in Coimbra in 1960–2, *Portugaliae Monumenta Cartographica*. This magnificent work records the history of Portuguese cartography during the sixteenth and seventeenth centuries, the period of its greatest brilliance. Professor Cortesão also edited two works, *Suma Oriental of Tome Pires* and *The Book of Francisco Rodrigue*, which were published for the Hakluyt Society in 1944. More recently, he produced the first two (of a proposed three) volumes of another splendid work, *The History of Portuguese Cartography*, volume 1 appearing in 1969 and volume 2 in 1971. In the introduction to this work Cortesão explained that the work is intended not only for the inner circle of academic specialists, but 'above all for my students'—and a worthy work for all students of cartography, at all levels, it certainly is. His latest book, the contents of which were originally intended to form part of volume 3 of *The History of Portuguese Cartography*, is *The Mystery of Vasco da Gama*. This book, published in 1973, is a penetrating study of the commander-in-chief of the most important expedition in the maritime history of Portugal. Most of Professor Cortesão's recent works, with numerous others on Portuguese maritime history, stemmed from the 'Agrupamento de Estudos de Cartografia Antiga' which was established in the University of Coimbra by Professor Cortesão in 1961. These works were published by the 'Junta de Investigações do Ultramar', a governmental organization.

Between 1935 and 1946 Professor Cortesão resided in London, and among the many honours bestowed upon him was the Gold Medal of the Royal Geographical Society for 1960.

The death of one of Portugal's leading men of letters will sadden not only the Professor's immediate friends and colleagues but all who have come to know him through his numerous and brilliant contributions to the history of the art and science of cartography.

Charles H. Cotter.