

Durham E-Theses

*The development and interchange of navigational
information and technology between the maritime
communities of Iberia, North-Western Europe and
Asia, 1500-1620*

R. C. D. Baldwin

How to cite:

Baldwin, R. C. D. (1980) The development and interchange of navigational information and technology between the maritime communities of Iberia, North-Western Europe and Asia, 1500-1620. Masters thesis, Durham University.

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a <https://etheses.durham.ac.uk/id/eprint/7997/> is made to the metadata record in Durham E-Theses
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the [full Durham E-Theses policy](#) for further details.

R.C.D.BALDWIN

The Development and Interchange of Navigational Information
and Technology between the maritime communities of Iberia,
North-Western Europe and Asia, 1500-1620.

Thesis submitted for the degree of
M. Litt.
University of Durham ,

April 1980.

The copyright of this thesis rests with the author
No quotation from it should be published without
his prior written consent and information derived
from it should be acknowledged



14 MAY 1984



Volume 1

ABSTRACT

This thesis examines the development of navigational technology and its subsequent transmission through various means to the emergent maritime powers of NorthWestern Europe. Since the fifteenth century the Portuguese, and to a lesser extent the Castillians had sought to impose a bureaucratic system of commercial security to prevent the exploitation by foreigners of the technical and cartographic knowledge available within their hydrographical agencies, navigation schools, and official trading monopolies. Some controversies over this are reviewed, but it is concluded that the most important feature of this technology was its international nature, even though until the 1540's this was disguised by Iberian security. This meant Portuguese sailors could share in a productive series of technical interchanges with Asian mariners after 1500. Possibly by the late sixteenth century they had come to rely too heavily on Asian information, Luso-Asian cartographers, and Asian pilots. This meant that once Northern European powers had obtained translations of Iberian navigation manuals, and taken Iberian experts into their service, they could quickly attain such proficiency as to sail directly into Asian or Pacific waters and themselves participate in similar interchanges.

This proved significant technically and politically because the Iberians were unable to place an effective security blanket on the interchange of navigational information in Asia. Asian waters had been typified by some long-standing traditions of relatively free interchange of such technology between seamen of different civilisations. Just as this mutually enriched Asian traditions, so it was also exploited by the Iberians and later European rivals. These interchanges are examined in chapters on the Arab, Indian, Indonesian Pacific, Chinese, and Japanese interchanges. They hastened the development of a world economy, and the decline of the sixteenth century Portuguese Empire and monopoly of Asia's oceanic trade.

CONTENTS

Volume I

	Page
Frontispiece	
Liverpool University MS. 4.3. Chart of the Iberian Peninsula, probably by Diogo Homem, c.1558-1560.	
Acknowledgements	i
Conventions and Abbreviations	iii
List of Illustrations	vi
Introduction	1

PART I

Chapter 1 - The Origin of Official Portuguese Navigational Services (1317-1520).	38
Chapter 2 - The Development of Portuguese Navigational Services (1520-1580).	84
Chapter 3 - The Organisation and Nature of Spanish Navigational Services prior to 1580.	114
Chapter 4 - The dissemination and decline of Iberian navigational skill (1580-1620).	155
Chapter 5 - The navigational interchanges of North Western Europe before 1580.	196

PART II

Chapter 6 - Asian influence and the slackening of official Iberian navigational policies.	254
Chapter 7 - The Arab Interchange.	284
Chapter 8 - The Indian Interchange.	330
Chapter 9 - The Indonesian Interchange.	351
Chapter 10- The Pacific Interchange.	384
Chapter 11- The Chinese Interchange.	437
Chapter 12- The Japanese Interchange.	479
Chapter 13- Conclusions.	511
Appendix 1	530
Appendix 2	539
Appendix 3	549
Bibliography	550

Volume II

Captioned Illustrations - Figures 1-66.

ACKNOWLEDGEMENTS

The preparation of this work has involved many individuals and bodies to all of whom I am grateful. To mention all would be my wish, but as it is impossible to refer to them all by name, I record here some of them.

From my first expression of interest in Richard Eden in 1974, Dr. David Loades has encouraged me to pursue this subject, and offered very helpful advice as my tutor and supervisor, both over my B.A. Dissertation entitled *The Iberian Influence on English Navigation, 1540-1570*, submitted in 1975, and subsequently over the research presented in these two volumes.

The staff of Durham University's various libraries have been most helpful, but the Keeper of Rare Books and Reader in Bibliography, Dr. A.I. Doyle, together with Miss E. Rainey, Dr. A.D. Burnett, and Mrs. M. Hird at Palace Green Library and Dr. S.V.R. Char at the Oriental Library, all deserve mention. At St. Chad's College the Vice Principal, the Rev. P.F. Johnson and his predecessor the Rt. Rev. G. Roe, extended to me the most special opportunities in respect of the college library, while Dr. Fagg of the University Palaeography and Diplomatic Department and the Dean and Chapter of Durham Cathedral gave further assistance. Other notable advice about Spanish and Portuguese sources was given by the late Dr. P. Brightwell of the History Department, Mrs. Henderson of the Spanish Department, and by my former student colleague Miss Mia Rodriguez Salgado of St. Andrew's University. Over the Chinese sources Mr. David Helliwell, another colleague of mine as a student at Durham University who is now at the Bodleian, gave much scholarly assistance.

The staff of the National Maritime Museum, Greenwich have made a great contribution in helping me to exploit the Museum's rich resources for such study. Particular mention must be made of the Director, Sir Basil Greenhill, who has authorised many of the illustrations, and the former Deputy Director and Head of the Navigation Department, Lt. Cmdr. D.W. Waters, who has taken a kindly interest since 1974. Lt. Cmdr. D. Howse, Mr. Stimson and other members of the Navigation Department have always given me the most thoughtful attention, while Dr. R. Knight and Miss M. Deacon of the Manuscripts Department, Mr. D.V. Proctor now Head of Printed Books, Mr. P. Sugg of the Education Department, and Mr. P. Van der Merwe have all taken much trouble in answering my many questions and requests, while their colleagues who have manned the Reading Room have always been most helpful. The Museum as hosts of two most valuable international conferences has provided me with the chance to meet in person other correspondents and to be introduced to many overseas scholars. Amongst whom I am particularly grateful to have met A. Teixeira da Mota, Dr. G. Schilder and Dr. C. Koeman.

My thanks must also go to the staff of the British Library Reference Division, and the British Museum Manuscripts and Maps Departments, especially Dr. Helen Wallis & Dr. J. Hudson; Dr. Ratcliffe and Ann Young at the John Rylands Library, Manchester; Mr. Bloomfield, Mr. A. Cook and Mr. Moir of the India Office Library and Records; Mr. Perkin, Curator of the Special Collection at Liverpool University, who has taken much trouble and arranged for several of the photographs; the Librarians of Liverpool City Libraries, especially the photographic departments; Mr. Stammers of the new Merseyside Maritime Museum and Mr. T. Whitehead of B.S.C.; Dr. Mason of Christ Church College, Oxford, and the Librarian and

staff at Magdalene College's Pepysian Library, Cambridge; Miss M. Williams and Miss J. Close at Bristol City Record Office; the Librarian and staff at Bristol Reference Library; and those at Southampton Record Office, the Public Record Office, the National Gallery, the Royal Scottish Museum, Edinburgh, and the Manchester City Reference Library; and Mr. Richard Nicolson of Chester who has provided much photographic help, supplemented by Will. A. Rose of Chester.

Some most useful and formative correspondence has been exchanged with Dr. Scammell of Pembroke College, Cambridge, Dr. Melvin Jackson of the Smithsonian Institution, Washington D.C., and with the former Professor of Modern History at Liverpool University, Dr. D.B. Quinn.

My personal thanks are also due to Dr. De Cossart, Liverpool University History Department, for help with the Italian translations, to Canon J.C. Fenton, formerly Principal of St. Chad's College, for much encouragement and for arranging that I saw Martin Llewellyn's Atlas at Christ Church, Oxford.

Most importantly, I owe very special thanks to my family without whose encouragement and help this work would never have been possible. The help given by my father and my brother has been tremendously generous and practical, as has my mother's support also. To Mrs. Maureen Price of Stafford who has typed the text I also owe the warmest thanks for a vast and devoted effort. Lastly the staff at Old Shire Hall at Durham University have copied and bound Volume I, and Mrs. Barbara Downes who has helped me collate this volume.

R.C.D. BALDWIN.

April, 1980.

CONVENTIONS AND ABBREVIATIONS

Chronological conventions, especially those concerned with the various types of calendar in use in different parts of the world, present a highly complex problem. A simplified account of the various systems is however available in Whitakers Almanack for 1967 pages 185-194. There is also a discussion in C.R.Cheney, Handbook of Dates for students of English History, Royal Historical Society, 1961, pages 1-11. The convention adopted in writing this thesis has been to use the dates given on the documents in respect of any specified day, but no adjustment has been made in respect of the days lost in the adjustment from Julian to Gregorian calendars. Though to avoid confusion double dating of days was adopted on relevant diplomatic correspondence with Europe, this was largely confined to English diplomatic letters written from the latter part of Elizabeth's reign onwards. In 1582 Pope Gregory XIII ordained that October 5th should be the 15th, and that of end of century years only the fourth should be a leap year. This was done in Italy, Spain and Portugal. France made the adjustment on 10th 20th December 1582, and the Spanish Netherlands, Denmark and Norway on 15/25th December 1582. Prussia, German Roman Catholic states, Holland, and Flanders, together with some Swiss cantons followed in January 1583. and similar adjustments were made in Poland 1586 & Hungary, 1587, but the 18th century alterations required the adjustment to be 11 days. The German Protestant states, Netherland Protestant states and part of Denmark adjusted in 1700, Great Britain and Her Dominions in 1752. All did it in slightly different ways, but by then an adjustment of 11 days was needed. Great Britain did it by reckoning September 3 as the 14th, while Sweden did it by omitting the 11 days between 1700 and 1740. Japan was required to adjust to it with effect from 1st January, 1873.

In China until 1911 dating was based on a Lunar calendar as is still used in areas that had come under this cultural influence, e.g. Hong Kong, Singapore, Malaysia and other parts of South East Asia. From 645 Japan had used a similar system, reference being defined within eras, the changeovers now corresponding to accessions of Emperors, but their actual names are not necessarily used. The Muslim Calendar dates from July 16th 622 A.D., and was used in the Arab world and India. India has also used a system of six eras, but since 22 March 1957 they have run with official concurrence alongside the Gregorian one that had long been used by Europeans there.

The terms 'oldstyle' and 'new style' have therefore been deliberately avoided as it would not be clear to which system they applied. Herein such reference has always been made by the Christian Calendar, and not by the Iberian variant of it which by comparison with it begins on 1st January 38 B.C. but had been dropped in most parts by 1420 A.D.. Where confusion might arise over the period 1st January to 25th March, all years are begun as from 1st January, not 25th March. Where there arise special points footnotes are added, as has been done in respect of some correspondence now in the India Office Library.

Lastly on question of time it should be noted that sailors normally used the normal day, midnight to midnight, except for the formal navigational record in a log book, where the day ran from midday to midday as determined by solar observation from the time suitable instruments were used in conjunction with a written record. The Royal Navy did not stop this practice until October 1805, but it persisted

elsewhere. It is thus necessary to know that a record of the courses taken during a watch was kept on a traverse board like the one shown in Fig 66, where one peg was put into an appropriate hole representing the compass course taken during the previous half hour. (Other notes might be kept on Slates). These were then written up as the events of day running 12 hours in advance of the landlubbers' day. Early Pacific crossers puzzled contemporaries from Europe, but they did notice the dayloss/gain effect, now formally defined by reference to the International Dateline.

Asian languages have been approached without the author knowing any, and therefore a translator's phonetic equivalent^s used, but an effort, with the advice of experts, has been made to reduce a multiplicity of practices to a standard set for Chinese, (Wade Giles rather than variants like Needham's), Japanese, Arab, Indian, Persian and other Asian languages.

Abbreviations have been used and are listed separately. Long titles will be found in the Bibliography and in the footnotes on first use, though some of the very longest will only be found in the Bibliography. In footnotes after first mention a telescoped form is often used where the title is long and frequently used. The telescoped form is always distinctive and follows popular practice e.g. Purchas, His Pilgrime or for a modern work E.G.R. Taylor, Haven Finding Art.

TABLE OF ABBREVIATIONS

A.G.I.	Archivo General de Indias, Seville.
B.M.	British Museum, London.
B.L.	British Library, (at the British Museum)
con't	continued
C.U.P.	Cambridge University Press.
D.I.	Coleccion de Documentos inéditos para la Historia de España, Volume 21 (See Bibliography under Navarette)
E.I.C.	East India Company, (English)
Fol.	folio.
F.R.S.	Fellow of the Royal Society.
F.S.A.	Fellow of the Society of Antiquaries.
Hak. Soc.	Hakluyt Society.
H.M.S.	His/Her Majesty's Ship.
H.M.S.O.	His/Her Majesty's Stationery Office.
I.C.H.C.	International Conference on the History of Cartography, (papers delivered at the 6th conference, Greenwich, 1975.)
I.J.N.A.	International Journal of Nautical Archaeology and Underwater Exploration.
I.O.R.	India Office Records and Library, London.
" (U.C)	" " " " , Original Correspondence from India with collateral documents originating at any place between England and Japan from 1603-1708.
" MSS.Eur.	India Office, European Manuscripts
J.I.N.	Journal of Navigation (Royal Institute of Navigation)
Kelly	KELLY, Celsus, O.F.M., La Australia del Espíritu Santo The Journal of 'ray Martin de Munilla O.F.M. and other documents relating to the Voyage of Pedro Fernandez de Quiros to the South Sea, (1605-1627) translated and edited by Celsus Kelly, O.F.M. with ethnological introduction, appendix and other contributions by G.S. Parsonson. Hakluyt Society Series II, Volume cxxvi and cxxvii, Cambridge, 1966.
M.I.T.	Massachusetts Institute of Technology.
M.M.	Mariners Mirror (Society for Nautical Research)
MS.	Manuscript.
MSS.	Manuscripts.
N.M.M.	National Maritime Museum, Greenwich.
N.R.S.	Navy Record Society.
O.F.M.	Ordinis Fratrum Minorum
O.U.P.	Oxford University Press.
P.M.C.	Portugalia Monumenta Cartographica, Comissão Executiva das Commemeracoes de Quinto Centenario do Infante D. Henrique, Lisbon, 1960. (5 volumes and Index) (See Bibliography, Translations, under the authors A. Cortesao and A. Teixeira Da Mota.)
S.C.C.	Science and Civilisation in China, Cambridge University Press, (See under author J. Needham in Bibliography)
SEVPEN	Services d' Edition, et de Vente des Productions de l'Education Nationale, (Paris)
Univ.	University.
U.S.N.I.P.	United States Naval Institute Press.
V.O.C.	
Vol.	Volume.
6ieme Colloque	Actes de Colloque international d' Histoire Maritime (and likewise for other numbered colloqu

LIST OF ILLUSTRATIONS

- Frontispiece Title page of Sir Henry Mainwaring's treatise on navigation, c. 1623.
- Fig. 2 Frontispiece of W.J.Bleau's Light of Navigation 1612.
- Fig. 3 Woodcut map of Burma and East India, 1482.
- Fig. 4 Woodcut map of Africa, 1508.
- Fig. 5 Chart of the Atlantic, 1558.
- Fig. 6 Portuguese astrolabe, 1555.
- Fig. 7 World atlas of Diogo Homem, c. 1558.
- Fig. 8 Use of the astrolabe, 1552.
- Fig. 9 Spanish astrolabe, 1563.
- Fig.10 Title page of Martin Cortes's navigation manual, 1551.
- Fig.11 Woodcut of the Atlantic from Richard Eden's translation of Martin Cortes's navigation manual.
- Fig.12 Engraved map of the Guadalquivir Estuary and Cadiz, 1579.
- Fig.13 Plan view of the major buildings in Seville.
- Fig.14 Title page of Manuel de Figueiredo's Roteiro e Navegacao, 1609.
- Fig.15 Title page of Antonio de Leon Pinelo's bibliography of travel, 1629.
- Fig.16 Benzoni's woodcut map of the East Indies from Ramusio's Navigazioni et Viaggi.
- Fig.17 The Ambassadors by Hans Holbein the Younger, 1536.
- Fig.18 Sebastian Cabot. Engraving by S. Rawle, 1824, from lost portrait by Holbein.
- Fig.19 King Phillip and Queen Mary, painting after Hans Eworth, 1555.
- Fig.20 Planisphere by Joan Martines, c. 1572.
- Fig.21 Mariners using an astrolabe, 1575.
- Fig.22 Abraham Ortelius, 1579.
- Fig.23 Map of the Far East from Ortelius's Theatrum Orbis Terrarum, 1584.
- Fig.24 Title page from Jan Van Linschoten's Discours of Voyages into ye Easte and west Indies, translated 1598.
- Fig.25 Part of chart of the East Indies from Linschoten's Reysche schrift, 1595.
- Fig.26 Letter from King James I to the Emperor of China, 1613.
- Fig.27 Title page of Edward Wright's Errors of Navigation, 1610.
- Fig.28 Italian mariner's compass, c. 1580.
- Fig.29 Declination tables from notebook in use 1596-1616.
- Fig.30 Use of the kamal, c. 1850.
- Fig.31 Arabs using a fixed quadrant, standing staff, water or sighting level and portable quadrant, 1524.
- Fig.32 Part of chart by Harmen and Martin Jansz, 1597.
- Fig.33 Self-portrait of Manuel Godinho de Erédia from his Atlas of 1613.
- Fig.34 Map of Java Minor by Manuel Godinho de Erédia from his Atlas of 1613.
- Fig.35 Fragment of chart by Harmen and Marten Jansz, c. 1605.
- Fig.36 Capture of Bantam by the Dutch, 1597.

- Fig.37 Map of Asian waters, vignettes and views made by W.J. Bleau in 1631.
- Fig.38 Title page of Vaz Dourado's Atlas, 1568.
- Fig.39 Chart by Vaz Dourado of the Straits of Magellan, c. 1575.
- Fig.40 Chart by Vaz Dourado of the East of Asia, 1570.
- Fig.41 Double portrait of G. Mercator and J. Hondius, 1638.
- Fig.42 Chart engraved c. 1595 by Jodocus Hondius of the courses of Drake's and Cavendish's circumnavigations of the world.
- Fig.43 Sir Francis Drake, oil painting by Marcus Gheeraerts, 1591.
- Fig.44 Micronesian 'stick and stone' chart.
- Fig.45 Chinese mariner's compass, c. 1760.
- Fig.46 Chinese chart of Indian Ocean drawn after Cheng Ho's expedition in the early 1400s and printed in 1621.
- Fig.47 Sailing-diagram for Chinese ships sailing between Ceylon and Sumatra from the Wu Pei Chih, 1621.
- Fig.48 Two pages from Kuang Yu Thu by Lo Hung Hsien c. 1555.
- Fig.49 Map of China engraved for Purchas's Pilgrimes, 1626.
- Fig.50 Anonymous manuscript map of China, 1609.
- Fig.51 Map of China from Alonso de Santa Cruz's Isolario, as amended, c. 1606.
- Fig.52 Rodrigues's chart of the Canton River, c. 1515.
- Fig.53 Representation of Western Europe from Chinese map of 1615.
- Fig.54 Equatorial sundial illustrated in the Huang Ch'ao Li Ch'i Thu Shih.
- Fig.55 Ivory scaphe dial from Japan, 1879.
- Fig.56 Japanese chart copied from the San Philippe chart, 1596.
- Fig.57 'Demarkation' chart by Lopez de Velasco, c. 1575.
- Fig.58 Compass rose from Koh-un Ikeda's Genna Kokaisho, 1618.
- Fig.59 Compass rose from Richard Eden's Arte of Navigation, 1561.
- Fig.60 Portable quadrant illustrated in Koh-un Ikeda's Genna Kokaisho, 1618.
- Fig.61 Japanese instructions for graduating an astrolabe from Koh-un Ikeda's Genna Kokaisho, 1618.
- Fig.62 Astrolabe from Koh-un Ikeda's Genna Kokaisho, 1618.
- Fig.63 Astrolabe found in Valencia Island, Ireland, c. 1588.
- Fig.64 Rodrigues's panorama of the coast of Samadenga, c. 1515.
- Fig.65 Woodcut of features of the sea-bed from Pierre Garcie's Le Grant Routier, 1521.
- Fig.66 Sixteenth century traverse board.

INTRODUCTION

"Thus should man at once lose half his inheritance if the Art of Navigation did not enable him to manage this untamed beast /the sea/, and with the bridle of the wind, and saddle of his shipping, to make him serviceable. Now for the services of the sea they are innumerable. It is our great Purveyor of the world's commodities ... /and/ the sea yields Action to the bodie, Meditation to the Mind, the World to the World by the Art of Arts, Navigation."¹

So wrote England's Stuart propagandist of maritime expansion, Samuel Purchas. His statement, made after extensive study of maritime affairs, shows that he appreciated the international significance of the art of navigation which had developed in such a way as to transform not only the technology of navigation, but the contacts, trades and intellectual outlooks of western Europe and the Asian littoral. Thinking of navigation as a technical operation, the need for which goes unquestioned by today's travellers, we are apt to overlook its significance to the men of the fifteenth, sixteenth and seventeenth centuries. They saw a rapid advance in the art and skill of the navigator, and in the sci-

¹ Samuel Purchas, His Pilgrimes, London 1625. Book 1, section 6, p.17. The work's full title is Hakluytus Posthumus or Purchas His Pilgrimes, contayning a History of the World or sea voyages and land travells, by Englishmen and others. Wherein God's Wonders and Nature and Providence, The Actes, Artes, Varieties, and Vanities of Men, with a world of the worlds Rarities, and by a world of Eyewitness Authors related to the World. Some left written by Mr. Hakluyt at his death, More since added, His also perused and perfected. All examined, abbreviated, Illustrated with Notes, Enlarged with discourses, Adorned with Notes, and Expressed in Mapps. In fower parts. Each containing five Books. by Samuel Purchas B.D. Imprinted at London by Henry Fetherstone at the sign of the Rose in Pauls Churchyard 1625.



ence of the design and manufacture of his instrument and in the measurements taken therewith, and recorded systematically on his charts and in his log and journals. Yet, first to the Iberians, and by the mid-sixteenth century to the people of North-Western Europe, navigation was as new a technology as nuclear power is today, giving rise to somewhat similar political and commercial concerns over security and the international interchange of knowledge - concerns which could change a possessor's economic prospects without regard to the possession of indigenous natural resources. A further respect in which we must adjust our modern attitudes towards the use of the term 'navigation' is a function of the mobility of our present day society.² Whereas today the need for navigation on a long seaborne or airborne journey has become implicit, and is assumed for long-distance land travel, sixteenth century men would have understood the word as meaning only the art of conducting a ship safely across the sea

²The definition of navigation given by the Spaniard Martin Cortes, who wrote at Cadiz in the early 1540s, perhaps the most influential of all sixteenth century navigational manuals, Breve Compendio del Arte de Navegar published at Seville in 1551 reads as follows in Eden's translation of 1561 (Part III, Chapter II, fol.1vi):

"I say that navigation or sayling is none other thing than to journey or viage by water from one place to another".

The Arte of Navigation conteynyng a compendious description of the Sphere, with the making of certen instruments and rules for Navigations: and exemplified by manye Demonstrations. Written in Spanyshe tongue by Martin Curtis And directed to the Emperour Charles the fyfte. Translated out of Spanyshe into Englyshe by Richard Eden 1561. Colophon "Imprinted at London in Powles churchyard by Richard Jugge, Printer to the Quenes Majestie".

by the shortest (and therefore cheapest) convenient route between two accurately definable parts of the world. John Dee in 1570 wrote the best sixteenth century definition of navigation which reads as follows:

"The Arte of Navigation, demonstrateth how, by the shortest good way, by the aptest Direction, and in the shortest time, a sufficient Ship, betwene any two places, (in passage Navigable,) assigned; may be conducted: and in all stormes and naturall disturbances chauncyng, how, to use the best possible means whereby to recover the place first assigned ... "3

However, what Purchas was enthusing over, and what made the real difference to fifteenth and sixteenth century European attitudes towards the sea, was the development of the techniques and instruments of celestial navigation. These were exactly what Dee continued his definition to discuss. The evolution of this navigational technology is discussed in the early chapters of this thesis, so it will suffice to say here that the scientific revolution which took place in fifteenth century Portugal led to a series of technical improvements

3 H. Billingsley,
The Elements of Geometrie of the most ancient Philosopher Euclide of Megan, Faithfully (now first translated into Englishe tounge by H. Billingsley, Citizen of London. Whereunto are annexed certaine Scholies, Annotations and Inventions, of the best mathematicians, both of time past, and in our age. With a very fruitfull Praeface by M. I. Dee, specifying the chief Mathematicall sciences, what they are and whereunto commodius, where also are disclosed certaine new Secrets Mathematicall and Mechanicall, until these our daies, greatly missed. Imprinted at London by John Daye. 1570. Preface: Section on the Arte of Navigation.

in ships and how to sail them.⁴ Portuguese nautical science was the most advanced in fifteenth century Europe because the Portuguese were aware of what was being done elsewhere in Europe, and willing to invite foreign specialists to come to Portugal and participate in the research into navigation initiated by Henry the Navigator.⁵ There the talents gathered by Henry the Navigator set about the considerable intellectual challenge of simplifying the techniques and instruments of the medieval astronomer for marine use, and

⁴A vast bibliography of useful works on improvements to the ship could be compiled. For a preliminary guide those interested are referred to Bjorn Landström, The Ship, Allen and Unwin, 1961. This thesis will not direct itself to a detailed discussion of improvements in the rig, hull and handling qualities of ships of the period, except in passing. Amongst the best primary sources of information are ship pictures not cited by Landström such as:

- a. Bicci Di Lorenzo (1373-1452) "St. Nicholas Rebuking the Tempest", Ashmolean Museum.
- b. Anonymous, "On a M.S. Collection of the Ordinance of Chivalry of the fifteenth century belonging to Lord Hastings".
- c. Print of the Italian ship of 1470-75 acquired by the National Maritime Museum in 1975.
- d. Coin recovered from excavation of the Palace of Placentia, Greenwich 1971.
- e. Reliquary of St. Ursula, circa 1489, panels by Hans Memlinc. Musée d'Hospée, Bruges.
- f. Murals in parish churches at Snargate, Kent, and Shorewell, Isle of Wight.
- g. Illustrations from Reise ins Heilige land, E. Reuwich, Mainz, 1486, where there are some fine illustrations of large ships in harbours by the printer Bernhard von Breydenbach.

⁵Article by Joaquim Bensaude for "Comissão Executiva das Comemorações do quinto centenário da Morte do Infante D. Henrique" in "Dom Henrique the Navigator". Arranged by Fredrico Marjay. Lisbon 1960.

Costa Brochado, La Découverte de l'Atlantique in "Henri Le Navigateur". Comissão Executiva das Comemorações do quinto centenário do morte D. Henrique" Coimbra 1960.

See chapter II of this thesis "The origin of Portuguese navigational services 1317-1520.

gathering and interpreting information about the Atlantic Ocean and the African coast. However, the achievements of Prince Henry's captains were not simply the results of determined and courageous adventurers setting out with better than average competence in the traditional skills of European pilotage, and some experimental celestial instruments.⁶ There was the personal wealth of Prince Henry, the resources of the Order of Christ and Henry's forceful personal direction of the research effort. There were also the scholarly interests and library of his brother Prince Pedro gathered during his tour of Europe between 1425 and 1428. Pedro's

⁶The best description of the skills of "pilotage" is to be found in Michiel Coignet in Instruction nouvelle des poincts plus excellents et necessaires touchant l'art de navigateur. Contenant plusieurs regles, pratiques, ensiegnements, et instrumens tres-uidones à tous Pilotes, maistres de nauire, et autres qui iournellement hautent la mer. Ensemble, un moyen facil, certain e tresseur pour naviguer Est et Ouest, lequel insques à present a esté incognu à tous pilotes. Nouvellement pratique se composé en largue Thioise par Michiel Coignet, natif d'Anvers, Depuis reueu et augmenté par le mesme Autheur, en divers endroits. A. Anvers, chez Henry Hendrix a l'enseigne de la fleur de lis. Avec Privilege Royal 1581.

A translation of Coignet's words on pilotage reads thus:

... "the whole science of this form of navigation - pilotage - consists of nothing more than knowing perfectly by sight all the capes, ports and rivers met with, how they rise up, and how they appear from the sea, and what distance is between them, and what course or bearing they have from one another, also in what rhumb [bearing] of the moon high or low tide occurs, and the ebb and flow of the waters, and in knowing the depths and nature of the bottom. These are all things which are taught by experience and the instruction of old and well-tried pilots".

See D.W.Waters, Art of Navigation, p.4.

See also H.M.Hignett, An Outline History of Marine Pilotage in Britain. J.I.N. Vol.31 No.3 September 1978, pp.453-464.

journeys to Hungary were important for there he learnt of the Tartars and the Indians, whilst in Venice he learnt of other parts of Asia and acquired a manuscript of Marco Polo's travels which told of the entrepôts of the East Indies and China, and of Polo's experiences during his return voyage through the Indian Ocean. All such information was sought by the Portuguese Court and their scientists in a conscious attempt to evaluate information of possible navigational importance.⁷

In their keenness to cast their nets as wide as possible to gather such information, the Portuguese were to be found seeking information from many European sources even in the fifteenth century. For example Portugal's representatives to the ecclesiastical Council of Ferrara-Florence (1438-1441) were to be found closely questioning Nicolo de Conti, a Venetian who had returned to his native Italy after spending 25 years in India and South East Asia, and was in Florence to seek Papal absolution for abjuring and following Muslim customs to ensure the safety of his family. Much of Conti's information was closely

⁷ Much of the documentary evidence for this period of Portugal's nautical history is now easily available in the fourteen volumes of Monumenta Henricina Coimbra 1960. Comissão Executiva das Comemorações do quinto Centenário do Infante D. Henrique. Commentaries by Manuel Lopes de Almeida, Idalino Ferreira da Costa Brochado and António Joaquim Dias Dinis O.F.M. Also see D.F.Lach, Asia in the Making of Europe, Vol. 1, The Century of Discovery, Book One. University of Chicago Press. 1965, p.52. C.E. Nowell. Prince Henry the Navigator and brother Dom Pedro, Hispanic-American Review, XXVIII 1948, pp.62-67.

examined by Pope Eugene IV's secretary, Poggio Braccolini, and tested against the writings of Marco Polo and Hayton.⁸ It stood that test, for much of it was indeed accurate, and so Conti's information would exert marked influence on the work of Fra Mauro and Toscanelli in the mid-fifteenth century.

Such information as was contained in the accounts of Marco Polo and Nicolode Conti was the stock of most fifteenth century interchanges of information of potential significance to navigators. We know how extensive such interchanges might have been because, for works such as Poggio's Historia de varietate fortunae, we know the numbers of manuscript copies and later of printed copies, available to a European market.

A considerable debate has raged amongst historians as to the extent of the interchange of this kind of information between the Portuguese and the Venetians in the mid fifteenth century.⁹

⁸ Poggio wrote of Conti "His accounts bore all the appearance of being true, and not fabrications. He went farther than any former traveller had penetrated, so far as our records inform us". See D.Lach, op.cit. pp.60-61. Historia de varietate fortunae still survive in their original manuscript form, the oldest dating from 1448. The first printed versions were prepared in Cremona in 1492, while in 1502 his India Recognita was also published in Cremona. Later a Portuguese and three Spanish editions appeared, and were criticised by many including Ramusio for his famous Viaggi.

⁹ Following the fall of Constantinople in 1453, the Venetians sent several ambassadors to Persia as well as merchants, and obtained information about Asian trades, especially Calicut's before 1480. For a bibliography of foreign commercial involvement in Portuguese exploration in the fifteenth century see D.Lach, Asia in the Making of Europe, Vol.1, part 1, p.53, footnote 9. A review of the secrecy controversy is included within this thesis in Chapter One. Further comment on the role of Italians may be found in Charles McKew Parr, So Noble a Captain. The Life of Ferdinand Magellan, London, Robert Hale, 1955, pp.39-51.

However, it must be acknowledged this debate has not been as intense as the controversy over whether or not Portugal was operating a secrecy policy over her Atlantic discoveries in the fifteenth century. The early chapters of this thesis will deal with such controversies particularly as they affect sixteenth and seventeenth century maritime powers of Europe.

When the Portuguese authorities finally approved the printing of Marco Polo and Conti's books, their navigational contents, as opposed to their commercial contents, had been proved of little value or even misleading. As we shall see, Conti was wrong about the compass not being used by contemporary Arab navigators. However, Marco Polo's comments on Chinese stellar observations near the Equator, and Conti's remarks on those Arab celestial observations made in the Southern Hemisphere had set the men of Sagres (fifty years before those Portuguese printed copies appeared) on the right lines to solve the problem of how to fix latitudes by stellar observation near, or south of the Equator. This was vital to navigation beyond the North Atlantic.

Thus we see how Europeans truly interested in an oceanic route to Asia keenly sought information about the Asian continent and its surrounding waters. First hand accounts of Asia were so very significant to fifteenth century Europe because knowledge of the true position and size of Asia,

let alone of the East Indies and Japan, was not to be verified by European sailors until after 1500, and was to be kept within very restricted circles until about 1550. The geographical conceptions of the world held by fifteenth and even sixteenth century Europeans, were, if evident at all, often rooted in the limited background literature of the Bible, classical authors and medieval traditions, despite the oceanic explorations of Portuguese and Spanish or French and English seamen. Nevertheless amongst an increasingly large circle of Europeans truly interested in matters of oceanic navigation, it was realised that outside the small geographical area known to the classical worlds of ancient Greece and Rome, other civilisations existed offering alluring prospects to those European traders who could get a ship safely there and back.

This brings us to the crucial question as to how the sixteenth and seventeenth century Europeans came to be in a position to evaluate information of potential importance to those who wanted to sail safely across the world's oceans to new markets. This problem was further compounded by difficulties in interpreting Asian sources of information, but nonetheless was to be very effectively solved. Fifteenth century Europe did not have a rigorous approach to establishing the veracity of documents, or so sophisticated a theory of history as the Arabs had available after

Ibn Khaldūn had finished his Muquaddimah (Introduction) to his Kitab al-Ibar (History of the World) in 1377.¹⁰ If such navigational treatises as Ibn Majid compiled in the late fifteenth century are compared with European treatises of similar date, it is readily seen that the Europeans could not match Ibn Majid's command and critical appreciation of navigational writers of previous centuries.¹¹ As against this it is interesting, but not unexpected given the classical mould of European education, that later European writers on navigation such as Cortes, Hakluyt and Purchas should exaggerate a tradition of Mediterranean navigation in biblical and classical times to give their works an impression of scholarship and familiarity with navigational matters, and their subject seemingly the authority of age-long interest. As Cortes said in his preface ... "here I do not saye that Navigation is not a thinge of antiquitie".¹²

Amidst myriads of references in European navigational texts to Biblical voyages, most

¹⁰ See Ibn Khaldūn. An Introduction to History. "The Muquaddimah". Translated from the Arabic by Franz Rosenthal. Abridged and edited by N.J. Dawood. London, Routledge, Kegan Paul, 1967.

¹¹ See Chapter 8, The Arab Interchange, footnotes 49 and 50.

¹² Martin Cortes, (Richard Eden) Breve Compendio del Arte de Navegar. 1561 edition. Epistle Dedicato. Note also The first Volume of Purchas His Pilgrimes "Contayning the Voyages and Peregrinations made by Ancient Kings, Patriarkes, Apostles, Philosophers, and others, To and Thorow the Remoter Parts of the Knowne World: Enquiries also of Languages and Religions".

are used to stress the dangers of the sea such as the story of Paul's shipwreck at Malta after the master and centurion decided to ignore Paul's advice.¹³ However, there are references too to considerable navigational competence amongst pilots as in the accounts of Solomon and Ophir.¹⁴ Other common references in European navigational works are to Strabo and Hesiod, Virgil and Pliny, and to ecclesiastical authorities like St. Augustine of Hippo and St. Isidore of Seville. Amongst these references no sixteenth century authors could find ancient reference to oceanic navigation by the stars, nor could they find much to give as authority for the traditional cosmology such as was typified by the popular work of Sacrobosco (John Holywood) De Sphera. Secondly, it may be noted that the common form of European geographical theories led to the production of medieval maps after the style of the Hereford Map.¹⁵ These maps, often known as T-O maps showed Jerusalem at their centre, but this it was found could not be reconciled with the idea of a torrid uninhabitably hot equatorial zone, so the

¹³ Acts 27 v.20-23 and v.31-32.

For the popular analogy of control of a ship and control of horse with bridle see James 3, v.4.

¹⁴ I Kings 9, v 27-28
II Chronicles 8, v 18

¹⁵ Prebendary A.L.Moir, The World Map in Hereford Cathedral circa 1300 and the Pictures in the Hereford Mappa Mundi by Malcolm Letts F.S.A. Friends of Hereford Cathedral Publications Committee 1977.

known world was increasingly shown as part of the northern hemisphere, leaving vast scope for speculation about the land masses of the southern hemisphere. Many Europeans preferred making no alterations to their traditional outlooks, to discarding all or large parts of those traditional views, which, they felt were likely to be correct merely because of their long usage. However such discoveries as the fact that the world's equatorial zones were inhabited, led the more actively interested Europeans, in particular the Portuguese, to seek a new basis to their geographical outlooks which would permit better recording of the world's land masses, oceans and climatical features.

This interest led to what should now be regarded as cartography. The theoretical basis of this science, which was to recast the traditional geography of Medieval Europe, was provided by the European rediscovery of Ptolemy's Geography (or at least what Europeans took to be his work).¹⁶ More than forty Greek and Latin manuscripts of this work as it circulated in fifteenth century Europe still survive, testimony

¹⁶ See E.G.R. Taylor The Haven Finding Art - A history of navigation from Odysseus to Captain Cook. Hollis Carter, London. Augmented edition of 1971, pp.150-155. Note: All subsequent references are to this edition, not the earlier editions of 1956 or 1958 unless otherwise stated. N.A.E. Nordenskiöld Facsimile Atlas to the Early History of Cartography. Translated from the Swedish original by Johan Adolf Ekelof and Clements R. Markham. Stockholm 1889. Reprinted Kraus. Reprint Corp. New York 1961, pp.64-74.

to the demand of interested Europeans for access to its text explaining how to construct a network of lines of latitude and longitude for a map based on a conical projection. The mathematical basis of the work was that a degree of the arc of the prime meridian and of the equator was supposed to measure 500 stadia. The bulk of this text was, however, taken up with a listing of 8,000 places in the known world. Ptolemy was already known and respected amongst European scholars as an astronomer who had worked in Alexandria between 90 and 168 AD, and as the author of the Mathematike Syntaxis "the Great Collection" available in a Latin translation thanks to Arabic scholars of the Almagest.

Modern scholars have suggested that the fifteenth century Latin manuscripts of the "Geography" very largely comprise works by tenth and eleventh century Byzantines. Only 200 years before the first text of the Geography was translated into Latin, allegedly in 1409,¹⁷ Arab and Byzantine data seems to have been used to supplement I. Abrahams, The Legacy of Israel, Clarendon Press, Oxford, 1927, p212-4 & 260-261. A summary of the background to the early editions and publication of the Geography is given by D. Lach, op.cit. pp.67-9. The editions before this atlas were relegated to the status of a historical atlas about 1550 but are worthy of further attention for they have improved maps present in increasing numbers, for example the Strassburg 1513 edition has 47 wood-cut maps. Two copies of editions in the Bristol City Reference Library edited by Bilibald Pirkheimer are of particular interest, partly because of the errors introduced by an ignorant or careless printer Grunniger. They are: (a) Geographicae enarrationis libri octo B. Pirkeymhero interprete annotationes de Regio Monte in errores commisos, Angelo in translatione sua. Argentoragi (sic) Grieningerus, comminibus Koberger impensis excudebat. 1525 (Basle). EPB 306/BL 10 E Cat.No. 748; (b) Geographia universalis, vetus et nova enarrationis Libros VIII quorum primus nova translatione Pirkheimer et accessione commentarioli illustrior ... redditus est. Basilaee per H. Petram. 1545. EPB P43 Cat.No. 749

See also Volume 2 Fig. III of this thesis

ment the Ptolemaic maps which later accompanied European texts of the Geography . The standard European format of this work contained a world map incorporating curved meridians, one as far west as the Canaries with the other extreme meridian running to the east of an enclosed Indian Ocean. Twenty-six further maps compiled on the basis of the gazetteer in the eighth and last chapter of the book completed the work. [Amongst the postulations of *later editions* a vast southern continent and open seas to the east of Asia's eastern coasts, *are the outstanding changes*]

The impact of the Geography's ideas on defining place by latitude and longitude, of its gazetteer and of its maps can hardly be underestimated. The cartographic principles it contained were so important because they made available a simple intellectual frame onto which many forms of navigational information, otherwise requiring complex explanation, could be inserted. Cortes said of the sea chart that its great value was that it made information intelligible whenever

"it shall be hard to make the same understood by words or wrytynge. The best explication or invention the wyttes of men have found for the manifesting of this, is to give the same paynted in a carde. For the draughte or making whereof it shall be requisite to know two thynges. Whereof one is the right position of places, or placing of countries and coasts. The other is the distance from one place to another."¹⁸

During the sixteenth century many improvements and qualifications were made to these principles, as for example in the various measures

¹⁸ Martin Cortes (Richard Eden) op.cit. 1561 edition. Part III, fol. lvii.

taken to correct for the variation of the magnetic compass. Despite this Ptolemy continued as the subject of many references in European navigation manuals for his suggestions on cartographic methods fitted so neatly with new European ideas on fixing latitude and longitude at sea with simplified instruments for celestial observation. Indeed it may well have needed the appearance of the Geography in Latin some time after 1409 to lead Europeans to realise that if its ideas were taken in conjunction with simplified instruments for celestial observation, the traditional skills of coastal pilots, the knowledge and skills of instrument makers, engravers, and makers of portolanos, could all be used to produce a combination of navigation aids that would permit safer navigation and the systematic recording of courses taken, or intended, across the world's oceans.

Once mastered, these aids in skilled hands would permit oceanic navigation to Asia and America. This understanding formed the basis of an international technical language of celestial navigation which was, as European sailors in Asian waters were to experience at first hand, already highly developed within the maritime traditions of the Arabs, Indians, Indonesians, Koreans, Chinese, Japanese and the Polynesians. This is not to say that the aids deployed by all these peoples were identical, but rather that there was

such a similarity of principle and intention in the use of certain aids, that a small vocabulary and experience of the principles of oceanic navigation, could make all these traditional ways of navigating mutually intelligible amongst sailors of all those nations. Once the Europeans grasped how to utilise ideas of latitude and longitude, and instruments to measure latitude (with dead reckoning as a substitute for longitude measurements), they could sail into Asian waters and participate in the international interchange of navigational ideas and technology there. These interchanges would then vastly enrich the science and technology of European and Asian nations.

The Iberians were the initial European beneficiaries of this process, but though they attempted to maintain this exclusive access to these interchanges to the detailed navigational guides to Asian waters and to the sea routes to Asia, they were unable to deny the growing northern European maritime powers access to Asia and to such navigational information by the end of the sixteenth century.

This thesis attempts to survey those interchanges which took place in Asia and the way in which the information resulting from them was digested within Europe. It does not deal with the Atlantic seaboard of America or the Atlantic coasts of Africa because those areas had not

developed local traditions of oceanic navigation with which there could have been useful interchanges before 1620.

Of necessity, this thesis must review the history of various navigational traditions, so that what there was to be interchanged may be understood. The purpose is to show how various types of navigational information were disseminated and put to use. As such it is not like many histories of navigation which have sought to show the first usage of this or that technique or instrument, rather it is concerned with the wider adoption of those techniques. The consequences and process of such a dissemination of ideas were rather like the relationship of research and development to modern industry. Some ideas developed further than others, though always there was the concern to improve charts. It was not so much the new ideas as the adoption of useful ones which shaped the way the practical art of navigation advanced worldwide between 1500 and 1620.

This worldwide perspective for examining the art of navigation is important not only because the art itself was the key to access to four-fifths of the world's surface, and all the ports and coastal settlements of all continents, but because it was, almost by definition, the first great contribution to the formation of a worldwide economy and the widening of the world's intellectual horizons.

Most studies of Europe and Asia have been devoted to the problems of explaining the expansion and rise to world predominance of European nations by 1900, or to more narrow studies of voyages, administrative structures, missions or internal politics, with but a few exceptions like Donald Lach's distinguished study Asia in the Making of Europe.¹⁹ His work, and that of a few others has sought to investigate the significance of European discoveries in Asia for the subsequent development of Western civilisation and technology. J.H.Elliott wrote in 1969 that whilst the histories of Europe and America have been "reasonably well integrated" from around 1650, "what is lacking in English is an attempt to tie in exploration with European history as a whole".²⁰ This thesis, in its study of navigational documents, and in its particular emphasis on the significant Spanish navigation manuals and Portuguese cartography, is a response to these historical opportunities.

The Asian perspective in the study of a very advanced technical subject of sixteenth century interest, navigation, also provides an illuminating new perspective on another of J.H. Elliott's questions posed in his essay on "The

¹⁹ D.F.Lach, Asia in the Making of Europe, (Book 1 - 2 vols., Book 2 - 3 vols), University of Chicago Press 1965-1977.

²⁰ J.H.Elliott The Old World and the New, 1492-1650, Cambridge University Press 1972 edition, p.6. (These ideas were first delivered as the Wiles Lectures at Queen's University, Belfast in 1969).

Decline of Spain" where he asked:

"Why was it that science and technology failed to take root in Spain, at a time when they were beginning to arouse considerable interest elsewhere in Europe? It may be that further investigations will show a greater degree of scientific interest in Spain than has hitherto been assumed, but at present there is no evidence of this. Indeed, such evidence as does exist points in an opposite direction - to the gradual separation of Habsburg Spain from the mainstream of European intellectual development."²¹

It will be argued that the Iberian peninsula was until the end of the sixteenth century the primary European clearing house for navigational information arising from interchanges of information in Asia, as well as being where the northern European powers looked for authoritative guidance in the technology of oceanic navigation until about 1620. Seventeenth century Spanish research effort into matters like a method of fixing longitude continued, but this pure research did not produce results anything like so useful or practical as the development of their technology made when they had exclusive contacts with Asian sailors of very comparable technical competence during the sixteenth century.

The significance of the emergence in Lisbon and Seville of schools of navigation was partly that it was an important example of training in a scientific subject, and partly that the very

²¹ This essay by J.H.Elliott is to be found in Crisis in Europe 1550-1660 - Essays from Past and Present, edited by Trevor Aston, London, Routledge Kegan Paul, 1970, paperback edition, pp.186-7.

scientific discipline of recording position at sea permitted the seeking and finding of new lands and markets, and became an indispensable part of subsequent efforts to develop them. Many of the consequences of this are well known and might be summarised in Abbe Raynal's statement that "No event", up to 1770 when he wrote his Philosophical and Political History of the Settlements and Trade of the Europeans in the East and West Indies, "has been so interesting to mankind in general, and to the inhabitants of Europe in particular, as the discovery of the new world, and the passage to India by the Cape of Good Hope".²²

There have been many other historical reviews of the European overseas discoveries made before 1620. In the early sixteenth century Italians generally took the most considered and scholarly views of the achievements of Iberian sailors while Italian bankers were interested in calm assessments of the discoveries of oceanic navigators. Venice, though it was a place of declining commercial importance had obvious concern with the new technology of navigation, and from 1576 to 1587 was home to Giovanni Battista Ramusio, who took great pains to inform himself of many details of Iberian voyages for his volumes of Navigationi et Viaggi published in mid century.²³ Later Rome took great interest in the missionary plans of Quirós in the south Pacific. One of the best political

²² J.H. Elliott, The Old World and the New, 1492-1650, p.1.

²³ See D.Lach, Asia in the Making of Europe. Vol.1, Book 1. pp.204-6.

assessments of the significance of the new navigation is to be found in a few pages of Francesco Guicciardini's Historia d'Italia.²⁴ He utilised his political experience to explain how celestial navigation had transformed Spain's position in the European balance of power, and how Portugal's navigators on the Cape route had diverted the wealth of the Persian, Indian and Moluccan trades from the merchants of Alexandria and Venice to Lisbon. He anticipated the rise of other powers who could exploit this technology.

Such Italian, and other European efforts like the writings of Sebastian Munster, Richard Eden, Richard Hakluyt, and Jan Huighen^{Van} Linschoten, in attempting to publicise and evaluate the commercial possibilities of overseas discoveries for a curious Europe, created a demand which could only be met through the printing press. An idea of the way sixteenth century readers broadened their interests and altered their tastes in reading matter is given by the work of Febvre and Martin. They have shown that whereas a negligible number of works on discovery and navigation were produced in Paris in 1500, by 1600 nearly 10% of the output of Parisian presses was devoted to scientific subjects, and mainly within that to works on navigation and overseas discovery.²⁵

²⁴ Francesco Guicciardini La Historia d'Italia. Appresso Pietro Maria Bertano. Venice 1616. pp.172-4. See also p. 511 of this thesis for the full title

²⁵ Lucien Febvre and Henry Jean Martin The Coming of the Book; The Impact of Printing on Western Europe 1450-1800, Foundations of History Library, New York 1976, p.67. Also R.C.D. Baldwin, "The sixteenth century. Books in St.Chad's College Library. An insight into Tudor Tastes". St.Chad's College Magazine, 1976, p.22.

Such works were often the products of men who were not navigators but were climbing on a bandwagon. Amongst them were some remarkably misleading works such as the "Nova typis transacta navigatio" by Gaspar Plautius, Abbot of Seiten-setten, who clearly did not understand matters of navigation.²⁶ Some of the more widely read commentators such as Acosta and Purchas were able to see a "moral history" in the way the new technology of navigation had shaped opportunities before 1620.²⁷ The more general European reader seems to have found it hard to discriminate in his purchase of books, largely because he lacked the experience of oceanic navigation and he found the traditional world picture taught to him in childhood as the cosmography of the ancients needed re-interpretation. Dr. Robert Recorde, when sponsored by the Muscovy Company to give lectures to trainee pilots in Queen Mary's reign, was prepared to advocate Copernican theories, but few others were prepared to throw over traditional ideas so boldly, particularly after Copernicus's books were put on the Index in 1616²⁸ Sir John

²⁶ Gaspar Plautius, Nova typis transacta navigatio: Novi orbis Indiae Occidentalis et Nunc primum e variis scriptoribus in unum collecta, authore H.P. Vāticiniū de Messia 1621. Also includes "Observatio de Magneta Nautico" on the last two pages with a diagram of a 26 point compass rose and some of Theodore de Bry's illustrations. H.P. stands for Gaspar Plautius's pseudonym, Honorius Philiponus.

²⁷ José de Acosta, The Naturall and Morall Historie of the East and West Indies translated into English by E.G. [Edward Grimestone], Sims for Edward Blount and William Apsley, London, 1604. Purchas's work has already been cited.

²⁸ R. Recorde. The Castle of Knowledge. Reyner Woolf, London 1557, p.165. Robert Recorde attended the Protestant Underhill in prison as well as Queen Mary herself in 1557-8. He was as widely esteemed for his medical skill as for his astronomical scholarship.

Davies caught the popular dilemma in his long poem Orchestra written in 1594. He wrote

"Only the earth doth stand for ever still
Her rocks remove not nor her mountains meet:
(Although some wits enricht with learnings
skill
Say heav'n stands firm and the earth doth
fleet
And swiftly turneth underneath their feet)".²⁹

Most writers of navigational manuals trained to have practical rather than academic minds, included the traditional cosmographical ideas on earth and the heavens, but made other points against classical learning. Martin Cortes is thus to be found arguing

"that the burnt zone is inhabited and well replenished with people that live there, we know so certainly by the number of them that daily pass to and fro the Indies of your Majestie discovered in your most happy daies. And therefore it is greatly to be marvelled that certayne wyse menne have affirmed these partes to be uninhabitable ... They of Guinea Calicut and Malacca all live under the burnt zone, and many of them live very long ... whereby it is concluded that the ancient authors erred, not only in affirming this zone to be uninhabitable by reason of ye great heat thereof, but in lyke manner affirmyng that zone that is between the great circle Articke and pole Articke, to be also uninhabited by ye great cold".³⁰

Jean Fernel who lived from 1497 to 1558 wrote in the course of his career as a physician and mathematician, a Dialogue in which he identified the navigator's contribution to the revision of

²⁹See E.M.W.Tillyard, The Elizabethan World Picture. Penguin, London 1968, p.129. Recently Tillyard's views have come under attack, notably by S.K.Henniger, Jr. The Cosmographical Glasse. Renaissance Diagrams of the Universe. Huntington Library, San Marino, 1977, p.xv.

³⁰Martin Cortes (Richard Eden) op.cit. 1561 edition. Pt.1, Ch.16, fol.xvii.

classical outlooks. He wrote:

"This age of ours sees art and science gloriously rerisen after twelve centuries of swoon. Art and Science now equal their ancient splendour, or surpass it ... Our age today is doing things of which antiquity did not dream ... The Ocean has been crossed by the prowess of our navigations and new islands found. The far recesses of India lie revealed. The Continent of the West, the so called New World, unknown to our forefathers, has in great part become known. In all this and what pertains to astronomy, Plato, Aristotle and the old philosophers made progress, and Ptolemy added a great deal more. Yet were one of them to return today, he would find geography changed past recognition. A new globe has been given us by the navigators of our time ..."³¹

The sixteenth century had to accept many revisions of their traditional geographical ideas, the biggest adjustments being perhaps to come to terms with the implications of America's existence. However veneration of the ancients died hard in a world where education retained its classical bias. Thus with some justification all the great studies of overseas discovery, and the early specialised studies of the history of the art of navigation show such features.

The historiography of the art of navigation before 1620 is interesting, for apart from the acknowledgement of sources which you would expect of contemporaries like Hakluyt, surprisingly little specialised study seems to have survived from before the nineteenth century, except in the learned references of introductions to navigation manuals. Two notable exceptions are however the Astronomer Royal, Flamsteed's 'Act of the

³¹ D.F.Lach, *Asia in the Making of Europe*, Bk.II, Vol.III. University of Chicago Press 1977, pp. 415-6.

beginning and Progress and present State of our improvements and Deficiencies in ye Doctrine and Practice of Navigation¹, dated April 21 1697, and a treatise by James Wilson entitled A dissertation on the Rise and Progress of the Modern Art of Navigation .

These treatises differ greatly from the potted histories of so many navigation manuals because of their extensive and scholarly acknowledgement of foreign and native contributions to the advance of the subject. However, in some ways Flamsteed was misleading in failing to acknowledge the significance of Asian interchange in the sixteenth and seventeenth centuries. In the section dealing with Ptolemy's contribution he wrote

"Ptolemy conveyed the works of Hipparchus downe to posterity and gave us of his own moreover the longitudes and latitudes of the eminent cities of his time, from him the Arabians borrowed their knowledge of the heavens and made no doubt good use of it in their navigation. But their territories extending to the Red Sea and the Persian Gulf where Europeans had then no trade 'tis probable their navigations were all in them or to the East Indies and therefore wee have no account of them".³²

Flamsteed acknowledged many of the technical advances of other Europeans, making but one concession to non-Europeans in his historical review of the art of navigation saying that "The

³²Flamsteed "Act of the beginning and Progress and present State of our improvements and Deficiencies in ye Doctrine and Practice of Navigation". 21 April 1697, Pepysian Library Manuscript No.2184. p.5.

Spaniards borrowed their knowledge of the heavens from the Moors and Arabians".³³

However, this concession was more than many writers on navigation would acknowledge until the twentieth century. The explanation of this curious blind spot of these writers may lie in the fact that by the mid-seventeenth century European sailors had little more to gain from Asian sources. Having based their advance of the previous three hundred years on interchanges of technical ideas and information across European frontiers, and having learnt much from Asian sources to supplement their technology, further advances would depend on some new instruments and techniques such as the chronometer, which though foreshadowed by Gemma Frisius and William Cunningham in the mid-sixteenth century,³⁴ could not be made to the accuracy required at sea until Harrison's ideas were adopted in the late eighteenth century. Even then John Robertson, who taught the Christ's Hospital boys between 1748 and 1755, could remark that chronometers would have to

³³Ibid.

³⁴Gemma Frisius De Princeps Astronomiae et Cosmographiae Deo usu Globi ad eodem editi. Item de Orbis divisione, et insulis rebus nuper inueventis Joan Grapheus, Antwerp, 1543 (1st edition 1530) pp.64-5 suggested that longitude could be found by a portable spring driven clock set to the local time of the place of departure. This would permit measurement of the time between the time shown on the clock and the midday altitude of the sun easily observed at sea on fine days.

William Cunningham, The Cosmographicaall Glasse, conteyning the pleasant Principles of Cosmographie Geographie, Hydrographie or Navigation, John Day, London 1559. In the Third Book of the work Cunningham wrote "You shall prepare a parfait clock artificially made such as are bought in Flanders, and we have them as excellently without Temple Barre, made of our countreymen".

become very much cheaper before they could be considered as other than an academic solution to the problems of determining longitude³⁵

As the technology once led by the example of the Spanish Casa de Contratacion and the Portuguese Armazéns ossified in the seventeenth century, so King Charles II did much to foster a rather different spirit of navigational improvement in England. In France a system of state paid "professeurs" in all the major ports gave a certain scope for variety but was unlikely to foster recognition of foreign achievements. National pride in a technically advanced subject with important political consequences became increasingly evident in Europe, and further reinforced reluctance to rely on foreign ideas. This is seen in the preface Greenville Collins wrote to his 'Coasting Pilot in 1689. There he addressed his fellow British mariners, saying

"His most excellent Majesty King Charles the Second, who was a great lover of the noble Art of Navigation, finding that there were no sea-charts, or maps of these kingdoms, but were Dutch or copies from them, and those very erroneous, his Majesty out of his great zeal for the better improvement of Navigation, was pleased in 1682 to give me the command of a Yacht for the making of the Survey;"³⁶

³⁵E.G.R.Taylor, Haven Finding Art, p.262. [1971 edition]

³⁶Captain Greenville Collins, Great Britain's Coasting Pilot, Being a new and Exact survey of the Sea Coast of England and Scotland, From the River of Thames to the Westward and Northward with the Islands of Scilly And from thence to Carlisle likewise the Islands of Orkney and Shetland, Describing all the Harbours, Rivers, Bays, Roads, Rocks, Sands, Buoys, Beacons, Sea-Marks, Depths of Water, Latitude, Bearings and Distances from Place to Place. The Setting of and Flowing of the Tides; with directions for the knowing of any Place, and how to harbour a ship in the same with Safety with Directions for coming into the Channel between England and France, London, J.Mount, T.Page and W.Mount. 1779 (First edition 1693). Preface p.2.

Charles II also initiated the modern emphasis on a mathematically minded sailor by founding a mathematical school for forty boys at Christ's Hospital in 1673. In 1694 there was a debate about the need for such an emphasis, with one group of the school's Governors arguing for the type of experience which had produced heroes like Drake and Hawkins, while another group who consulted Isaac Newton, supported Newton's view that "Mathematicall children being the flower of the Hospitall, are capable of much better learning ..."³⁷

The triumph of the mathematical emphasis led to a rather distorted view of the history of navigation, epitomised in John Robertson's large manual The Elements of Navigation . He wrote in the preface of this book written in 1772 that:-

"About the middle of the sixteenth century, Navigation began to be considered as an art, in great measure dependent on the Mathematical Sciences; and on such a plan it has been cultivated by the laboures of the most judicious, who have applied themselves to its perfection; and although the art has been enriched by the observations of some learned men in different nations, yet it has

³⁷ Isaac Newton continued by saying that these children "when well instructed and bound out to skilful Masters may in time furnish the Nation with a more skilful sort of Sailors, builders of ships, Architects, and Mathematicall Artists of all sorts, both by sea and land, than France can presently boast of".

See E.G.R.Taylor, Haven Finding Art, p.251.

See also article by N.M.Plumley, "The Royal Mathematical School Christ's Hospital", History Today, 1965 pp.581-7.

so happened that the chief of the improvements, and particularly the mathematical ones were first published in Britain".³⁸

The same biases led to the underestimation of the value of the Asian learning and navigational skills by eighteenth century Europeans. Progress had been rapid during the previous three hundred years and therefore did set them a problem of appreciation. Nevertheless, a rather typical arrogance evidently pre-conditioned the outlooks of eighteenth century writers, such as the geographer George Henry Millar, who with the help of one of Captain Cook's men William Langford wrote the authoritative and vast New and Universal System of Geography first published in 1783. The biases may be seen for example in his comments on Arab science of which he wrote

"Whatever progress they may formerly have made in the sciences, they are at present at a very low ebb, the Arabs affording no monument of genius, no productions of industry that entitle them to any rank in the history of the human mind. Physic, philosophy, astronomy and mathematics, for which they were once so famous, are so lost amongst them that scarcely any traces are remaining".³⁹

³⁸ John Robertson The Elements of Navigation, containing the theory and practice, with the necessary tables. To which is added a treatise on marine fortification. London (First edition 1772). This quotation is taken from the preface of the fifth edition (1784) corrected by William Wales, Master of the Royal Mathematical School, Christ's Hospital, London. John Robertson ~~between 1755 & 1766~~ was first master of the Royal Naval Academy, Portsmouth. Note also the first text book for Christ's Hospital Boys A New System of Mathematics, written by Sir Jonas Moore, produced in 1681, had a title page showing pupils with many navigational instruments, an early indication of the mathematical bias of the school.

³⁹ George Henry Millar, The New and Universal System of Geography being a Complete History and Description of the Whole World. Alex Hogg. London. 1783. p.117.

Though Millar mentions Arab trades across the Indian Ocean and Red Sea, his dismissal of Arab science and reference to the ousting of the Arabs by Portuguese ships in the sixteenth century was more likely to reinforce the prejudice of European superiority rather than the study of interchanges of technology. This point comes out even more clearly in Millar's misappraisal of Chinese technology and in his dismissal of what might be termed the Chinese interchange.⁴⁰

Most of the eighteenth century studies of navigation were severely practical manuals like John Barrow's 'Navigatio Britannica: Or a Complete System of Navigation', published in 1750. Besides Barrow's four references to Frenchmen, and mention in his preface of 'Ulloa's Relacion de Viage a la America Meridional por la Medida Geometrica y Astronomica de la Meridiana, por Orden de sic [sa] Majestad Catholica , foreign ideas were totally ignored, or unacknowledged.⁴¹ John Robertson's work by contrast is outstanding in its fairer acknowledgement of European, and especially Iberian advances in navigational methods. However, for this Robertson relied almost totally on the treatise of James Wilson first published in the fourth edition of Robertson's work in 1780.

⁴⁰ Ibid. p.49 and "Chinese Interchange" chapter XIII note 1.

⁴¹ John Barrow. Navigatio Britannica: Or a Complete System of Navigation in all its Branches, both with regard to Theory and Practice. London. W.& J. Mount and T. Page. 1750. p.viii, for reference to Ulloa's work. Barrow's book was dedicated to Baron Soberton (Admiral Anson) who took special interest in problems created by Spanish strategy in the Pacific Ocean.

This is all the more surprising because the eighteenth century was the heyday of splendidly produced accounts of voyages of discovery and speculation about the southern continent such as the two volumes of Navigantium atque Itinerantium Bibliotheca by John Harris (1705). Accounts by Anson, Callendar and Astley were so widely read that popular editions (prefixed with the author's name or sometimes the publishers) also went through many editions. Often features of these works were thinly disguised revisions of rival works or predecessors. Even the more careful revisions like Dr. John Campbell's second edition of Navigantium atque Itinerantium Bibliotheca produced between 1744 and 1748 concentrated on the theme that "there is no doubt trade will maintain us" and dismissed the earlier Spanish achievements, particularly attacking the methods of Quiros.⁴²

In preparing the two volumes of 'An Historical Collection of Several Voyages and Discoveries in the South Pacific Ocean', Alexander Dalrymple (later to be appointed the first Hydrographer to the Navy by the Admiralty in 1795) admitted that he owed much to the ideas of Charles de

⁴² John Harris. Navigantium atque Itinerantium Bibliotheca. A complete Collection of Voyages and Travels of above four hundred of the most authentic Writers, by John Harris, AM, FRS. London, 1765. A copy of this work held by the Prehorne family, passed into the hands of the British Steel Corporation, and is now on loan to the Merseyside County Museum Service. J.C. Beaglehole in The Life of Captain James Cook. A. & C. Black. London 1974 gives some interesting background information to John Campbell's revision, on pp. 118-119. He cites the Navigantium atque Itinerantium Bibliotheca, carefully revised by John Campbell, 1744-8, Vol. 1. p. xvi and p. 335, as examples of the prevalent idea of 'exclusivity' and Campbell's sentiment that British settlement of the Southern Continent would enhance "the true and natural Strength of this Country, extend our Naval Power and raise the reputation of this Nation".

Brosses, author of 'Histoire des Navigations aux Terres Australes'. Nevertheless the first volume of Dalrymple's work as published in 1770 is noteworthy for it concentrated entirely on Spanish achievements. Dalrymple could not speak too highly of Quiros and his methods and outlooks.⁴³ These volumes, and his earlier argumentative book An Account of the Discoveries made in the South Pacific Ocean before 1764' stemmed from his youthful interest in the voyages of Magellan, Mendaña, Quiros, Schouten, Le Maire, Tasman and Rogeeveen. This interest was supplemented between 1759 and 1764 by his voyages in the Secret Service of the East India Company to Macao, Formosa, the Philippines and the East Indies. On Sulu he had established very friendly relations with the natives, or 'Indians' as he called them, following this up with a second visit. On his second visit to Manilla he met many Spanish sailors, and gathered many tales of exploration, including details of Torres's passage south of New Guinea, and of the islands discovered by Juan Fernandez. He combined these details with his own meticulously kept Journals, which included coastal profiles and surveys, and with details of other shores gathered from various sources, to produce not a running

⁴³See J.C.Beaglehole. Op.cit. pp.104-5, 120-121, 286, 349, 354, 368, 372. It is also revealing to compare Callander's buccaneer treatment of De Brosses's Histoire with Dalrymple's careful acknowledgements.

survey, but as he was at pains to stress, charts which comprised details from a wide range of sources.⁴⁴ These charts of the coasts of China, Hainan, Palawau, Borneo, the China Sea, and even one later provided to his great rival, James Cook, showing the Torres Strait, were markedly better than those provided by the motley bunch of London cartographical suppliers. Nevertheless the East India Company only paid him £5,000 for all this work in 1769.⁴⁵

In 1779 they appointed him Hydrographer to the Company, to prepare accurate printed charts for the Company's ships, and to look after those charts which the East India Company had retained albeit haphazardly since 1600. He did extract as much as he usefully could from the surviving charts but he was well aware that in a scientific approach to the gaining of this type of information from various sources, the Company lagged behind the example of the French *Depôt des Cartes et Plans*, founded in 1720, and which since 1750 had begun to print charts based on the systematic gathering and appraisal of navigational data. In all this Dalrymple was however virtually alone in acknowledging the extent of the technical achieve-

⁴⁴Rear Admiral G.S.Ritchie, D.S.C., *The Admiralty Chart. British Naval Hydrography in the Nineteenth Century*. Hollis & Carter. London 1967. p.11. Here Dalrymple's comments on his own Journals compiled aboard the schooner Cuddalore whose command he obtained in 1760, make interesting comparison with the ideals of Quirós whom he admired. Quirós laid down that navigation is "an art that does not admit of ignorance or carelessness". Dalrymple wrote "My journal of the coast of Hainan is perhaps the most imperfect of any in my whole voyage; it was on my first setting out in the Cuddalore; the Chief Mate was not an artist and had all the prejudice which constantly attends ignorance. He was besides very careless at keeping the log".

⁴⁵G.S.Ritchie. *op.cit.* p.18.

ments of the Spanish, Dutch and latterly the French.

By way of contrast, eighteenth century Frenchmen acknowledged the English advances, and did not overstate their own. However, with the rise of nineteenth century "nationalism" this began to change and French "firsts" were sought. Louis Estancelin produced some studies showing how the mariners of Dieppe had been the first to Africa, America and the East Indies. These studies appearing in the 1830s seemed to find support from the Counts Avezac and Alexandre de Humboldt.⁴⁶

Meantime in Spain D. Martín Fernández de Navarrete, President of the Academia Royal of Madrid supported the research of Visconde de Santarém into the documentary evidence of fifteenth century discoveries, in particular into the charts which had survived. The first product of these studies appeared in 1836 in the Bulletin de la Société de Géographie de Paris from Navarrete's

⁴⁶ Alexandre de Humboldt Voyages du Bonpland: Voyages en régions équinoxiales du nouveau continent et du progrès de la première partie (Examen critique de l'histoire de la géographie du Nouveau Continent et des progrès de l'astronomie nautique au quinzième et sixième siècles), Paris 1836. Facsimile autégral. Amsterdam 1971.

Armando Cortesão. Cartografia e cartógrafos Portugueses dos séculos XV e XVI. Lisbon 1939, pp.365-404.

Humboldt acknowledged the contribution of Arab civilisation to Europe and the importance of the Spanish and Portuguese ideas on astronomy and geography. He withdrew his remarks about French achievements in a letter to Visconde de Santarém after the latter had published the Recherches of Visconde de Santarém. See Lives of the brothers Humboldt translated and arranged from the German by Klencke and Schiller by Juliette Baur. London, Ingram and Cooke and Co. 1852. For reference to Louis Estancelin's Recherches sur les voyages et découvertes des navigateurs normands en Afrique dans les Indes orientales et en Amérique see Armando Cortesão. *op.cit.* p.369.

pen.⁴⁷ Santarém's researches appeared in 1841-2 as the Memoria sobre a prioridade dos descobrimentos portugueses na costa d'Africa Occidental, par sevoir de illustração Chronica do Conquista da Guiné por Azurara", Paris 1841, and this included an Atlas of Visconde de Santarém.⁴⁸ He was the first to gather and publish these products of the Portuguese voyages, and, it is claimed was the first to use the term "cartography". His work caused Humboldt to retract his earlier claims, and markedly influenced subsequent studies of navigation which have since acknowledged the leading role of the Portuguese in fifteenth and sixteenth century development of the art of navigation.⁴⁹

Studies made in the nineteenth century began to reflect a much closer study of sources. The Hakluyt Society, founded in 1846 "to advance education and public knowledge through publications of Voyages, Travels and Naval Expeditions" was typical of interest which concentrated mainly on discoveries and involved such scholars as Sir

⁴⁷ See Armando Cortesão op.cit. p.366.

⁴⁸ The objective in his publication was "Restabelecer pois os factos, e mostrar com documentos de indubitarel fe que a lal pretendida prioridade dos descobrimentos dos maritimos de Dieppe no século XIVE insustentarel lal e o objecto de presente memoria".

⁴⁹ Armando Cortesão Cartografia e cartógrafos Portugueses dos séculos XV e XVI, Lisbon 1935.

See also Humboldt, Examen critique ... 1836, pp.257, 385-6, and 478-83.

Clements Markham, and William Noel Sainsbury, and the German Count Von Hammer Purgastall. Slowly this type of interest has led to a wider appreciation of the sources of material available for the study of navigation history. An international approach was encouraged through the foundation of the International Hydrographic Bureau in 1921, and the wide scholarship of Professor C.R.Boxer and by several Portuguese historians.

Since the end of the Second World War, Eva Taylor, Joseph Needham and D.W.Waters have published the results of invaluable research into the origins of certain navigational methods. However it has not been so much the discovery of new ways of solving problems of navigation, as the dissemination and adoption of easily understood and practical ideas which has led to the transformation of the world's trading patterns and and economy since the seventeenth century. In this process the simple harbourside swapping of information about hazards, and the co-operation of local pilots in strange waters have been as important. J.H.Parry in his work The Discovery of the Sea first published in 1974, stressed the role of local pilots and the effect of Spanish employment of foreigners, but said "The basis of our knowledge of the discovery of the sea is in the eyewitness accounts of the men who did the discovering".⁵⁰

⁵⁰J.H.Parry, 'The Discovery of the Sea', The Dial Press, New York, 1974, p.291.

Zoe Swecker produced a thesis in 1965 on Iberian accounts of Asia in the sixteenth century, but this had little to say on the specialised subject of navigation.⁵¹ After this had been completed J.H.Elliott could still write that

"There are great opportunities for research into the Spanish texts, as indeed into the general sixteenth century literature of exploration and discovery. But the most rewarding results of this textual research are likely to come from intelligent attempts to set it into a wider context of information and ideas".⁵²

This is what this thesis attempts to do, and in examining such literature alongside charts, surviving instruments and some new evidence gained through underwater archaeology, it is hoped that the international interchange of navigational knowledge between 1500 and 1620 will be better appreciated for its significance within that precocious development of worldwide economy which ensued and was made possible by improvements in navigational methods.

⁵¹ Zoe Swecker, "The Early Iberian Accounts of the Far East 1550-1600." A Dissertation submitted to the Faculty of Social Sciences in candidacy for the Degree of Doctor of Philosophy. Department of History. University of Chicago, 1960.

⁵² J.H.Elliott, The Old World and the New, 1492-1650, Cambridge University Press 1972, p.6.

PART IChapter 1THE ORIGIN OF OFFICIAL PORTUGUESE NAVIGATIONAL
SERVICES (1317-1520)

By John II's reign (1481-1495) Portugal's rulers had realised that the organisation of navigational and hydrographic services had become a matter of major political, economic and scientific concern. The adoption of the techniques of oceanic navigation, new to western mariners, and the discovery of new lands with their possibilities of valuable trade had put Portugal in this position. Exploitation of these opportunities demanded a more comprehensive organisation than had hitherto existed for the information and skills built up by Portugal's maritime community and its royal patrons. Tighter regulation of such information was only possible in a central repository run on bureaucratic lines in Lisbon.

From the outset the purpose of such an organisation was to improve navigational standards, and safety at sea amongst the pilots of the 'Carreira da India'. The concerns of the permanent officials of this bureaucracy would cover the training, examination and standards of oceanic pilots, the equipment of ships, and the standards of workmanship amongst the instrument makers and cartographers of Lisbon. They issued instructions to these pilots to the effect that they should bring back a record of all observations taken at

sea or secured otherwise, so that the Cosmographer Major in Lisbon could co-ordinate efforts to improve the official charts - the "padrões d'el Rei". Upon those official charts were based the only copies that they would authorise for use on ships of the "Carreira da India".

The fact that selling charts in particular was a lucrative practice, ensured that cartographers in Lisbon were anxious to meet the standards laid down by these officials. Consequently cartographers visited the offices of the Armazéns da Guiné e India (Storehouses of Guinea and India) where the "padrões d'el Rei" were alone visible. It was the quality of work done in the rooms of the Armazéns and by the instrument makers of Lisbon for the Portuguese fleets which established Portugal's reputation for the production and use of these aids. As late as 1620 Portuguese charts were still amongst the best in the world. Though typified by conventions and practices developed for use in Europe and the Atlantic, they were supplemented in vital respects by elements drawn from Asian practice, encountered particularly as the Portuguese proceeded east from India. Given the excellence and utility of these aids it was natural that copyists should arise amongst the world's maritime communities and outside Portugal's control. The ensuing erosion of Portugal's technical lead led quite literally to the arrival of hostile well-armed competitors

on the shores of her far flung maritime empire. Such competitors, once in possession of the information and techniques necessary confidently to make such voyages, posed a strategic threat to Portugal which thereafter proved insoluble because of the limited defensive resources Portugal could muster.

This long term political and economic threat was evident to Portugal's rulers from the time of the first Atlantic voyages onwards. Thereafter, despite espionage and some uncomfortable moments, the threat did not become a serious reality until the late 16th century. Nevertheless the threat shaped the organisation and policies of the Portuguese government and navigational offices quite as much as technical considerations. This was especially true of the early 17th century administration, when policies often formulated in Spain, proved to be an incubus to that very spirit of discovery that had earlier taken the Portuguese so profitably across the oceans of the world.

The Portuguese Royal family were deeply involved in the provision of navigational and hydrographic services from the outset of Portugal's maritime expansion. It was initially a very creative influence, especially valuable for importing foreign talents. Men of wide experience and great talent were brought into Portuguese service to hold posts of great influence. In

1317 the king appointed a Genoese, Manuel Pessagno, as hereditary admiral of the Portuguese fleet.¹ A score of Italians, who were skilled masters and pilots, came to work under him in Portugal.

The Mediterranean traditions of navigation which they and others brought to Portugal were based on the use of the magnetic compass, the traverse table and the portolano. Thus we find Portuguese charts of the early explorations down the African coast employed the same networks of loxodromes, coloured alternately red, green and black as earlier Italian portolanos. Other cartographic symbols were adopted as standard by the Portuguese from the Italians.²

¹ E.G.R.Taylor, The Haven Finding Art , p.157.

² Rear Admiral G.S.Ritchie (for the International Hydrographical Organisation) "500 years of graphical and symbolised representation on marine charts", paper presented in September 1975 at 6th International Conference on the History of Cartography. (IHC) Greenwich. In that paper Italian cartographic symbols were described as follows on pages 2 and 3:

"The Red Sea is normally shown in red, as are off-lying islands and important river mouths giving access to shipping. Names of ports where safe anchorage, water and provisions were available are also shown in red, black being used for other names. Coastal names are on the land and at right-angles to the coastline, which permits the navigator a 'clear view' of inshore waters and associated dangers. Dotted in reddish brown is used to show sandbanks or shallow sandy bays. Green is invariably for mountain ranges. Flags and banners of states and cities are a prominent feature and doubtless served a useful purpose by indicating, indirectly, what sort of reception the mariner might expect when he landed. There are also a few vignettes, but these indicate the importance of a major city rather than providing recognition views from seaward.

The loxodromes are a major feature finely drawn alternately in black, green and red to facilitate their use for setting the vessels course. In contrast with the draughtsmanship employed on the loxodromes are the carelessly drawn scales, usually two in number. Each division of the scale is subdivided into five parts by crudely penned dots, each division representing two portulan miles

Alongside this, Majorcan navigational traditions and knowledge found their way into Portuguese traditions. Symbols such as the cross to mark an inshore submarine rock, and the compass rose both made their first known appearances on the great Catalan Atlas of 1375 presented to the French Court, and soon after featured on Portuguese charts. The Majorcan tradition was also valuable for the information on oriental traditions to which it gave access. Thus Arab influences are found to survive the Aragonese conquest of the Balearics in 1229. This 1375 Map is the first to show an accurate European depiction of a Chinese ocean going junk.³ Yet further traditions were represented by Abraham Cresques, believed to be the major contributor to the Catalan Atlas. He practised the professions of cartographer and instrument maker, while Master Jacome, very probably his son, did the same and established for himself a fine reputation. Jacome's services were secured for Portugal by Prince Henry The Navigator in 1420. Not only did this bring Majorcan traditions to Portugal, it set the precedent for the next 300 years of Iberian practice where the professions of instrument maker and cartographer were often combined.

³G.R.G.Worcester, Junks and Sampans of the Yangtze Naval Institute Press, Annapolis, 1971, p.18.

Master Jacome also brought Jewish scholarship and geographical learning to Portugal. It was a tradition that had earlier been fostered in Aragon, where the King patronised both Jacome and his father.⁴ It also included the learning of men such as Rabbi Benjamin of Tudela who left for Baghdad in 1159 and returned via Egypt to Castille in 1173. His itinerary and tales of places as far away as China was full of detail. It was more interesting than that of the second great 12th century Hebrew traveller, Rabbi Petachia of Ratisbon whose itinerary of a journey via Transcaucasia to Baghdad was heavily edited and reduced by Rabbi Yahudi the Pious. Undoubtedly one of Benjamin's purposes was to seek safe refuges for his brethren who were being increasingly persecuted in Europe.

⁴In 1381 Aragonese royal records show the right of establishing public baths in Majorca was conceded to Abraham Cresques described as "magister mappamundorum et buxolarum" ("master of maps and magnetic compasses"). Other orders for maps, tables and traverse tables followed in 1382 and 1387. In 1392 after Abraham's death King John of Aragon sent to Majorca for "tablas de navegar" and "mappamundi" (maps and navigating tables).

Duarte Pacheco Pereira in the Esmeraldo de Situ Orbis circa 1508 noted that Prince Henry had brought from Majorca one Master Jacome, master of nautical charts "... who taught the making thereof to those with whom these living in one time hence also learnt". See A. Teixeira da Mota, "Some notes on this organisation of hydrographical services in Portugal until the beginning of the 19th century". ICHHC 1975.

Though this persecution reached a peak of sanguinary hatred in 15th and 16th century Iberia, it did not prevent Iberian Jews from making a considerable contribution to navigational advance when given the opportunity by royal patronage.⁵

The Portuguese were also in contact with the maritime traditions of sailors from north western Europe. Though there was a much frequented route to and from the Channel ports, the Portuguese rarely appeared to find the skills or knowledge of northern pilots very useful for oceanic exploration.

Prince Henry's respect for pilots from northern Europe was scant. This was shown in his attitude to Gil Eannes's stories of the African coast in 1433.⁶ The Prince said:

"If there were any authority for the stories that they tell I would not blame you, but you have reported to me only the opinions of four seamen from the Flanders trade, or from other well-frequented ports who know nothing of the needle or of the sailing chart".⁷

⁵ John Kirtland Wright. The Geographical lore of the time of the Crusades. A study in the History of Medieval Science and Tradition in Western Europe. Dover Books. NY. 1965, pp.117-8.

⁶ David Divine, The Opening of the World, Collins London 1973 p.100.

Eannes was a young squire sent to pass Cape Bojador. It was the 14th attempt to do so, but Eannes exploited his chance once he was beyond Cape Nun to go instead to the Canaries and collect natives to sell as slaves back in Lagos. Eannes explained himself to Henry by blandly asserting like northern sailors that wind and current would make such voyages impossible. He was told to try again and succeeded in passing Cape Bojador in 1439.

⁷ Ibid. This translation is based on one by C.R. Beazley and Edgar Prestage, The Chronicle of the Discovery and Conquest of Guinea written by Gomes Eannes de Azurara, Hakluyt Society London, 1896, Vol 1, p33.

It was the international gathering of experts in 15th century Portugal as a result of royal patronage which is the useful core of the legends about Sagres. Perhaps the court of Sagres with its palace, a school of navigation, and observatory, filled with an entourage of scientists, cartographers and astronomers, was a generic name for establishments used by Henry at Visca, Covilha, Lisbon, Lagos, Raposiera, Sagres, Faro and Silves. By 1453 Azurara declared in his Chronica dos feitos de Guiné that he had wished to write:

"... an account of that noble town which our Prince caused them to build on Cape St. Vincent, at the place where both seas meet, to wit the great Ocean Sea and the Mediterranean Sea. But of the perfections of that town it is not possible to speak here at large, because when this book was written there were only walls standing, though of greath strength, and a few houses"⁸.

The chronicler Azurara also provides evidence for the view that Henry the Navigator fostered Portugal's hydrographic services. He notes that 450 miles of coastline beyond Cape Bojador was added in 1443 to the cartographical representation, probably the same coast as that mentioned in the letter of Don Pedro dated October 22nd, 1443. Don Pedro said that Prince Henry "had caused a nautical chart to be made" of the lands

⁸ On the file of Sagres note that the chapel of Guadalupe at Sagres where Henry prayed still stands. Sir Francis Drake drew a plan of one building standing there in 1587. The remains of others are discussed by Ursula Stuart Mason and Charles G. Miller in "There and Back Fortaleza" NMM Monograph No. 36 1978 pp.103-108.

discovered beyond Cape Bojador.⁹

The improvement of such navigational aids posed major scientific and technical challenges both to scientists, instrument makers and sailors. Between 1430 and 1485 not only were the quadrant and astrolabe first used at sea to fix positions relative to the heavens, rules for observation of Polaris appeared. Towards the end of the century rules for obtaining the same co-ordinate, but by observing instead the sun in its meridian passage, also appeared. This was directly linked with the intervention of John II in 1484.¹⁰ He formed a commission, the so-called 'Mathematicians Junta' to find solutions to the general problems of position finding at sea (and the particular ones of doing so in the Southern Hemisphere, where Polaris was not seen) and of securing positional information to improve rutters and charts. João de Barrós says the King's Junta was to utilise a wide range of talent. Thus the Junta included a Royal physician Master Rodrigo, a Royal chaplain Bishop Ortiz, and a learned Jew Jose Vizinho. The last mentioned was a pupil of another learned Jewish astronomer from Salamanca, Abraham Zacuto. Zacuto had produced even more accurate tables for the Sun's daily declination than those compiled by his more famous contemporary, Regiomontanus.

⁹A Teixeira da Mota. "Some notes on the organisation of hydrographic services in Portugal until the beginning of the 19th century". A paper presented to 6th ICHC September 1975. p.1.

¹⁰D.W.Waters, Art of Navigation, p.47.

Vizinho undoubtedly knew of Zacuto's observations and tables with radix 1473 which were later published as the Almanack Perpetuum. He probably influenced the Junta to suggest that handwritten copies of Zacuto's work be prepared for the most highly trained pilots and masters in order to assist them in position finding on important oceanic voyages. The fact that the oldest surviving navigation manual, the Regimento do Astrolabio e do Quadrante, printed in Lisbon in 1509 contains a list of latitudes going only as far as the equator suggests it was compiled in the early 1480s, possibly as a result of the Junta's work. This manual was probably first printed about the time Zacuto left Salamanca for Lisbon, that is about 1495.¹¹

The development of such new aids, techniques and knowledge presented a whole series of new problems. It was no easy matter to teach a simple mariner the new Regiment of the Sun. Again there were problems in working out how to use instruments copied from Asian or Arab prototypes. The account written by John of Galicia on Cabral's voyage in 1500 illustrated those problems and serves to underline how much more difficult it was for a simple sailor to work accurately when even an experienced astronomer like John faced problems of inaccurate and inconsistent observations. Clearly the problems of making, teaching and issuing the latest navigational aids required

¹¹ E.G.R.Taylor, The Haven Finding Art, p.162.

a more comprehensive answer than the royal patronage of a few experts.

It has long been thought that the competent body set up to do this, among its many other responsibilities, was the Casa da India. The recent research of F.Mendes da Luz has established that the Casa's responsibilities were for the economic aspects of Empire and that the competent body for providing navigational services was the "Armazén da Guiné", later renamed after the rounding of Africa as the "Armazén da Guiné, Mina e Indias".¹² Its origins are to be found towards the latter end of that same period of rapid technical advance in navigational practice from 1430 to 1485.¹³ A letter of acquittance

¹² A.Teixeira da Mota, op.cit. ICHHC, 1975 p.2. cites from F.P.Mendes da Luz. O Conselho da India, Lisbon, 1952 pp.60-68 and Dois organismos de administração ultramarina no século xvi: a Casa da India e os Armazéns da Guiné, Mina e Indias a viagem di Fernão de Magalhães e a questão das Molucas Lisbon 1975, pp.100-108.

¹³ E. G. R. Taylor, Haven Finding Art, p. 162 took the opposite view of this period. The first recorded marine use of a quadrant by the Portuguese in 1456-7, their use of the astrolabe by 1481 and their use of latitude tables stretching to the equator compiled in 1473 suggest Taylor's view must now be thought erroneous. See also Mallett, Florentine Galleys of the Fifteenth Century, Oxford Univ. Press 1967, p.200 for discussion of Pole Star observations recorded in The Diary of Luca di Maso degli Albizzi, Captain of the Venetian Galleys visiting Flanders and England in 1429-30. Other interesting references in this printed version of the diaries may be found on pp.209-210, 224, 236 and 241.

records Diogo Marques as holding the post of Receiver of the Armazén from 1480 to 1487, and being responsible for the fitting out of ships with food, weapons and many nautical articles, including 96 compasses.¹⁴ That the holder of this post was responsible for issuing such aids as a keeper of stores, (*almoxarife*) is confirmed by other references to Marques's successor in the post, Bartholomeu Dias.

Yet another important responsibility falling upon the holder of this post included assessing the competence of a ship's master prior to royal confirmation of the command. Royal writs of December 3, 1487 and October 11, 1496 show that both Marques and Dias acted in this way, while two of Dias's own writs confirming the commands of Duarte Goncalves and João Aveiro have also survived.¹⁵

In its early days many other responsibilities for nautical matters fell upon this body including

¹⁴A. Teixeira da Mota, *ICHC* 1975 pp.3 and 17 cites MSS in Bibliotheca Riccardiana, Florence MSS 1910 f. 82.

¹⁵*Ibid.* pp.3 and 17 (Notes 11-13) Writ of December 3, 1487 mentions Diogo Marques as keeper of stores at the "casas do almagén de Guiné" and João Coelho as fit for the post as master of the caravel "Santa Maria do Mondego", before confirming the appointment.

Writ of 10.7.1494 mentions Duarte Goncalves as master of the "Santa Maria".

Writ of 25.2.1497 mentions João de Aveiro as master of the "Cirne".

the payment of ships' gunners and advice on shipbuilding. There is little evidence about the junior staff employed by the Armazén before the reorganisation of 1501. However, one document shows the 'almoxarife' was involved in 1496 in the decision to employ Andre Affonso at the Armazén da Casa da Guiné.¹⁶ Doubtless the staff included clerks who kept records of instruments issued, and copied various Regimentos, while hydrographers worked to copy the standard charts issued to pilots. A decision to centralise information in one locality is suggested by the moving of the Casa da India in 1481 from Lagos to Lisbon.¹⁷ There it was near the offices of the Armazén and the site of a new royal palace on the Tagus to be completed in 1505.

Despite its appearance as an efficient organisation, it was in reality very dependant for its smooth operation on the individual skills of its 'almoxarife'. He had to be a top level nautical expert, well aware of the latest discoveries - a man like Bartolomeu Dias. This man's vast knowledge of shipbuilding qualified him to supervise the construction of Vasco da Gama's fleet. Dias's reputation as a navigator and master was established by his famous voyage of discovery in 1487-8, when he had established the nature of the South Atlantic wind system in rounding the Cape of Good Hope. He practised

¹⁶Ibid. pp.3 and 17 (Note 10) for 10.1.1496.

¹⁷Ibid. p.2.

celestial navigation to fix his positions and draw a chart of his new discoveries. Thus his untimely death in the South Atlantic when sailing with Cabral in 1500 deprived the Armazén of a vital and experienced official, and led directly to Manuel II's re-organisation in 1501.

A royal letter to Alavarez Dias on October 27, 1501 revealed that the king had decided to add another clerk to the staff of the Armazén, "seeing and considering how the house our Almazém de Guiné is growing, as also the business thereof by reason of the present trade of the Indies". In November a major new post was created and the nobleman Jorge de Vasconcelos appointed to it with the title of 'Provedor dos Armazéns'.¹⁸ He was given authority over the 'Almoxarife' and responsibility for the management of the whole body. He also had the particular function of supervising the fitting out of all Royal ships going to Africa or India, including all the nautical tackle, weapons, stores and crews.

The scope for rapid expansion of the office was vast, but so too were the difficulties facing this newly expanded and important body. Something had to be done quickly to improve the safety record of the Portuguese fleets. Pedro Alvarez Cabral had just returned from a voyage to India in which 6 of his original 13 ships had failed to

¹⁸ Ibid. p.4 and Note 17.

return to Lisbon.¹⁹ The future of the Armazéns was now assured as they continually sought to solve the safety problems of oceanic voyages by improving the quality of their aids.

However the Armazen's activities must also be seen in a broader context. The prospects for Portugal revealed by the voyages of Vasco da Gama and Cabral were as alluring as India's wealth was legendary. Having superiority of fire-power in their ships, the first reaction of the Portuguese was to secure the carrying trades of the Indian Ocean by terrorising their rivals along the African and Malabari coasts. This was typified by the policies of Dom Vasco da Gama's second eastern voyage which began in 1502. Insofar as terror could secure mastery Da Gama was successful in establishing the Portuguese position.²⁰

However Manuel realised that to obtain exclusive control of Eastern trade, he would

¹⁹Cabral, The Voyage of Pedro Alvares Cabral to Brazil and India . Hak. Soc. 2nd series LXXI 1937.

²⁰A pamphlet purporting to be a letter from King Manuel to the King and Queen of Castille announcing da Gama's success was printed in 1505, though it bore the date July 1499. It stated Portuguese policy. "We hope with help of God, that the great trade which now enriches the Moors of those parts ... shall in consequence of our ordinances, be diverted to the natives and ships of our own kingdom". See J.H.Parry, The Discovery of the Sea , Weidenfield and Nicolson, London 1975, p.213.

have to do more than send out occasional voyages of plundering piracy. He would need permanent representation in India and a military presence to protect that position. Such a policy was advocated by Duarte Pacheco, a soldier of considerable wisdom who had sailed for India in 1503, and who had conducted a brilliant and successful defence of the Portuguese factory at Cochin when attacked by the vast army of the Zamorin of Calicut. This led to Manuel's appointment of Francisco de Almeida as the first Viceroy of India in 1505. At his disposal was a large fleet and several thousand soldiers to be used in capturing strategic ports and establishing a monopoly of overseas trade in the Indian Ocean.

Duarte Pacheco Pereira's book Esmeraldo de Situ Orbis shows King Manuel also appreciated that for exclusive control of the sea route to India, the details of how to navigate along it were a strategic prerequisite. This underlay Manuel's concern to leave nothing to chance in 1497 when preparations for Vasco da Gama's voyage were being made with Dias's advice. Likewise Manuel's choice of the determined Vasco da Gama, a fine navigator and someone who would leave nothing to chance showed how politics and navigation were becoming intertwined. As to cost Duarte Pacheco Pereira wrote of these preparations that there was no technical skimping.

"The best and most skillful pilots and masters in Portugal were sent on this voyage and they received besides other favours, salaries higher than those of the seamen of other countries. The money spent on the few ships of this expedition was so great that I will not go into detail for fear of not being believed".²¹

Another thread of this policy involved the development and acquisition of a systematic body of information about the ocean routes. From the outset of Da Gama's voyage, and over the next century there was a systematic attempt to utilise local navigational knowledge hitherto restricted to Asian sailors. Acting on the Asian experiences of earlier travellers, Vasco da Gama took three Arabic interpreters on his voyage of 1497-9, knowing the Arabs controlled the sea route from Africa to India.

Not only did Vasco da Gama's voyage represent the contemporary climax of European navigational skills, it also marked the evolution of the traditional interest in Eastern travelogues, into the first hand exchange of local eastern knowledge, between competent navigators of two different traditions. The full implications of the technical exchange initiated by Da Gama with the Arab pilots off the east coast of Africa will be discussed later. Suffice to note here that Da Gama brought home five or six Indians, a Jewish merchant and a young Moor. Together they

²¹ D.Lach, Asia in the Making of Europe, Chicago University Press. Chicago and London 1965. Vol.1, Book 1, pp.95-6.

would provide invaluable first hand information to Portugal. Further valuable information on the Atlantic wind system, Arab methods of celestial navigation, the monsoon pattern of the Indian Ocean, the quality and dangers of using East African pilots and ports was invaluable to the Armazéns. Thereafter technical exchanges of navigational knowledge with Asian sailors was so developed as to vastly enrich both Iberian and other navigational traditions as we shall see.

Manuel's thinking about the development of navigational services for his fleets on these Asian voyages is further revealed by a letter of a Florentine who sailed with Affonso de Albuquerque's fleet which set out for India on April 6, 1503. There the need to draw charts showing the vast regions of Asia and the routes thither together with all the known islands and coasts was stressed. The King is therein reported as commanding that this be done on the basis of charts made by experienced seafarers and with new place names in order that "shortly these seas will be quite as well known as the Mediterranean ones".²² For similar reasons in 1507-9 the author of Esmeraldo de Situ Orbis included details of the latitude observations taken on an Indian voyage. That the new charts were based on latitude observations taken by both Portuguese

²²Da Mota 6th ICHC p.4.

The Florentine was Giovanni da Empoli, agent of the Gualtevotli-Frescobaldi syndicate.

and Arab sailors is shown by the famous Cantino planisphere with its much more accurate placing of Africa's coasts.

The Cantino planisphere also serves to highlight the problems of such an approach to Portugal's navigational problems.²³ This map showed the very latest information brought back by Cabral in 1501. In October 1502 the map was surreptitiously obtained by Alberto Cantino, acting as an agent for the Duke Ercole d'Este of Ferrara. It is now on the Bibliotheca Estense in Modena, a standing tribute to Italian anxiety to learn of the new sea route that threatened their old route.

The Portuguese were anxious too, for the smuggling out of the Cantino planisphere represented a considerable loss. Not only was it one of the few copies of manuscript charts made at the Armazén, and valuable on account of its rarity, it was a much better representation of Asian waters than most contemporary charts of

²³Teixeira da Mota "Cartographia Nautique dans l'Océan Indien avant le xv^e Siècle." 6^{ème} Colloque International d'Histoire maritime et du Deuxième Congrès de l'Association Historique Internationale de l'Océan Indien. (held at Laurenço Marques) published Paris SEVPEN 1964 pp.77-9 and figs 3 and 4.

R.A.Skelton, Explorers Maps, Spring Books, London 1970, p.33 and fig.19.

The Cantino planisphere shows the coast of São Jorge da Mina Guiné (Gold Coast) and further south crosses mark the padroes set up on Vasco da Gama's voyage and by earlier explorers. Flags on the east coast of Africa denote the points where Da Gama and later Cabral landed.

the East.²⁴

Yet the best representation of India, Ceylon, Malaya, Sumatra and the China Coast was still in Portugal, the roughly contemporary world map of Nicolò da Caneiro. This Genoese operating in Lisbon showed India in a blunter and more accurate form than the Cantino chart. He still used the traditional names e.g. Tartaria, Cataio, but his utilisation of Arab sources is not so clear as on the Cantino map.²⁵

Portuguese anxiety led on November 13 1504 to a royal charter forbidding nautical charts to show data on navigation relating to ports beyond the river Congo. Charts not complying with this provision had to be taken to the Provedor dos Amazéns, Jorge de Vasconcelos who was to eliminate the data. The construction of all terrestrial globes, without exception was forbidden, but one presumes such work continued within the supposedly secure walls of the Amazéns.²⁶

²⁴J.Cortesão. Geographical Journal LXXXIX, 1937, "The Pre Columbian Discovery of America", p.30.

J.Cortesão cites Alguns documentos do Archive Nacional da Torre do Tombo Lisbon. 1892 pp.9, 14, 45.

²⁵PMC, Vol 1 pp.8-9.

²⁶D.Lach. Asia in the Making of Europe . Vol.1, p.219. Note Juan de la Cosa was on a mission of cartographical espionage to Lisbon in 1502. He soon returned to Seville to make a map of Asian waters.

The explanation of this about turn in policy can only be found in an attempt to classify charts as state secrets. A long standing sensitivity amongst Portugal's rulers to economic arguments pushed the king towards advancing navigational knowledge within an overall policy of official secrecy on such strategic matters. Such a climate could not be congruent with the best climate for advancing nautical astronomy and hydrography.

Navigational knowledge is by its very nature international in character and application, and is best advanced by an international interchange of knowledge amongst practitioners. It is ill-suited to national bureaucratic control in the long term as was shown by events in the Hanseatic League, China and even 15th-17th century Portugal, Spain and Holland. There navigational progress was supported or retarded as dictated by those governments' financial interests in an exclusive control of sea routes and trades.

Whereas today many of the problems associated with national hydrographic institutions have been solved by an international approach to ensuring safety at sea, the appreciation that the maximum advantage can be made of limited resources through international co-operation stems from the founding of the International

Hydrographic Bureau in 1921. However such a bureaucratic approach tailored to the nature of navigational knowledge could not fit 14th and 15th century official outlooks. Jaime Cortesão attempted to outline the approach of the official 15th century mind, for it exercised a formative influence on the development of navigational knowledge inside and outside official organisations in the 16th and 17th centuries. Against it only occasional lurches were made toward an international approach.

J. Cortesão stated that Portugal, on finding a new sea route which also offered the possibility of a lucrative trade, sought to "transform the trade into a monopoly; to close the routes by means of treaties and prohibitory fables, or by persecution of all transgressors; to conceal their policies and commercial activities, as well as the facts connected with them; to keep an eye on foreigners abroad and at home, and to exclude them from their social circle ... This policy of monopoly and secrecy was stricter in proportion to the weakness of their defensive means, the number of potential competitors, and the extent of the maritime routes and of the newly discovered lands".²⁷

As we have seen, and will see, Portuguese royal policy towards navigational advance will not fit so simple an economic analysis. In the

²⁷ Jaime Cortesão "The Pre-Columbian Discovery of America." Geographical Journal LXXXIX, 1937 pp.29-42. This extract is from p.30.

15th century the crown clearly patronised foreigners who could make a contribution to navigational advance. We shall examine later the Portuguese success in enforcing those secrecy classifications of navigational information which constituted the pre-entry barrier to those seeking to break Portugal's monopoly of the direct sea lanes to India. What Cortesão has demonstrated is the development of an official policy of exclusivity, by successive merchant-kings who wished to use Portugal's navigational skill to this economic end. In this context the employment of foreign navigators, instrument makers and theoreticians is explained. They were employed by the Portuguese kings to quicken the attainment of their ultimate economic goal.

The initial moves towards secrecy and exclusivity made in 1443 were strengthened as a result of deliberate political pressure put on the Pope. By 1454 this pressure had secured a Papal Bull which forbade Christians to navigate towards the newly discovered lands without the permission of the King of Portugal. However, Fra Mauro preparing a famous map of the world for the King of Portugal at Murano near Venice, seems to have had easy access to Portuguese reports of voyages made down

the west coast of Africa.²⁸ They may have been made available by Venetians in Portuguese service, such as Alvise de Ca da Mosto who sailed thither in 1455 or 1456 or through Antonio de Not who followed and returned by 1460. It was such activity, especially amongst Italians, that led to the King directing in 1480 that crews of foreign ships found in the Portuguese zone of navigation should be thrown into the sea to drown.²⁹

The maintenance of such an official policy of exclusivity commanded wide popular support in Portugal. In the Cortes of 1481 King John II was petitioned to forbid any future settlement of foreigners in Portugal or his other dominions. They pointed out that Genoese and Florentines

²⁸ Fra Mauro's inscriptions are discussed in the Introduction to Portugalia Monumenta Cartographica Vol.1 by A.Cortesão. The most interesting of Fra Mauro's inscriptions reads as follows and applies to the African coast south of the Equator.

"Many opinions and writings are found asserting that in the southern part of the ocean does not surround this our habitual and temperate zone: but we have many witnesses to the contrary and above all those his majesty the King of Portugal has sent to discover and see with their eyes, ... and they made new charts of that navigation, and gave new names to rivers and coasts, capes, harbours of which I have had copy: and if anyone contradicts this that they have seen with their eyes, all the more will it be impossible to agree with or believe those that have left in their writings, not what they see with their eyes, but thought to be so".

See also p.450-451 of this thesis

²⁹ Cortesão op.cit. p.30.

were particularly dangerous because they revealed the secrets of the Mina and the Atlantic Islands.³⁰

Within a year of Cortesão publishing this interpretation of Portuguese policy, G.R.Crone wrote that the influence of the policy of secrecy "has been exaggerated, and that it was unsuccessful".³¹ He noted in particular the rapid inclusion

³⁰J.Cortesão, op.cit. p.31.

³¹G.R.Crone. "The Alleged pre-Columbian Discovery of America", Geographical Journal, LXXXIX, 1937 pp.455-460 (December Ed.).

Crone's article cites Grazioso Benincasa's chart made at Venice in 1468 showing the Canaries found in 1456-7 and the discoveries of Diogo Cao in 1485 and Dias (1487) on charts by Soligo made in Venice 1489. (B.L.Egerton 73) and on a world map engraved by Henricus Martellus (B.M.Add.MS. 15760).

S.E. Morison - Portuguese Voyages to America in the Fifteenth Century - Cambridge Mass. 1940, p.82.

B.W.Diffie and G.D.Winnius Foundations of the Portuguese Empire, 1415-1580 Oxford Univ.Press 1977, p.xii.

The Times. Monday 17 January 1976. Obituary "Samuel E.^{nnited}Morison" p.16.

The first^{nnited} mention of any Portuguese voyages into the Atlantic is in Vasco Fernandes Galasci Fernandi utriusque iuris consulti Illustrissimi Regis Portugallie oratoris ad Innocentium octauum pontificem marimū de obedientia oratio. Rome, Andreas Frietag 1485. On ff.4-5 there is reference to Cadamosto's discovery of the Cape Verde Islands "in oceano athlantico decem insule ...", the capture of Arzilla in 1471, the founding of Elmina on the Gold Coast in 1482, and a strange reference to the rounding of the Cape of Good Hope in 1484.

See Sotheby's Catalogue. The Celebrated Library of Boies Penrose. 9th September 1971. Lot 262.

of information on Portuguese discoveries in the Atlantic on Italian charts of the late 15th century. The late Samuel E. Morison attacked the Cortesão thesis with regard to the pre-Columbian discovery of America noting at the same time the secrecy policy "did not exist with regard to Africa". In 1977 Professor Diffie concluded "there is no basis for secret discoveries before the known voyages of Dias, da Gama, Cabral and others".³²

Particular difficulty in assessing the merits of both sides of this argument is presented by the nature of the evidence. It would be necessary to decide whether a "secrecy policy" existed had the Portuguese been totally successful in denying information of their latest discoveries to others. Some evidence as to the nature and date of the discovery is necessary to ascertain what the Portuguese were protecting and for how long they gained advantage by their subsequent actions. It is only where the Portuguese were lax in regard to secrecy, or where officially released information may be

³² Samuel E. Morison, Portuguese Voyages to America in the 15th Century. Cambridge Mass. 1940, p.82. Samuel E. Morison, Admiral of the Ocean Sea. A life of Christopher Columbus. Little and Brown, Boston, 1942 pp.57-72. Of particular interest is his discussion of Oviedo's references to an "unknown pilot" on p.61. B.W. Diffie and G.D. Winnius, Foundations of the Portuguese Empire, 1415-1580, Oxford. / pp.439-465. ₁₉₇₇

contrasted with accounts in official Portuguese hands, that any evaluation of these arguments can take place. By the 16th century another dimension, the information extensively exchanged in Asia and Europe, shows by contrast Portuguese determination to keep navigational details from their European rivals.

A pattern emerges in J.Cortesão's claim that much detail was censored from the official chronicles of Azurara and Ruy da Pina in the mid 15th century. The absence of details of Pero de Covilha's voyages to Goa, Calicut, Hormuz and Sofala, or the fact that no details of Dias's voyage to chart 1,400 miles of African coast around the Cape of Good Hope to the Great Fish River appeared in the official chronicle of John II's reign, are part of his case.³³

Against this, the maps pointed to by Cortesão's critics, e.g. Martellus's 1489 map showing Dias's voyage of 1487, merely serve to point the contrast of Portuguese and Italian outlooks and reinforce Cortesão's arguments as to the existence of a Portuguese policy.

Comprehensive study along these lines is impossible for today's historians because the Lisbon earthquake of 1755 destroyed so many relevant documents including those kept safe

³³J.Cortesão, op.cit. p.31.

D.W.Waters. The Art of Navigation, in England in Elizabethan and Stuart England, N.M.M., Greenwich 1978, pp.81-2.

and secret by the Portuguese agencies. J.Needham wrote

"the disappearance of documentary proof of many alledged Portuguese discoveries has caused great heart-burning among modern historians, but it seems those who have maintained the existence of a policy of secrecy are justified".³⁴

A 'secrecy policy' would seem to explain several other early and tantalising references. For example in 1485, three years before Covilha or Dias set out for the east coast of Africa, Vasco Fernandes de Lucena said his countrymen had attained to the gates of India "almost to the Promontorium Prassum, where the Arabian Gulf begins". Nothing further was divulged, so it must remain inexplicable unless there had been a secret voyage to the East African coast, before details of Dias's were gathered in Italy.³⁵

Orthodox historians have always taken Vasco da Gama to be the first European to sail up to Sofala after Dias. However we know Covilha visited it before 1498, having set out with Pavia for India, travelling on Arab ships, speaking Arabic and assuming Muslim dress.³⁶

³⁴J.Needham, Science and Civilisation in China Vol.4, Part 3, CUP 1971, p.528.

³⁵Ibid.

³⁶Charles E.Beckingham "The travels of Pero de Covilha and their Significance". International Conference for the History of Discoveries. Lisbon 1960.

Covilha is known to have left Goa for Hormuz in 1489, and, as Francisco Alvares reports, to have written to King John of Portugal about the port of Sofala and the feasibility of rounding Africa by sea on the way to India. Yet further evidence of discovery is given by the Arab pilot Ibn Majid within manuscripts found in Leningrad containing navigationnal mnemonics, and which distinctly say a Frankish expedition was shipwrecked near Sofala as early as 1495.³⁷

Thus orthodox historians of discovery may be attacked not only for relying on official chronicles, but also for ignoring unpublicised navigationnal information. No longer do we have to accept the ignorance of European navigators, especially Portuguese, about Asian waters on the basis of what Carl Errera called "The insuperable argument of silence".³⁸

There were a growing number of travellers' accounts of the east in European circulation, though few before 1520 were published in Portugal.

³⁷J.Needham, Science and Civilisation in China, Vol.IV, pt.3.p. 528.

Tibbetts, Arab Navigation before the Coming of the Portuguese. Royal Asiatic Society - Oriental Translations Fund, Luzac, London, 1971 pp.10-11.

Grosset-Grange, "An Arabian Sea Chart of the Middle Ages,"

Journal of the Royal Institute of Navigation, p.448. Vol. 28, No. 4.

³⁸J.Cortêsão, op.cit. p.30.

It would be foolhardy to suggest the Portuguese were not aware of this information, for there is evidence to suggest they actively sought it, but concurrently Portuguese bureaucracy disguised a tradition that grew ever stronger during the 16th century - a tradition of utilising the particular knowledge of Asian sailors and pilots. In paying Fra Mauro to produce a world map during the years 1456-60, the Portuguese crown was indirectly paying for particular knowledge about the Asian seas. Fra Mauro utilised such sources as European travellers like Marco Polo and Nicolo Conti, while two insertions suggest he had access to Chinese sources.³⁹ He provided the information that Africa could be rounded, though, as he notes the Portuguese had not yet proved this despite venturing many miles down the west coast. It would be interesting to know if he actually had a Chinese map in the Korean style which had correctly shown the slightly south western orientation of Africa's southern capes since the mid 14th century, or whether he had Arabic information based on traditional Arabic maps after the form of Ibn Khurdadhbih's 9th century exemplar. This might account for the triangular shape of Africa with a south eastward orientation of its southern capes actually shown in the one copy of Fra Mauro's

³⁹ J. Needham, Science and Civilisation in China, Vol. IV, pt. 3, p. 528.

map that survives in Venice.⁴⁰

The intensity of Portuguese interest in eastern information from the mid 15th century is further attested by consultations with the Florentine, Paolo Pozzo Toscanelli. Canon Martinez, one of King Alfonso's councillors, asked for Toscanelli's opinion on the shortest way to the spice islands and for a chart showing the route. The Florentine replied:

"You tell me that His Majesty asks for a declaration or visual demonstration, so that he may comprehend it, and whether it is possible to follow the said route ... and have decided to demonstrate it with a chart similar to those used in navigation".⁴¹

He continued to say that this chart showed eastern Europe's coastline and Africa's as far south as Guinea, the east coast of Asia including Cipangu (Japan) and many other Asian islands. He stated from Lisbon to Quinsay in China was only 6,500 miles by a western route and from the island known as Antilla only 2,500 miles. The inference was the route via Africa's southern tip was far longer than 6,500 miles. This in the event was far more accurate than the wild estimate of the length of a western route that would later hold such attraction for Columbus.⁴²

⁴⁰ S. Maqbul Ahmed. 'Islamic Cartography', paper presented to 6th International Conference on the History of Cartography (p.1) presented here differed from Crone's views and included a discussion of other Islamic maps.

⁴¹ G.R. Crone, op.cit. p.17.

⁴² Christopher Columbus corresponded with Paulo Toscanelli in 1474, the latter sending Columbus a copy of a letter which he had previously written to Fernando Martinez, Canon of Lisbon. Washington Irving, The Life and Voyages of Christopher Columbus, H.G. Bohn, London, Vol.1, p21-2.

Thus we see there was a considerable amount of Eastern information available through Portuguese patronage *to those interested in it*. This was not directly available except to navigators like Vasco da Gama, as a result of the considerable and varied pressures from all sides to adopt a policy of exclusivity and vigorous secrecy of classifications in regard to navigational information, even censorship where necessary. Also, popular and economic pressures affected many of the regulations governing the operation of Casa da India and the Armazéns in Lisbon, as much as the conduct of the pilots and masters in the Carreira da India. The regulations certainly prompted an Italian agent in Lisbon to write shortly after the return of Cabral's difficult voyage to India

"it is difficult to get a chart of this voyage, because the King has declared the death penalty for anyone sending one abroad".⁴³

The same considerations also motivated the ban of 1504 on the production of charts of the sea routes to Asia. But did Jorge Vasconcelos use his new authority to destroy charts of the East?

The answer is undoubtedly no, for his intention was to ensure that only in the Armazéns

⁴³R.A.Skelton, Explorers Maps, Spring Books. 1969. p.33.

did such charts exist. From there they could be issued only to those with due authority i.e. the pilots of the Carreira da India and a few other privileged officials. It was an attempt to wreck the practice of copying and selling the padrões, and to deter and prevent foreigners from gaining such details of the sea lanes to Asia. Charts and other aids were presumed to be safe from such commercial espionage if they were inside the Armazém or if they were issued to pilots by the 'almoxarife' on the basis that the pilot was bound to surrender them again to the 'almoxarife' when he returned to Lisbon, along with any new charts and information prepared on the voyage.

Confident in the efficiency of the Armazéns' bureaucrats to operate the desired restrictive practices and maintain secrecy, the Portuguese set out to improve their cartographic record and improve the observational accuracy possible with the other navigational aids they issued. Considering the large number of people entrusted with secrets during the course of the sixteenth century, their confidence was in large measure justified. However, these officials failed to understand all the difficulties involved in an attempt to restrict such knowledge, especially once an international interchange of navigational information in Asia had been fostered.

The policy of utilising such sources was for long concealed by the secrecy provisions, though its early existence has been stressed by J.H.Parry in his recent publication The Discovery of the Sea.⁴⁴ The same secrecy policy so necessary once the Venetians began to produce copies of charts on woodblocks for printing in 1508 is now best illustrated not by reference to European copies of Portuguese charts, but by reference to the rather more numerous Portuguese charts of the sixteenth century, which it might be suggested have often survived as much for their beauty as for their practical value. Reference to such charts serves also to show how the secrecy policy concealed both ignorance and knowledge, while revealing the scope for local information from eastern pilots. Pirated copies of Portuguese works very rarely recorded the state of knowledge with such honesty.

An inscription on Jorge Reinel's chart of 1510 shows the Portuguese situation in its tantalising inscription near the East Indies -

"The very populous and noble city of Malacca, about which we still neither know, nor has it been discovered".⁴⁵

⁴⁴ J.H.Parry, The Discovery of the Sea, Wiedenfield and Nicolson, 1975, p.229.

⁴⁵ P.M.C. Vol.1, p.19.

Yet at the same time Asian information was good enough for Reinel to put in another inscription, the ultimate goal of Portuguese expansion to the East -

"In this island grow all the spices".⁴⁶

Also grateful at this time to local information was Diogo Lopes de Sequeira who would reach Malacca on 11th September 1509. Greater still was the impatience with which his detailed reports were awaited in Lisbon. This was the keener as Ludovico d Varthema had already brought back a considerable amount of information which had been published in Rome, Venice and Milan early in 1510. Other useful information had appeared in a Dutch newsletter Calcoen, in 1504, mentioning that Ceylon and Malacca were good sources for spices.^{47a} A small printed pamphlet appearing in Nuremburg also spoke of the East Indies giving a roughly correct distance from the Indian port of Quilon to Malacca and Sumatra. The Portuguese found there was nothing so tantalisingly attractive as partial knowledge of another nation's secret. Soon they were to suffer from exactly this, but by 1510 they knew the Dutch account stemmed from a Dutch sailor taken on Vasco Da Gama's second voyage and that it was inadequate from the navigational point of view.

46 Ibid.

47a Calcoen was first published in Antwerp in 1504. See translation by J.P.Berjeau Calcoen...(London,1874). Another similar account by an unknown author survives in the National Library in Vienna, having come originally from the collection of Philipine Welser. See D.Lach op. Cit. Vol1, p160-1 and Vol2 p503. He cites Christine von Rohr, Neue Quellen zur zweiten Indienfahrt Vasco da Gama, (Liepzig, 1939)

When the desired details were secured in Lisbon, the Portuguese made a deliberate attempt to maintain total secrecy. King Manuel made no move to announce that the Portuguese now had the vital information. Though Sequeira returned to Lisbon in 1510, King Manuel did not announce the formal Portuguese discovery of the route to Malacca until his momentous announcement in 1513.^{47b}

Besides the exclusivity considerations, the secrecy was maintained at this high level to give Albuquerque in his attempted conquests of Malacca and the Red Sea ports a free hand to capture a vital strategic strongpoint.

"Whoever is lord of Malacca has his hand on the throat of Venice. As far from Malacca, and from Malacca to China, and from China to the Moluccas, and from the Moluccas to Java, and from Java to Malacca and Sumatra, all is in our power".⁴⁸

The full significance of this from a navigational standpoint is considered later. Similar policy considerations can be seen in both Albuquerque's policy and the Armazén's over the attempts to capture Socotra at the entrance to the Red Sea. João Gomes accompanied Afonso de Albuquerque to the Red Sea in the capacity of a pilot from India. From there he brought a plan of Dahlak Island. This island, of considerable strategic importance, thus entered Portuguese records from an Arab source

47b. For a full version of Manuel's letter in English see:- Calendar of State Papers Colonial Series East Indies China & Japan . Ed. Noel Sainsbury, Longmans London 1862 . Document 1

48 J.H.Parry The Discovery of the Sea London 1975, p277

in the Red Sea. Perhaps as a result of secrecy provisions, it has not survived in its original form for Albuquerque certainly had a grasp of the strategic importance of navigational charts. This much was revealed in a series of documents about Indonesian navigation sent to the king by Albuquerque in August 1512. Likewise the Casa and the Armazén also managed to protect the works of Pires, Rodrigues and Barbosa on Asian trade and navigation with very tight secrecy as a result of their understanding of the strategic importance of the documents. The secrecy the Casa and Armazén managed to maintain around the Suma Oriental and its interleaved charts and coastal profiles by Francisco Rodrigues must remain a tribute to the official Portuguese navigational agency. Those vital passages about the Spice Islands themselves were never revealed until the publication of the complete text of the Suma Oriental in 1944. Ramusio records his frustration in the 1540s as he sought access to this document made twenty years before.

To maintain effective secrecy such as this, the Armazén had to grade their secrecy classifications, for a system classifying everything could not be expected to work or command the respect of all very long. They proceeded therefore to restrict those knowing all the secrets, in addition to restricting access to the Armazén itself. They attempted to satisfy national

curiosity and pride by certain disclosures and to placate bankers and other important foreigners with interests in the Casa by selective disclosures. Alongside this, censorship was also maintained to prevent undesirable disclosures from official records in literary formats.

Valentim Fernandes was responsible for many official disclosures which might be seen by foreigners and other interested persons. He published the travel accounts of Conti and Marco Polo with official sanction at Lisbon in 1502.⁵⁰ They did not, however, contain any vital navigational information, but were part of the government's attempt to excite and maintain interest in the wonders of the east. In this role he was acting semi-officially as the editor and translator of interesting but non-technical information. It might be a valuable supplement to a navigator once the latter reached the east, but not before.

However this German printer and notary domiciled in Lisbon had other official roles when he acted as intermediary between the wealthy German merchants of Lisbon and the government. In this capacity he was often called upon to act as interpreter, translator, agent and informer on Eastern matters. He helped secure German participation in the 1505 fleet, and German

⁵⁰Lach, op.cit. p.158.

financial backing for the Portuguese fleets.

The price demanded for finance was information about the East and so with embarrassed reluctance he sent a series of charts, manuscripts, even a parrot to Augsburg between 1505 and 1508.

There Conrad Peutinger, a relative of the Welsers, bound the charts in wooden covers and entitled them "De insulis et peregrinationibus Lusitanorum", but did not publish them.⁵¹

This and other cases show Fernandes acted with discretion in choosing those whom he was going to inform in Germany. Another letter, unpublished until 1960, he addressed to Steffan Gabler in Nuremberg on 26th June 1510.⁵²

Valentin Fernandes does not appear to have been so careful over manuals of navigational instruction designed for universal use and in teaching coastal pilots the skills of the oceanic navigator. He seems to have printed the Regimento do Astrolabio e do Quadrante in 1509 and the Regimento do Astrolabio in the Reportorio dos Tempo in 1518. The last item is almost certainly a copy of the same Portuguese Reportorium as was reported lost along with the sea chests of John Borough before the High Court of Admiralty in 1533.⁵³

⁵¹Lach. *ibid.* pp.108 and 159.

⁵²Teixeira da Mota. 6th ICHC. *Ibid.* p.5.

⁵³E.G.R.Taylor, The Haven Finding Art, p.193. D.Burwash, English Merchant Shipping, p.29 and footnotes of chapter The Navigational Interchanges of N.W.Europe 1520-1580.

Fernandes's publications are significant because of their uniqueness. They are both rare today, and in their own day they were rare. They are the only publications printed in Portugal prior to 1520 to contain extensive navigational information. Not only did the Reportorio contain rules for using instruments like the astrolabe, it also included calendical material and astronomical tables. It is suggested they may have been printed secretly to avoid copyists' errors and were as tightly restricted in circulation as charts. Certainly the Conselho da India did not authorise any other printing of navigational texts until Gaspar Reimão's rutter in 1611.⁵⁴ Their reasoning whenever the subject was discussed was the reduced likelihood of surreptitious copying of manuscripts, each one individually identifiable.

Royal revelation of certain geographical discoveries, sometimes gave a little navigational information away, but at this period it was only undertaken to forestall the rival claims of Spain to an Eastern empire on the basis of papal division of the world into exclusive Spanish and Portuguese spheres. At the treaty of Tordesillas signed in 1494 the dividing line between the empires was fixed along a meridian 370 leagues west of the Cape Verde Islands. This

⁵⁴PMC. Vol.IV, p.87 but note Manuel de Figueirido Hidrografia was printed in 1608.

was the best settlement Portugal could make in 1494 because it seemed to offer her perhaps a foothold in the new world she suspected to exist in the west. The consequence was unfortunate for Portugal because though Cabral could claim Brazil for her, the rights of discovery and navigation to the Far East were jeopardised.

Much of Portugal's exploration effort was directed into the production of charts showing the antipodal continuation of the 'raya', 180 degrees of longitude distant from the Atlantic line.

Anxious to protect his exclusive rights King Manuel sent news of the Indian discoveries to Pope Julius II in 1505 and secured three papal bulls favouring Portuguese commercial and missionary activity in the area. Similarly when a project was mooted in Spain in 1512 to claim and capture the Spice Islands for Spain, Manuel took speedy action to announce the capture of Malacca and seek further Papal confirmation of Portugal's rights.⁵⁵ He sent a letter to the Pope in June 1513, a copy of which later found its way into Henry VIII's papers in England. This letter was followed by a diplomatic mission led by a distinguished navigator and naval commander, Tristão da Cunha. On 7th June 1514 Leo X granted Portugal's wishes and issued a bull which gave "great security" and navigation rights to:

⁵⁵Lach op.cit. pp.160 and 167.

"All unfrequented places, recovered, discovered, found and acquired from the aforesaid infidels by the said King Emmanuel and his successors, both from Capes Bojador and Nao to the Indies, as in any place or region whatsoever, even although perchance unknown to us at present ..."⁵⁶

Concurrently the quality of Portuguese hydrography was rapidly improved. The appointment of Tomé Pires by Albuquerque to bring Malacca's finances into order in 1511 led to the latter undertaking a tour of the area. Over the next three years he kept a record of his voyages to Java and Sumatra, and came to appreciate the value of the area's trade.

Pires had undertaken these voyages in order to discover whether the riches of the Moluccas were or were not on the Portuguese side of the Tordesillas meridian defined in 1494. His intention was to beat and forestall a possible Spanish claim to the area. Albuquerque sent with Pires, Antonio de Abreu, Francisco Serrao, and Simao Affonso Bisagudo as captains, and to accompany them, two Javanese pilots and Francisco Rodrigues

"a young man of very good knowledge and able to make maps and report on the area".⁵⁷

⁵⁶Lach, *ibid.* p.168.

⁵⁷PMC, p.80. Letter of Albuquerque to the King, 20 Aug. 1512.

To this expedition we thus owe not only the Suma Oriental , but Serrão's descriptive letters to his friend Magellan, which though now lost, incited Magellan's famous circumnavigation, and the first European charts of the area beyond Malacca drawn by Francisco Rodrigues in 1513.

As the Portuguese were beginning to chart the Moluccas, so they also began to chart the -- way to China. As we shall see, this necessitated different types of approach and interchange of ideas. It began with Jorge Alvares taking two junks to the mouth of the Canton River in 1513. Fernão Peres de Andrade was commissioned by King Manuel to conduct a mission to the Chinese Emperor in 1516. On the strength of the Suma Oriental Pires was appointed envoy to the Chinese Imperial Court. He was landed in 1517 at Canton, but his mission failed because the Portuguese fell foul of the Chinese in Canton and were imprisoned. One of the captives, Christovão Veira, managed (we do not know how) to send intelligence reports on the depths of the river near Canton.

Their problems were, however, minor ones compared to the long-term threat posed to the operation of Portugal's navigational services and policy by the defection of cartographers, instrument makers and pilots to rival powers. It began with a drift into the service of Castile ,

Portugal's wealthy neighbour. Amerigo Vespucci took part in Portuguese expeditions to Brazil under Goncalo Coelho in 1501 and 1503 and therefore had the opportunity to become familiar with the organisation of Portugal's central hydrographical services. He then entered Spanish service and in 1508 was made responsible for the operation of a _____ navigational agency newly set up in Seville. In 1508 another Portuguese pilot João Dias de Solis entered Castile's service and in 1512 succeeded Vespucci.⁵⁸

The problem took a turn for the worse in 1517. Magellan who already had experience of Asian waters had seen the markets of Malacca, and formed a close friendship in correspondence with Serrão who was to live out his days in Ternate, left Portugal at the insistence of Duarte Barbosa and Cristobal de Haro. The loss was not just of a skilled master and soldier, but was the more serious because of Magellan's activities when he was in disgrace in Lisbon in the years before his departure for Spain. There he met Ruy Faleiro, the astronomer and geographer who claimed to have discovered the way to find longitude and to have proved a crossing of the Pacific ocean was feasible. He was able also to follow up the theory that America could be rounded by a southerly strait, on the basis of

⁵⁸Teixeira da Mota. ICHHC. op.cit. p.5.

evidence provided by Germans in Lisbon, Behaim and Schoner, because though Manuel had forbidden Magellan to serve any other power, he had omitted to forbid him that entry which was his right as a noble to the archives of the *Armazéns da Guiné e Índia*.⁵⁹ He could thus consult all the charts, logbooks, rare nautical instruments and informative documents in the Armazén's care as official secrets. Thus when Magellan defected to Seville in 1517 he took more than poorly regarded and fiery Ruy Faleiro with him.

Portugal's loss became more serious still in the course of 1519 for Jorge Reinel, son of the famous cartographer Pedro Reinel, left for Seville also. In these circumstances, a precedent for future problems, the Portuguese turned to an extensive system of spies. They also sent Pedro Reinel to collect his son and bring him back, but not before the spy could report that he had seen

"the land of the Moluccas put on the globe, and the chart that this son of Reinel has made here, which was finished when his father came to fetch him, and his father finished it and put these islands of the Moluccas on it, and this is the standard [padrão] for all the other charts which are made".⁶⁰

⁵⁹E.Roditi, Magellan of the Pacific, Faber, London, 1972, p.102.

⁶⁰R.A.Skelton *ibid.* p.139.

The actions of the Reinels were also important for they produced the best navigational charts of the period before 1520 which are extant still and show the East Indies. Pedro Reinel had access to Rodrigues's charts in the Suma Oriental when he made his anonymous chart of Africa and the Indian Ocean as far as the Moluccas. This chart and one made in 1519 by Jorge Reinel and perhaps the same as that mentioned above, found their way into Peutinger's collection. The only changes evident from Portuguese practice were that none of the ships on Jorge's charts had the Cross of Christ on the sails in the way that typified Portuguese charts. Most important of all, these charts show the Portuguese charts in 1520 embodied the very latest information, and were constructed on the soundest principles known, to the highest and most beautiful standards. They are representative of the quality of the Armazén's work, but also symbolic of the problems faced by the Armazén's cartographers and administrators.

Chapter 2The Development of Portuguese Navigational Services (1520-1580)

During the period from 1520-1580 Portuguese excellence in the production of navigational aids was evident to all outsiders. Behind the improving standards of the Portuguese lay the strategic anxiety to improve safety at sea and facilitate more accurate navigation to the far flung parts of the Portuguese empire. It was an uphill struggle characterised by political problems, administrative changes, censorship and attempts to revitalise traditional methods with ideas and knowledge drawn from her overseas empire. These developments took place against a very competitive background, where all the major European maritime powers sought access to the same information.

The incident which cast the darkest shadow over the development of Portuguese navigational services was Magellan's defection in 1517. Not only did Magellan have personal experience of the navigational problems of Asian waters while in Portuguese service, he had as a nobleman access to the archives of the Armazéns in Lisbon, the value of which he fully realised. King Manuel did not think of this so although Magellan fell from his grace at court in 1514, the sea captain was not

banned from the Armazéns.¹ Thus when Magellan and Ruy Faleiro defected to Spain in 1517, they were taking vital knowledge with them. The Portuguese Ambassador to Spain accordingly made vigorous diplomatic protests and tried to ferment jealousy amongst the Spanish on account of the large number of Portuguese pilots and sailors that Magellan hired for his attempt to discover a south-western and all Spanish route to the wealth of the Spice Islands.

Anxiety that Magellan might have the necessary cartographic knowledge on the 23 charts he had taken onto his flagship, as well as enough skilled

¹Edouard Roditi, Magellan of the Pacific, Faber, London, 1972, p.102.

Charles McKew Parr, So noble a captain, Robert Hale, London, 1955, pp.122-3. It is suggested by Parr that John of Lisbon, a famous navigator, much trusted by King Manuel, had sailed on a secret voyage to South America financed by Cristobal de Haro in order to search for the entrance to a westward passage to the Indies. Full details of this voyage, which preceded De Solis's fateful attempt of 1515, seem to have been restricted to Haro and King Manuel, until John of Lisbon met Magellan in Porto just before the latter's flight to Spain. John of Lisbon gave Magellan details of his discovery of the River Plate estuary including his charts and other celestial observations made near Cape Santa Maria. Haro seems to have obtained information about new lands and markets from Arab and Asian sources which were not available to official Spanish or Portuguese bodies or their sailors. Well established in the highest councils of Spain and Portugal, Haro may have been amongst those high ranking Spanish officials whom Manuel bribed to provide the information as to which Portuguese serving in India were also in Spanish pay and providing strategic information to Spain. Amongst those Albuquerque suspected of supplying Spain with details of Indian waters were Duarte Barbosa and Ferdinand Magellan. Both subsequently did enter Spanish employment but it is more likely their changed allegiance was due to this fall from the favour of Portuguese officialdom.

seamen able to take celestial observations,² prompted the King of Portugal to order the fitting out of a fleet at Malacca whose purpose was to intercept and destroy any of Magellan's fleet should they succeed in crossing the Pacific. In addition a fort and a factory (trading station) were to be established at Ternate in an attempt to prevent this and any subsequent Spanish ventures from ———trading with the Moluccans.—

Great therefore was Portuguese chagrin to learn in 1522 that though they had successfully captured the 'Trinidad' in a very distressed condition, another ship of Magellan's fleet, latterly commanded by a rough Basque seaman, Sebastián del Cano, had arrived back at Seville, having circumnavigated the world.³

²D.W.Waters, Science and the techniques of navigation in the Renaissance. NMM Monograph 19-1974, p.29. See the Inventory of the Magellan expedition where 56,422 marevedis were devoted to charts and navigational aids - Appendix 1. Duarte Barbosa and John Serrano both with reputations based on their Asian experiences, changed their allegiance before Magellan, and then as friends were instrumental in facilitating his flight and giving support to his project of getting specific royal support for his westward exploration. When Magellan left for Spain he was accompanied by John Rodrigues de Mafra and Vasco Gomes Gallego, both experienced Portuguese navigators who subsequently also sailed with him on his great voyage. Magellan's chief pilot was another disgruntled Portuguese emigre, but he was the agent of Bishop Fonseca and Cristobal de Haro, and deserted Magellan with his ship when the famous strait was discovered in order to claim the glory as its discoverer and wreck Magellan's reputation.

³Until 1524 the Portuguese were sceptical about official claims from Madrid, and about Pigafetta's account until the story of this Spanish expedition was confirmed by a letter from Antonio de Brito, the Portuguese Captain at Ternate dispatched on 23 May 1523 to Rei Dom João III. See also D.F.Lach op.cit. Vol.1, p.176.

Sebastián del Cano had only been able to achieve this feat, and evade Portuguese warships, because his skill as a navigator had been supplemented by the services of a Moluccan pilot, who had guided him through the hazards of the reef strewn Banda Sea as far as Timor, after which he followed the route of earlier Asian migrants to Madagascar, thus keeping well to the south of the sea lanes frequented by the Portuguese ships.

The return of del Cano produced two parallel sets of consequences, firstly - open war between the Portuguese and the handful of Spaniards left behind by this expedition on island kingdoms hostile to neighbours who traded with Portuguese, and secondly - the decision to hold a conference of experts to fix the position of the Moluccas with respect to the "raya" drawn up at Tordesillas in 1494. Of necessity these experts who met at Badajoz-Elvas in 1524 were navigators and hydrographers. As a result of defections, Portuguese cartographers attended in both Castile's and Portugal's delegations.

At this Junta arguments took place on the size of the earth and the length of its circumference, for this materially affected where the eastern extension of the "raya" was to be drawn. The Portuguese claimed the islands were 43 degrees west of this anti-meridian and therefore were Portuguese, while the Spaniards claimed they were 3 degrees east of it and therefore Castille's by right. A

transcript made by the French Ambassador to Portugal from 1559 to 1561, Jean Nicot, from information compiled by Lopo Homem in 1529 illustrates the way elements of nationalism entered the latest cartographic productions of both sides. It begins thus:

"Notes for the King of Portugal which were made by Lopo Homem, cosmographer and knight of his household, on a navigation chart based on the Sun and moon eclipses, which was made to show that from the meridian of Lisbon to India and to the meridian of the Moluccas, it was less distance and longitude of equinoctial degrees than was shown on the old navigation charts, by which at first navigation was done, by which [padrão] it is very clearly to be prejudicial and contrary to the contract of the Moluccas between King [John III] and the Emperor [Charles V], thus being much more in favour of the rights and justice of Castille and the Emperor than the King of Portugal ..."⁴

The letter then goes on to describe the 'padrão' ordered by Dr. Pedro Nunez and shown by Lopo Homem at the specific request of King John III. This stated that "the said islands [the Moluccas] are more than 400 leagues within the demarkation of the King of Portugal".⁵ In the light of such evidence, it is not surprising that the submissions of the celestial observations of navigators and the accuracy of many charts and observations were questioned. Thus this conference which had occupied the attention of Portugal's 12 best cartographers broke up in disagreement.

⁴PMC Vol.1, p.51. Note Magellan had formed a conclusion in 1512 based on his voyaging that the Moluccas were in Castille's domain.

⁵PMC Vol.1, p.51.

In retrospect the conference would seem to have been a great stimulus to the production of better Portuguese charts, so much so that Charles V conceded the Moluccas in the Treaty of Saragossa. This victory, however, was not achieved without a high cost to Portugal. Nicot's transcript reveals that the Portuguese were compelled to pay Charles V 370,000 ducats for the exclusive rights to the Moluccas conceded at Zaragoza in 1529 though a price of 350,000 ducats was agreed in the treaty.⁶

Portugal thereafter had to pay more for the knowledge and products of its skilled cartographers J.H.Parry has asserted that

"the only practical result of the conference was the opportunity it afforded to the Spanish Crown to buy Portuguese cartographers into its service".⁷

Certainly the Spanish did succeed in securing the cartographer Diogo Ribeiro's distinguished services, but they failed to entice Pedro and Jorge Rienel into their service in 1524. Though generous offers of 35,000 and 30,000 marevedis per annum were made to Pedro and Jorge Rienel, these offers were not enough to attract them into Spanish service.⁸ Such offers caused anxiety to Portugal's security services after the lessons of Magellan's defection.

⁶An item later in the treaty said that if certain payments were made at "The fair of Medina del Campo" they would be charged 5 or 6 per-cent tax which would explain the excess 2,000 ducats.

⁷J.H.Parry, Discovery of the Sea, p.295.

⁸It is noteworthy that the specialised training of pilots in Lisbon ensured that until 1550 there was little risk of navigational information passing out of Portugal via students attending foreign universities. PMC Vol.1, p.20. See Luis de Mato's 'Les Portugais a l'université de Paris entre 1500 et 1550'. Colloque 1950.

A letter written from the village of Tomar on the Portuguese border shows the problems Portugal faced at this time in maintaining the security of navigational information about the Asian sea lanes. In particular she had to prevent her expert navigators and cartographers from seeking to improve their condition by selling their knowledge to interested foreigners. A transliteration of the cipher in which this letter was sent by the Spanish Ambassador to Portugal, Zúñiga, to Charles V reads as follows:

"In the evening of the 18th of this month, Diogo Lopes de Sequeira came to the inn where I am staying, alone and on foot, and told me everything about how badly he was treated by the King of Portugal. After much discussion it was decided that if your Majesty wants his services he will do it very willingly and that at present he does not want to make any other conditions but that your Majesty treat him as you find out what he deserves. He is a person much esteemed over here and of great wealth and who knows more about the spices and navigation than all who have gone there. He had in India servants and friends who write to him ..."⁹

This extract, referring to no lesser a person than a former Governor of India from 1518-22 was followed on the next page of this amazing dispatch by the statement that:

"Diogo Lopes told me that this astrologer [Simão Fernandes] would go with him because they gave him little over here, and he is a great friend of his ... I have told the astrologer [Simão Fernandes] what your Majesty has ordered; he has written to the Cosmographer Major of Castile for him to tell it to Your Highness. Meanwhile he works to inform himself as well as possible. He has sent to Lisbon to see if they want to make him a complete chart of all the navigation because this week they will furnish him one in a book. The one who makes those

⁹PMC Vol.1, p.50 footnotes.

of the King of Portugal is called Lopo Homem. This and one negro they have in Lisbon, and have orders to make no chart for anybody but the king, but sometimes they venture at a price, and with security though it is very difficult."¹⁰

Still the Portuguese managed to rise to the threat, and send in the end a very distinguished delegation to Badajoz Elvas, including Simão Fernandes, Lopo Homem and the Provedor of the Armazéns da Guiné e Índias, Pedro-Afonso de Aguiar, for whom the Spanish delegation had especial respect on account of his seamanship and cosmography.

Concurrently attempts were made to tighten Portuguese security. The treasurer of the Armazéns was made responsible for the safe delivery of charts to masters and pilots. It was obligatory for those charts to be returned after the voyage. This issue and return was covered by a system of double receipts as is attested by the four extant receipts for October 2nd 1533.¹¹

Until 1550 censorship also seems to have been very effective for no detailed work on Asia leaked into print from Portuguese sources. The 'Suma Oriental' and the book of Duarte Barbosa remained unpublished until Ramusio secured part of their texts for publication in 1550. Even then

¹⁰PMC Vol.1, p.50 footnotes.

¹¹ Avelino Teixeira da Mota "Some notes on the Organisation of Hydrographical Services in Portugal", Sixth International Conference on the History of Cartography, 7th-11th September 1975, Greenwich, p.6.

Ramusio did not know Pires's name and was unable to gain access to that part of Pires's book which covered the Moluccas and into which the vital sketch charts by Rodrigues were interleaved. Likewise treatises on military and political establishments in the East were left unpublished. Castanheda, who began publishing a famous chronicle in 1552 was forced to recall and "revise" the first volume about Manuel's reign on account of his discussion of strategic discoveries made before 1521.¹²

After 1550 censorship was not quite so effective, but as late as the 1570s Molucca's material still received a top secret classification. António Galvão (d.1557), a distinguished soldier and later governor of the Moluccas from 1536-9, busied himself on his return to Portugal in 1540 with a narrative of the Portuguese discoveries put together from his private material. Shortly after his death Francisco de Sousa Tavares, Galvão's friend and executor, was instructed to turn the draft of this history of the Moluccas over to Damião de Góis, head of the royal archives and officially responsible for a chronicle of King Manuel's reign. Tavares was finally allowed to publish in 1563 with the Tratado ... dos descobrimentos, but now it omitted a systematic treatment of the area. Galvão knew best south-east

¹² Zoe Swecker "Early Iberian Accounts of the Far East. 1500-1600". A Dissertation submitted to the faculty of Social Sciences in candidacy for the degree of Doctor of Philosophy, Department of History. University of Chicago 1960. pp.50-62.

Asia and the Moluccas. Despite that, this text does provide now the only source for some scattered references to Spanish expeditions to the Moluccas.¹³

Meanwhile Góis himself wrote the Crónica do felicíssimo Rei Dom Manuel¹⁴ in 1566-7. He again made few references to the East, having little of navigational value to say about Pegu, Siam, Ceylon and Malacca. Despite his privileged access to Galvão's account he hardly appears to have used it except for his description of Java, the best yet published. For China he relied on Castanheda's history. His work, however, was the subject of widespread interest, on account of which it was widely translated. His readers included Montaigne and Lope de Vega.

Censorship also delayed publication of other works containing strategic information on eastern seas. Gabriel Rebella, who spent 13 years in the Moluccas, had prepared his Informação das cousas de Maluco by 1569 though he did not reach print until 1856.¹⁵ His manuscript was, however, quarried by Diogo do Couto in writing another account covering the same contemporary events. Couto's career spanned 50 years in India, and included spells of trade administration and extensive responsibilities as keeper of the official archives at Goa. Couto too failed to publish before the 17th century, though his friends Garcia da Orta and Luis vaz de

¹³D.Lach, Asia in the Making of Europe, pp.153 and 186-8.

¹⁴Swecker op.cit. p.116.

¹⁵D.Lach, Asia in the Making of Europe, p.196.

Camoëns did publish their works, one on Asian plants, the other an epic poem.

The publication of Camoëns's poem, the 'Lusiads', was interesting in many respects. His family came from the lesser nobility of Galicia. His grandfather had married into the Da Gama family, from whom no doubt Luis would inherit some of his interest in Asian navigation. His father, Simão Vaz de Camoëns, also sailed to India as a ship's captain but was wrecked off Goa. With this background he went to one of the great Portuguese seats of learning, the ancient university of Coimbra, which had been in ^{the} forefront of some advances in geographical learning even before its final move to that site in 1537. About the age of 30 he set out for India in 1553 and had a torrid passage, of which his ship was the only survivor of four. He visited Aden, Ormuz and Malacca in his duties before sailing on to Macao for another two years, returning to Goa in 1561. Among his friends were many sailors, one of whom, a captain, offered him a passage to Mozambique in 1567. Diogo do Couto rescued him from poverty there and helped pay his return passage. Camoëns's first work, the Parnasso de Luis de Camoëns was stolen and lost for ever, but his second, compiled in Lisbon, was passed by the censor and he was granted a royal licence to publish in 1571.¹⁶ It appeared in 1572 to

¹⁶ Luis Vaz de Camoëns, The Lusiads, Translation by William C. Atkinson, Penguin 1973. See especially pp. 15-20 of Atkinson's preface.

meet a poor reception in Portugal. Outside Portugal it was extolled by many as a valuable source of maritime information, especially by Linschoten, who was himself later to go to India and collect much navigational information for publication in Holland.

It was, however, the historian João de Barrós (1496-1570) who met with the closest attention of the censor, on grounds of possible breaches of security concerning the sea lanes to Asia. João de Barrós had himself only sailed as far as Guinea, but he had access to vital documents in the course of discharging his job as Treasurer of the Casa da Índia from 1525-1528. An idea of the type of document he might have seen there is given by the fact that the holder of the parallel post as Treasurer of the Armazéns, was the very person who both issued charts to the ships of the *Carriera da Índia*, and to whom they had to be obligatorily returned. The extent of Barrós's access to information normally very restricted is further revealed by the fact he had access to the commercial information in the works of Pires, Paes and Barbosa in order to do the job to which he was appointed in 1533 - factor for the Indian and African trades. We know too that he would have been a very knowledgeable reader of cartographic information like the Rodrigues charts of the Suma Oriental, for his keen interest in such matters is revealed by the many references in his published works to the

unpublished manuscript charts of his Geografia Universal.¹⁷ The compilation of his great history the Decádas da Ásia, which he began in 1531, therefore takes on a new significance because of the nature of Barros's sources.

That significance is, however, only fully appreciated when it is known that he also used oral accounts of pilots and navigators who had sailed on Asian seas and on the basis of their testimony was prepared to point out the mistakes of the hitherto fashionable Ptolemaic geographers. Barros's scholarship did not stop at using European observations exclusively. He was constantly trying to procure native Asian accounts of the East. His remarks on India were finally to incorporate material from Persian, Arabic and Indian manuscripts, which he had translated by buying educated Asian slaves when necessary. He also had a fine Chinese library and a Chinese slave as a translator. Barros's first draft was complete by 1539, but he continually revised it in the light of his Asian sources as fast as his onerous duties allowed. As a result, the first Decáda da Ásia was not ready for publication before 1552. Its subtitle was even more revealing of its contents for it reads in translation - 'Deeds done by the Portuguese in their Discovery and Conquest of the Seas and Lands of the East'.

¹⁷Swecker, pp.90-94. For partial translation of the works see G.M.Theal, Records of South Eastern Africa collected in various libraries in Europe Vol.6, Cape Colony. 1900.

Even so, the censor's touch was evident, as we have already seen in Barros's discussion of Affonso V in the first book. The second Decáda da Ásia published in 1553 took the story of Portugal's discoveries to 1525. The third included much information on southern and eastern Asia. It was published in 1563 and seems largely to have escaped the censor's attention. The fourth Decada, however, was considered to contain information prejudicial to the security of Portugal's eastern empire, so publication of this was not permitted until after Barros's death. The fifth Decáda, never finished by Barros, was actually edited and revised for publication very much later by Philip III's Cosmographer Royal, the brilliant João Baptista Lavanha. It finally appeared with the addition of extra maps of the East, in Madrid in 1615.¹⁸

Rather surprisingly in view of their authoritative coverage, the works of Barros appeared only in the one Portuguese edition during the 16th century. However as we shall see, they were regarded as very important sources of information by other Europeans interested in the East and the sea lanes thither, with the result that they were extensively translated and bought.

But if the publication and subsequent translation of these chronicles is held up as a marked breach of security in an otherwise reasonably

¹⁸ PMC Vol.IV, pp.71-2, plates 424-5.

thorough security policy, the publication of Dr. Pedro Nunez's works would seem to have constituted a ~~deliberate and significant exception~~. Nunez appears to have been involved in top level navigational matters from the 1520s. Lopo Homem's notes on the Badajos-Elvas Junta show Nunez was present. He became chief cosmographer and keeper of maps and instruments to the King of Portugal in 1529. Both Prince Luís and his brother Cardinal Prince Henry were pupils of Dr. Nunez.

The real significance of the works of the Jewish scholar lay in the contents of two tracts on navigation, included amongst his many works on mathematics and astronomy. These navigational tracts were the Tratado sobre certas duvidas da navegação and his Tratado em defensam da carta de marear com o Regimento da altura, published in 1537 at Coimbra.

In the first of these tracts he discussed subjects liable to puzzle any non-mathematical seaman. He explained why a course, say due east designed to take one between two points equidistant from the equator, was not in fact the shortest course. The cosmographers and chart makers of Lisbon might understand the difficulties of attempting to draw correct plane projection of the sphere and ensuring that Sacrobosco's text De Sphera was printed in all navigational manuals. However, to expect an ordinary sailor or a trainee

pilot to grasp not only that the world was a globe, but also the properties of a 'spherical surface and an 'oblique meridian' was quite another problem. Nevertheless, Nunez sought to show how if two ships headed north by identical compasses, they would get steadily closer, due to the convergence of meridians, an idea contrary to popular conceptions. Dr.Nunez was able to show that the shortest route between two places was not a line of constant bearing, and was also the first to demonstrate the true nature of the rhumb.

Nunez's Defence of the Sea Chart actually lambasts the globe and map makers of Lisbon for not taking account of errors in their work arising from these sources. Many charts not only failed to show the convergence of meridians, they omitted both lines of longitude and latitude altogether, relying on an arbitrary marking off of 'altura' along the eastern and western margins of the chart. Dr.Nunez's criticisms went even further in condemning the standards of many of Lisbon's globe-makers. He considered their outlines little better than scribbles, although they used plenty of gold paint and decorated maps with flags, camels, elephants and the like.

Speaking of the conceited pilots of the India voyage, he claimed they used barbarous language to pronounce on the Sun, the Moon and the stars in their motions and declinations, in their risings and settings and bearings. They spoke in like

manner of the 'alturas' and 'lenguras' of places all over the world; and of astrolabes, quadrants, cross-staffs and hour glasses; of common and leap years, equinoxes and solstices, but in reality they knew little of such subjects. Perhaps Dr. Pedro Nunez had had some tiresome pupils, who handled with unjustified disdain the fruits of his patient scholarship. Some pilots, he said, had the impudence to claim knowledge of the sphere (astronomy), and to triumph over those who had not, saying that navigation was quite another thing now.

Yet Dr. Nunez still felt Portuguese navigational science was the best in the world, of which fact the pilots he condemned may also have been equally aware. His pupil, João de Castro, who in his famous rutters of 1538, 1539-40 and 1541 recorded a considerable body of observations with a view to improving the safety and accuracy of navigation to and from Indian seas, would certainly deserve an epithet, recognising him as the finest of the sixteenth century navigators.¹⁹

Pedro Nunez's own practical contribution was of

¹⁹ João de Castro prepared three rutters:-
 one from Lisbon to Goa covering 6th April to 11th September 1538;
 one from Goa to Diu covering 21.11.1538 to 29.3.1539;
 one covering the Red Sea from 31.12.1540 to 9.8.1541.

João de Castro also wrote a short instructional work on navigation in 1538 on the basis of Nunez's instruction. It was entitled Tratado da sphaera, por perguntas Erepostas a mod de Dialogo.

For further comment see E.G.R. Taylor, The Haven Finding Art, Hollis and Carter. London 1971, pp.180-184, and P.M.C. Vol. 1, pp.127-135.

itself significant, particularly on the design of instruments. He included the details of how to build an instrument to correct for the 'convergence of meridians', which was in fact a quadrant designed to show the number of leagues in a degree along each parallel. Later turning his attention to the problems of variation, he designed the shadow instrument, which Prince Luís ordered João de Castro to take and use on his voyage to India in 1538. The prince had a 'shadow instrument' made by João de Goncalves, said to be famous throughout Europe for his skill as an instrument maker. A brother of Pedro's, Dr. Luís Nunez, travelled with the Chief Pilot of the Portuguese Indian fleet to assist in the testing of the instrument, and in recording observations.

By 1547 Pedro Nunez had established such a reputation that he was appointed to a new post as Cosmógrafo-Mor (Cosmographer-Major), which he held until his death in 1578. Slightly later documents reveal that the post of cosmógrafo-mor was linked with the Armazéns de Guiné e Índias, where he worked closely with the provedor. Even before this appointment Dr. Pedro Nunez appears to have exerted great influence on the Armazéns, though not always for the better. Lopo Homem, writing in 1559 is critical of his influence in some notes presented to the King of Portugal about the Badajoz-Elvas junta. Lopo Homem criticised a particular "padrão de navegar" based on the observation of the eclipses of the moon and the sun,



"in accordance with which padrão the charts needed by the Almazém of the aforesaid Lord for his fleets and navigations to India are made".

Among Nunez's 1537 notes on the current navigating manual or "Regimento" was his comment that declination tables should cover four years, and that they did not need correction for the "convergence of meridians" until the user was six hours away from that for which they were calculated. This together with a misleading correction for the motion of the north star, based on a mistaken calculation of the precession of equinoxes by the German astronomer Werner, were almost certainly included in the 1559 revision of the Regiment of the Cosmógrafo Mor, now lost. Thus a figure of $4^{\circ}9'$ replaced the earlier figure of $3\frac{1}{2}^{\circ}$, a feature recurring in the working diagrams of the Spanish manual by Martin Cortes, and in its subsequent French and English translations.

The Cosmógrafo-Mor was also obliged to give regular classes in navigation to seafarers, such as those Pedro Nunez gave, and to conduct an obligatory examination of masters of nautical charts and manufacturers of nautical instruments in the presence of another master of nautical charts brought in by the provedor dos Armazéns. Charters issued to António Martins (1563), Bartholomeu Lasso (1564), Luis Teixeira (1564), Marcos Fernandes (1582), Pedro de Lemos (1586) and

Francisco Luís (1591) all contain the same provision that was also later insisted on under the 1592 text of the 'Regimento do cosmógrafo-mor' - namely that an examination charter should state

"that the nautical charts partial charts, globes and any other instrument he makes concerning the aforesaid art of navigation shall be in accordance with the pertaining *padrões* existing in the *Almazém*, without altering, shortening or adding anything of the seas, coasts and lands recorded in the aforesaid *padrões*".²⁰

By 1552 there were six offices where sea charts were being made in Lisbon employing eighteen people. All charts made by these offices had also to be submitted to the cosmógrafo-mor to see if they met the same conditions as above. If they did they would be signed by the cosmógrafo-mor, otherwise they would be amended or destroyed. The Provedor had to be informed who the charts or globes were intended for, in case there were security objections to their delivery. Similar provisions also applied to makers of other nautical instruments, which on examination were marked distinctively (see Fig.5). Fees were set which the cosmógrafo-mor might charge for examining various types of charts, sun-dials, compasses, cross-staffs, astrolabes, and nautical regiments. Penalties were laid down for masters who failed to submit their work for examination, just as they were also ordained for those who made them without a charter. Also subject to penalties were those

²⁰PMC Vol.1, p.120.

who owned, used or sold charts, globes and instruments, not examined by the cosmógrafo-mor, even though this person may not have been the maker.

Bureaucratic surveillance of this strategically vital profession of navigation was extended even further under the cosmógrafo-mors in order to maintain standards, records, and security, in conjunction with the issuing departments of the Armazéns. Examination in the presence of the cosmógrafo-mor, the provedor, the piloto-mor and the patrão-mor and several pilots and masters of charts was made obligatory for all naval officers, pilots, under-pilots, and masters. A book recording these various grades of officer was kept at the Armazéns to record them. However the critical power envisaged as enforcing these many monopoly provisions and controlling this skilled Lisbon community was the power that any proceedings arising from these provisions should take place at the Armazéns. Thus Lisbon's maritime community was controlled with semi-magisterial efficiency.

The same body also honoured some masters of nautical charts by calling upon them to share in the production of charts for the royal fleets, the earliest of which known concerns Luís Teixeira.²¹

²¹ Luís Teixeira was examined and passed on his performance by Jorge Rienel at Lisbon on 18 April 1564. On 15 June 1569 he was appointed to make charts and instruments for the King's Fleet.

The charter dated 1569 said

"He is to execute the part that falls to him in the making of the said charts, as well as of other instruments of navigation for my fleets, which charts and instruments will be received from him and paid for at my Almazém da Guiné e Índia provided they are of fitting quality and perfection, and thus as they are received here, they shall be paid as to the other officers who make such charts and instruments for the said almazem".²²

Such honour is not known to have been bestowed again before 1596. The explanation of this absence may well be that the bureaucratic control no longer served to raise standards, but rather was tending to stultify improvements for the sake of controlling the dissemination of navigational knowledge. Such a criticism would not contradict Nunez's criticism of Lisbon's cartographers, nor João de Castro's views set out in the dedication of his "Roteiro from Goa to Diu" that the navigator was "served only by rough and imperfect devices". To partly rectify this he

"put in hand the coast of India, as the most noble, and illustrious of all in the universe, which being until the present day ill-understood by some Portuguese, and badly misjudged by others, was so wild and repellent that I could hardly find any person capable of giving me any sure information about the part of it more frequented".²³

This again suggests that Portuguese navigators

²²On 10th October 1596 Pedro de Lemos was appointed by the King "to do his part in the making of nautical charts and navigation instruments in my Armazém for my fleets ..."

²³PMC Vol.1, p.135.

were turning to eastern traditions of navigation to improve their knowledge. Thus the Armazéns in Lisbon were to be found increasingly importing Asian navigational information and even practising cartographers, such as Vaz Dourado, into Lisbon. It had to be a selective process for the reasons de Castro stated thus:

"Truly this science or manner of navigation is so badly distributed among men, that either they go to idols who by long time and continuous practice, arrive at many details, but never gain authority in their office, or to persons without any experience but plenty of letters and great practice in the mathematical science who reach the shadow of the art but not the true science".²⁴

This development, utilising Asian sources, opened a whole series of new security risks, though it did provide undoubted gains as we shall see. Without needing to worry about these problems, the Portuguese had many serious security problems as they sought to uphold their exclusive knowledge of vital navigational information. Particular problems were posed by João de Barrós who because of his job had to know the contents of restricted documents. The Armazén's problems were complicated by the need to work closely with the Casa da India which had a worldwide network of commercial arrangements and commitments, and with Royal administration and the Court, where men like João de Castro were brought up and trained in navigation, but where others were less scrupulous in their use of information

²⁴PMC Vol.1, p.135.

Security procedures had to be simple and flexible if they were to help the cartographers to do their job effectively. This placed a real personal responsibility on each member of Portugal's maritime bureaucracies, as well as on pilots, masters and other responsible officers, not to abuse their situation.

Given the bureaucratically fixed and inflexible levels of reward for particular posts, the incentive to increase that by illicit trading especially in something so valuable commercially as navigational details, was very great. Rapid European inflation, and lavish life styles in Asia only added to the temptation. Linschoten noticed that a Portuguese pilot in the *Carreira da Índia* earned for a round trip 2,700 reis.²⁵

No matter how much the personal responsibility of each individual was stressed, the emphasis was wasted on the unstable, the violent, the over-ambitious, the greedy and the corruptible personalities. There is no doubt that while most of these Portuguese bureaucrats, pilots and cartographers were loyal and honest enough, others were tempted by a life of freebooting piracy in the East; others sought the profits of an Asian office. Most spectacular of all were those few who effectively jeopardised the whole bureaucratic and skilled structure and doctrine of exclusivity in commercial and navigational matters. Many of the problems

²⁵Linschoten, *His Discours*, London 1598, Book 1, Chapter 1, p.4. The full title is given in footnote 64 of the chapter 'The Dissemination and Decline of Iberian Navigational Skill (1580-1620).

that faced Portugal in the most acute form arose out of the nature of the quarter of Lisbon where many of the cartographers lived. It could be the scene of violent quarrels such as the one between two cartographers in 1565 which resulted in João de Galvão being brought before the magistrates for sentence.

Some went so far as to kill, like Lopo and Diogo Homem, Pinteado and several others. These men, who had promising careers ahead, sought to escape before the rigours of the law caught up with them. This meant a life of exile, given that their trade was one that could only be pursued with the help of wealthy patrons interested in navigation, or in commercial ventures overseas. These men constituted positively the worst security risk from the Portuguese angle. Consequently the King was sometimes persuaded to issue a public pardon to entice these men back to Portugal. One such notice appeared in Richard Eden's "History of Travayle", referring to the Portuguese pilot, Pinteado, who sailed in the first English voyage to Guinea. In this case the Portuguese king went so far as to offer him a knighthood if he would return

²⁶ R. Eden/R. Willes 'The History of Travayle in the West and East Indies and other countreys lying by either way, towards the fruitfull and ryche Mollucas. As Moscovia, Persia, (sic) Syria, Aegypt, Ethiopia, Guinea, China in Cathago and Cipangu. With a discourse of the North West Passage. Gathered in part and done into Englysshe by Richard Eden. Newly set out in order and augmented by Richard Willes . Imprinted at London by Richard Jugge 1577. This copy now in the N.M.M. was formerly in the Board of Trade Library but its title page is slightly damaged.

Consequential as some of these exiles were to prove in conveying information to other countries particularly to England, France and Venice, it must be remembered that Portuguese counter-measures were occasionally spectacularly successful. The correspondence of M. de Fourquevaux, French Ambassador in Madrid and that of Guzman Da Silva, Spanish Ambassador in London, suggest that in 1567 the Portuguese managed to regain and punish their defectors. Writing on 27th September, Da Silva noted that two Portuguese who were to accompany Hawkins on a voyage from Plymouth

"have run away from his company. Which is true as I was informed. And that the cause of that is the steps taken in France by the ambassador of their King, who promised them forgiveness for the past and security ... It has been made known that they had arrested Caldeira and others when they went, but we are not sure about their arrest".²⁷

M. de Fourquevaux reported from Madrid that

"two other Portuguese who came from England were taken at Bilbao; one is called André Hanne, I do not know the name of the other. It is said that they were going to Portugal to spy for the English".²⁸

In fact Gaspar Caldeira was taken by the Portuguese to Lisbon, where he was hanged on 16th February 1568. Antao Luis with André Homem, associated through a letter of 1567 with Caldeira, were lured by Periera Dantas, Ambassador in Paris, to the French border. While they stayed over at Fuenterribia the Spanish took them prisoner and

²⁷PMC, Vol.II, p.67.

²⁸PMC, Vol.II, p.68.

delivered them to the Portuguese authorities who were only too glad to execute these traitorous cartographers to solve the security problem.²⁹

These incidents are exceptional in that normally the diplomatic processes and pressures acted against Portugal because many an ambassador jumped at the chance to obtain the services of a Portuguese cartographer for his king.

This type of espionage had taken place as early as 1502 when Cantino obtained a map for the Duke of Ercole. It was still going on even in the last years of Portugal's separate existence before 1580. Shortly after the appointment of Abraham Ortelius as Philip II's geographer in 1575, Ortelius had received a letter from D. Juan de Borja, Spanish Ambassador in Lisbon. This letter spoke of the Portuguese Luís Jorge (D. Barbuda) an official Portuguese cartographer "who has served me for more than four years, and had begun making a book of 'empressans' for me".³⁰ The following year Ortelius received a letter dated 28 February from Benedictus Arias Montanus in Rome saying that the latter's friend Johannes Baptista Raimundas, a cartographer worthy of praise, had received from a Portuguese envoy "pulcherrimum exemplar descriptionis Synarum regionis".³¹ The writer promised Ortelius a copy of this for publication, which duly appeared in Ortelius's Typus Orbis Terrarum as republished

²⁹PMC Vol.II, p.68.

³⁰PMC Vol.II, p.124, letters A, B, C and D. See also Documentos Inéditos, Vol. 21, p.107.

³¹This

in 1584. That chart, as reproduced by Ortelius in Amsterdam, carried the legend "CHINAE, olim Sinarium regionis nona descripto, auctore Ludonico Georgio". Clearly evidence proving espionage thus far is tenuous, but two other letters from Giovanni Battista Gesio to Philip II of Spain show the exact sequence of subsequent events after Luís Jorge had passed out these secrets of the Chinese coasts.

Gesio was an Italian spy working in Portugal for Philip II and he wrote in June 1579 that Luís Jorge, a Portuguese geographer, had "always been devoted to your Majesty and desirous to enter your royal service".³² Gesio goes on to say that D. Juan de Borja had taken Luís Jorge with him when he returned to Spain, but the Portuguese had been alerted and arrested the cartographer on the frontier in Olivengia, brought him back to Lisbon and imprisoned him for two years. When set free again Gesio had managed to get him safely to Madrid. There he had kept Luís Jorge in his house because of the Portuguese secrets in matters of navigation which he had disclosed. He recommended this cartographer to the King in the light of this story. A further letter of Gesio's dated 21st July 1579 comments on Luís Jorge's diligent work for Philip II in Madrid, of which he says "Your Majesty has seen in the painting and description of China which I have shown you".³³

³²Ibid.

³³Ibid.

This late example of espionage is a reminder of the continuing Portuguese efforts at security, as well as being typical of many European attempts to obtain vital navigational information, particularly about the Far East.

Taking all these security factors into account we must conclude like Donald Lach³⁴ that the Portuguese managed to retain a remarkably effective internal security system until the 1570s. It was not infallible, but it did serve to keep the work of several major cartographers secret and confined to the Armazéns. In this context the works of Tomé Pires and the world atlases of Sebastao Lopes, and the rutters prepared for the India pilots remained remarkably closely restricted in their circulation, so that the Portuguese were able to keep their secrets to a large extent intact. Many documents do not now survive which must also have been kept secret and confined to the Armazens in Lisbon, but these merely because they were so successfully restricted, were to be destroyed on a large scale during the Lisbon earthquake of 1755. Thus even though the existing record of rutters and charts is heavily biased towards those which arrived in foreign hands, it is still clear that the Portuguese were largely successful in their security endeavours. However, the consequences of maintaining such bureaucracies as the Armazens, the Casa and the licensing offices of the Lisbon censor acted like a dead hand to curb Lisbon's

³⁴D.Lach. *Asia in the Making of Europe*. Vol.1, pt.1, p.154.

innovations in navigational method and instruments. It was a slow process, obscured by the innovations flowing in from the East and from the experiences of the India pilots. Ultimately it was to be the very thing which curbed the spirit of discovery and empire that had brought so much wealth and prestige to Portugal. But the most disastrous effects were yet to come, following the amalgamation of the kingdoms in 1580, when Spanish influence became very evident in nautical administration.

Chapter 3THE ORGANISATION AND NATURE OF SPANISH NAVIGATIONAL SERVICES PRIOR TO 1580

While the later middle ages saw Portugal turning increasingly towards a seaborne future, so also were the other maritime communities of the Iberian peninsula. Happily the medieval mariners of northern Spain did not have to rely on Beatus's schematised maps of the world as produced in nearby Valcavado Abbey.¹ This was because more accurate practical knowledge of the coasts of western Europe was to be gained from contact with well-travelled northern European seamen, familiar with such sound methods as were included in the King's Mirror and with long experience of coastal hazards.² These northern European sailors brought to Spanish ports both merchandise and pilgrims bound for shrines such as that of St. James of Compostella at Santiago. St. Godric of Finchale, with experience and "skill in navigation"³ is said to have known well the coasts and ports as far apart as St. Andrews and the Holy Land. He is known to

¹ Kirtland-Wright, Geographical Lore of the Time of the Crusades :Dover Books , New York, 1965, p 68-9 Reprint of 1928 edition

² E.G.R. Taylor, The Haven Finding Art , pp.81-84 refers to the knowledge of Norse navigators on points of technique and interpretation of sea conditions. The King's Mirror (Konungs Skuggsjá) was written by an unknown author about AD 1250.

³ Coulton, Medieval Panorama, C.U.P. 1945, p 15 Extracts are quoted from a lengthy extract from the (1847) Surtees Society edition of The Life of St. Godric . written by a monk of Durham about 1170; it enables comparison to be made with Chaucer's description of the Shipman who also traded in the same waters and exhibited great knowledge of coastal pilotage about 200 years later.

have visited Santiago in the twelfth century and no doubt swapped travellers' tales on the harbour fronts and in the taverns of Galicia with seamen very like the shipman of whom Chaucer wrote:-

"He knew wel alle the havenes, as they were
From Gootland to the Cape of Finistere
And every cryke in Britanye and in Spayne".⁴

The sailors of northern Spain participated in such interchanges, becoming increasingly common visitors to the Low Countries. Meanwhile the export trade in Castillian wool grew and fostered the expansion of the maritime and shipbuilding communities of northern Spain. Just as St. Godric admitted that in trading to the ports of Brittany he "learned much wisdom", so the Castillians built up trade with Brittany particularly after the signing of the treaty between the King of Castille and the Duke of Brittany in 1440. A measure of the significance of this interchange is given by the fact that it was from St. Giles sur Vie in Brittany that Pierre Garcie, (author of Le Grant Routier et Pilotage, completed in May 1483), hailed.⁵ He says that his work was based upon his consultations with the expert and chief masters in the main ports of Northern France.

In contrast to Castille's experience of Atlantic conditions and coasts, the medieval empire

4 .G. Chaucer. The Canterbury Tales, The Prologue, lines 407-9 See W.W. Skeat, Chaucer Complete Works, Oxford University Press, London, 1967. p424

5 P. Garcie, Le Grant Routier et Pilotage is reproduced by D.W. Waters Rutters of the Sea, Yale University Press 1967,

of Catalonia, based around the "Libre del Consolat", directed most of its ships and resources into the Mediterranean trades in spices, cloth and corn. Thus, though Catalan ships and merchants were seen in Bruges, many more were to be found in the Levant, North Africa, and trading with Arabs in Alexandria and Sicillian ports. The ships most useful in these Mediterranean trades were, however, of unsuitable proportions for the very different conditions of the Atlantic, and so many Catalan ships and resources were directed into the competition for Mediterranean trade with Genoa.

While Catalonia and Valencia struggled to overcome the major demographic catastrophies of the fourteenth century, the Genoese who had settled in Seville, Córdoba and Cadiz built up a solid alliance with Castille and secured the wool carrying trades of the southern Spanish ports at the Catalans' expense. The Genoese brought to Castille their knowledge of Italian methods of navigation, including the compass, the portolano, and the traverse table, and perhaps even the simplest instruments for observing the height of Polaris and hence latitude. These navigational traditions, coming via the Genoese connection, were to prove even more useful in oceanic navigation. Later they exercised a profound influence on the growth of Castille's trans-oceanic trade and navigation to America and thence to the Far East via the Pacific.

Sixteenth century scholars had no doubt at

all as to the value of the Genoese and Portuguese influence, especially that of the Genoese, Christopher Columbus. He departed from Palos in Southern Spain on his famous voyage in 1492, only after he had received a basic grounding in the new navigational methods from his experience under Portuguese masters. Peter Martyr d'Angheria (later to be President of the Council of the Indies, the body ultimately responsible for deciding navigational and colonial policies), wrote excitedly about the significance of the voyage of this Genoese captain: - "Hear about the new discovery and that Christopher Columbus has returned safe and sound".⁵ That letter was reprinted eight times in 1493 and a further twenty times by 1500.

The Spanish historian of the 16th century discoveries, Gonzalez de Oviedo wrote of Columbus both as "the first discoverer and finder of the Indies" and as a "brave and wise sailor and a courageous captain".⁶ Later views of his significance were markedly affected by the biography often attributed to his son, Hernando Colón, published in Venice in 1571.⁷ Nevertheless Ramusio, Oviedo, Benzoni and Sir Francis Bacon made detailed studies of European voyages, and they thought Columbus's achievement merited the erection of a statue.⁸ It was no coincidence that these writers,

J.H.Elliott. Europe and the New World. 1492-1650 C.U.P. London 1972, p.8-9

⁶J.H.Elliott, *ibid.*, p.11.

⁷J.H.Elliott, *ibid.*, p.10.

⁸J.H.Elliott, *ibid.*, p.11.

like Richard Eden in Marian England, or Louis Le Roy and Montaigne in France, saw these discoveries as awakening the world to new intellectual horizons. Those same writers were to have direct access to the Spanish navigational manuals and charts where the new technology and discoveries were clearly set out.

Martin Cortes, a Spanish navigator well aware of the huge value of the annual silver fleets, sidestepped the intellectual challenge when giving his reasons for preparing a famous navigational manual. In 1551 he wrote a dedicatory epistle to Charles V which, as translated by Eden, said:-

"And if it is and has been muche to discover and subdue the newe worlde; it is doubtlesse no lesse glory to your Maiestie; not onely to possesse and enjoy it, but also that you dayly procure to sende thyther Judges to governe with lawes and preachers to instruct in doctrine, to bryng those Indians to the knowledge and honouring of the true God. And therefore considering your Maiesties godly desire and purpose as touching these navigations, and the danger of such as go to discover this newe worlde ... and in consideracion hereof I have the more wyllingly published these my travayles for the furtherance of all such as shall hereafter attempt these navigations".⁹

Another interesting interpretation of the significance of the new technology was that given by the distinguished Italian historian Guiccardini. Writing in 1561 he praised the skill of Portuguese and Spanish sailors and said:-

⁹R.Eden. The Arte of Navigation. London, 1561, Epistle dedicatorie fol.III.

"Not only has this navigation confounded many affirmations of former writers about terrestrial things, it has given some anxiety to interpreters of Holy Scriptures".¹⁰

If Spanish churchmen did manage to respond to the missionary challenge of the new discoveries their theology and in particular the traditional view of the world's concentric spheres failed to respond to the challenge set out by the Portuguese Jew, Pedro Nunez, who wrote in 1537 of

"New islands, new lands, new seas, new peoples, and what is more a new sky and new stars".¹¹

Many teachers found the challenge of these new missionary, political and intellectual problems almost too much. It was as difficult to break away from the idea that "orbis terrarum" consisted of three land masses, Europe, Africa and Asia, as it was for some to break away from the idea of an unnavigable and uninhabited torrid zone.¹² Treatises such as Sacrobosco's "De Sphaera"¹³ and Macrobius's even older "Somnium Scipionis"¹⁴ remained popular from the fourteenth to seventeenth

¹⁰ Guicciardini, Historia d'Italia, Pietro Maria Bettano, Venice, 1616, p.173. Its first edition was 1561.

¹¹ J.H.Elliott, The Old World and the New, 1492-1650 C.U.P. 1972 p.39-40.

¹² R.C.D.Baldwin, "Sixteenth Century Books in St. Chad's College Library. An insight into Tudor Tastes". St.Chad's College Magazine, 1976. p.22-26

¹³ For a discussion of Sacrobosco's significance see E.G.R.Taylor, The Haven Finding Art, pp.154 & 176, and D.W.Waters, Art of Navigation, pp.41 & 52-3.

¹⁴ Macrobius, Somnium Scipionis ex Ciceronis Libro de Republica sexto excerptum, Jocodius Badius, Paris 1524. Its engravings by Roigny clearly owe much to John Hollywood's (Sacrobosco's) treatise. Sacrobosco's treatise and drawings are also used in Eden's translation of 1561 of Cortes's Breve Compendio del Arte de Navegar, Seville, 1551,

centuries because the clarity of their orthodox cosmology was unrivalled as an aid to a gentleman's education. However, experience showed their idea of the torrid zone was erroneous. Indeed the Portuguese voyages down the African coast showed this as early as the fourteenth century. Gradually more and more of the theses contained in these medieval treatises came under challenge. Though the Bering Straits were not charted until 1728, the existence of clear water between America and Asia was implicit in the search for a North West passage. Despite the growingly obvious implausibility of both these medieval treatises, the most serious threat to Catholic orthodoxy was posed by the Copernican theories which became increasingly popular amongst Europe's navigational theorists later in the sixteenth century.¹⁵

The Spanish maritime community, however, continued to accept the traditional Christian outlook throughout the sixteenth century. Hide-bound in this way, Spain's navigators were denied the chance of progressing toward better astronomical theory and practice, such as would be advocated in the latter part of the sixteenth century in London by men such as Robert Recorde, John

¹⁵Patrick Moore. Watchers of the Stars. Michael Joseph 1974, pp.71-84. The objections of Luther, Melancthon and Calvin are also interesting, as is the fact that Copernican theory seemed to make its greatest early progress amongst the mathematical practitioners of Marian England.

Dee, Edward Wright and John Davis.¹⁶ That Spain's maritime community should eventually suffer in this way was partly due to the intensely orthodox Catholicism imposed by its Habsburg rulers with the aid of the Inquisition, and to the great care for Catholic orthodoxy evidenced in the ship's ordinances which ensured that daily prayers and mass were celebrated often by travelling friars or priests entrusted with this duty in the course of their care for human souls.¹⁷ As confessors, they could both play an important part in keeping a ship's discipline, and in excluding heretical tendencies.¹⁸ Such provisions would, however, be of little avail if orthodox cosmographical teaching had not formed a significant part of the pilot's training. We know of this because as late as 1634 the Cosmographer-Major had to lecture the Spanish Court on Sacrobosco's theories. Standard illustrations show a fixed earth around which revolved

¹⁶ Robert Recorde, Castle of Knowledge, Reyner Wolf, London 1557

¹⁷ S.E. Morison, Admiral of the Ocean Sea, A Life of Christopher Columbus, Little and Brown, Boston 1942, p. 226-36. Columbus's voyage was a dramatic forerunner of such religious observances aboard many Spanish ships, a further indication of which is found in ships' ordinances such as those prepared by Sebastian Cabot in 1553, especially Ordinances 12 and 13. Extracts of these ordinances are to be found in D.W. Waters, Art of navigation, Appendix 4. & in R. Hakluyt, Principal Navigations, Vol. II, Hak. Soc. Extra Series, p. 195 et seq.

¹⁸ Fr. Celsius Kelly, La Australia Del Espritu Santo and the Franciscan Missionary Plan, Hak. Soc. 2nd Series, No. CXXCI, especially pp. 120-129 and pp. 140-150 and pp. 265-266 though the whole of Fr. Munilla's journal is helpful in assessing the role of friars aboard Spanish ships.

the sun and the stars. They appeared in all the Spanish navigational manuals published during the sixteenth century. If questioning of these concepts did not occur to many trainee pilots, the more thoughtful could turn to authorities like Fernandez de Oviedo who was never tired of stressing in the light of recorded discovery

"What I have said cannot be learnt in Salamanca, Bologna or Paris" ¹⁹

There is, however, no evidence to show that pilots themselves went to these universities.

There was no substitute for a pilot's own observations and experience, allied to professional training revolving around the discipline of careful recording and plotting courses, stellar observations, and coastal features. This was markedly different from the fashionable sixteenth century tendency to collect facts or curios from new lands.²⁰ Although such items might figure as valuable commercial information in the log of the voyage, the systematic navigational records of a pilot were vital if another voyage to the same destination and back were to benefit from the experience of the earlier one. Failure to record information not only would deprive others of it, it almost negates the value of carrying any navigational aids. The keeping of systematic Spanish navigational records was fostered by royal recognition of the value of such records, compiled by

¹⁹ J.H. Elliott, *Europe and the New World, 1492-1650*. C.U.P. 1973, p32

²⁰ D.Lach, *Asia in the Making of Europe*, Vol.II Part I. Passim.

pilots familiar with the best navigational methods.

Thus it was that in 1508 Ferdinand called to his Court Juan Diaz de Solis, Vicente Yanez Pinzon, Juan de la Cosa and Amerigo Vespucci.²¹ This handful of men with proven ability as cartographers and navigators formed so small an élite of suitably skilled men on whom Ferdinand could call that he realised that Spain's best interests would be served only if he concentrated their activities in particular projects. Thus it was resolved that especial effort would be put into the discovery of a passage to the East via a north westerly route. Shortly afterwards, Pinzon and De Solis set out on their ill-fated voyage, having resolved that at least one of those present at Burgos should remain in Seville to construct charts and to teach and examine pilots. This choice may well have fallen on Amerigo Vespucci because as the eldest, and the only one of the group fully familiar with both Portuguese and Italian navigational methods, he was best suited to stay. That the crown understood the possible benefits of a hydrographic

²¹ A conference to discuss this was first arranged to convene in Toro to discuss prospects in the Indies with the proposal that Vespucci and Pinzon should take a fleet to the Spice Islands, but due to the disturbed political situation following Queen Isabella's death, it was put off until 1508. For the consequence of this meeting in terms of voyages of discovery, see J.H. Parry, The Discovery of the Sea, Wiedenfield and Nicolson, London, 1975, p267-9.

bureau and a school of navigation, is shown by the instructions of Queen Joanna to her appointee to the new post of Pilot Major.²² She wrote that it was her understanding that Spanish pilots were not as well trained in the use of the quadrant and astrolabe as they ought to be. So she decreed that all pilots should be instructed by the Pilot Major. These trainees were forbidden to embark as pilots, just as the merchant owners of ships and masters were forbidden to engage them until they had received a certificate from Amerigo Vespucci which they could show as proof of their competence.

A measure of the importance attached to his job are the two cédulas of March 22, 1509 awarding him 50,000 marvedis annually as Pilot Major and a further 25,000 for "ayuda de costa", in other words, as hydrographer. In the latter capacity he was responsible for formally gathering information from pilots returning to Seville for incorporation into a great master chart that he had to draw and subsequently update in the light of new knowledge. The hope was that by controlling those

²² C.H.Haring, Trade and Navigation between Spain and the Indies in the Time of the Habsburgs, Peter Smith, Gloucester, Mass. 1964. (First published 1918.) pp.298-9 gives text of the letter dated August 6 1508

Further references are given by Haring on p.35 of the above work.

The office of the Pilot Major thereafter remained as a specialised departmental agency within the Casa de Contratacion, though not physically in the same building as its main trading functions were situated. The Casa de Contratacion (the House of Trade) was founded 1503 to administer Castile's trade with the New World on monopolistic lines.

licensed to copy this Padrón-Real, greater safety could be ensured by excluding incompatible or outdated cartographic information. We know the Padrón-Real was completed and the privilege of being able to copy it was formally extended in 1512 to Andrés San Martín, and to Amerigo's nephew Juan Vespucci. These were to be sold at a price fixed by the Casa de Contratación.

The death of Amerigo Vespucci on 22nd February, 1512 was significant, for on his death Spain lost the services of an experienced trans-Atlantic navigator. He had served under King Manuel but since 1505 had become a naturalised Spaniard prepared to give his knowledge to the benefit of Spain. During his time as Pilot Major he had trained pilots at his house in Seville, enabling them to obtain their certificates. Due to the rarity of his skills, he was able to get away with issuing such certificates without reference to other high officials of the Casa despite the fact that he received fees for teaching. The same applied to his brilliant successor, Juan de Solís, who held the post until his murder on the banks of the Rio de la Plata in 1516. However, Sebastian Cabot, who was to succeed to the post as from 5th February, 1518, would later be accused of irregularities in his conduct.²³ Observance of strict bureaucratic rules only became important as the skilled élite of pilots and cartographers grew large enough to become competitive and conscious of status within their profession.

²³See below in this chapter.

However, the Casa's hydrographic and navigational offices did not grow to that size without problems. The expansion of this highly skilled elite, as opposed to the trainee pilots, was slow. To the initial group of Amerigo Vespucci, De Solis, Pinzon and Juan de la Cosa, who received stipends for exploration as royal pilots, were added first the two given the privilege of copying the *Padrón-Real*, and then in 1515 a group who later distinguished themselves as "pilotos reales". This group consisted of Juan Serrano, Vasco Gallego, Sebastian Cabot, Andrés de San Martín and Juan Vespucci. In 1519 Nuno Garcia Torreno was given the title of "maestro de tracer cartas", followed in 1523 by the Portuguese trained Diogo Ribeiro.²⁴ It is not insignificant that many of this group had connections outside Spain, if not records of actual service for other powers. That Sebastian Cabot, who had sailed in English ships, but no doubt making use of his Italian background, should be made Pilot-Major suggests that Spain had a severe shortage of suitably qualified men.

Though the Casa was a monopolistic organisation in its practice and outlook, in its early years it certainly looked to expand its trading and markets. This of course placed upon it the problem of

²⁴ C.H. Haring, *ibid.* p.35, notes that Harrise in Fernand Colomb Paris 1872 believed Miguel Garcia to be none other than Nuno Garcia de Torreno, which interpretation seems also to have been followed recently by Ursula Lamb in A Navigators Universe The Libro de Cosmographia of 1538 by Pedro de Medina. Translated by Ursula Lamb. Chicago University Press, 1972

finding skilled "pilots" prepared to undertake exploration. The problem became the more serious because several of those appointed to offices within the Casa chose to give up the risks of major voyages, preferring instead to earn livings by supplementing their official stipends and privileges by teaching and examining pilots or making instruments, despite the legal problems that sometimes flowed from these activities. Thus Spain was only too anxious to obtain the services of Ferdinand Magellan and the Faleiro brothers and Diogo Ribeiro from Portugal. Some of the personal animosities that accompanied this influx of talent, and Magellan's desire for exploration, were a small price to pay for their knowledge. This Charles V realised when he heard of Magellan's plans and granted permission for the voyage that began in 1519. Spain's subsequent loss of Magellan, San Martin and indeed all but 31 of the 270 who set out in 1519 was certainly counterbalanced by the discovery of a western route to the East Indies, details of which were brought back by Sebastian del Cano. The fine account kept by Antonio Pigafetta as subsequently published achieved a wide circulation.²⁵

²⁵D.Lach, Asia in the Making of Europe, Vol.1, pp.173-176.

D.W.Waters, The Art of Navigation in England in Elizabethan and Early Stuart Times. p81-2 discusses the question of 'secrecy' of discoveries and the dispersal of skilled cartographers around Europe.

As none of this solved the problem of the small size of this élite of pilots, Spain can be seen first encouraging Jorge Rienel to reside in Madrid in 1520, and later giving a permanent job to Diogo Ribeiro, both from Portugal. Magellan's discoveries and the disputed eastern meridian dividing Spanish and Portuguese rights in the East merely exacerbated Spain's need for hydrographers and pilots with such knowledge. The intrigues of the Spanish ambassador, Zúñiga, to entice Portuguese pilots into Spanish service, and the Spanish attempts to bribe Portuguese hydrographers attending the Badajoz-Elvas Junta in 1524 into Charles V's service were reflections of Spain's problem. Later Sebastian Cabot took unashamed advantage of the scarcity of his skills in his correspondence with the Venetian Council of Ten in 1522-3 and subsequently in his relations with Charles V after his departure for England in 1548.

The Casa was, however, left with the problems of organising its élite. When Cabot went on the voyage to the Rio de la Plata in 1526, his tasks of examining pilots and instruments fell to Miguel Garcia and Juan Vespucci.²⁶ For hydrography and lecturing, the responsibilities were devolved to Diogo Ribeiro and Alonso de Chaves ad interim. From 1527 the idea the Pilot Major might appoint deputies to prepare charts and read lectures was finally accepted from

²⁶ See note 24 of this chapter.

pressure of necessity. Diogo Ribeiro took over the hydrographic functions and produced his four justifiably famous world maps during the two years before his untimely death in 1530.

A further attempt at streamlining the organisation of the Casa to take some burden off the Pilot-Major, who was often otherwise occupied, was the handing-over-of-the-task-of-instruction to a Professor of Cosmography, leaving only the final examination to the Pilot-Major, together with general oversight of map and instrument making within and without the Casa. This chair was founded by Prince Philip in December 1552. It suggests royal appreciation of the part played by Pedro Nunez in Portugal in holding a rather similar post.²⁷

The intervention of Prince Philip in 1552 was provoked by some rather corrupt and unsatisfactory tendencies that had begun to bedevil and stultify

²⁷C.H.Haring, Trade and Navigation, p.38 footnote. Haring here describes the tasks given to yet another official who reported to the Council of the Indies from Peter Matyr's time onwards. This official was entitled the "cosmographo-cronista", and his duty was to collect not only data on the natural and political history of the Indies, but also to collect the astronomical and navigational details, journals of voyages, rutters and observations made on oceanic voyages. This is reminiscent of the Portuguese practice cited by João de Barros and Castanheda.

See also C.H.Haring, The Spanish Empire in America, Oxford University Press, 1947, p.319.

the Casa.²⁸ Royal concern in earlier years had been to improve the quality of both pilots and instruments. Philip's action now was the result of his hearing of various irregularities in the way the Casa examined trainee pilots through Dr. Hernan Perez, one of the Council of the Indies. A Sevillian pilot, Alonso Zapata, wrote to Perez alleging that Diego Sanchez Colchero and Pedro de Medina accepted bribes from examinees. Perez proved this and also reported on other scandals in 1551. These included acceptance of testimony from witnesses as to the fitness of candidates, payment of the examiners by witnesses to obtain lists of questions that would be asked in their examinations and the admission of between thirty and forty foreigners in the previous two years (despite Charles V's letter of August 1547 instructing that no unnaturalized foreigner be admitted).²⁹

²⁸ Ordenanzas reales para la Casa de Contratación de las Indias, Seville 1552. These, as commented upon by Haring, *ibid.* pp. 300-303, reveal several of the faults found by Dr. Hernan Perez, who was acting as visitador of the Casa, and looking into far more serious irregularities than these complaints. These ordinances also changed the legal status of the Casa's jurisdiction and reflected the advice of three very senior ministers of Charles V, Francisco de los Cobos, D. Juan Tavera, archbishop of Toledo and President of the Council of Castille and D. Francisco Garcia de Loaysa, Archbishop of Seville and President of the Council of the Indies.

²⁹ Haring, Trade and Navigation, p. 301.

Philip's idea was that the Professor Cosmographer would give a year's formal lecture course within the Casa in the hope that this would improve a pilot's knowledge and improve on the appalling safety record. Twenty-five ships had been lost in two years. It would also serve to separate the teaching and examination of pilots, but it did not end the practice of bribery.

Philip's strict intentions in 1552 when a specific course was prescribed were soon undermined.³⁰ In 1553 the term of instruction was reduced from one year to three months and in 1567 to two months. An order in council of 1568 further reduced this by interpreting the two months as including all holidays falling in the period. This reduced teaching was scarcely justified on the grounds that it kept men, sometimes of considerable practical experience, from sea-going employment.

All this was of course in marked contrast to the attitudes of the first two Pilot-Majors. In 1512 the Pilot-Major had made a submission to the officials of the Casa saying that Juan Rodriguez Sardo, although of practical experience as an American pilot, should be given six months instruction in which to learn the use of the quadrant or the astrolabe. In a foretaste of future developments, the officials of the Casa agreed, but permitted him to make one more voyage before learning how to make celestial observations.³¹

³⁰Haring, Trade and Navigation, p.303.

³¹Haring, Trade and Navigation, p.299.

Amongst the practising pilots of the Casa in Charles V's reign there was a great keenness to improve not only the skills of pilots, but also their aids. San Martin's careful observations during Magellan's voyage on the night of 19th December, 1519 showed up faults in Zacuto's and Regiomontanus's tables then in use.³²

--- Martin Fernandes Enciso, another of the --- early Spanish enthusiasts of the new techniques of navigation, was one of the early Spanish immigrants to the new world. He took part in various expeditions, e.g. to Santo Domingo and Darien. He later returned to Seville in 1512 and secured publication of the first printed rutter. It was a compendious work designed to give pilots and navigators the information necessary to permit further discovery of the West Indies. Part of the manual was devoted to navigational instruction and part was compiled as a rutter for the Atlantic. Its best sections covered the West Indies, though it also attempted to give practical rules such as the "Regiment for the North Star". Though reprinted twice in Spain, first in 1530 and then in 1546, it was too riddled with errors about areas other than the West Indies to stand the test of time. Nevertheless, as late as 1578 John Frampton, then in London, saw fit to translate Enciso's chapter on the West Indies.

³² "Memoria sobre la tentativas hechas y Premios efreidos en espana al que resolvieret problema de la longitud an la mar" by D.Eustaquio Fernandez de Navarette, Vol.21, Documentos Inéditos, p.105, which in turn cites Herrera, *ibid.* Dec.2, Book 9, p 235

The great significance of Enciso's manual was that it served as a model for future manuals that attempted to instruct trainee pilots.³³ In 1535 a new attempt to produce a navigation manual was made by a Portuguese scholar in Spanish service, Francisco Faleiro. Many years before he had been involved in the preparations for Magellan's voyage along with his volatile brother, the scientist Ruy Faleiro. It re-used the tables of solar declination for the years 1529-32 first found in Enciso's reprinted manual. His

Tratado del Esphera y del arte del marear; con el regimiento de las alturas: con algunas reglas nueuamente escritas muy necessarias was published in Castilian in Seville.³⁴ It included

³³Martin Fernandes de Enciso, Suma de geographia q trata de todas las partidas e provincias del mundo: en especial de las indias, e trata largamente del arte de marear: juntamente con la esphera en romãce. con el regimiẽto del sol del norte, nueuamente hecha. First edition Seville 1530, 2nd edition 1530, 3rd edition 1546.

J.Frampton translated part of this as A briefe description of the portes, creekes, bayes and havens of the Weast India, translated out of the Spanische tongue by J(ohn) F(rampton). H.Bynneman. London 1578.

³⁴Francisco Faleiro, Tractado del Esphera y del arte del marear; con el regimiẽto de las alturas. co algunas reglas nueamente ascritas muy necessarias . John Cromberger. Seville, 1535.

Magellan appears to have taken a manuscript copy of this on his voyage of 1519. This text later examined by a Professor of Astrology at Salamanca was licensed for the press in 1534 and given a ten years monopoly. John Cromberger was a fine German printer then working in Seville and he was able to include some most useful diagrams into the text. For further comment on this text see E.G.R.Taylor. The Haven Finding Art, p.185.

printed definitions of terms used in navigation, and described how a navigator kept track of his position by celestial observation. It was also notable because it included a discussion of the problem of magnetic variation (suggesting an instrument to measure it) and because it included a diagram showing how to "raise" or "lay" a degree of latitude using both the Portuguese measurement for a degree of $16\frac{2}{3}$ leagues and the Spanish length of $17\frac{1}{2}$ leagues. As such, therefore, it was the first navigational textbook to be published. It was the model for the subsequent printed manuals such as those to be produced ten years later by Pedro de Medina and Martin Cortes.³⁵

³⁵See note 58 for full title of Martin Cortes Breve Compendio de la Esfera y de la Arte de Navegar. Seville, 1551, translated by Richard Eden 1561, Part III. "The XI Chapter of composition and use of an instrument, by the which without observing the South Sunne, or midday is known the altitude of the Pole and the that is".

fol.xxvi to xxix.

Other innovations of the heyday of the Casa's navigational school in the 1540s and 1550s were the particularly important theoretical contribution made by the experienced sailor, Alonso de Santa Cruz. This man sailed with Cabot in 1526-7 ostensibly as the Royal Treasurer on a voyage expected to reach the Moluccas. Despite the failures of that voyage, Alonso de Santa Cruz was able to gain entry to the Casa de Contratacion in 1536 and by 1539 was to be found lecturing on cosmography and astronomy before no less a person than the Emperor Charles V at his court. In 1545 he went to Lisbon to study the charted routes to the East Indies and to learn about the peculiar magnetic variation of the eastern seas. Conscious of the special nature of his knowledge, he tried to persuade Philip II to appoint him a Councillor of the Indies in 1557 and by 1563 had obtained a royal sinecure as "Cosmographer to the King".³⁶

³⁶Haring, *Ibid.*, 311-12 and Alonso de Santa Cruz Libro de las longitudes 1530. Publication of Antonio Blaquez y Delgado Anguitero 1921, p.151.

The special nature of his claim to fame was his idea of finding longitude by noting the peculiar magnetic variation of different parts of the world. If these readings could be set down accurately on a chart, they would, he erroneously thought, enable longitude to be determined. It may be remembered that Don João de Castro had made good observations of variation on his famous eastern voyage in 1538, and set a precedent of Portuguese measurement of variation on all eastern voyages that was still to be seen in some of the Portuguese rutters translated by Linschoten in the 1580s.³⁷ Santa Cruz proposed the construction of isogonic ocean charts showing this data on variation, presumably first noted at Lisbon.

Santa Cruz had another claim to fame in that he proposed a way to construct maps on a spherical projection, and so in two major ways he anticipated later sixteenth century attempts to achieve such projects. Even after his death in 1572, he was long remembered in Spain as the greatest of their navigational theoreticians.

Another work anticipating seventeenth century development in northern Europe was the nautical dictionary compiled by Alonso de Chaves some time between 1520 and 1538.³⁸ It formed part of a larger manuscript "Quatri partitu encosmographia pratica i por otro nombre llamado espeio de navegantes".

³⁷Linschoten, Itinerario 1596 (as below). See also Chinese, Japanese, Indian interchange.

³⁸D.W. Waters, Art of Navigation, p.466, footnote and p.467. Another early dictionary was Juan de Moya, Arte de Marear, Seville, 1564.

Pedro Dias said that it was extensively used in preparing pilots for their examinations.³⁹

There was one bureaucratic control however which restricted greatly any innovation in Spanish navigational aids. This was the rule that on ships bound for trans-oceanic destinations, no Master or Pilot might carry any chart, or astrolabe or cross staff, or regiment unless it had been signed and sealed by the Pilot-Major and Cosmographer. These officials met once a week (later in the century twice a week) to attend to this business. From 1565 onwards they were assisted by two other senior pilots chosen each year by the President and the "jueces". Maps or charts or instruments made by one of the cosmographers himself might be presented, but then the master could have no say in the subsequent decision. If an astrolabe or compass were passed, it was given a special stamp of approval. The dies of these stamps were kept in a special locker with two keys, one belonging to the Pilot-Major, the other to the cosmographer responsible for instruments. One of the distinctive Spanish conventions enforced in this way was the practice of graduating astrolabes directly in altitude heights, rather than the zenith heights used by

³⁹"The examination of the Masters and Pilots which saile in Fleetes of Spaine to the West Indies: Written in the Spanish tongue by Pedro Dias a Spanish Pilot taken by Sir Richard Grenville 1585 ... Written by one Pedro Dias, born in the Isle of Palma, one of the Canaries, upon the request and gratification of M. Richard Hakluyt in February 1586." Richard Hakluyt, Principal Navigations , Vol.III, 1600, p.868.

the Portuguese. An astrolabe of this type, clearly bearing its authenticating marks, showing that it was made in Seville in 1563, still survives.⁴⁰

✓ If an astrolabe or quadrant were rejected, it was broken and melted down, but it was a rather more sensitive matter to offer similar opinions about charts, as we shall see. This was significant because the efficiency and safety of the vital sea lanes connecting the parts of the Spanish overseas empire depended in no small measure on the quality of the pilots and their navigational aids. Especially important were the charts, for they alone showed new discoveries and hazards to shipping, as well as of course indicating where to sail.

The actual quality of Spanish cartographical knowledge is rather difficult to assess because none of the early Padron-Real has survived. Peter Martyr d'Angheria, one of the best contemporary witnesses of the state of navigational practice, wrote in 1511 that navigators valued the charts

⁴⁰ Mariners' Astrolabe, Royal Scottish Museum, 1972, pp.12 and 13, describes and illustrates the Astrolabe in the Conservatoire National des Arts et Metiers. It is likely that the marks were added by Sancho Gutierrez (1516-80). It has been marked with the Casa's marks (a tower between two batons) and those of the Spanish Crown (the pillars of Hercules surmounted by a crown) and some decorative half suns. It also bears three scallop-shell marks, which are commonly used to signify St. James the Great. This suggests that its maker might have been a Galician from Santiago, perhaps João Galêgo, rather than Gutierrez as Destombes thought.

of Juan de la Cosa above all others. Indeed he included woodcuts based on Juan de la Cosa's charts in his first Decade of the New World.⁴¹

Juan de la Cosa's cartographic work and practical experience were impressive. He had sailed with Columbus in 1492 as master of the Santa Maria and been appointed "maestro de tracer cartas" on Columbus's second voyage. In 1500 he began to draw a world map showing a continuous American coastline from north to south, interrupted only at the neck of the chart by a picture of St. Christopher covering the area in which Columbus sought a strait in 1502-3. He figures frequently in the accounts of the Treasurer of the Casa after 1503 as the recipient of payments for special navigational and cartographic services. Thus his tragic death in a skirmish in 1510 with local Indians on Ojeda's second voyage was a serious loss to the Casa.⁴²

His place was to some extent filled by Andrés de Morales who had also sailed with Columbus and then acted as pilot to Rodrigo de Bastida's voyage of 1500-2. Andrés de Morales was employed by Governor Ovando in Santo Domingo for a number of years to produce maps and charts of the coasts of the Antilles. Endowed with great gifts of observation, he was the first to deduce a comprehensive theory about the current systems of the Atlantic, a most important discovery not available

⁴¹R.A.Skelton, Explorers Maps - Fig.37, p.61.

⁴²Haring, p.309.

to the English until the late sixteenth century. He was appointed in 1515 as a Royal Cosmographer.⁴³

Also in 1515, a special junta was called to improve the quality of Spanish charts copied from Amerigo Vespucci's Padrón-Real. Arthur Davies has suggested that the Egerton Atlas, usually attributed to the Italian Vesconte Maggiolo, may well be a copy of the original Padrón-Real.⁴⁴

A far more influential event was Magellan's voyage for which the charts were prepared at Seville by Nuno Garcia de Torreno. Unfortunately, when the 'Trinidad' was captured by the Portuguese, so too were the charts. A chart, prepared in 1522 in the light of information brought by survivors of Magellan's voyage, does survive in Turin.⁴⁵ That chart by Nuno Garcia shows the "raya" passing through Sumatra, thus assigning Spain the Spice Islands and the Malay peninsula. It is, apart from Pigafetta's sketches, the first to name the islands of the Moluccas.

It was the first clearly political map drawn to stress the Spanish claim, and of course formed a part of the case argued by the Spanish

⁴³ Haring, pp.309-10.
⁴⁴

Egerton Map is B.M. MS. 2803, illustrated in D.B. Quinn, W. Cumming and R.A. Skelton, The Discovery of North America, , Paul Elek, London 1971, Plate 61, p.70.

⁴⁵ R.A. Skelton, Explorers' Maps, footnote no.68.

at the Badajoz-Elvas Junta of 1524 that the Moluccas were 3° inside the Spanish side of the "raya". Nuno Garcia, with Diogo Ribeiro who had first come as a Portuguese exile to Seville in 1519 (and whose "inside" knowledge was recognised when he was made "maestro tracer de cartas" in 1523) represented the Spanish case at Badajoz-Elvas. They found themselves bound by the politics of Spain's claim when arguing about the length of Magellan's Pacific voyage. Ribeiro represented the "raya" at 125° of longitude. This was 25° more than shown by the Italian Agnese in 1536, but still 25° less than the true width (150°), an underestimate prompted by the need for the Moluccas to be drawn on the eastern side of the "raya".

Ribeiro's four great maps still extant are often taken to be copies of the Padrón-Real as it stood after 1527. However, Juan Vespucci who took over so many of Cabot's duties in 1526, and who had been present at the 1515 junta, had made the chart now in the Hispanic Society Library, New York, the nearest thing to the Padrón-Real as it stood in 1526.⁴⁶ He certainly included details of Pedro de Quexos's voyage of 1525 as reported to the Pilot-Major's office.

⁴⁶Quinn and Cumming, *ibid*, pp.84 and 86-7 (plate 87).

Alonso de Chaves first seems to have been involved in doing Cabot's duties of examination in 1527, although by late 1528 he had also received royal permission to read lectures in the house of Fernando Columbus. The latter knowing of his close work with Ribeiro asked him to complete a new Padrón-Real in 1526. Over 100 pilots were consulted over 10 years before this new Padrón-Real, described by Oviedo, was finished.⁴⁷ It was hardly surprising therefore that the Empress Isabella should remind Fernando of the project in May 1535, before it was finished. She perhaps had reason for impatience because so much had been learnt at Badajoz-Elvas. On the other hand, once Charles V had sold his claim to the Moluccas under the Treaty of Saragossa in 1529, a chart now had to be made "accurate" rather than "politically accurate". The particular problem here was to mount an expedition that could confirm the finding of the 'Vittoria's' survivors.

Thereafter Alonso de Chaves would be involved in a very long period of cartographic squabbling, and would several times be called upon to give testimony in royal examinations of alleged irregularities. Nevertheless, he was always there to take over from Cabot when the latter was unable to do his duties. Finally in 1552 Alonso de Chaves

⁴⁷Fernandez de Oviedo's reference is cited by Haring, p.307 as Historia General y Natural de las Indias, Book XXI, Chapter 10.

was rewarded with the post of Pilot-Major which he kept until 1586 by which time he must have been a very old man. During his years as Pilot-Major he had the support of his son, Jéronimo, who, following Prince Philip's creation of the chair of Cosmography, held the other senior post in the Casa's hydrographic office.⁴⁸ If this does not seem in the spirit of the 1552 reforms, then it is worth recalling that the next Pilot-Major, Rodrigo Zamorano, would hold both senior posts at once.

Alonso de Chaves held the post of Pilot-Major at a very trying time in the fortunes of the Casa, and those who so eagerly sought to train pilots. Begging Charles V to respect the intent and not the gift of "Breve Compendio del Arte de Navegar" Martin Cortes said that

"in the most happy tyme of your Maiestie, it appeareth that Spayne is renewed, not onely in the excellency of mechanically and handy craftes, but also in the knowledge of letters and the discipline of war".⁴⁹

Clearly Cortes was well aware of the progress in the production of better navigational instruments in the mid-sixteenth century, but at the

⁴⁸ Jeronimo de Chaves had established his reputation as a cosmographer with the publication of "Chronographia o reportorio de los tiempos e las materias muy provechosas de Astrologia, Cosmographia ... contiene asi mismo el calendario. Romano con todas los Lunarios y Eclipses verificados has la el año de seiscientos inclusive contiene asi mismo otras muchas reglas y secretos naturales necesarios al concieniento de los tiempos. Todo lo qual ... compuso Jeronimo Chaves mathematico, astrologio, y cosmographo. Seville, Juan de Leon, 1548".

⁴⁹ M. Cortes (tr. R. Eden, The Art of Navigation, 1561) Epistle Dedicatorie, fol. III.

same time he was well aware of the difficulties of widening the elite who had such skills, for he wrote later in the same dedicatory epistle that

"fewe or none of the Pilotes can scarcely reade, and are scarcely of capacities to learne. And whereas in the first chapter of this booke I have made mention, that the governall or steerage ought to be committed to expert men and of good understanding, he should see that nowe a dayes the ignorant presume to governe others which were never able to rule or governe them selves".⁵⁰

These timely comments coinciding as we shall see with certain teaching scandals, show that at least the experienced seagoing navigators grasped the need for literate and intelligent pupils if they were to gain more than a paper qualification from the Casa's training. It is, however, interesting that Prince Philip, to whom the problem fell, made little attempt to ensure literacy amongst the pre-entry qualifications for training in navigation, preferring to concentrate most of his attention on the hierarchy who did the teaching, as his creation of the chair of cosmography showed.

These glimpses show that formal regulation of the navigator's profession, often at royal initiative, was probably every bit as important in the attempt to improve navigation as were those economic pressures to seek gains from overseas empire and trade. This was the more important because of the constraining intellectual

⁵⁰Ibid.

climate in Spain.⁵¹

The Casa's staff relations became a further constraint as officials were preoccupied by internal politics from the middle of the sixteenth century. Such a preoccupation was no doubt partly a reflection of some fairly volatile personalities who held key positions, such as Sebastian Cabot, but no doubt it was also fostered by attempts to cover up breaches of rules by traders and masters. Most of the Casa officials took biased decisions, such as to which foreigners might operate within the Sevillian monopoly of trade with the colonies.

⁵¹ Another Casa de Contratacion was erected at Corunna in December 1522, after the voyage of Magellan. It was no doubt established there because of the traditional maritime interests of that coastline where both Magellan and DelCano had spent their early years. It also had established a close trading link with Antwerp, after Lisbon the principal emporium of the spice trade. Coruna never assumed great importance as the port for the dispatch of fleets to the Moluccas as envisaged in 1522, because there was much less incentive after Charles V sold his political and commercial rights to the Moluccas to Portugal for 350,000 ducats in 1529. By the time the problems of the Pacific return crossing were solved, the control of trade with Spain's new discoveries was firmly in Sevillian hands.

Largely out of the same financial exigency that led Charles V to sell his claim to the Moluccas in 1529, Charles also passed, under pressure from his German bankers, liberal legislation allowing ten Castillian ports to trade with the New World. None of the ports could compete effectively with Seville because they could not command sufficient royal support, financial backing or afford to train pilots to the same standards as Seville's, or enjoy the full benefits of 'flota' protection. Thus there was neither a commercial nor a navigational reason to use Castillian ports other than Seville unless driven there by storms, damage or intelligence about pirates at sea off Cape St. Vincent. The ports of Cadiz and San Lucar, because they enjoyed a specially close relationship with the Sevillian Casa, managed to operate oceanic trade and even expand it in the seventeenth century. Largely because the fortunes of Castillian ports outside Seville depended on trade with northern Europe, there was no significant outcry when the privileges given in 1529 were revoked in 1573.

As the Casa grew, so possibilities of corruption grew, especially after it assumed responsibility in 1553 for ensuring that ships were laded to certain rules, and provisioned with adequate stores and navigational aids. Its officials were drawn into a sensitive area, where the fraudulent recording and long collusion of "éscribanos" and the ship masters who appointed them, had thereby been brought to an abrupt end in the interests of ensuring safe sea travel by preventing under-provision. This step did not stop under-provisioning, but rather built into the organisation another group interested in preserving their particular opportunity for corrupt trading or inspection. However the most damaging aspect of this corrupt atmosphere was the effect it had on the Casa's cartographic attitudes.⁵²

Sebastian Cabot, who was accused of accepting excessive bribes and letting foreigners pass the examinations, may have been partly to blame for the unfortunate atmosphere amongst Sevillian hydrographers. He was certainly evasive about his particular knowledge of the north-west Atlantic though he seems to have been prepared to set it down on a chart compiled in 1544. He does seem also to have confided that information to Santa Cruz, because the Cabot Strait was included on Santa Cruz's 1545 map. This does not seem to show

⁵² See Haring, *ibid.*, pp.24-31, 49 and 60-63 for the activities of *éscribanos* and pp.11-16 and 281-292 for details of ships' inspection and the various loopholes.

knowledge of the French voyages up the St. Lawrence which proved it to be a river.⁵³

When Cabot left, never to return, in 1547, he left behind him a great deal of trouble over the way he had used the office, despite Charles V's trust. Today we would commend Cabot's attempt to standardise all Spanish charts, and his refusal to approve maps or charts not in conformity with the Padrón-Real. However, this was seen in a rather different light in the mid-sixteenth century, especially in view of Cabot's refusal to approve maps or charts made by those of whom he did not approve. He was seen as using his power of general oversight to compel all to come and buy charts approved by himself or the royal cosmographers. The Pilot-Major himself might sell charts or instruments outside Seville (thereby spreading knowledge to foreigners and effectively evading Charles V's specific wish to exclude foreigners from the pilots' training) or he might make globes or other objects not for use in navigation. If, however, he were caught selling charts or instruments in Seville, he was to be subject to a fine of twice the price he had received for his goods.

These provisions are first recorded in the ordinances of the Casa issued in 1552, though they almost certainly had their origin in the events

⁵³W. H. C. Cummings and D. Quinn, The Discovery of North America, plate 69, p.70.

following Ribeiro's death. After 1530 a number of separate licences were granted to individual cosmographers, instrument makers and cartographers. Many of those so approved were doubtless of lesser professional status than Pedro de Medina, who having been allowed to practise through a royal cédula, criticised the standards expected. Medina's criticisms sent to the Royal Council of the Indies, suggested that the "regimentos" currently on sale in Seville were sub-standard. The implied criticism led Sebastian Cabot, the Pilot-Major, to refuse Medina entry to the Casa's buildings to consult the Padrón-Real, and to refuse to license his charts which were said not to accord with the latest amendments to the Padrón-Real. Such professional sanctions were serious because charts without the Pilot-Major's authentication could not be sold to pilots. They provoked therefore an incentive to forge these marks. This could only be controlled through recourse to the Casa's semi-judicial powers of control in its profession. Such litigation, if once begun resulted in much bitterness, as Medina's law suits of the early 1540s showed.⁵⁴

Medina's career also illustrates another change in the character of the Casa and its members. He went to sea for long enough to learn some of the practical problems of navigation, having started his study of the subject at the age

⁵⁴Ursula Lamb, 'A Navigators Universe'. The Libro de Cosmographia of 1538 by Pedro de Medina. Translated and with an introduction by Ursula Lamb. Chicago University Press, 1972, p.4. Details of his law suits are cited from AGI Justicia Sección Legajo 1146. Ramo 2.

of 25. However, he forsook the sea for a job as tutor to Juan Carlos, the 6th Duke of Medina Sidonia. No doubt the latter learnt much about the sea from his tutor, though his tutor seems to have benefited even more through obtaining the support of a powerful patron in his later litigation.

It is evident from the litigation described recently by Ursula Lamb that Medina taught quite a number of trainee pilots after he began his career as a cosmographer in 1538.⁵⁵ In turning to teaching he was following a fashion that was becoming increasingly lucrative as trainee pilots paid to acquire the requisite examinations and qualifications and sought posts in the growing numbers of ships making oceanic passages.

Medina's background as Tutor and Librarian to the Dukes of Medina Sidonia stood him in good stead when introducing his Sevillian pupils to the relevant books and theories. The experience showed its worth in the clarity of his writing. His "Libro de Cosmographia" was the work of a mature scholar of 45, not of a newly trained pilot.⁵⁶ It was based on Ptolemaic views of the universe, but these were needing detailed revision merely in order to match increasingly easily observed celestial facts. The answers were therefore

⁵⁵Ibid. p.4.

⁵⁶Ibid. p.6.

rather too complex and cumbersome for inclusion in a simple teaching manual for would-be pilots.

Aware of the problems of teaching, Medina set about using his powers of expression to produce a good primer in navigation, which would not only present him with an intellectual challenge to write, but a means to obtain the large commercial rewards that accompanied the production of a book much wanted by anxious examinees and professional pilots who might be rusty on particular points of navigational technique. So the next of Medina's works to appear in print was the Regimiento de Navigacio published in Seville in 1543.⁵⁷ This was a compilation of the principal cosmographical knowledge of the time as applicable for purposes of oceanic navigation. Meantime Medina set to work drafting and illustrating a work which was to be far more authoritative. This was finished in draft by 1545 and published at Valladolid the same year.⁵⁸

⁵⁷ Pedro de Medina, Regimiento de navegacio contiene las casas que los pilotos tra de saber para bien navegar: y auisos que hau de tener parapelegros que navegando les pueden suceder... Por el Maestro Pedro de Medina Simon Carpintero. Seville 1543, 1552 1562 and 1563.

⁵⁸ "Arte de navegar en que se contienen todas las reglas, Declaraciones Secretos, y Auisos, q̄ a la buena navegacio son necessarios, y se deuē saber, hecha por el maestro Pedro de Medina. Dirigida el serenissimo y muy esclarecido señor, don Philipe principe de España, y de las dos Sicillias sa e con privilegio imperial".

Francisco de Cordova, Valladolid, 1545.

131.

The imperial privilege was granted to this work in an attempt to protect it from unauthorised copying.

The latter work contained good descriptions of the navigators' instruments and instructions, together with diagrams showing how to use them, and how to use declination tables. It did, however, include a very naïve description of variation and could easily lead to serious errors. Nevertheless, the work came to be regarded as one of the standard works on navigation throughout Europe.

At the same time as the Arte de Navegar was published, another much more cautious seaman, Martin Cortes, seeing both the commercial possibilities and the professional need for an accurate manual, drafted a superior work, under the title of Breve compendio de la sphaera y de la arte de navegar. This work, though complete in draft by 1545, was not published until 1551.⁵⁹ Cortes claimed in his preface that he was the first man to:

⁵⁹ Martin Cortes, Breve compendio de la sphaera y de la arte de navegar - con nuevos instrumentos y reglas exemplificado con muy subtiles demonstraciones: compuesto par Martin Cortes natural de burjaloz en el reyno de Aragon y de presente vezino de la ciudad de Cadiz: dirigido al inuictissimo Monarchia Carlo Quinto Rey de las Hespañas etc. Señor Nuestro, Anton Alvarez, Seville, 1551.

}

"have brought the arte of navigation into a brief compendiousness giving infaylable principles and evident demonstrations describing the practice and speculation of the same".⁶⁰

This was evidently an overstatement, but it was followed by a good summary of the contents of his manual as

"shewing ways to pilotes, by teaching and making use of instruments, to knowe and take the altitude of the Sunne, to knowe the tydes or ebbing and flowing of the sea, how to order theyr cards and compasses for navigations, giving them instructions of the course of the sunne and motions of the Moone: teaching them furthermore the making of dyalles, both for the day and for the nyght, to certen, that in all places they shall knowe the true houres without defaute. And have likewise declared the secret property of the lode stone, with the manner and causes of the North eastinge and North westing (commonly called the variation of the compasse) with also instruments thereunto belonging".⁶¹

The manual contains many simple cosmological explanations for the pilot, reassurance and information about phenomena like lightning, affirmations of God's providential regard for the sailor, in addition tracts which still remain today good guides to the principles of navigation and hydrography. The section on how to construct a

⁶⁰ Richard Eden The Arte of Navigation conteyning a compendious description of the sphere with the making of certen instrumentes and Rules for Navigations: and exemplified by many Demonstrations. Written in Spanyshe tongue by Martin Cortes. And directed to Emperour Charles the fyfte. Translated out of Spanyshe into Englyshe by Richard Eden R. J. [Richard Jugge] London, 1561.

Epistle dedicatorie of Martin Cortis to the most mighty and victorious monarch Charles the Emperor, the fyfte of that name, kynge of Spain, etc." fol.II.

⁶¹ Ibid.

chart, together with those on the construction of instruments, were particularly important for therein was contained information to enable a skilled craftsman to make such an item. It also comprised working volvelles and drawings of the instruments.

Other manuals were written in the years before 1580 by men such as Rafael Pardo de Figueroa and Juan Perez de Moya but they were far less original and far less influential.⁶²

One notable Spanish work on navigation foreshadowed the political attitudes which came to have their most stultifying effect after the Union of Crowns in 1580. The Itinerario de navegacion of Juan de Escalante de Mendoza was written about 1575.⁶³ It was intended as a compendium of all relevant data about the North Atlantic, and represents the experience of one who had begun his seagoing life under his uncle's patronage at a very tender age. His uncle, one of the Sevillian captains, trained him so well that by the age of 18

⁶² Rafael Pardo de Figueroa, Regimiento de navegacion. Contienne las cosas que les pilotos han de saber para bien navegar. Seville 1563. 2nd edition, Cadiz 1867.

Juan Perez de Moya Obra intitulada fragmento mathematicos. Lib I, Juan de Canara. Salamanca 1568, 271 pages. Lib II 1567, 493 pages. 2nd edition of Obra intitulada mathematicos by Alcatá de Henares, Madrid, 1573, 3 vols.

⁶³ See Haring, *ibid.* pp.312-3 for full details of Juan Escalante de Mendoza.

Escalante was in command of his own vessel on the Honduras run, where he distinguished himself in action against pirates. The Itinerario was written after 28 years at sea, and included copious details of winds, currents, storm conditions, construction of ships, provisioning, manning, naval tactics as well as a good deal of navigational theory and practice. It was commended by the Council of the Indies, but the same Council forbade the printing of the text lest it give foreign foes precious knowledge of Spanish seas and sailing routes.

It is a sad postscript that Escalante petitioned for the 10,000 ducats he had spent on its compilation but failed to secure them. Forty-eight years later, long after Escalante's death as Captain General of the Tierra Firme fleet in 1596, that manuscript was finally returned to his son for printing. By then, however, it had already been pirated and erroneous copies had been circulating for a number of years.

Chapter 4

The dissemination and decline of Iberian navigational skill (1580-1620)

Commenting on Portuguese cartographic achievements after 1580, Armando Cortesão categorised them as the products of a period of decline.¹ This may be slightly misleading because, as never before, accurate navigational information, particularly charts and rutters, gained immense political and strategic value. Not only did the Iberians face testing world-wide commitments, they faced new European sea powers looking beyond Europe. In forming a view of how their navigational information was developed and used, we need to look first at the political context in which it was deployed.

The military seizure of the Portuguese crown by Philip II in 1580 initiated sixty years of Habsburg rule over a world-wide maritime and colonial empire. That empire comprised some of the finest ports in Africa, Asia, America and Europe, linked together by sea lanes. Concerning those sea lanes the Spanish and Portuguese between themselves had the finest collection of navigational information yet assembled. These routes were plied by a merchant marine of between

¹ Armando Cortesão, Cartografia e Cartógrafos Portugueses do Séculos XV e XVI, Lisbon, 1935, Vol. 1, p.32.

250 and 300,000 tons.² This was bigger even than the 232,00 tons of the Netherlands fleet and vastly bigger than England's 42,000 tons. Only perhaps China could boast a bigger tonnage employed in coastal and riverine trade, but unlike the European maritime powers, China did not have a strategic commitment far from its own coastline by the late 16th century. By 1580 Spain and now Portugal were involved in what was becoming a major battlefield, the Atlantic Ocean, for across it passed the wealth of their empires continually inviting the very avaracious attention of Protestant Dutch, French and English corsairs. United by ties of friendship and religion against the Spaniards,³ whom they detested for their religion and arrogance, these northern corsairs sought in the words of the Huguenot, La Noue, to take Spain "by way of the Indies".⁴

²J.H.Elliott, Imperial Spain, Pelican, 1970, p.276. A.P.Usher, 'Spanish Ships and Shipping in the Sixteenth and Seventeenth Centuries'. This essay is in Facts and Factors in Economic History, E.F.Gray, Harvard University Press, 1932, pp.181-213. This also shows how disastrously rigid specifications for galleons were laid down in administrative cédulas that showed no understanding of the subtleties of ships' architecture. Thus resources spent by Bazán in developing the design were largely wasted in the late sixteenth and early seventeenth centuries by building badly proportioned, unweatherly ships.

³Maltby, The Black Legend in England. The Development of anti-Spanish sentiment 1588-1660, Harper Torchbooks, 1970, pp.80-88.

⁴J.H.Elliott, The Old World and the New, 1492-1650, C.U.P., 1972 edition, p.93, cites a letter from La Noue of 17th August 1588 to Sir Francis Walsingham. The reference given is in Henri Hauser François de la Noue, Paris, 1892, pp.315-19.

Some of Philip II's advisors saw the strategic nature of his problems. In 1585 Cardinal Granvelle unsuccessfully urged Philip II to transfer his government to Lisbon. Granvelle felt Lisbon would prove the perfect observation post for the new battle of the Atlantic, besides having easy maritime communications with his Empire, a proud maritime tradition and a tradition of secrecy about the very seaways that Northern Europeans sought to strangle. Another of his advisors, Juan de Idiáquez, said the objective of the Spanish Armada was "no less the security of the Indies than the recovery of the Netherlands".⁵

Philip II was ready to grasp at political technological or military solutions to his many immediate problems, but he lacked a long term strategic grasp of his problems. He was able, however, to immerse himself in the detail of particular problems, and it was through this that he began to grasp the significance of naval intervention, first to cope with the problems created by Mediterranean corsairs, and then in the very different theatre of the Atlantic. His interest in the idea of a 'flota' escort derived from the forceful strategic insight of his admiral Pedro Menéndez de Avilés, who saw the need to protect the Atlantic sea lanes, but Philip may well have been more convinced by the advocate than the

⁵ John Lynch, Spain under the Habsburgs, Vol.1, Blackwell, Oxford, 1964, p.315, cites Idiáquez as does J.H.Elliott, as above.

strategic idea, for he could not grasp the strategic advantage of a permanent West Indian squadron such as was advocated by the admiral's successors up to 1640. When in 1573 Pedro Menéndez de Avilés advocated the seizure of the Scillies and the maintenance there of a squadron of weatherly cruisers to "stop up the main earth of the corsairs",⁶ he received royal support. When the admiral died suddenly in 1574, Philip thereupon let the project die, failing to appreciate the value of its objective, for lack of its advocacy at court by a permanent naval administrator. Philip's actions, sometimes precipitous, were more often those of the administrator who failed to formulate helpful policy due to concern about administrative detail. Thus during the planning of the Armada campaign, he filled his mind with details of shoals and sandbanks off the French shore, but formulated few strategic guidelines for his fleet in the Channel.⁷ With clearer leadership the Armada might not have forfeited the chance to

⁶ J.H. Parry, Spanish Seaborne Empire, Pelican, 1973, pp. 120-122 and p. 263, for discussion of the Armada de las Islas de Barlovento y Seno Mexicano as it operated in the 1640s.

D.W. Waters, The Elizabethan Navy and the Armada of Spain, N.M.M. Monograph No. 17, 1974, p. 15.

⁷ D.W. Waters, as above, p. 60 cites from letter D of N.M.M. collection PHB/1 ff. 438-51 instructions for Don Alonso Perez de Guzman, Duke of Medina Sidonia under the King's monograph by Don Martin de Idiáquez.

bottle Hawkins up in Plymouth, and might have avoided sailing, as it proved, too near the Grave-lines sandbanks, thereby exposing itself to the English guns while nearly defenceless.

Such was the king who, taking advantage of his easy conquest in 1580, and with the support of the nobility and church, decided to call the Cortés of Tomar and legalise his seizure of Portugal's crown. Perhaps he sensed that the Portuguese people still had their national pride in those achievements of which Camoëns wrote. Thus Philip not only agreed to preserve the Portuguese laws and language and to consult Portuguese advisors on matters concerning Portugal, but also he swore to prohibit Spaniards from settling or trading in the old Portuguese empire and vice-versa, and promised that both empires would continue to be administered by their own officials. The old Portuguese office of the Secretary of State for India did continue to operate as a separate administrative agency, and the Casa da Índia controlled the sale and distribution of eastern goods. However, when it was announced in Goa in 1587 that the pepper trade had been handed over to a consortium of contractors, disturbances followed. During the years 1588-91, only half the pepper contracted for arrived in Europe and financial panic ensued. This led Philip II to realise the error of surrendering both source and market to a non-Iberian consortium, as opposed to the old

Portuguese policy of royal monopoly. Concerned about the financial implications, his decree of November 20th, 1591 abolished the Portuguese financial offices, and created a new Council of Finance consisting of his nominees. The Casa da Índia and the spice trade were put under the control of the new council together with such important fringe bodies as the Armazéns.⁸ Yet these changes represented but minor breaches of the Tomar agreement compared with what Philip III and Philip IV did to achieve financial centralisation for military purposes clearly related to Castille's ambitions.⁹

If such Habsburg actions were an ever present bone of contention, other deep Luso-Hispanic jealousies surfaced at many levels in the 60 years of union. By the early 1590s Spanish traders were beginning to invade Portuguese monopolies in trading with Macao and Japan, while Portuguese Jews made themselves increasingly evident in Peru. Other grievances were carried across the seas, all too often causing serious problems. Evidence of regularly poor relations between Spanish and Portuguese pilots is given in the way that

⁸D.Lach, Asia in the Making of Europe, Vol.1, p.135

⁹The Union of Arms as proposed in 1624 followed by the adoption of Portuguese bankers by the Crown in 1626-7 immediately after the Crown had suspended payments to its Italian bankers increased Portugal's suspicions of the Habsburg rulers.

"Instructions" were drafted for Rui Gonçalo Sequeira in March 1613. In carrying reinforcements to the Philippines he was told to ensure

"that good relations are maintained between the Spanish and Portuguese pilots, in such wise that the Portuguese instruct the Spaniards in the art of navigation, taking the latitude of all the islands and lands you see, taking soundings thereof, and carefully making the necessary observations of the course taken, with due care and vigilance..."¹⁰

Long before it became necessary to issue such orders, it was clear that royal actions were going to bring discord between the hydrographic offices and navigators of Seville on the one hand and Lisbon on the other. It stemmed from the desire of the Spaniards to utilise hitherto restricted Portuguese information, a desire which Philip II also shared.

As early as 21st August, 1581 Herrera could write to Juan Lopes de Velasco saying that the papers and charts of Juan Battista Gesio were in use at court in Lisbon because the king wanted to have a universal map showing the ancient "Taya" and because the king felt his latest map "was spoilt by the Portuguese".¹¹ This is another reference to the espionage of Juan Battista Gesio who, as we have seen, got Luís Jorge de Barbuda out of Portugal in 1571 so that his

¹⁰ C.R.Boxer, Portuguese Roteiros 1500-1700, M.M. 1934, Vol.20, p.182.

¹¹ P.M.C. Vol.II, p.124.

cartographic knowledge could be used in Madrid. Herrára's letter goes on to show that Luís Jorge de Barbuda had made three of the five maps he was commissioned to prepare , showing respectively India, Portugal and Japan. Having got Luís Jorge out of Portugal, Philip was not going to give him and knowledge back to the Casa in Lisbon where once before Luís Jorge had been imprisoned on account of this willingness to work for Philip. Thus this cartographer was appointed by Philip II to an official post in the new Academy of Sciences in Madrid. There his skills as "master of charts, of cosmography, geography and navigation" were publicly acknowledged and utilised. As Philip II had clearly breached the spirit of the Tomar agreement in respect of Luís Jorge, the cartographer could not be returned. He could only be promoted in Spain. Almost inevitably this happened when Luís Jorge and Andrés Garcia de Cespedes were jointly chosen to correct the Casa de Contratación's Padrón-Real in Seville in June 1596.¹²

¹²PMC, Vol.II, p.124 (letter F) of June 1596 gives details of the twin appointment. It arose from a meeting of experts held in the Casa de Contratación at Seville in February 1585. There "the pilots of the Navigation to the Indies pointed out the bad state of the subjects concerned with this navigation, when they asked that a man expert in the preparation of instruments for navigation should be sent to Seville, and as we have no one it is necessary to send to Lisbon for them". On 30 March they chose Luís Jorge, and having established his reputation, became an obvious choice in 1596, while Garcia de Cespedes was the most dynamic of the Spaniards.

The advance of Luís Jorge in Spain was not the only aspect of his career to annoy the Portuguese. His chart of China, representing the latest Portuguese information, found its way into the hands of Philip's official geographer, Abraham Ortelius in Antwerp. In 1584 it was published there as part of Ortelius's Theatrum Orbis Terrarum.¹³ This widely read atlas was later consulted by Dutch sailors making incursions into former Portuguese preserves like the China coast in the seventeenth century. This subsequent and important dissemination of information about China gave yet another bitter twist to feelings in the Portuguese Armazéns where the old attitudes of official secrecy in such matters died hard.

In the short term, however, the Portuguese were more rankled by Luís Jorge's working in conjunction with Andrés Garcia de Cespedes. The latter was a distinguished navigational theorist employed in Seville, who had risen to fame with the publication of Regimiento de navegacion y de la hidrografía published in 1603.¹⁴ That book represented a considerable advance over the works of Zamorano, Medina and Cortes, and was consequently well received in scientific circles. Its sequel, however, created the real stir because in it the Spaniard sought to show the Moluccas were 3° inside the Spanish zone. The Portuguese

¹³For full details of Ortelius's work see footnote 44 of this chapter.

¹⁴C.H.Haring, Trade and Navigation, Peter Smith, Gloucester, Mass. 1964, p.313.

immediately responded. Lavanha led the replies,¹⁵ but the most bitter reaction was that of Luís Jorge's own son who wrote in 1624:-

"But who can doubt great offence is perpetrated against the Portuguese nation by those writers who pretend to take these islands [the Moluccas] out of the demarkation of her conquests".¹⁶

These sensitivities reflected not only the indignant reaction of the monopolist and discoverer, they were made at a time when the English and Dutch were enjoying commercial and naval success in the area at Portugal's expense, against which the only Iberian success was the Spanish recapture of Ternate in 1608. These sensitivities also had a diplomatic basis which harked back to the Treaty of Saragossa signed in 1529. The Spanish regarded the "Raya" fixed then, less definitely than the Portuguese. That Philip II wished to have the "ancient demarkation" shown (i.e. the line the Spanish argued for at Badajoz Elvas in 1524, rather than the one conceded by the Treaty of Saragossa) is indicative of how the Spanish regarded the matter by 1581. Spaniards like Lopes de Gomara justified their views by claiming rightly that the 350,000 ducats King Manuel had agreed to pay grossly undervalued

¹⁵ PMC, Vol.IV, p.67 gives details of Lavanha's reply to Cespedes "A Report on the situation of the Moluccas. Madrid. 1611". Lavanha claimed the Moluccas were 3° inside the Portuguese sphere.

¹⁶ PMC, Vol.II, p.125, footnote 4 cites from Empresas Militares de Lusitanos 1624, Lisbon, f.264.

Spanish claims and that from the first Charles V had conferred the balance of their worth on Manuel as a gift. However, the Spaniards felt that if they repaid the 350,000 ducats, these islands would again be the subject of "debate and strife". Indeed, in 1548 the Cortés of Castille had proposed repaying the 350,000 ducats.¹⁷

Alongside this attitude, which owed its bias to the possible gains of trading in Moluccan spices, Spanish popular interest in China grew apace and fostered another interpretation of the treaty of 1529. This interpretation saw the Pacific extension of the Tordesillas meridian as only the eastern limit of the Spanish claim pawned in 1529. Further west lay the western limit, i.e. near Malacca and extending north behind the Chinese seaboard. Such a view was used to justify expeditions to the Philippines and to justify missionary aspirations in China. This interest in China was at its height about 1580 when Philip II himself drafted a letter to the Chinese Emperor. This was to be taken there by three Augustinian friars in 1580 but in fact they never got nearer than New Spain. This was because travellers returning from China suggested such a mission could only fail. However, the Augustinians did gather much useful material,

¹⁷ Z. Swecker, Iberian Accounts of the Far East 1500-1600, Ph.D. Thesis, Chicago, p.178.

¹⁸ Ibid. p.216.

such as the Chinese navigational manual of Martin de Rada. This Gonzalez de Mendoza would use to draft a book which itself stimulated further interest in the area, as we shall see in the Chinese interchange.

This interest in the Far East owed much to Philip II's own scientific interest, especially in particular features of his nearer overseas possessions in America and the Far East. This combined with the "shocking ignorance" which Juan de Ovando's visitation of 1569 revealed within the influential Council of the Indies, led Philip II to initiate a series of scientific ventures.¹⁹ Sometimes these took the form of questionnaires addressed to local officials. The replies often included maps and charts of areas Philip specifically asked about. On one such mission he sent the Valencian cosmographer Jaime Juan to make astronomical observations in New Spain and the Philippines in order to supplement information already available to navigators.²⁰ Sometimes this type of approach led to colonial officials reporting local scientific work. One such report was made by Fernán de Grado, Governor of the Canaries, in 1570. On this occasion the governor was trying to reap credit for a universal astrolabe designed by the deceased Juan Alonso. Though the latter

¹⁹C.H.Haring, The Spanish Empire in America, Oxford University Press, 1947, p.104.

²⁰Ibid, p.124.

had claimed the astrolabe would facilitate the easy finding of longitude, it did not do so. This was, however, only proved after the Council of the Indies had ordered him to send them the instrument and an explanation of its usage.²¹ Nevertheless, the instrument showed them that it might be possible to make an instrument that permitted observation of longitude.

About the same time Alonso Alvarez de Toledo, saw a method demonstrated by Juan de Ledesma, secretary to Admiral Menéndez de Avilés.²² Citing its use in the king's fleets, he used his official position as Cosmographer to the King to advocate adoption of that method until it was discredited in critical examination. Another discredited method was one which Fr. Martin de Rada and Fr. Urdanetta had seen in use amongst the conquered natives of Cebu.²³ These attempts were all based on the idea fashionable in Spanish scientific circles that compass variation, if it could be accurately determined, would show a result particular to one meridian. It was based on the research Santa Cruz had done in Lisbon in 1545

²¹Cedula 4 Aug. 1571 cited by Navarette, D.I. p.17.

²²D.Eustaquio Fernandez de Navarette, Documentos Ineditos, Tome XXI, 'Memoria solvire la tentativas hechas y Primios efidos en españa al que resolvire el probleme de la longitud an la mar', Madrid 1852, p.20.

²³Ibid.

late magnetic variation as recorded in 1538-41 by 168
D. João de Castro on the India voyages. In
England similar work done by Robert Norman and
William Borough and published in 1581 as the
Newe Attractive had proved that variation was
not regular throughout the world, or particular
to any meridian.²⁴

Iberian scientific research, and later Dutch
research, continued to pursue this false errand.
This line of research was followed even more
actively after 1598 when Philip III offered a
prize of 1,000 ducats for the development of a
method of determining longitude.²⁵ This sponsor-
ship had both a scientific motive and the signif-
icant political motive of perhaps fixing Pacific
meridians in a way that would advance Spain's
claims to Portugal's detriment.

A major technical controversy, fought out
before the Council of Indies, ensued. Its

²⁴Robert Norman, The Newe Attractive, containyng a
short discourse of the Mages or Lodestone, and
amongst his other vertues, of a new discovered
secret and subtil propertie, concernyng the
Declinyng of the Needle, touched therewith under
the plaine of the horizon. Now first founde out
by Robert Norman Hydrographer .

Hereunto are annexed certaine necessarie rules
for the art of Navigation, by one R.N.

Imprinted at London by John Kyngston for Rich-
ard Ballard, 1581.

A Discours of the Variation of the Cumpas, or
Magneticall Needle. Wherein is Mathematically
shewed the manner of observation, effectes, and
application thereof, made by W.B./William Borough/
And this is to annexed to the Newe Attractive of
R.N. 1581 .

²⁵C.H.Haring. Trade and Navigation, p.305.
Navarette. D.I. Vol.21. p.60.

Augustino Salinas. Spain's Efforts to solve the
Longitude Problem in the 16th Century. Summary of
papers offered to the Third International Reunion
for the History of Nautical Science and Hydro-
graphy. Greenwich. 24-28 September, 1979. Salinas
suggests that Philip II offered a prize for this
as early as 1567, the total value of which was
as much as 6,000 ducats. This was, in fact, the
total value of the award made to Fonseca Coutinho
in 1610. See below.

technical advisors on the subject of navigation, D. Diego Brochero, Antonio Morena, D. Diego Molina, D. Alonso Flores and others, for long tried to assess the rewards due to Huan Arias de Loyola and the Portuguese, Fonseca de Coutinho, for their rival instruments and methods of determining longitude.²⁶ A very worthwhile objective, however, became in this case a study in the waste of resources, scientific bitterness and Luso-Hispanic rivalry.

Coutinho's proposals were presented to the King in 1607 for use on the India voyages. He required 20 to 30 compasses to be bought by the Casa in Seville and a similar number in Lisbon. Each ship involved in the experiment was to carry six compasses, three ordinary ones and three fixed in boxes, for the purpose of comparing measurements of variation. The cost of the Lisbon order alone was 300 ducats. In addition six new astrolabes were ordered at a cost of 40 ducats each while a further 100 ducats were provided for cartographic aids. The compasses were taken by the Admiral of the India fleet, Blas Tellez, on the 1609 voyage. Afterwards he reported that they had all given "fixed" results on the outward and return voyages. Similar compasses examined by Fernando de los Rios in Madrid, Seville and Cadiz confirmed these results. Fonseca de Coutinho, hearing of

²⁶Navarette, D.I., Vol.21, pp.114-141.

this disappointing outcome, was allowed to submit redesigned compass needles and to insist on their use. In reward 6,000 ducats, made up of 2,000 from the Averia, 2,000 from the Real Hacienda and 2,000 from the crown of Portugal, plus certain presents from the King and 1,000 ducats towards the cost of the research, were offered to Fonseca de Coutinho.

However, on 8th June 1610 it was decided that Coutinho being incorrect, Arias's instruments (first considered in 1603) should get the prize in addition to the 600 ducats he had earlier been awarded to cover his research costs. In the event he was awarded 6,000 ducats rental by Rodrigo Zamorano and Baptista Lavanha and 2,000 ducats for life. Arias, however, felt cheated of the prize and wrote a book about his special compass in which he also mentioned another method of determining longitude that anticipated a future solution. He proposed using one of Galileo's telescopes and observing the motions of Jupiter's moons. He specifically requested his detailed specifications be kept secret from the Flemish. But when complaining of his treatment by the Council of the Indies as late as 1633 he revealed that he had been offered 100,000 escudos in gold to betray the detailed contents of his book to a foreigner.

Arias also knew of other research into longitude done by a French soldier who is presumed by Navarette to be Captain Juan Mayllard who tried about 1616 to determine longitude throughout the Mediterranean, but had especial difficulty in fixing his positions "due to sea currents".²⁷

Contemporaneously with Mayllard's work, a Genoese noble, Benito Escoto, presented details of his proposed methods of making voyages to China and Japan easier in a memorial addressed to the King of Spain.²⁸

Navigational technology seems to contradict Professor Elliott's assertion

"that science and technology failed to take root in Spain at a time when they were beginning to arouse considerable interest elsewhere in Europe".²⁹

In Spain after 1580 the spirit of inquiry was alive. In longitude research, there were the continuing efforts to collect data for cartographical improvement based on the practice that new discoveries were to be added to the Padrón-Real as well as various improvements in instrumentation. Equally it can be seen that despite Cespedes's conclusion that there was no scope for improving instrumentation in such a manner as might permit determination of longitude with current knowledge, much effort was still directed into mathematical research.

²⁷Navarette, D.I., Vol.21, p.143.

²⁸Navarette, D.I., Vol.21, pp.145-151.

²⁹J.H.Elliott, Imperial Spain, Pelican, 1970, p 186-7.

Navarette notes that the Jesuits promoted the study of mathematics, but some more modern Portuguese writers such as Armando Cortesão,³⁰ have suggested that Jesuits sought to stifle scientific research, in particular the work of the Academy of Sciences founded by Philip II in 1583 at the suggestion of Juan de Herréra.³¹

Against this C.R.Boxer wrote:-

"Whatever their shortcomings in other respects the Jesuits certainly never interfered with the teaching of nautical science and their ranks included at least two eminent cartographers of the early 17th century Fathers Francisco da Costa and Cristoforo Borro".³²

Graduates of the Jesuit college of São Antão, Lisbon included Diogo do Couto, Antonio Boccarro, Dom Antonio de Attayde and Dom Francisco Mallo, showing that Dr.Cortesão was misleading in his comment. However Boxer does concede that the bigoted activities of the Inquisition did have a blighting effect on the development of science in Portugal, in particular their persecution of "Christãos-novos" and crypto-Jews who were often amongst the best pilots, mathematicians and scientific practitioners.

Boxer's comments too must be regarded with caution in respect of the Inquisition. We have already seen the importance of Pedro Nunez's contribution, but there was another Portuguese, born of Jewish parents in the mid-sixteenth century,

³⁰A.Cortesão, Cartografia e Cartografors Portugueses do Séculos XV e XVI, Lisbon, 1935, pp.39-42 and 56.

³¹J.H.Elliott, Imperial Spain, p.342.

³²C.R.Boxer, M.M., 1936 pp.118-123. A review entitled "Reram" of A.Cortesão's work cited above.

who exercised great influence under Philip II, III, and IV as the resident master of mathematics at court. This man, João Baptista Lavanha, obtained a special Papal dispensation to wear the habit of Christ. His career began under King Sebastian of Portugal, but he managed to impress Philip II on his long visit to Portugal just after the conquest, so much so that from 25th December, 1582 he was ordered to

"occupy himself in matters pertaining to cosmography, geography and topography and in reading mathematics".³³

In 1583 he was appointed principal professor of mathematics at the new Academy of Sciences with a salary of 375 reals. A Spaniard, Pedro Ambrosio Onderiz, was appointed to a post there as his assistant and the Portuguese emigre Luís Jorge de Barbuda as cartographer.

Lavanha was soon given a special scientific commission to translate into Spanish books on mathematics such as those by Euclid, Tectoria, Aristotle, Vitruvius, and most interestingly Copernicus (for whose astronomical work Philip II sent specially to Venice in 1584). The benefits of this work were to reach trainee navigators, for by 1591 Lavanha is known to have been in Lisbon giving lectures to pilots and seamen and generally discharging the office of Cosmographer-Major because Tomas de Orta was too ill to carry out the duties.³⁴ When Tomas died Lavanha was

³³PMC, Vol.IV, p.64.

³⁴A.Cortêsão, Cartografia e Cartografos,/Lisbon 1935 Vol.II, p.298.

confirmed in the post until sent to Flanders to do historical and cartographical work for Philip III in 1601. He remained conscientious in his duties to navigational science, participating in the Junta de Guerra da India that was examining the special compasses of Luís Fonseca Coutinho. He also prevented the Jesuits from incorporating the Academy's chairs and endowments into the -----
Estudios Reales during his lifetime. However, despite the fact that he personally had tutored the Prince of Asturias, the latter on becoming king was persuaded to incorporate the Academy of Sciences within the Estudios Reales (Colégio Imperial) in 1625.³⁵

Lavanha's written works spanned all aspects of navigation from the theoretical to the severely practical. He began a draft of the Tratado del Arte de Navegar in 1588 which was published along with the text of a lecture on the use of the globe given by his understudy Onderiz to a Madrid audience in 1592.³⁶ In 1595 he published two translations of Castilian originals, one the Tratado de Gnomica ³⁷ based on the work of the mathematician Clavius, the other being the Tratado do Astrolabio ³⁸. Among his more theoretical works

³⁵J.H.Elliott, Imperial Spain, p.342.

³⁶PMC, Vol.IV, p.65.

³⁷Ibid.

³⁸Ibid.

were a compendium of geographical knowledge,³⁹ a description of the universe,⁴⁰ tables compiled between 1596 and 1600 for computing feast days of the Church, longitude (he hoped), "altura",⁴¹ and instructions on how to use the instruments as designed and explained by Coutinho and Arias,⁴² and some of the clearest ever instructions on what records and observations should be kept on a voyage of discovery,⁴³ together with other interesting works.

³⁹ PMC Vol.IV, p.67 cites the "Compendio dela Geografia ordenado por el erudito baron Juan Battista Lavaña Cavallero Portugues Comendador de la orden de Christus. Cronista Mayor del Reyno de Portugal y maestro en la geografia del mui alto y Muy Poderoso Señor Don Philippe quarto El Grande N. Senor Rey de las Españas y Nuebo Mudo".

⁴⁰ PMC Vol.IV p.67 cites "Descripcion del Universo" This was prepared as a little didactic manual of cosmography for the royal prince in 1613. It consisted of an introduction on Geographical Principles followed by a description of the world running over 30 chapters, clearly too much for a boy of the age of six to understand.

⁴¹ See PMC Vol.IV, p.65 for:
 a. notes on "Computo Ecclesiastico pela depois de emenda do calendario 1596;
 b. "Tabulas de largura ortiva de sol". Drawn up in 1600 these tables needed little subsequent revision by Manuel de Figueiredo in 1608. They were used by Sebastio Prestes in 1608 and Simão Castanho in 1609-11.
 c. The same codex Bib. Ajuda (51 VIII - 21) contains the "Regimento do Intrumento p. saber por elle altura a qualquer ora do dia q̃ sol" dated March 8th 1608 and the "Uso do Intrumento das Agulas uma fixa, e outra Regular" signed by Lavanha and dated Madrid 1610.

⁴² PMC Vol.IV, p.66. Bib. Ajuda 51 VIII - 21 ff.63-4 and 87-9.

⁴³ PMC Vol.IV p.67 "Instructions which, as it appears, should be observed on the discovery and description of the Coast from Cabo Negro to the Cape of Good Hope", see Codex 51 VIII, ff.45-46 in Bib. Ajuda.

One aspect of the scientific spirit patronised by the Habsburgs and typified by Lavanha was a wish to publish discoveries, theories and methods. It is evident earlier in Spain than in Portugal where security and secrecy were much more closely equated. Philip II, unlike the Portuguese kings, did not proceed against those who let information outside the Armazéns reach the Netherlands. Indeed Philip II appointed the Fleming Abraham Ortelius to be his Geographer, knowing that he lived in Antwerp.⁴⁴ In the same spirit that Philip created the post of Cosmographo-cronista in 1571 for Juan Lopez de Velasco, so in 1596 he divided it into two offices to encourage publication of information. To one of the new posts he appointed the distinguished author Antonio de Herráera de Tordesillas.

Iberian enthusiasts of the printed text, particularly Castillians, who had used printed

⁴⁴ Abraham Ortelius was born in Antwerp in 1527, but changed his name to Ortelius about 1547 by which time he had begun to acquire a collection of maps. To support his widowed mother and two sisters, he had started buying maps which he had coloured and then sold at the Frankfurt Book Fair and indeed at other cities in Italy and France. He established a wide circle of friendly cartographers in many countries, among whom were the Welshman, Humphrey Lluyd, the Venetian Giacomo Gastaldi, the Hungarian Wolfgang Lazius, the Frenchman Ferdinand de Lanoy, the Tuscan Girólamo Bell Armato, the Spaniard Jéronimo de Chaves, and the Portuguese Luís Jorge de Barbuda and Luís Teixeira. Ortelius drew all the maps for his famous *Theatrum Orbis Terrarum* himself from originals obtained through such contacts as listed here. They were then engraved on copper plates by Frans Hogenburg, Ambrosius, and Ferninand Arsenius. Between 1570 and 1612 nearly 50 editions with texts in Latin, German, French, Dutch and Spanish were published.

navigation manuals, increasingly advocated the printing of rutters for the route taken by the Portuguese India fleet because of its growing losses. They argued that the printing of the best rutter available would increase safety, eliminating the dangers to ships of copyists' errors. Even so it took the appointment of a new and very able Portuguese Cosmographer-Major, Manuel de Figueiredo, who served from 1607 to 1622, to get such a rutter into print in 1609.⁴⁵ It was quickly followed by rutters for Brazil, Angola, Guinea, Cape Verde Islands, and Newfoundland, and then in 1609 by a supplement with rutters for the Spanish Main and the West Indies. The entire work, known as the Hidrographia, Exame de Pilotos etc. was prefaced by an "Arte de Navegar" giving the elementary rules of mathematics, geometry, and astronomy, together with illustrations of how to use the various instruments.⁴⁶ The format of this work

⁴⁵ Manuel de Figueiredo, Hidrographia, exame de pilotos, no qual se contem a, regas que todo piloto deve guardas em suas navegacoes, assi no sol, variacao d agulha, como no cartear, com alguns regras da navegacao, de leste, Oeste ... em os roteiros de Portugal pero o Brasil, Rio de Plata... etc. Lisbon, 1609. Further editions with erratic pagination were produced in 1614, 1625 and 1632.

⁴⁶ The 'Arte de Navegar' consisted of about 30 pages, though later editions greatly expanded the coverage. One accusation made about them is that they are plagiarised versions of Andre de Avellar's sixteenth century writings, but this allegation by Stockler in his study of mathematics in Portugal is neither proven nor discredited by Figueiredo's writings which never mention him. See also C.R.Boxer, Portuguese Roterios 1500-1700, M.M., 1934, p.181.

was based on Jan Lucas Waghenhaer's sea atlases but to a lesser extent owed something to the works of Linschoten and Hakluyt who had printed the Iberian rutters that they had obtained unofficially.

The idea of printing rutters brought about a most interesting discussion in the Council of the Indies in 1610. A report of one meeting shows that the old Portuguese fear of printing rutters was not dead. It states that all those who had seen the information that Gaspar Ferreira Reimão had gathered had agreed that it would be useful and advantageous for navigators. However, they appreciated the risk or "inconvenience in printing it lest it should fall into the hands of foreigners who might profit from it". Nevertheless, they saw that printing it offered the chance to check and eliminate the copyists' errors that marred manuscript versions. They agreed further that

"printing must be made with all care putting the printer in a house where he cannot print more copies than those which are ordered" ⁴⁷

⁴⁷ PMC. Vol. IV p. 82 for 'Opinion of the Conselho da India about the secrecy to be observed in the printing of the rutter by pilot major Gaspar Ferreira Reimão'. Prior to compiling the rutter, of which only one printed version survives in the Biblioteca Nacional in Lisbon (RES 453P) dated 1612, and some manuscript version of 1610, Gaspar Ferreira was "sota-piloto" of the ill-fated São Thomé in 1589. However, he rose to be Pilot-Major of India, and as such went to India with the Vice-roy Rui Lourenco de Tavora in 1608 before returning in 1610. He was later made a Knight of the Order of Santiago and made further eventful voyages to and from India. In the Instructions given to Rui Goncalo de Sequeira, the need to take "in each of the caravels a copy of the Roteiro of Gaspar Ferreira, Pilot-Major of my Crown of Portugal, printed in Lisbon in the past year of 1612" was specified. See Boxer, Portuguese Roteiros 1500-1700, M.M., 1934, p. 182.

"and that once printed the copies had to be kept in the Council or one of the Armazéns as the King might order." From there they might be issued to pilots and under pilots when they departed on voyages to India "under oath that they will not copy it and with the death penalty for any who translates it or causes it to be translated". On their return pilots were obliged to hand it back so that the rutter could not fall into foreign hands. Only when all this had been decided was Philip III advised to grant the favour necessary for Reimão's work to be published.⁴⁸

In several ways this debate and its outcome was indicative of the clash of Portuguese and Spanish traditions over what both saw as strategically vital navigational information. It may also be significant that it was an issue fought out not in the complex new bureaucratic bodies imposed on the Portuguese, but in the Council of the Indies, second only in prestige to the Council of Castille, so often truly referred to as the Council of State. It was also typical of those exasperatingly traditional conflicts brought to the important Councils and which led both the Duque de Lerma and the Conde Duque de Olivares to realise what a dead hand these Councils could be on government and enterprise. Conciliar influence on the development of Iberian navigational knowledge was no exception.

⁴⁸ PMC. Vol.4, p.82.

The Council of the Indies was the most obviously competent of the Councils to interfere in navigational matters. It was an enervating institution in its first twenty years of existence, but by Philip II's reign it was not always adequately informed about colonial matters or navigational matters despite Philip II's personal encouragement. Partly responsible for this may have been its growth in numbers. At the beginning of Philip II's reign it had 9 regular members, at the end between 12 and 19 members.⁴⁹ If this development made it increasingly unwieldy, so its ability to identify issues and make clear decisive judgements seems to have been impaired. This may be due also to the fact that its members were no longer restricted to those trained in civil law, as was the requirement at first. It became increasingly open to grandees, especially after 1604 when two "capo de espada" were appointed.⁵⁰ Conciliar indecision may partly have been due to the fact that its members were fed inappropriate detail by subordinate administrators, and partly because its members permitted as much time to be consumed by correspondence such as Quiros's lengthy memorials advocating missionary exploration of the Pacific submitted between 1602 and 1616.⁵¹

⁴⁹ C.H.Haring, Spanish Empire in America, O.U.P.London 1947 pp.102-118.

⁵⁰ J.H.Elliott, Imperial Spain, Pelican, London 1970, p302

⁵¹ C.Kelly, La Australia del Espiritu Santo Vol.II. Hak. Soc. 2nd Series, CXXVI.

These difficulties were compounded by the Council's obsessive concern as to what to do in the face of the Dutch threat. That dilatoriness was worsened by factional strife, similar in nature to the strife that had hamstrung the Council of Castille since the conflict of the various noble factions in the 1570s.⁵² It impaired the maritime replies of Philip II and Philip III to the Dutch threat, and the formulation of positive instructions.

This sort of administrative approach invited disastrous results on the world's oceans. So when in 1594 a false report reached Philip II that the Hollanders had of late discovered a shorter course to the East Indies than their ordinary voyages and that they were busy preparing a navy to go there, the King's councillors were not in a position to give good advice to the King.⁵³ So he "resteth very discontent as yet, not knowing how to prevent it".⁵⁴ Some councillors advised further negotiation with the Dutch, others advised it were better to arrest all their ships coming to Spain, or to any of the King's dominions. Neither course was universally liked in late 1594, although they seemed so inclined to the former course that the Viceroy in India was instructed to make sure that Dutch

⁵²J.H.Elliott, Imperial Spain, Pelican, London, 1970, p260

⁵³N.Sainsbury, Calendar of State Papers, Colonial, East Indies, 1513-1616 p.97. The substance of a letter written from Lisbon. 6 December 1594.

⁵⁴Ibid.

merchants in the East paid all duties to the King of Spain. In the end the latter faction won the king's heart and hastened the Dutch challenge in the Far East.

It may be argued that the very success of the "no compromise with the Dutch" faction exacerbated the problem, because that faction came to dominate at a time when such policy was inappropriate. The faction was irked by the fact that the heretic Dutch whom they were fighting in the Netherlands still plied a huge and lucrative trade with the Atlantic ports of the Iberian peninsula. They urged Philip II to place embargoes on Dutch ships to give an extra bargaining counter in any subsequent negotiations with the Dutch. However, though hurt, the Dutch in 1593 had begun voyaging to the Caribbean and capturing Spanish goods in retaliation. So when isolated from the salt of Setúbal by the ban on English and Dutch ships entering Lisbon in 1595, the Dutch knew enough to sustain their herring industry by planning the capture of the Caribbean salt island of Araya which they took in 1599. Similarly exclusion from Lisbon's spice markets led the Dutch to challenge the Portuguese control of the spice trade in the East Indies. The Dutch arrived there in 1596 with Linschoten's encouraging words in mind and the quality of his navigational espionage at Portuguese expense amply proven.

Jan Van Huyghen Linschoten had actually said of the Portuguese in India that

"They do not seem to have much stomach for fighting any more, nor do they want to discover and conquer new lands the way they did in years past".⁵⁵

The first part of this statement was to prove erroneous, but the second was to prove a remarkably good insight into conciliar attitudes thereafter. The Council of Indies having spent 184,322 ducats on Quirós's voyage to the Austral lands of the Pacific in 1605-6 related all Quirós's achievements to the Council of State in reply to this proposal for another expedition. It considered

"that further expenditure and involvements, as proposed by this man, should not be entertained, considering the exhausted state of the Treasury and the many things more pressing that have to be attended to; and that when there should be a treasury surplus it would be then more just to spend it on further exploration and settlement of the many provinces which your majesty possessed within the Kingdom of Peru and New Spain, and this apart from the great difficulties which become daily more apparent".⁵⁶

This is interesting because it shows the days of Spanish voyages simply to discover new shores were at an end, for Spain could not afford them or defence of new discoveries. Instead interest was directed to less costly landward exploration of the Americas. The only major exception was the voyage of the Nodal brothers to chart the Cape Horn route to the Pacific in 1619.⁵⁷ Rather similar thinking is seen amongst colonial officials in the former Portuguese colonies, perhaps because due

⁵⁵Linschoten, His Discours of voyages into ye Easte and West Indies. Devided into foure Bookes, John Wolfe, London, 1598. p.82.

⁵⁶C.Kelly, La Australia del Espiritu Santo and the Franciscan Missionary Plan, Hak. Soc. Series II, No 57, 1966, Vol. II. p.361.

to Philip⁸'s governmental reorganisation they were conscious of the financial considerations of exploration. One particular letter from the Viceroy of India, D.Francesa de Ganagan, reported the death of another frustrated Portuguese who was imbued with the ideals of the descobrã dor, Manuel Godinho de Eredia in 1623. The Viceroy acknowledged this explorer and cartographer had -----
D.Francesco da Gamazar said of Eredia

"... I knew him from the other time that I governed this state, when he gave me some of these papers of discoveries and I always thought them to show little ground for putting capital into them; and now (as it seems to me) even less as we have little for that".⁵⁸
In choking the spirit of maritime discovery,

so as not to have spread their defensive resources even more thinly, the Iberian councils realised they faced a major problem of what to do with men whose minds were bent on such enterprise and who consequently avidly searched for information that could embarrass Philip III. Certain 'consultas' of 1607-8 showed the way thinking went in the Council of State. The Council of 25 in September 1607 advised

"that for reasons given by the Council of the Indies it was not considered advisable to treat further of this discovery, but, in order to prevent this Captain /Quirós/ from having recourse to your Majesty's enemies in order to occupy it, he should be retained here by the Council of War as cosmographer in the drawing of marine charts and maps".⁵⁹

⁵⁸ Letter of Viceroy to King of 12th March, 1623, as translated in PMC, Vol.4, p.41.

⁵⁹ C.Kelly, Australia del Espiritu Santo, Vol.II, pp.362-3 for Consulta of the Council of State.

The Council decided that Quirós should be sent back to the Viceroy of Peru at the second of those meetings, but their most interesting decision was stated in the consulta of 2nd May, 1609. It almost amounted to a reversal of earlier policy on Quirós for the strategic reason that

"as a consequence of the truce effected in Flanders, the Dutch can go and trade in those parts of the Indies where your majesty's dominion does not extend".

Thus they concluded it was very desirable

"to set foot immediately in the lands discovered by the said Captain, even if by way of a trading post as is done by Portugal, so as to deprive the Dutch and other nations of the opportunity of forestalling us".⁶⁰

This twisted and even contradictory policy was also followed over Erédia who, after trying to verify the existence of Meridional India as "Descobriador para a empresa do Ouro"⁶¹ was to be found working on maps and charts of the straits of Malacca for the besieged Portuguese in Malacca. It was only long after in 1629 that Philip IV took further interest in Erédia's discoveries because of the Dutch landings on Eendracht's land (Australia) asking his viceroy

"to learn with certainty from whatever source may be most convenient what the land is, and ... what ports, centres and anchorages there are ..."⁶²

⁶⁰ Ibid. p.363.

⁶¹ PMC. Vol.IV p.40. Erédia unsuccessfully sought formal recognition as "Descobriador para a empresa do Ouro".

⁶² PMC. Vol.IV p.41 for letter of 27 March, 1629 from Viceroy of India to King.

This negative attitude towards the Dutch was based on the realisation of how vital was the stock-in-trade knowledge of Iberian navigators and cartographers about the Indian Ocean and the Pacific. Most valuable of all was direct local knowledge, and the detailed content of rutters, often learned or gained through close contact with native pilots. Building on knowledge the Portuguese had variously gained before 1580, considerable efforts were made in the light of increasing losses to produce in Lisbon a first class rutter for the voyage to and from the Far East. After the vast improvements made by Dom João de Castro and his contemporaries, Manuel Alvares and Diogo Affonso, in the mid-sixteenth century a couple of rutters were produced by Manoel de Mesquita Perestrelo and Vincente Rodriguez de Lagos about 1575.⁶³ It was these two rutters, plus those by Francisco Pais and Diogo Affonso, which Jan Van Huyghen Linschoten specifically obtained in Goa and had printed

⁶³ See C.R.Boxer, Portuguese Roteiros 1500-1700, MM, 1934, p.177 for details of Manoel de Mesquita Perestrelo's rutter Roteiro do Cabo de Boa Esperanca ao das Correntes c.1575. The original is now lost, but two contemporary copies still exist at Evora and Oporto. The rutter by Vicente de Lagos is extensively discussed in Part II, The Asian Interchanges.

by 1596 his Itinerario.⁶⁴ Publication of this navigational information gave the Dutch and English access to the best available Portuguese information and starkly awakened Iberian bureaucrats.

To this Baptista Lavanha's reaction as Cosmographer-Major was to try and produce an even better rutter for use by the Carreira da Índia. Though he had never been to the Far East, an improved rutter was ready by 28th March, 1600 thanks to the efforts of Manuel Montero and Gaspar Ferreira in Lisbon. Shortly afterwards another

⁶⁴Vincente Rodriguez de Lagos's rutter is twice cited by Jan Van Huyghen Linschoten, and that of Diogo Affonso once. See Book Three, chapters 2, 5 and 17 respectively of John Huighen Van Linschoten, His Discours of Voyages into ye Easte and Weste Indies. Devided into Four Bookes, Printed at London by John Wolfe, Printer to the Honourable cittie of London, 1598. (Pepysian Library 2100).

Francisco Pais is referred to in Chapter 36 of Book Three. This is entitled 'A voyage from Macao in China to the land of Lingaqu or Nagasche in the Is. of Japan the shippe called S. Crus, the captain being a Portugall called Francisco Pais, and the gunner Dirrck Gerritsz of Enkhuizen in the year of our lord 1585. Written by the pilotte of the same ship'.

rutter was finished, incorporating the fashionable idea that the measured variation of the compass in particular places permitted the determination of longitude. It was revealingly entitled

Rutter of the navigation of India and passages with the iron needle beneath the fleur de lys and its differences and the marks, sea currents and winds in divers places.⁶⁵ This rutter was corrected by João Baptista Lavanha from that of Vincente Roiz (Rodriguez) and "it is very certain and contains very many good and certain things".⁶⁶

⁶⁵ PMC. Vol. IV p. 66, João Baptista Lavanha 'Derotas de la navegacion dela India com la aguja que tenga los hierros debaxo de la flor de lis y de sus diferencias y variaciones i assi miesmo las señales corrientes i vientos que en diversos pasages se hallan. Hecho en Lisboa por Manuel Montero, Gaspar Ferreira pilotos de la India. Estando presente Juan Bautista de Labaña Cosmografo mayor del Rey nuestro senor en los Reynos de Portugal. 25 de Março de 1600'.

⁶⁶ João Baptista Lavanha, Roteiro da navegação da India, e de Rotas com ha Agulha ferrada debaixo da flor de lis, e differencas delta, e signas correntes de Agoa, he ventos q em diversas pasages se achao: Este derroteiro foi ho que emmendon João Baptista Lavanha pollo de Vicente Roiz. E he muito certo, E tem muitas E mui boas curiosidades. This rutter was produced in Lisbon about 1604 and was a corrected version of one by Vincente Roiz (Rodriguez) "and it is very certain and contains very many good and certain things". It is virtually certain Roiz was Vincente Rodriguez who died on the homeward voyage of the Bom Jesus in 1592.

See C.R.Boxer, Portuguese Roteiros 1500-1700, MM., 1934, p.178.

About 1606 a third improved rutter was produced by Gaspar Manuel de Villa de Conde including certain details first available that year. The King's instructions of 13th March, 1608 to Gaspar Jorge de Couto show the general concern to improve rutters in the light of new information. They read thus:-

"For the voyage you will use the Roteiro da India which was compiled by João Baptista Lavanha and of which you will take a copy and should you find it to differ in any part from what your actual experience teaches you, you will note the same, so that it may be corrected where necessary".⁶⁷

It was this very approach which made such pilots as Gaspar Jorge de Couto and their rutters so desirable to the avaricious Dutchmen eager to reach Asian ports. Realising this, and anxious to take what advantage he could from Dutch interest in these navigational details João Baptista Lavanha compiled Instructions for what is to be done by the Pilot in going to India in the Dutch ship and dated them in his own hand 24 January, 1610.⁶⁸ It contained special instructions on nautical espionage and how to give false detail for a Portuguese pilot who was to sail for Indonesia as Lavanha's secret agent. It is indicative of a subtle change in official Iberian attitudes soon after a truce with the Dutch had been signed, and was obviously worth attempting as a supplement to the naval protection of Asian waters which Portugal could offer. It shows recognition that the quality of Portuguese information was regarded as

⁶⁷C.R.Boxer, Portuguese Roteiros 1500-1700, M.M., 1934, p.179.

⁶⁸P.M.C. Vol.IV, p.67 No.15 Bib.Ajuda Codex 51 VIII 21 f 01

so good as to be unquestionable, and the consequent hope that false information might lead to long term errors in official Dutch cartography. It also reflects the conviction of the Councils that the Dutch were a long term problem in the East.

These instructions also mark the beginning of a new phase of interchange because of the implicit assumption that Northern Europeans had information good enough to get them safely to Indonesia. Some of this might of course be better than Portuguese information if it were based on the actual observations of Dutch pilots. Thus the 1615 edition of Manuel de Figueiredo's Hydrographia contained a description of Mauritius⁶⁹ taken as Boxer believed from a Dutch rutter, and several briefer extracts from rutters describing China, Siam, the Philippines and Japan which had already been printed to illustrate Linschoten's famous Itinerario of 1596.

This phase was taken a stage further when Schouten and Le Maire rounded Cape Horn. It was a new discovery of the same importance as the Spanish and Portuguese had made a hundred years before, and proved the existence of yet another route that might put pressure on the Habsburg navy. Needing to verify whether there was another westward route to the Pacific other than the Magellan Straits,

⁶⁹C.R.Boxer, Portuguese Roteiros 1500-1700, MM, 1934, p.181.

the Spanish sent Bartholomé and Goncalo Nodal to chart the area. Setting out from Lisbon they were able to confirm the existence of the coastline that Le Maire and Schouten had seen in 1616. They even made a new discovery of some small islands which they called after their cosmographer and pilot, Diego Ramirez, and then to close any doubts as to whether Schouten had sailed the Straits of Magellan they returned to Spain sailing eastwards through those straits, confirming Tierra del Fuego as an island.⁷⁰

This fine feat of navigation must, however, be regarded as showing Iberian knowledge following, not leading, northern European cartographic progress. The King's orders in 1629 to verify alleged discoveries of Erédia and verify what the Dutch were calling Eendracht's land must also be regarded as top level recognition of this fact about the state of Iberian cartographic knowledge.⁷¹

⁷⁰ See Early Voyages to the Magellan Straits, Hak.Soc. Series II, Vol.XXVIII 1911 for
Relacion de viaji que por orden de sa magd:
Y acverado del real consejo de Indias Hizeron
los capitones Bartolome Garcia Nodal, y Goncalo
de Nodal hermanos, naturales de PonteVerda al
descubrimiento del Estrecho peubo de S.Vicente,
y reconsimi de Magellanes. A Don Fernando
Cabrillo En Madrid por Fernand Corica de Montenegro.
 Anno 1621.

See also chart by Pedro Teixeira Albernás, Cosmographer to His Majesty. Nodal's description of the tides and coasts of Cape Horn was far superior to Schouten's, indeed it was only a few miles in error compared to modern charts, but Schouten's was over 100 miles wrong in locating Cape Horn.

⁷¹ As footnote 62.

Concurrently with these discoveries comes the abandonment of attempts to restrict closely information about the Moluccas. This is, not surprisingly, more evident in material published in Spain. Thus Argensola's Conquistia de las Islas Moluccas is published in Madrid in 1609, João de Barrós's "Decádas da Ásia" (with maps by Lavanha of the Moluccas) is published in 1615 in Madrid, and many other works are granted the necessary royal privilege permitting printing.⁷² Most interesting of these works is however Antonio de Leon Pinelo's Epitome de la Biblioteca Oriental i Occidental, Nautica i Geografica and this bears a most interesting frontispiece showing it was published in 1629 with the approval of the "relator" of the Council

⁷² João Baptista Lavanha, Quarta década da Ásia de João de Barrós Dos feito que as Portugueses fizeram no descobrimento, e conquista dos mares, e terras do oriente, Madrid, 1615.

Lavanha produced this volume with the aid of a loan of 540,000 reis from the Municipal Council of Lisbon in 1615, but even so he failed to sell enough copies to recoup the loan. So by 1628 it was being sold with reprints of the first three volumes. The first three volumes were the real selling point for Diogo do Couto wrote to Philip II in 1598 to say

"the Decadas of João de Barrós, our fellow countryman ... were so highly esteemed by us, that there was no edition after the first, which has been so consumed by time that I do not know if there are ten copies left in Lisbon and even one in India".

See PMC, Vol. 4, pp. 71-2 and Plate 424.

of the Indies.⁷³ It was the first bibliography of travel in any language and it contained references to all the authoritative works published on the Iberian empire. These are shown on that frontispiece. Likewise the frontispiece illustrates the art of navigation as covered inside, referring even on its frontispiece to works by Sacrobosco, Pedro de Medina and Pedro Nunez.

The fact that this bibliography published in 1629 illustrates such old navigational manuals is rather indicative of the way the updating of these manuals was, with the notable exception of Cespedes's manual mentioned already, largely ignored. Many doubtless instructed using Martin Cortes's manual and did not challenge his claim made in 1551 that

"it manifestly appeare that in these prosperous and fortunate days of your majesty Charles V, it hath pleased God to bring the knowledge of navigation to perfection, with this my briefe discourse touchyng the same ..."⁷⁴

⁷³Antonio Leon Pinelo, Epitome de la Biblioteca Oriental, Nautica i Geografica. Al Excelentiss
Senor D. Ramiro Nunez Perez Felipe de Guzman, Senor de la Casa
Guzman, Duque Medina de las Torres, Marques de Torali
i Monasterio, Conde de Parmcoello i Valdorce,
Comendador de Valdepeñas Gran Canciller de las
Indias. Tesorero General de la Corona de Aragon, i
Consei de Italia, Capitan de los cien Hijosdalgo
de la guarda de la Real persona i sumiller de
Corps. Por el Licenciado Antonio de Leon Relator
del Supremo i Real Consejo de las Indias. Con
privilegio En Madrid. Por Iuan Gonzalez Ano de
M.D.CXXIX. (1629)

See The Celebrated Library of Boies Penrose Esq.,
F.S.A., F.R.G.S., Sotheby's Catalogue, The First
Portion Travel and Exploration. Monday 7th June
1971. Lot. 138.

⁷⁴Martin Cortes (tr. Richard Eden, 1561 ed.), Art
of Navigation, Epistle Dedicatory f.iiii.

One of the Casa's cosmographers who did attempt to write a new manual after Cortes was Roderigo Zamorano who was to hold the posts of Professor of Cosmography and later became Pilot-Major. He was a landlubber and trained mathematician. Nevertheless his manual the Compendio del arte de navegar published in 1581 was even clearer and more concise than Cortes's even if it had nothing new to teach his pupils in navigational theory.⁷⁵ When republished in 1588 its main amendment was only the substitution of a proper compass rose in place of a sketch of 32 radial wind rhumbs. This impression of Zamorano's traditional outlooks is reinforced by Pedro Dias's account of his examination before Zamorano.⁷⁶ Similarly indicative of this state of affairs were the two navigational tracts by Andrés de Rioriano also printed during the 1580s.

⁷⁵Roderigo Zamorano, Compendio de la arte de navegar de Rodrigo Camorano, en Seville Año 1581 and Compendio del Arte de Navegar del Licenciado Rodrigo Camorano, Cosmografo y Piloto mayor de su Magestad. Catedratico de Cosmografia en la casa dela Contratacion de las Indias. Con Privilegio. Impresso en Sevilla en casa de Ioan de Leon. Año 1588.

⁷⁶Richard Hakluyt, Principal Navigations Volume 3. 1600, pp.866-8.

"The examination of Masters and Pilots which saile into the Fleetes of Spaine to the West Indies; Written in the Spanish tongue by Pedro Dias a Spanish Pilot taken by Sir Richard Grinuille 1585."

After this sterile phase there came the lucid and useful tracts written by Lavanha and Cespedes. Thereafter, like cartographers and politicians, the writers of navigational manuals can be seen looking for the latest information to northern Europe. Thus it was that Antonio de Najera looked to the Rudolphine Tables, compiled from the observations made at Hven by the Danish nobleman Tycho Brahe, as a practical reform on which to seek sales of his work Navegacion especulativa published in Lisbon in 1628.⁷⁷

Then Iberian navigational technology, like so much else in the life of that peninsula, is seen to be in relative decline. Nevertheless, its standards remained high enough to inspire Richard Hawkins when writing his Observations, published in 1622, to say

"In this point of Steeridge, the Spaniards and Portugalls doe excede all that I have seene, I meane for their care, which is chiefest in navigation. And I wish in this, and in all their workes of Discipline and reformation, we should follow their examples ..."⁷⁸

⁷⁷Antonio de Najera, Navegacion especulativa y practica reformadas sus reglas y tablas por las observaciones de Ticho Brahe, Lisbon, Pedro Craesbeck, 1628.

⁷⁸Richard Hawkins; The Observations of Sir Richard Hawkins. Ed. J.A. Williamson of 1622 edition, Argonaut Press, 1933, p.57.

Richard Hawkins, The Observations of Sir Richard Hawkins, in his voyage into the South Sea. Anno Domini 1593. John Jaggard, London, 1622.

Chapter 5The navigational interchanges of North Western Europe before 1580

The improving status of the navigator's profession in north western Europe in the hundred years prior to 1620 owed much to the techniques of navigation learnt from Iberian sources. The higher value and status accorded to the oceanic navigator was based on his higher standards of competence in position finding, higher safety standards, and on his indispensability aboard ships trying to exploit the trading possibilities of far distant lands. Celestial navigation demanded higher standards of intellectual understanding and exposition than those sought of the medieval pilot and required by guilds of shipmen.¹ It was the transmission of knowledge about navigational methods even more than the circulation of first reports on Asia which would eventually give other European nations the chance to become maritime rivals. As that technology was grasped from the mid-sixteenth century onwards, so the avaricious commercial and diplomatic outlooks of the powers of North Western Europe determined that their access to navigational information would act to the detriment of Portugal and Spain.

¹Shipmen's Guilds are known to have existed in fourteenth century Lynn, York, Hull, and Bristol. From 1442 the Ordinances of the Bristol Mariners Guild restricted membership to those examined in "connyng" of ships by its wardens. See page 190 of Vol.II of The Little Red Book of Bristol . Ed. Francis B.Bickley, Council of the City of Bristol, and Henry Southeran, London,1900.

In the early sixteenth century the evidence of Iberian technical progress in navigation, reinforced by their unique advantage of being the only Europeans to contact other civilisations practising long-distance voyaging, filtered almost subliminally under the threshold of general European consciousness. It was subliminal because only the barest reference was made to it in the flurry of excitement at the discovery of new lands. Most of the printed accounts of new discoveries before 1550 aimed at creating and satisfying this excitement, and as such permitted the Portuguese Armazéns to maintain the commercial security of the less obviously exciting navigational technology. Most of the early accounts of Iberian voyages were printed and published in Northern Italy or Germany where the printing trade was at its most highly developed. Portuguese policy ensured as little navigational information as possible escaped there from those with direct experience of Asian waters and the means to get there and back. Thus the celebrated pamphlet of the Dutch sailor who went to Calicut, and published his experiences in Calcoen in 1504 stands out by contrast with contemporary publications.²

However, the Portuguese needed to inform their German financiers of their achievement and plans in order to secure the finance necessary to permit

²D.Lach. Asia in the Making of Europe. Vol.1, Part 1, p.160.

Asian exploration and trade. In this context Martin Behaim's real role becomes clear, as the one chosen to explain to the Nuremburg financiers Portugal's plans. It was for this purpose he constructed the celebrated terrestrial globe of 1492 which they kept. Similarly the Welsers were later able to see the latest information, while Conrad Peutinger and Stefan Gabler could actually acquire collections of Portuguese charts in the course of their banking contacts with Valentim Fernandes, the Portuguese agent.³

Though not so heavily involved financially as the German cities, Italian cities and especially Venice, had a strong maritime interest in the transit of goods from Asian sources. They felt directly concerned and threatened by the Portuguese discovery of the sea route to India, China and the Moluccas, while as the nation principally responsible for developing the use of the portolano, they well understood the significance of new charts. They were quite prepared to use their established diplomatic network to obtain such strategic information. Thus Soncino, the Milanese ambassador to Henry VII's court in London, took great interest in John Cabot's display of charts of the newly

³Ibid. pp.158-9.

discovered (American) coast.⁴ One of the most effective testimonies to Italian anxieties about the Cape of Good Hope seaway was their theft of a Portuguese world map bearing the inscription "Chart for the navigation of the islands, lately discovered in the parts of India". This was obtained for the Duke Ercole d'Este by his agent Alberto Cantino in October 1502.⁵

The Italians never lost their "inside" contacts with the cartographers of the Lisbon Armazéns. This is particularly evident in the works of the Venetian civil servant, Giovanni Battista Ramusio who lived from 1485 to 1557 and was closely associated with a humanist circle which included Andrea Navagero and Paulus Manutius Aldus, manager of the famous Aldine Press, and Tomasso Giunti, another publisher. Navagero seems to have been collecting material for him in Lisbon as early as 1525, though Ramusio did not start seriously editing his material for Delle navigationi et

⁴The Milanese Ambassador to Henry VII wrote to the Duke of Milan on December 18th 1497 saying of John Cabot "This Master John has the design and description of the world in a chart, and also in a solid globe, which he has made".

See R. Beazley, John and Sebastian Cabot (Builders of Greater Britain), Fisher Unwin, London, 1898, p.100.

See also J.A. Williamson, The Cabot Voyages and Bristol Discovery under Henry VII, Hak. Soc. Ser. II, No.CXX, 1961.

For an interesting historiography of John Cabot and his Venetian background prior to his move to Valencia in 1490-93 see the Introduction, pp.v-vii, and pp.209-11.

⁵R.A. Skelton, Explorers Maps, pp.31 and 35.

viaggi until 1548. Ramusio's first volume, which appeared in 1550 included material on Africa, the Red Sea, India and the Moluccas. In his introduction Ramusio says his purpose was to collect materials and charts to correct Ptolemy's maps that had become so popular since the Geography had been brought west from Constantinople in 1406. Though Ramusio remarks on how few Portuguese records were accessible, he included a series of letters written between 1499 and 1510 by participants and observers in Lisbon, the letters of Sernigi and Vespucci, the narrative of the anonymous Portuguese pilot from the Paesi, the Spanish text of Varthema's itinerary (1520) and the book of Duarte Barbosa which was used at Badajoz Elvas in 1524. Most interesting of his Asian items was a partial version of Tomé Pires's Suma Oriental which it seems likely Navagero obtained for him together with the information that publication of Barbosa's and Pires's works was prohibited in Portugal. Ramusio in his background brief to material on Magellan's circumnavigation regrets not being able to print Peter Martyr's account of this expedition as that seems to have been lost in the sack of Rome in 1527, but he did manage to include both Maximilian of Transylvania's and Antonio Pigafetta's accounts. In dealing with Magellan he closes with

a report addressed to the Emperor by Juan Gaetano, navigator who accompanied Ruy Lopez de Villalobos from Mexico across the Pacific in 1542, and returned to let Europe know of Villalobos's failure. In the 1550 edition of this, Ramusio's first volume of Navigationi, he adds five significant Jesuit letters about Japan and six chapters in translation from João de Barrós's Décadas de Asia.⁶

A Genoese cartographer working in Venice between 1536 and 1564, Battista Agnese, produced many exquisite atlases, of which more than seventy survive today in various parts of the world.⁷ This would seem to show there was a ready European market for hand-produced charts on vellum, even though Agnese's were only small scale.⁸ The two Agnese atlases currently in the National Maritime Museum were clearly in the hands of noble German families.⁹ Likewise the Lambeth Palace atlas would also seem to confirm Wagner's view that such

⁶D.Lach. Ibid. pp.204-6.

Note the Catalogue of John Dee's Library in 1583 also contained the Italian version of João de Barrós's "Décadas da Índia".

⁷H.R.Wagner, "The Manuscript Atlases of Battista Agnese." Papers of the Bibliographical Society of America XXV, 1931, pp.1-36.

⁸National Maritime Museum, Greenwich, MS-39-9922 C/P24. This one is not recorded by Wagner. This volume of 29 charts is entitled "Seekarten von Bapista Agnese Anno MDLIV d 1v May".

⁹National Maritime Museum, Greenwich, MS 33-9922 C/P12. This edition is cited by Wagner as No.LVIII. It was on f.8 "Baptista agnese fecit uenetijs anno domini 1555. 24 marcij".

Lambeth Palace Library. This copy of Agnese's Atlas is merely catalogued as a Portolano.

person. Thus I ever desirous of being of service to the the world, have with some persuasion, obtained a description of Europe and parts of Africa and Asia, compiled according to sailor's usage from Giacomo Homem of Portugal. The excellence of his skills extends beyond accuracy and length, to attention to details as to show all the islands, ports, rocks and shallows and suchlike, necessary to good navigation." (1 October 1569)

Diogo Homem, resident in Venice from 1568 to 1576, was the son of the famous Portuguese hydrographer Lopo Homem from whom he is assumed to have learnt his craft, before he fled to London in 1547 to escape justice for murdering Antonio Fernandes in Lisbon.¹³ He was typical of the many emigre Portuguese cartographers, who very conscious of the value of their knowledge and skills were prepared to sell their services to the highest European bidder. This group of people were to be the leaven to the rising professional status of the navigator in North Western Europe as royal houses, noble families and merchanting communities patronised them.

To appreciate fully the significance of this, we need to note that there was little need for wealthy patronage to secure the medieval coasting pilot his living for the demand to tranship goods, and the scarcity of his skill were sufficient. An old Norse handbook called the King's Mirror (Konugs Skuggsjá) written by an unknown author about 1250 gives an idea of the skills that would earn a master a modest merchant's income.¹⁴ It is

¹²Derek Howse. "The Earliest Printed Charts 1485-1569", NMM, Monograph No. 36-1978, Ingrid and other Studies, ed. P. G. W. Annis, pp.18 and 19. Derek Howse and Michael Sanderson, The Sea Chart, David and Charles, Newton Abbot, 1973, p.37.

¹³PMC Vol. II, pp. 547-548, Geographical Names, pp. 1-4.

E.G.R. Taylor, Heaven Finding Art, Hollis and Carter, London 1971, p.81.

cartographic information was keenly sought after by the noble families of Europe, with motives John Dee described in 1570 thus:

"Some to beautify their halls, parlours, Chambers, Galleries, Studies or Libraries ... liketh, loveth, getteth and useth Maps, Charts and Geographical Globes".¹⁰

Nevertheless Agnese's charts cannot be written off so easily because they did include a considerable scoop of Spanish information, for he correctly showed the Gulf of California, as explored by Francisco de Ulloa in 1539-40 and Juan Rodriguez Cabrillo in 1542-3. This is interesting because many subsequent charts would show California as an island.¹¹

Another cartographic achievement of the Venetians was the publication of a chart in 1569 using the engraved copper plate process which for the next 350 years would be the primary method of producing charts. The engraver was Paolo Forlani, a Veronese resident in Venice who in his dedication stated to His Magnificence Giacomo Murari:

"The description of the known world has, if I do not mistake, been printed in whole and in part, but never I think, has such a description been made that follows the contemporary practice of sailors, nor yet a whole sea chart been printed as is so necessary to every sort of

¹⁰ J. Dee's Preface to H. Billingsley's Elements of Geometrie, London, John Day, 1570. Extract from passage on Geographie.

¹¹ Battista Agnese, Portolano, NMM, MS 39-99226/P24 f.5. Near the head of the Gulf of California on this map appears the legend in three lines "Mar Vernieglio que en lacanar de plena mar ay xi brazas plena mar viij". The idea the sea here had reddish tinge is presumed to have stemmed from the now lost charts of Ulloa who reported the Gulf in 1539. The unit of depth "braza" is the Spanish fathom or the equivalent of the French "brasse".

stated there that seafaring traders ought to know what conclusions to draw from the length of daylight in a place, have a good knowledge of arithmetic, observe the courses of the heavenly bodies, recognise the quarters of the horizon, mark the movements of the ocean, understand the rise and fall of the tides, interpret the movement of whales and fish, seals and walruses, and appreciate the trading opportunities of the melting edge of the sea-ice.

Similarly St. Godric of Finchale, who as we saw "by his skill in navigation wherein he excelled all his fellows" earned promotion to the post of pilot, had to supplement his income by trading in the ports he visited.¹⁵ In this way he managed to obtain a half share in one ship and a quarter share in another. However, it was not on the basis of this worldly success that he earned the esteem of thirteenth century society in the north of England; it was because he forsook that for the life of a hermit contemplating God.

By the fifteenth century the Church's attitude towards those who earned their livings at sea was beginning to change, for it began to stress more God's care for the safety of ships rather than the terrors of the sea. In Portugal Henry the Navigator built a special chapel dedicated to St. Mary

¹⁵G.G. Coulton, Medieval Panorama, Cambridge University Press, 1945, p. 319.

of Belemi, at Restello. This was intended specifically for the use of his seamen before they sailed on missions to chart the African coast or the Atlantic Islands. Whereas European attitudes towards the sea had been typified by paintings such as St. Nicholas Rebuking the Sea by Bicci di Lorenzo (1373-1452), later in the century emphasis is laid less on fear of the sea and its storms as the wrath of God, and more on care for seaborne safety.¹⁶ The mural in Shorwell Parish Church, dating from the late fifteenth century, shows St. Christopher and the concern for safe seaborne travel.¹⁷ The change was in large measure a result of the confidence that came with the adoption of navigational methods that included the use of compass, lead and line and the associated knowledge of European waters. This technology went some way towards countering superstition amongst the sailors of Northern Europe, and so Robert Copeland could translate Garcie's rutter saying that it was no longer necessary to counter the sea's ferocity.

"A seeborde mates S. george to borow
Mary and John ye shal not nede to fere,¹⁸
But with this boke to go safe thorow".

¹⁶ See Bicci de Lorenzo. Jesus Rebukes the Tempest. Ashmolean Museum, Oxford.

¹⁷ Shorwell Church, Isle of Wight, Mural of St. Christopher c.1450.

¹⁸ R. Copeland The Rutter of the Sea to the havens, rodes, soundings, kenninges, wyndes, flodes, and ebbes, daungers and coasts of dyvers regiois with y lawes of the vele of Auleron, the Judgements of the See. With a rutter of the North added to the same. London, 1550 edition, p.5.

For a facsimile edition reproduced by D.W. Waters see footnote 30.

G.G. Coulton, Medieval Panorama, p.321.

From 1266 the pilot's status aboard his ship, the regulation of conflicting interests between master, merchant and pilot, the ways of paying a ship's crew and responsibility for the safety of the ship were regulated by the Laws of Oleron. This codification of maritime law was accepted by the mariners of France, Flanders, Holland, England and most of the Baltic cities, and indeed is enshrined in such maritime legal codes as the Laws of Wisby of Jutland, the Code of the Consolat del Mar for the Mediterranean and in the Black Book of the Admiralty for England. Amongst the provisions of the Black Book were the following provisions about the pilot's (or lodesman's) status:

"It is established for a custom of the sea that if a ship is lost by defeaute of the lodeman the maryners may, if they please, bring the lodeman to the windlass, or any other place and cut off his head withoute the maryners being bound to answer before any judge, because the lodeman has committed high treason against the undertakynge of pilotage".¹⁹

However, by 1537 these draconian provisions were being mollified as it became clearer that the pilots' skills and knowledge were too valuable to forfeit by summary death at sea. Thus the Admiralty Inquisitors at Walberswyck in that year ordered that three pilots who had wrecked Hanse ships should only be arrested and imprisoned for six months.²⁰

¹⁹H.P.Mead, Trinity House, London, 1947, p.10.

²⁰D.Burwash, English Merchant Shipping 1460-1540, David and Charles, Newton Abbot, 1969 p.63.

Those same Inquisitions give an idea of the remuneration a coastal pilot might expect, for they show that Magnus Logget who offered to "serve Nicholas Blyburghe of Walberswick in the Art of Navigation and fishing for four years" is said to have received at the end of that time²⁰ shillings, a bed and vestment for feast days and work days²¹.

By way of contrast with Magnus Logget's earnings, Richard Hall of Ratcliff was promised 5 shillings over his wages for using the navigational skills developed in Iberia, and "pricking a card" for a voyage to Malaga in 1539.²² These terms suggest he was familiar with manuscript charts and methods of plotting courses on them that almost certainly included use of celestial observation to identify latitude. This was a very different type of skill from that shown by the coastal pilot of Magnus Logget's type, and these extra new skills are seen to be rewarded accordingly.

Demand for the skills of a navigator like Richard Hall of Ratcliff had increased rapidly as the numbers of ships trading to French, Dutch and Iberian ports increased during the late fifteenth and early sixteenth centuries. An examination of the growth of trade between northern Spain and Bristol shows not only growing numbers of ships coming to English ports, but growing values of cargoes and growing numbers of direct voyages. For example, whereas no ships arrived in Bristol

²¹Ibid. p.49

²²Ibid. p.20.

from Rentaria in 1479-80, fifteen arrived in Bristol from Rentaria in 1517-18 and similar figures can be found for other ports.²³ All this put a premium on the skill with which these ships were navigated and led to the demand that more young men receive appropriate training, in the absence of which English merchants were looking abroad for pilots.

This position is well illustrated by the petition which led to the granting of a licence by the King of England on 19th March 1513 for

"Masters, Rulers and Mariners of the Kings Navy in the Thames, to found a guild in Honour of the Holy Trinity of St. Clement in the Church of Deptford Strand for the reformation of the navy lately much decayed by the admission of young men without experience and of Scots Flemings and Frenchmen as loadsmen".²⁴

This charter, often seen as marking the foundation of the Trinity Houses, laid the responsibility for reforming the standards of pilotage by teaching on the Masters of Deptford. It led over the next century to the emergence of a definite hierarchy of skill and social position within the profession. The hierarchy which developed had a "Master" at the top of the Trinity House, four "Wardens" ranked next, and beneath them

²³Ibid. p.236.

²⁴H.P.Mead, Trinity House, London, 1947, pp.16-20. Note also the provision for "Sisters" was made in the Charter of the Trinity House of Newcastle upon Tyne granted in 1536 and in the Charter granted to the Wardens, Masters, Brothers and Sisters of the Fraternity or Guild of the Holy Trinity of Kingston upon Hull, 1541.

the "Brothers and Sisters". The very nature of the organisation as a hierarchy of skill from which the Master was elected annually at Candlemas by the Brothers and Sisters ensured that the Masters were very skilled and experienced men rather than crown appointees without these professional skills. Examination of the men who were the early Masters shows such distinguished holders as Thomas Spert, William Lawson and Stephen Borough.²⁵

The charter of the Trinity House of Newcastle upon Tyne, as regranted in 1582, shows the concern of the Trinity Houses to maintain their exclusive and competent professional reputation.²⁶ Thus Newcastle's Trinity House was charged with the duty of examining and appointing pilots from Flamborough to Berwick and to punish by force any unauthorised pilot. Their increasing concern with the technical competence of coastal pilots is made explicit by their fifth charter of 18th January 1606 which stated that:

"The fraternity are to have power to settle disputes and deal with matters relating to the marine knowledge and science of seamen that resort to the Tyne and creeks and members of the same; Blyth; Sunderland, Hartlepool, Whitby and Staithes".²⁷

²⁵H.P.Mead, Trinity House, London, 1941, p.35.

²⁶D.R.Moir, The Birth and History of the Trinity House of Newcastle upon Tyne, Mackenzie Vincent, Glasgow, 1958, p.20.

²⁷Richard Welford, Newcastle and Gateshead Vol.II The Sixteenth Century, Scott, London, 1885, p.174.

All this, however, happened to the status of the coastal pilot whilst his most common navigational aids seem to have been produced by foreigners, especially in the early sixteenth century.²⁸ In 1511 a merchant of Scarborough imported four dozen compasses from Amsterdam. There were a few fifteenth century English manuscript rutters for the English coast, but the first printed rutters were the sailing directions of the French pilot Pierre Garcie, originally written about 1483 as Le Grant Routier.²⁹ Garcie's sailing directions were first printed between 1502 and 1510 and contained information on tides, phases of the moon and woodcuts of prominent coastal features from Gibraltar to the north-east of England. A copy of the 1520 edition published as Le Routier de la Mer was seen by an English mariner in Bordeaux, who, thinking the English were ignorant of much of its content, bought it and took it to London for Robert Copeland to translate and print in 1528.³⁰ This went through eight known editions in the next 50 years, the last edition also containing a rutter for Scottish waters by Alexander Lindsay, methodised by Nicholas d'Arville, chief cosmographer to

²⁸ D. Burwash, English Merchant Shipping (1460-1540), p. 19.

²⁹ D. W. Waters, Rutters of the Sea, Yale University, 1967, p. 35. Pierre Garcie (1430-1503) was married in 1471 to Jeanne Oliver, the daughter of Perrot Oliver, probably an Englishwoman. He lived in the port of St. Gilles-sur-Ville, where his father, Pierre Garcie Ferrande, settled after leaving his home in northern Spain.

³⁰ D. W. Waters, Rutters of the Sea, Yale University, 1967, pp. 52-3. For the facsimile of Robert Copeland's Prologue to the Rutter of the Sea ff. 4 & 5.

the French King.³¹

The northern French ports whence Garcie collected the material for Le Grant Routier became through their traditional trading links with Portugal and Spain perhaps even the first places in northern Europe where the navigational methods and aids developed in Portugal and Spain were fully appreciated. Very early in the sixteenth century they provided a home for emigré Portuguese cartographers often with seagoing experience. Their cartographic skill and knowledge was very highly esteemed, especially in Dieppe where there is evidence to suggest that a school of navigation was founded. A distinctive style of decoration typifies the products of the "Dieppe school" but it is noticeable that the majority of maps show Portuguese, or corrupted Portuguese nomenclature, while French nomenclature is rare.³² Teixeira da Mota has gone so far as to say that the Hague Atlas, which he dates to 1536-7,³³ constitutes a missing link in the transition from a Portuguese map prepared by an anonymous emigré, and the emergence of the distinctive Dieppe style typified by the Harlan planisphere of about 1543,³⁴ and the atlases of Rotz, Deseliers, Desliens and

³¹ Ibid. pp.28-31.

³² PMC, Vol.V, p.140.

³³ PMC, Vol.V, plate 54.

³⁴ W.P.Cumrning, R.A.Skelton, D.B.Quinn, The Discovery of North America, Elek, London, 1971, plates 162-3.

Guilliaume le Testu. Furthermore, it is known that between 1536 and 1541 João Afonso, Diogo Homem, João Frerire were all in France though they seem certainly not to have been the makers of the Hague Atlas.

This interchange becomes the more significant when taken together with the oceanic experience of these communities in mounting regular fishing expeditions to the Grand Banks off Newfoundland, and the more exact navigational skills of Vernazano and Cartier. The Somnium Scipionis³⁵ published by the Parisian Badius showed that interest in the instruments of celestial navigation was growing, and that the French were aware of contributions from the Arabs as the engraving of three Moors using a fixed quadrant, a portable quadrant, a standing staff and an alidade in exactly the manner Lavanha later specified for those engaged on voyages of discovery.³⁶ The sea communities of Brittany, familiar with charts by the 1540s, even began to innovate in their production of navigational aids. Guilliaume Brouscon produced, with

³⁵ Macrobius, Somnium Scipionis ex Ciceronis Libro de Republica Sexto Excerptum . J. Badius, Paris, 1524 p.1. See Fig.31

³⁶ PMC Vol.III, p.45 for Lavanha's "Regiment that it seems must be kept for the discovery and description of the coast from Cape Negro as far as the Cape of Good Hope". This states "From all Capes, Bights, Bays, Harbours, River Mouths and Shoals shall be noted with great precision in the height of the Pole, so far as possible (for which every effort must be made) taking it ashore, observing the Sun with the large quadrant on which can be read distinctly the twelfth part of one degree ...".

(A)

his tide tables, some small scale charts of Biscay, the Channel and the Irish Sea in which ports with similar tidal establishments specified on points of the compass were linked by lines so that a 'ports establishment' could be seen at a glance, and then the correction for the day made using the tide tables on the following pages of the book.³⁷

More significant still was Henry VIII's success in encouraging pilots trained at Dieppe into English service in the early 1540s. Sixty were enticed with naval commissions; one Jean Rotz was offered the post of Hydrographer Royal in 1542.³⁸ Rotz had been trained in Dieppe, but had spent two significant years studying in Paris. This explains his familiarity with all the latest European advances in astronomy and navigation, in particular the writings of Peter Apian, Gemma Frisius, Stoeffler and above all Pedro Nunez. The chance of hearing Orancée Finée, Professor at the College de Navarre in Paris, and an enthusiastic mathematician also keenly interested in navigation and discovery,

³⁷Guilliaume Brouscon, Tide Tables and Almanack, c.1546. The copy in the Pepysian Library (Magdalene College, Cambridge) (No.1) bears the signature "F.Drak" opposite its flyleaf and a manuscript map of the coast of Western Europe. The NMM copy L/CB(CC1) also belonged to Pepys and bears opposite f.7 the manuscript note "That this appeared to S/amuel/ P/epys/ to have been K/ing/ Hen/ry/ 8ths own Book". The Pepysian Library copy seems to have been acquired by Pepys from Evelyn and before that to have belonged to the Duc de Condé and was kept at Chantilly.

³⁸E.G.R.Taylor, Mathematical Practitioners of Tudor and Stuart England 1485-1714, Cambridge University Press, pp.15-16 and 170-171. Taylor quotes the French Ambassador Marillao who wrote in 1540 that the majority of pilots on Henry VIII's ships were Ragusans, Genoese, Venetians, Normans and Bretons.

See E.G.R.Taylor, Tudor Geography 1485-1583, Methuen, London, 1930 for Chapter IV, The French Influence 1542-7, 159-74 especially p.64.

would help Rotz's comprehension of the mathematical revolution which swept across Europe and helped navigational advance. Also teaching in Paris was the Queen's Physician, a Spaniard who gave regular lectures on 'the Sphere' (i.e. astronomy and cosmography) at the Sorbonne.

When he came to England he brought with him a new compass constructed in the light of Finée's lectures, which was designed to measure variation far more accurately than Nunez's much praised design. Accompanying the compass was a manuscript full of working drawings, which discussed navigation with particular reference to abuse of the plain chart of variation and the lack of a method to find longitude at sea even though Gemma Frisius had offered a theoretical answer in 1533.

In addition to the Traicte des differences du Compass Aymantie, et des pointz notables du celluy he presented Henry VIII with a 'Boke of Ydrographie', an exquisite atlas of the world, prefaced by a summary of the art of celestial navigation which included rules for the determination of the North Star and solar declination tables.³⁹ The second chart of this atlas is particularly interesting as has already been seen, because it shows south-east Asia, South China and Indonesia and a great southern continent to the south of Java, seemingly based on the findings of

³⁹Christopher Lloyd, article in Decorative Arts of the Mariner, Jupiter Books, London, 1974, pp.147-51.

Parmentier's voyage of 1529-33, but in fact, like the contemporary atlas of Vallard and Deseliers showing largely corrupt Portuguese nomenclature.

Utilising this knowledge, it is Jean Rotz, himself probably of Scottish birth, who drew heavily on earlier international interchanges of navigational knowledge. Indeed he could hardly have attempted a world atlas when his personal experience was limited to voyages to Brazil and Guinea without such reliance. Most significant of all is that with such knowledge as his, he should have come to Henry VIII's court to seek denization, having already earned the written acclaim of the Chief Cosmographer of France, along with Jean Ribault and Jean Alfonse. Part of the incentive may well have been the high salary of £40 a year which Henry VIII offered in 1542. Equally Rotz's return in 1547 may well have been hastened by the fact that his salary was halved on Henry VIII's death.⁴⁰

The other reason for Rotz's return to Europe was the summons issued by the French King Henry II to all French pilots in foreign service, asking them to return to France. It was clearly conceived as a strategic move, no doubt prompted by realisation that these pilots had materially helped England defeat the French fleet at sea between 1542 and 1545. This was the first high level French shot in a diplomatic competition to secure

⁴⁰ D.W.Waters, Art of Navigation in England in Elizabethan and Early Stuart Times, NMM, Greenwich 1978, pp.67-71 and 118.

the services of highly trained men proficient in celestial navigation. This competition would get ever more intense, enabling such men to bid up their worth, establishing a vast differential between their rewards and those of coastal pilots (whose standards and esteem were dragged upwards in the wake of interest caused by oceanic counterparts).

Henry II's interest in these pilots may have been heightened by Pierre Deseliers of Arques who presented to him an atlas about 1546, and by the writings of Jean Fonteneau (Alphonse), a pilot of Saintonge in La Cosmographie avec l'espere et régime du soleil et du nord. Alphonse discussed not only points of technique but their value in reaching such places as Indonesia and even the great southern continent.⁴¹

Henry II's appointment of Gaspard de Coligny as Admiral in 1552 gave further impetus to French navigational advance, securing the allegiance of many Huguenot pilots who might otherwise have recrossed the familiar channel and joined the Marian exiles⁴² and who would later become

⁴¹ See index at N.M.M. "People" under entry "Dieppe Cartographers". The work of Jean Fontenau, nicknamed Alphonse, was written in 1544 and survives at the Bibliothèque Nationale, Paris as MS. Français No. 676. Voyages Avantureux was published in Paris in 1559.

⁴² Sir Edward Horsey, implicated in the Throgmorton/Dudley conspiracy 1556, later served as Captain of the Isle of Wight from 1566 to 1583, allowed the Sea Beggars to revictual their fleet there on 27th March 1572. See S.F.C. Moore, The Seizure of Brill by the Sea Beggars, History Today, 1972, pp. 364-72.

counterparts in the various piratical rings such as were operated by the Carews and Horseys from the English side of the Channel.⁴³ One product of Coligny's appointment was a fine atlas presented to him by the Huguenot Guillaume le Testu in 1555.⁴⁴ In another Huguenot city, Lyons, Nicolas de Nicolai, who had earlier been in English service for Lord Lisle, translated Pedro de Medina's

⁴³C. Garrett, Marian Exiles, Cambridge, 1938, p.108 gives details of how John Ponet in exile in Strassburg annotated Peter Carew's copy of Peter Martyr's Decades of the New World producing thereby a tolerable rutter for the North Atlantic based on these annotations, principally of the chapter treating of "the ordinary navigation from Spaine to the West Indies", through Jean Ribaut to the French Court itself, and a trade in smuggled Protestant literature from Emden to London.

⁴⁴Cummins Skelton, Quinn, The Discovery of North America, Paul Elek, London, 1971, p.153.

Arte de Navegar into French in 1554.⁴⁵ Le Testu and Nicolai owed much to Portuguese and Spanish sources respectively, but were both deeply hostile to Spain. Another distinguished Huguenot pilot,

⁴⁵Nicolas de Nicolai served Henry VIII as a pilot, but returned to France in 1547 taking with him various English charts and a copy of Alexander Lyndsay's Rutter of the North. Once back in France he obtained and translated a copy of Pedro Medina's Arte de Navegar about 1549. He wrote in the dedication of this work:

"Recourant donc au secours des livres, pour mettre au not mes peregrinations terrestres et marines, la plupart faictes par vostre commandant, en m'aidant du livre le Seignuer Pierre de Medine, Pilote du Roy d'Espaigne sur les Indes Occidentales, le trouney tant utile et necessaire à ceux qui ont à voyager sur mer par vostre autorité, que le deu de mon estat me contraignit volontairement à le leur faire entendre par le traduction que le leur en presente sous vostre bonne grace et royalle faveur". f.2.

Nicolai was eventually granted the King's Privilege protecting his work from unauthorised reprinting for ten years on the 11th September 1550.

See Nicolas de Nicolai, L'Art de Naviger de Maistre Pierre de Medine Espagnol: contenant toutes les reigles, secrets et enseignements necessaires, à la bonne navigation. Traduit de Castillan en Francoys, avec augmentation et illustration de plusieurs figures et annotations, par Nicolas de Nicolai, du Dauphiné, Geographe du tres Christian Roy Henri II de ce Nom: Et dedie à sa tres Auguste Maieste. A Lyon chez Guillaume Rouille. Avec Privilege pour dix ans 1554.

A reprint of this work by De Boer Maritieme Handboeken Bussum is available. It contains an interesting woodcut chart of the Atlantic by Nicolai on ff.24-25. It is very nearly identical with the printed charts produced from the Nicolai original by the Venetian printer Forlani in 1560.

Derek Howse 'The Earliest Printed Sea Charts, 1485-1569' in Ingrid and Other Studies, N.M.M. Monograph, No.36-1978, p.18.

later to die fighting the Spaniards, was Jean Ribault. In 1556 he involved himself in a conspiracy against Philip and Mary's rule in England which met with failure at Scarborough, but he survived until 1565.⁴⁶

The French interest in oceanic navigation, and its early alliance with the Huguenot cause, is, until Queen Elizabeth's reign, in marked contrast to the way in which the English adopted these skills even though there were several common points of interchange. Until 1550 the English were not broadly speaking appreciative of the technology of

⁴⁶ Jean Ribault sailed from Le Havre on 15th February 1562 with 150 men in two Dutch vessels and reconnoitred the coast of Florida as has been revealed by the recent discovery in the Museo Naval in Madrid of the map made in 1562 by Nicolas Barre, a pilot who accompanied Ribault. On his return he fought with the Huguenots during the siege of Dieppe in 1562 and then fled to England from the troubles of the civil war in 1563. Ribault created a sensation in Elizabethan London with his news, published as "The whole and True Discoverye of Terra Florida" in 1563 and accompanied Stukeley on a river procession. However, though imprisoned in England, afterwards he later managed to escape to rejoin Admiral Coligny who had meanwhile dispatched Laudonnière to found a colony in Florida. Ribault, however, encountered the Spanish forces of Pedro Menéndez de Avilés, Admiral of Spain and newly appointed Governor of Florida and was killed and the colony annihilated. Pedro Menéndez de Avilés wrote to Philip II on 15 October 1565

"I had Juan Ribao, with all the rest, put to the knife ... and I hold it very good fortune that he should be dead: for the King of France could do more with him with fifty thousand ducats than others with five hundred thousand; and he could do more in one year than another in ten, for he was the most experienced seaman and corsair known, and very skilful in this navigation of the Indies and the coast of Florida".

See Cumming, Skelton and Quinn, The Discovery of North America, Paul Elek, London, 1971, p.171.

oceanic navigation. In this context it is interesting to note John Cabot was of Genoese birth, and though his son Sebastian sailed the Atlantic twice more, the latter took his knowledge and charts to Spain in 1512 aware that the significance of his knowledge would be appreciated and generously rewarded. His departure left certain cartographic information about the Atlantic with a group of Bristol merchants. Apart from the attempt to cross the Atlantic made by John Rastell in 1517, little or no use was made of the knowledge. Indeed, John Rastell himself was moved to write a play in 1519 deploring the failure to maintain interest in Newfoundland, geography, cartography, navigational instruments and astronomy.⁴⁷ Until 1540 there was

⁴⁷ Jeanette T. Connor, Jean Ribaut, Florida State Historical Society, Miami, 1927.

John Rastell was a London printer interested in cosmology who pressed for the dissemination of scientific knowledge, but his one major voyage, an ill-fated expedition to Newfoundland, failed because he was unable to command the allegiance of his crew who returned to London with him locked in his cabin. John Rastell's play was written in 1519 and entitled "A New Interlude and a mery of the nature of the iiii elements". The players in this Interlude brought astronomical instruments and a world map onto the stage. Anthony à Wood says the text was illustrated with maps and woodcuts and covered matters such as the discovery of America and Cathay and the need to translate into English works on astronomy. In fact nothing was published until 1550 when William Salysbury published a translation of Linacre's Latin text of Proclus's 'Sphaera'. This was only found after a lengthy search of the bookstalls around St. Paul's churchyard and even 30 years after Rastell wrote his testimony to the lack of English interest in navigation before Queen Mary's reign outside the small group patronised by the Lisles.

See also F.R. Johnson, Astronomical Thought in Renaissance England, A Study in English Scientific Writings from 1560-1645. John Hopkins Press, Baltimore, 1937, p.121.

only one book which even mentioned America. That was written by John Doesbrowe, but was printed in Antwerp in 1511. Its title reveals that it was fundamentally a popularist account called Of newe landes and of ye people founde by the messengers of the Kynge of Portuygale named Emanuel of the X dyvers nacyons crystened Of Pope Johan and his landes and of the costely keyes of wonders melodyes that in that land is.⁴⁸

Those Englishmen who were interested in navigation went to Spain to work with the Casa de Contratacion. Those emigrants included such dynamic individuals as Robert Thorne, Roger Barlow, Thomas Bridges and pilots Henry Latimer and Sebastian Cabot. The Wardens and Drapers of London objected to the mooted idea of enticing Sebastian Cabot back and into their service, saying in 1521:-

"And we thynk it were sore aventour to joperd V shipps as with men and goodes unto the said Iland uppon the singular trust of one man, callyd as we understand, Sebastyan, whiche Sebastyan, as we here say, was never in that land hym self, ... for the said Sebastian cannot be but in one ship, than the other iiij shipps and men stande in grete perill, for lak of connyng maryners in knowledge of thoos parties".⁴⁹

⁴⁸ J.A. Williamson, The Ocean in English History, London, 1941, pp.60-62.

⁴⁹ J.A. Williamson, The Cabot Voyages and Bristol Discovery. Hak.Soc.Ser.II CXX 1961. See an Extract from the MS. Records of the Drapers Company of London on pp.288-9.

In 1525-7 England had the chance to acquire a share in the spice island trade, a project which interested Archbishop Lee of York when he heard Robert Thorne advocate this purchase. However, when Lee proposed to Wolsey that Thorne's suggestion be followed up by buying the share Charles V planned to sell to Portugal, nothing was done.⁵⁰

Given this lack of official interest or patronage, it is not surprising that the first serious English interest in Iberian navigational methods should be seen amongst those regularly sailing past France to the Iberian Peninsula. This is revealed by the early records of the High Court of Admiralty. In 1533 John A^lBorough is cited as possessing navigational instruments worth over £5. His instruments included a Portuguese Reportium (geographical guide), Spanish and English rutters, two Spanish compasses, a chart for "all levaunt" and another chart of an unspecified area. He also possessed two hugely significant instruments which appear in the inventory of his ship,

⁵⁰ Note also the Thorne brothers left an important collection of nautical charts, instruments and books to found a sailors' library in Bristol. See p.531-2

For details of English commercial involvements see E. Connell-Smith 'English Merchants trading to the New World in the Early Sixteenth Century', Bulletin of Historical Research 1950, pp.53-66; and Pauline Croft, 'The Spanish Company', London Record Society 1973, pp.vii-liv.

For Lee's proposal to Wolsey see Antonia McLean Humanism and the Rise of Science in Tudor England, Heinemann, London, 1972, p.124.

See Appendix 1; p.531-2 Extract of the Will of Nicholas Thorne in The Great Orphan Book and Book of Wills No. 1. Bristol Record Office D4421(1).

the 'Michael of Barnstaple' as follows

"A balestowe [cross-staff] a Quadryant
and a Lodestone and a Rynnyng Glasse
which is worth xxvjs viijd."⁵¹

By 1540 a few English seamen began to appreciate the value of such aids, and therefore took what opportunities offered themselves to obtain both instruments and practitioners. Thus in the law suit that followed the attempted voyage of the "Barbard" to Brazil in 1540, John Phillips and Richard Stone are reported as forcibly taking several navigational aids from a captured French pilot, Robert Nycoll of Dieppe. The "Barbara's" crew, arrested on suspicion of piracy, subsequently also stated that they captured a Spanish pilot from a Biscayan ship and another Spanish pilot in the Caribbean and took every Spanish chart they could.

⁵¹ High Court of Admiralty, Instance and Prize Courts, Libels etc. PRO. HCA/24/5. File of Proceedings in the High Court of Admiralty. John A borough contra John Andrewes.

Just as the Spaniards adopted Italian ideas, so did John A Borough, for he had experience in the Mediterranean trade from Bristol, see Jean Vanes, 'Documents Illustrating the overseas trade of Bristol in the Sixteenth Century', Bristol Record Society Vol. XXXI 1979, pp.159-61 cites. HCA/24/7 A bill of exchange compiled by Robertus Cressy, Public Notary, 23 June, 1533 cites "noble John Aborow, Englysheman, patron of the shipp Saynt Myghell, standing at the present tyme in the port of Messina.

"John Phellypes had the French pilotte's card chart and one Richard Stone of Dartemouthe had the master's cheste and a little carde with an estrolaby, which was the pilotte's, a balestely cross-staff an instrumente belongyng to the office of a pilotte for the nyghte nocturnal ... Grene a merchant who died on the voyage had a very excellent goodly carde for all the parteyes of England, Fraunce, Brittagne, Spayne, Portyugale, the Strayghtes of Malaga, into Scio, all the quoste of Brasell and Kennyballes, all the empirours Indians, so along New founde lande, with other dyvers straunge places. Which carde, William Hare of Berkyng brought of Gremell for IXs."⁵²

Also in 1540 with encouragement from Viscount Lisle, an enthusiast for the new techniques of navigation, Henry VIII began to extend royal patronage to the practitioners of these arts, appointing John A Borough, Overseer of harbour works at Dover.⁵³ Shortly afterwards he began the patronage of French pilots already discussed. Henry VIII, through his interest in mathematics, also made a major contribution to the mathematical revival in England begun by Bishop Tunstall with De Arte Supputandi in 1522.⁵⁴ Henry VIII's

⁵² High Court of Admiralty, Oyer and Terminer Records PRO.HCA/1/33. The Book of Examinations of Pirates for the years 1535 to 1546 reveals that the "Barbara's" crew were arrested on suspicion of piracy in 1540 by the Mayor of Dartmouth. The Spaniards involved were "Petro Ryvero late master and Redrigo Allveris late pylott". This case is also discussed in PRO's introductory notes to the High Court of Admiralty Records.

⁵³ E.G.R. Taylor, The Mathematical Practitioners of Tudor and Stuart England 1485-1714, Cambridge, 1970, Biographical Notes, p.167.

⁵⁴ Cuthbert Tunstall, De Arte Supputandi Libri Quatuor, Pynson, London, 1522. This work aroused considerable interest in Europe, being republished in Paris in 1529, 1535 and 1558 and in Strasburg in 1543, 1544, 1548 and 1551. Italo caused Simon Gryneaus to dedicate his Euclid to Tunstall, Bishop of Durham.

interest became so well known, that Peter Appianus sent him one of the seventeen hand printed copies of his own work Astronomican Caesareum in 1546. This mathematical interest was important because it helped to foster mathematical theorems useful at sea, as well as creating the intellectual leaven upon which navigational progress would henceforward depend. Patrons of mathematics in the 1540s included John Dudley and his wife. They patronised Jean Ribaut, John Cheke and his pupil at Cambridge, John Dee. Lisle's patronage and action through Edward VI's privy council brought three important strands of development together: French pilots and native mathematicians, and direct interest at the highest level of government. As Lord High Admiral between 1542 and 1547 and indeed later, he was prepared to use his powers, contacts and influence to further his own interests as opportunity offered. His use of power to imprison Jean Ribaut in the Tower in 1547 to prevent his return to France, and his preparedness to pay Ribaut as much as £75 per year, show that his interests were not just avaricious, for he clearly appreciated Ribaut's skills and knowledge.⁵⁶ Likewise Lisle and Sebastian Cabot had a close working relationship based on Cabot's knowledge. This was a vital part of the ambitious plans they laid for voyages to the North West, Peru, and Guinea.⁵⁷

⁵⁶E.G.R.Taylor, The Mathematical Practitioners of Tudor and Stuart England 1485-1714, Cambridge, 1970, p.17. A Charter party for a tramp voyage in the Mary Plantagenet 1531 is signed by John A Borough as the "attorneye and depputty for my Lord Lysle yn this behalffe. PRO. S.P.3/9/66.

⁵⁷R.Beazley, John and Sebastian Cabot, Fisher Unwin, London, 1898, pp.197-8.

Sebastian Cabot had been encouraged back to England partly by his marriage to the daughter of an important member of Bristol's merchant community with close Spanish connections, partly with the encouragement of his stepson, Harry Ostrich, and his navigator friend, John Alday, but most significantly by the prospect of the huge financial incentive offered by the English Privy Council. In 1547 they were prepared to offer £100 for his safe passage from Spain, a yearly grant of £166 13s.4d. and the prospect of other subventions, such as the £200 he received in 1551.⁵⁸ They were also prepared to fend off the diplomatic pressures and requests from Charles V for his return which the latter persistently made between 1547 and 1554.⁵⁹

Within a year of his return Cabot had organised a navigational training cruise to the Mediterranean in the barque "Aucher" under Roger Bodenham and a Spanish pilot called Nobieza. Bodenham later told Hakluyt

"... all those mariners that were in my said ship - which were besides boys three score and ten, - for the most part were within five or six years after, able to take charge of ships and did".⁶⁰

⁵⁸Ibid. pp.166-7, 169-70, 172-3, 175 and 202.

⁵⁹Ibid. pp.170-1, 195-200.

⁶⁰R.Hakluyt, Principal Navigations, Hakluyt Society Extra Series Vol.5, Glasgow 1903-5, p.76.

Among the more famous members of the "Aucher's" crew was Richard Chancellor, who was trained at the expense of Sir Henry Sidney, who had also arranged that John Dee tutor his protege. Chancellor proved a man of great talent as a navigator and was chosen as chief pilot of the 1553 expedition to the North West sponsored by the Company of Merchant Adventurers. A detailed set of 'Ordinances' for the voyage of 1553 were drawn up by Cabot on the Spanish model. The seventh ordinance in particular specified the duty to keep a written record of the observations of land, tides, elements, altitudes of sun, moon and stars which were to be agreed at weekly conferences and the records kept for the company's future usage.⁶¹ Not only did this long voyage bring a new discipline, the voyage brought England new markets in Russia and acclaim to Chancellor as the discoverer.

From the technological point of view, the voyage is interesting because the Company at Cabot's insistence bought navigational instruments and charts after Spanish prototypes. Not only did England gain directly from his cartographic knowledge, his interest in instruments encouraged the

⁶¹ R. Hakluyt, Principal Navigations, Hakluyt Society Extra Series, Vol. II, p. 195.

See there "Ordinances, instructions and Advertizments of and for the direction of the intended voyage for Cathay, compiled, made, and delivered by the Right Worshipful Master Sebastian Cabota Esq., Governor of the Mystery and Company of Merchants Adventurers for the discovery of regions, dominions, islands and places unknown".

English in the art of metal working and engraving to a new and far higher standard. An astronomer's astrolabe of this period survives bearing the crests of the Duke of Northumberland, Edward VI and Sir John Cheke.⁶² It was made by Thomas Gernini, a Fleming who settled in London "within the Precints of the late Blackfriars" in the reign of Henry VIII perhaps as a Protestant refugee, because he became a member of the Dutch (Reformed) Church in Austin Friars.⁶³ His craft may owe something to the instrument makers of his native Louvain and Antwerp and to Mercator and Walter Arsenius, the nephew of Gemma Frisius. The significance of such contacts with the Low Countries was to grow rapidly in the late sixteenth and early seventeenth centuries, but even in the mid-sixteenth century it was very significant for instrument making.

The Dutch and Flemings were able to establish this position because shortly after 1500 they mastered a new technique of making globes which avoided the use of vastly expensive engraved hollow metal spheres. The technique utilised printed paper gores (usually twelve 30° gores) and thus permitted standard products because first wood blocks and later copper plates could be used.

⁶² D.W. Waters, The Art of Navigation in England in Elizabethan and Early Stuart Times, NMM. 1978, plates XXVII and XXVIII illustrate this astrolabe. See also page xvii.

⁶³ E.G.R. Taylor, Mathematical Practitioners of Tudor and Stuart England, pp.165-6.

Gemma Frisius initiated a technique of manufacturing globes large enough to be used for navigation, as typified by the celestial globe now preserved at Greenwich⁶⁴ and the terrestrial globe preserved in Vienna. These globes of $14\frac{1}{2}$ " diameter were made by mounting engraved gores on a stronger core of plaster, papier maché and wood. A further advance made by Frisius's pupil, Gerhard Mercator, between 1536 and 1541 was based on the work of Dr. Pedro Nunez. Mercator's famous terrestrial globe of 1541⁶⁵ shows engraved rhumb lines on the principles set out by Nunez in his Tractatus. Just as Gemini's work went to influential patrons in England, so did Mercator's. His terrestrial globe of 1541 was initially presented to Nicolas Perrenot, Siegneur de Granvelle, Councillor to Charles V and father of Cardinal Granvelle. All this shows the growing interest of influential patrons in northern Europe in geography, navigation and their associated aids and skills.

Such enthusiasts for these new skills were to be found not only amongst Charles V's political advisers, or only in Spain and Portugal, they were increasingly obvious in England in the government of Philip and Mary and in France. To some

⁶⁴NMM, ref.NA/G/135. This celestial globe by Gemma Frisius carries the inscription just above the equatorial meridian "Faciebunt Gemma Frisius Medicus ac mathematicus, Gaspar a Myrica & Gerardus Mercator Rupelmundamus anno a parita virgineo 1537".

⁶⁵NMM, ref.NA/G/88.

extent this was inevitable given the closely intertwined threads of economic political and maritime nature between Iberia, the Low Countries, France and England. In part, these were based on the Castilian wool trade, in part on the transference of Portugal's Spice Factor from Lisbon to Antwerp in 1504 and in part on the political unions created by Charles V and Philip II but gradually consciousness of these ties began to subside in the climate that emerged from the 1550s onwards. This happened mainly for religious and political reasons, but also because the northern powers became increasingly aware of regions outside Europe and of the value of the technology of navigation that permitted the Iberian seaborne empires to flourish.

Sentiments of this type led Richard Eden, on the back of the enthusiasm aroused by the north-western exploration of 1553-4, to publish a string of foreign translations. He began by translating Sebastian Munster's A treatyse of newe India with other new founde landes ... as well eastwarde as westward ... in 1553,⁶⁶ followed in 1555 by an

⁶⁶ Both this work and the translation made by Richard Eden of Peter Martyr d'Angheira's Decades of the Newe Worlde or West India, published in London 1553, appear in a collection of Eden's works published in 1577 by Richard Jugge. Therefore see The History of Travayle in the West and East Indies and other countrey's lying by eyther way, towardses the fruitful and ryche Mollucas As Moscovia, Persia, (?) Syria, Aegypt, Ethiopia, Guinea, China in Cathago and Cipangu. With a discourse of the North West Passage, Gathered in parte and done into Englysshe by Richard Eden, Newly set in order and Augmented by and finished by Richard Willes. Imprinted at London by Richard Jugge 1577. Richard Eden was cited before Bishop Gardiner of Winchester in 1555 by the Bishop of Lincoln in an accusation of heresy. It led to his being deprived of his post in the English Treasury of the Prince of Spain. His real offence against Spain was possibly his translation of Peter Martyr's Decades.

English translation of Peter Martyr's The Decades of the newe world or west India, Conteyning the navigations and conquestes of the Spanyardes ...⁶⁷ which had first been published in 1511 but had not caught the interest of northern Europe until 1555. By adding to this Oveido's Of the ordinary navygation from Spayne to the West Indies, he provided the English with an early Atlantic rutter.

Eden was a shrewd editor and translator and from 1544 had experience in the Treasury of the problems of government which permitted his close contacts with Sir William Cecil and later with Sebastian Cabot. This led to his being able to clearly point the moral of some voyages of exploration described in the Decades. Thus, when explaining the reasons for Vespucci's successful voyage,

⁶⁷ Richard Eden, The Decades of the Newe Worlde or West India, Conteynyng the navigations and conquestes of the Spanyardes, with the particular description of the moste ryche and large landes and Ilandes lately founde in the west Ocean perteynyng to the inheritaunce of the kinges of Spayne. In the which the diligent reader may not only consyder what commoditie may hereby chaunce to the holy chrystian world in tyme to come, but also learne many secretes touchynge the lande, the sea, and the starres, very necessarie to be knowe to al such as shal attempte any navigations, or otherwise have delite to beholde the strange and wonderfull woorks of God and nature. Wrytten in the Latine tounge by Peter Martyr of Angiera and translated into Englysshe by Richarde Eden. London: In aedibus Guilhelmi Powell. Anno 1555.

See also footnote ⁴³ for details of the rutter compiled from Peter Carew's copy in Strasburg in the autumn of 1555. However, Eden's best descriptions of the Atlantic were in the two accounts of the Guinea voyages rather than for the voyage to the West Indies which Ponet annotated.

he carefully included Vespucci's description of the Southern Cross with the added comment that Vespucci could observe such things in "havyng knowledge of geometrie" and because Vespucci had "byn skylful in the science of Cosmographie".⁶⁸

Important though the early works of Eden were in widening the horizons of the English, they did necessarily draw attention to the best and most useful navigational points. In extolling Vespucci's qualities he drew attention to the methods of French pilots, which was not necessarily the best training. Thomas Wyndham, who was put in charge of the English expeditions to the west African coasts in 1551-2, had been trained by French pilots. He realised the potential offered by the chance of falling into the company of two Portuguese pilots, Anthony Pinteado and Francisco Rodrigues, and yet though they taught his English crews the secrets of the wind systems and currents of the Guinea coast, he was not prepared to follow their advice and practice as closely as Cabot. Consequently Wyndham quarrelled with Pinteado and denied the Portuguese any say in the "Lion's" navigation. Again, disregarding Pinteado's advice not to sail east from the Guinea coasts towards the Niger Delta, Wyndham led his fleet east, only to find that he and the crews were unable to stand the climate and

⁶⁸D.W.Waters, The Art of Navigation, in England in Elizabethan and Early Stuart Times, N.M.M., 1978, p. 87.

disease of the region.⁶⁹ Only forty out of a hundred and forty men returned, and the survivors owed their lives to Rodrigues's guidance. The moral was to follow Iberian practice more closely.

The absence of such problems in the Russian trade speaks for the wisdom of Cabot's detailed ordinances which set out responsibilities in detail on the Spanish model. It was no doubt the absence of such problems in the North West, together with the fact that King Philip was anxious to prohibit the entry of the English into the Southern Atlantic and the Caribbean which encouraged Philip and Mary to charter the new

⁶⁹R. Eden (R. Willes) The History of Travayle 1577. See there "The Two viages made out of England into Guinea in Africke, at the charges of certayne merchantes adventurers of the Citie of London in the yere of our Lord 1553". This begins thus: "In the yeare of our Lord 1553 the xij day of August sayled from Portsmouth two goodly shyppes, the Primrose and the Lion, with a pynasse, called the Moone being all well furnished ... Having also two Captaynes, the one a stranger, called Antoniades Pinteado, a Portugale, a wyse discrete & sober man who for his cunnyng in sayling, being as well an experte pylot as politike Captaine, was some time in great favour with the Kynge of Portugale, and to whom the coasts of Brasile and Guinea, were commytted to be kepte from Frenchmen, to whom he was a terror on the sea in those partes, and furthermore a gentlemen of the King his maysters house. But as fortune in manner never favoureth ... he was after many adversities, inforced to come to England where in this golden voyage he was evil matched with an unequal companion" / Captain Wyndham /

Muscovy Company in 1555.⁷⁰

The Muscovy Company would prove the greatest English patron of the art of navigation before the East India Company was founded. In 1555 it mounted another attempt to the north-east which cost the valuable life of Chancellor, the leading English pilot of his day. That they were able to mount a successful expedition in 1557 under two English

⁷⁰ This charter granted on 26th February 1555 was the result of Chancellor's successful voyage to Russia in 1553-4. That voyage created pressure for a company with authority to hold meetings, make ordinances and secure compliance, and to hold property for the purpose of developing the trading opportunities revealed by the voyage. On 22 January 1555, the Privy Council wrote to the attorney general and solicitor general sending them

"certayn articles by the King and Quenes Majesties commandment touchyng an incorporation which their Majesties are pleased to graunte unto certayne merchauntes and adventurers".

The recipients of this letter, Edward Griffin and William Cordall were later to be members of the company as were five members of the Privy Council. The charter was granted to "The Marchants Adventurers of England, for the Discovery of lands, territories, iles, dominions, and seignories unknownen, and not before that late adventure or enterprise by sea or navigation, commonly frequented". This title was later altered, and the popular shortened titles adopted, such as the Russia Company or the Moscovy Company. In 1566 the title was in fact altered to the Company of Merchants trading with Russia. It was granted a monopoly of trade lying

"northwards, north eastwards and north westwards" which were "before the late adventure or enterprise not knowen, or by our fore-sayd marchants and subjects not commonly frequented".

The charter was granted on 26th February 1555 not 6th February 1555 as Hakluyt claimed, see Calendar of Patent Rolls 1554-5, pp.55-9 and T.S.Willan, The Early History of the Russia Company 1553-1603. Manchester University Press, 1968, pp. 7 and 8.

Note: Sir William Foster, England's Quest of Eastern Trade, A.& C.Black. London, 1933, reprinted 1966. Sir William on p.11 follows Hakluyt and gives the wrong date, 6th February, 1555.

Chief Pilots was largely due to their investment in such skills not only at the practical but also at the theoretical level. Among the men they patronised was Robert Recorde. He had studied mathematics at Oxford and Cambridge before coming to London to lecture and teach in 1547. Bale testified the quality of his teaching saying that

"He rendered so clear and obvious to all capacities that none did ever before him in the history of man".⁷¹

Two of Recorde's famous books of mathematical theory were dedicated to the Muscovy Company⁷² while the Castle of Knowledge which appeared in 1556 became a standard work, and one consulted to the turn of the century. We know Martin Frobisher took a copy with him on his voyage in 1576.⁷³ It contained useful information on the making of an armillary sphere and engravings showing its use,

⁷¹ Antonia McLean, Humanism and the Rise of Science in Tudor England, Heinemann, London 1972, p.132.

⁷² Robert Recorde's two books dedicated to the Muscovy Company were The Gateway of Knowledge no longer extant and The Whetstone of Witte, John Kyngston, London, 1557. It is a pity that his library was dispersed on his death in 1558, for it is supposed to have included many interesting works including some books earlier in monastic hands. Also missing as a result of this dispersal are copies of his lectures to the Muscovy Company pilots, though there are several known references to his medical patients.

⁷³ For details of the books taken on Frobisher's voyage in 1576, see the inventory printed in D.W. Waters, The Art of Navigation, in England in Elizabethan and Early Stuart Times, N.M.M. Greenwich, 1978, p.530. The Castle of Knowledge cost together with William Cunningham's Cosmographical Glasse a total of 10 pence when purchased from Humphrey Cole.

as well as explaining the use of quadrants, globes and dividers, though its content was more theoretical and devoted to astronomy. Recorde said of this in his preface to the Castle of Knowledge that:

"If a master of a shippe would say that he can saile and governe his course by his compasse and his card with his quadrant and his other instruments without any knowledge of Cosmographie or Astronomie, would not all that hear him, pity or deryde him, or think him madde, for speaking so indiscreatly"⁷⁴

Dr. Recorde planned as the climax of his works a text dealing with celestial navigation, but he never finished this before his untimely death in 1558.⁷⁵ Another lecturer retained to train navigators by the Muscovy Company was, however, able to step into the breach. John Dee gave his tutorials and instruction on many aspects of navigational theory including the plane-charts' errors, variation and the North West Passage. However, though he was in contact with many of Europe's leading thinkers,

⁷⁴R. Recorde, Castle of Knowledge, London, Reyner Woolf, 1557. In the Preface dedicated to Queen Mary he sought not only the Queen's support for his work, The Castle of Knowledge, but that "knowledge might bee maintained and revoked from exile".

He followed this rather thinly disguised political comment on the religious exiles by the comments quoted here.

⁷⁵R. Recorde, Castle of Knowledge, 'An Admonition for the orderly trade of study in the Authors worke: appertaynyng to the mathematics'. There he suggests that the "Treasure of Knowledge", a work on navigation, would be the climax of his works.

he remained reluctant to publish his stock in trade. Nevertheless, he tutored in the next forty years such men as Richard Chancellor, Stephen and William Borough, Martin Frobisher, Christopher Hall, Anthony Jenkinson, Charles Jackman, Arthur Pet, Humphrey and Adrian Gilbert and possibly even Drake himself. Through Dee, his pupils had the advantage of familiarity with the work of men such as Gemma Frisius, Gerhard Mercator, Dr. Pedro Nunez, Abraham Ortelius and Tyche Brahe.

Through the teaching of Recorde and Dee and with experience of the Arctic behind him, Stephen Borough was able to impress the Spaniards about Mary's court with his navigational knowledge. Mary's marriage to Philip proved invaluable at this point in 1558 because Philip II decided to dispense Stephen Borough from the laws prohibiting direct foreign access to the navigation secrets of the Casa and its training school for pilots. Stephen Borough thus visited Seville as an impressionable navigator of thirty. An honoured guest, he watched at first hand the methods of training and examining pilots.⁷⁶

⁷⁶See Richard Hakluyt's "Epistle Dedicatorie to the Right Worshipfull and Most Vertuous Gentleman Master Philip Sydney of Divers Voyages touching the discoverie of America and the Ilands adiacent" London, 1582, in D.W. Waters, Art of Navigation, in England in Elizabethan and Early Stuart Times, N.M.M. Greenwich, 1978, p.542. This says

"Master Steven Borrows, nowe one of the foure masters of the Queene's navie, told me that, newly after his returne from the discovery of Moscovie by the North in Queen Maries daies, the Spaniards, having intelligence that he was master in that discoverie, took him into their contraction house at their making and admitting of masters and pilots, giving him great honour".

Philip may have sought to benefit the Casa by introducing to it a new man with detailed knowledge of the Arctic like Sebastian Cabot, but in the event it was Stephen Borough and England which benefited immeasurably from the visit of 1558, for Borough was able to bring back encapsulated in a copy of Martin Cortes's navigation manual a whole technology wherein was described not the manufacture but the use of the latest celestial instruments. It was the clearest and most easily understood training aid for English would be oceanic navigators. This was not lost on Borough, or on Sir William Gerrard and three other Aldermen of the City of London, who appreciated its worth and commissioned Richard Eden to translate it into English.⁷⁷ Eden too saw their intent and wrote in his preface:

"Nowe therefore this work of the art of Navigation beyng published in our own vulgar tongue, you may be assured to have more of those skylful Pilotes".⁷⁸

⁷⁷R.Eden, The Arte of Navigation, 1561, Preface, f.7. The other aldermen were William Herrick, Blase Sanders and Edward Castlen.

⁷⁸R.Eden, The Arte of Navigation, 1561, Preface, f.7.

The translation of this manual which was published in London in 1561 had the most wide ranging importance. It was very highly regarded for the next 70 years, and was successively reprinted in 1572, 1577, 1584 and 1589 before it was enlarged and amended by John Tapp for further editions in 1596, 1609, 1615 and 1630.⁷⁹ William Bourne, himself the author of two navigation manuals, wrote in 1567:

"Now for your instruments of the sea with their uses, you shall repayre to the booke of Navigation, made by Martin Curtis, a Spaniarde, imprinted by master Jugge printer".⁸⁰

As late as 1627 Captain John Smith, author of the Sea Grammar, was of the same opinion in recommending it as among the items needed by a young man seeking to make a career at sea.⁸¹

Its publication did much to bring young Englishmen to appreciate what they must do to rise to command of their ships and to enjoy a life of adventure on the world's oceans. It was a work at once fit for a country gentleman's library and for

⁷⁹ This manual was reprinted with only minor changes between 1572 and 1577. One copy of the 1584 edition was given by Andrew Rothwell "to the Royal Mathematicall School in Christ's Hospitall" in the early eighteenth century. This copy passed subsequently into the hands of Boies Penrose before its sale on 7th June 1971. That edition was reprinted by the "widow of Richard Jugge". For Tapp's revision of 1596 a new title page showing ships was engraved. The editions of 1596, 1609, 1615 and 1630 show the title significantly altered. See bibliography and Sotheby's Sale Catalogue 7th June, 1971, A-H, Lot 52.

⁸⁰ William Bourne, A Regiment for the Sea. Chapter 21
See E.G.R. Taylor, A Regiment for the Sea,
Hakluyt Society. Series II, Vol. CXI, p 266

⁸¹ Captain John Smith, A Sea Grammar. With The Plaine Exposition of Smith's Accidence for young Seamen, enlarged Divided into fifteene Chapters what they are you may partly conceive by the Contents. Written by Captaine John Smith, sometimes Gouvernour of Virginia, and Admirall of New England. London. Printed by Iohn Haviland 1627. Chapter XV. Reprinted by Michael Joseph, London, 1970 p 94

convenient use at sea, and did much to popularise the navigator's profession in Elizabethan and Jacobean England and to improve the skills of the coastal pilot and the oceanic navigator.

Eden might have belittled the skills of the fishermen of Calais or the oyster catchers of the East Coast, by comparison with those of the oceanic navigator, but English mariners drew a wider lesson and remained conscious of the need for traditional skills of pilotage and for those of the celestial navigator.⁸² In the first few years after his return from Seville, Stephen Borough too advocated an approach which might have brought the results Eden envisaged, for he understandably advocated that same navigational administration and training programme which he had seen in Seville. However,

⁸²Eden, Arte of Navigation, 1561. Preface, ff.7-8.

Eden too joined the clamour for more patronage of the oceanic navigator justifying his view by noting "how indigent and destitute this realm is of excellent pilots". This may even have been suggested to him by Stephen Borough, for just a year later S. Borough was petitioning for "the Creation of the Office of Pilott Maior" (BM. Lansdowne MS. 116 ff.6 and 7) and arguing in similar terms. He said in 1562 in his petition that whereas the office of "Pilott maior ys allowed and esteemed in Spayne, Portugale and other places wheras Navigacion flourishethe ... if it please the prynce and others of habilitie to attempt any viages of discovery or viages unaccustomed to be travayled, that then they may be sure to have men of their owne cuntrey to serve their turne and not to be constreyned to seke into other cuntreis for men of skill in that arte when they shall have nede of them, as hath the bine here In England of late yeres to send into spaigne and fraunce for men skilful in that arte ..." This is reproduced in full by D.W. Waters, The Art of Navigation, in England in Elizabethan and Early Stuart Times, N.M.M. Greenwich, 1978, pp.513-4.

while agreeing with Eden and Borough about the importance of navigational skills to the realm, Elizabeth, her Privy Council and her Parliaments sought to progress along several lines rather than slavishly follow the Spanish model which was already showing signs of stultification.

In part Elizabeth responded as Borough hoped in appointing a Chief Pilot of England with responsibility for promoting the training and technology of celestial navigation.⁸³ This involved not only the training of navigators, but also the ordering of instruments of the kind described in Cortes's manual. Amongst the English craftsmen employed making such aids was Humphrey Cole who had probably served under Gemini before the latter's death in 1562. So successful was this policy that by 1576 Cole could be entrusted with the whole provision of instruments for Frobisher's voyage, at a vast saving over the costs of obtaining them on the black market from Iberian sources.⁸⁴

Thanks to the advocacy of men such as Lord Clinton (who had risen with Philip's approval, for reasons of his maritime interest, to the post of

⁸³Draft of Stephen Borough's Appointment of Cheyffe Pylott of this our realme of Englande (BM. Lansdowne MS. 116, ff.4 and 5 (Jan.1564)) as in Waters op.cit. pp.515-6.

⁸⁴As footnote 73.

Lord Admiral under Mary and then Elizabeth), navigational aids such as sea marks came to be regarded as more important than just the Lord Admiral's perquisites.⁸⁵ An Act was passed in 1565 to enable Trinity House to erect sea marks for the benefit of all mariners.⁸⁶ For this and other reasons the professional standing of these bodies grew, and gained the support of men like Stephen Borough who agreed to be its Master in 1572.⁸⁷

⁸⁵ Calendar of State Papers Spanish. Vol.13, ed. Royall Tyler, Kraus Reprint. New York, 1972.
 London. Feb. 2 1558 pp.350-6 No.397 Simancas 811
 Brussels Feb.15 1558 p.358 No.403 Simancas 811
 Brussels Feb.18 1558 p.360 No.405
 London March 10 1558 p.368 No.413.

Edward Fiennes de Clinton, Lord Clinton of Saye was first appointed Lord High Admiral in 1550, having served in the English fleet against the Scots and French between 1544 and his appointment as Governor of Boulogne in 1547. Having supported the Dudleys to whom he owed the post of Lord High Admiral in 1550, and because of suspected involvement in support of Lady Jane Grey, he was deprived of office in 1554. However, he helped Mary suppress the Wyatt revolt and pursued his interests in navigation and the navy, so as to re-establish his position at Court as an expert in naval affairs a point not lost on Philip II. Some interesting diplomatic correspondence surrounds Clinton's re-appointment as Lord High Admiral in February 1558. Count Feria wrote to Philip II from London on 2nd February to say

"Her Majesty says she is going to appoint Clinton Admiral, as your Majesty recommended. William Howard has been discharged of that office today yet not without difficulty, because the Queen kept putting the matter off ... Clinton is not a member of the Privy Council, but as he is in favour with the Queen, and knows more about Military affairs than the others it seems wise to appoint him to that body". (Extract from 397 as above). As Lord Admiral he personally led the Channel fleet including the Brest raid of 1558, planned ventures in 1560 and 1562-3. He again led the fleet to sea in 1570 before his death in January 1585. His portrait hangs in the Ashmolean Museum, Oxford and shows him holding a magnetic compass.

⁸⁶ H.P.Mead. Trinity House, London 1947, p.20.

⁸⁷ See footnote 25.

All these steps towards the English mastery of navigational skills already practised by the Spanish and Portuguese were so significant because they were first steps towards independence of the Iberian model with its narrow professional outlooks. In France similar beginnings developed very differently. As we have seen, France's kings showed a certain interest in navigational matters but France did not enjoy such close diplomatic links with Spain as made possible Stephen Boroughs's visit to Seville in 1558. Despite this, Jean Alphonse had obtained a copy of the revised 1536 edition of Enciso's Suma de geographia which he was able to polish into the manuscripts of the Cosmographie of 1544.⁸⁸ This was a work the Spanish government "called in" in 1558 as being too generous with navigational details about the Atlantic sea lanes. So France had to rely more heavily on suborning renegade Portuguese cartographers than England. However, in this respect the Treaty of Cateau-Cambrésis constituted a self-denying ordinance agreed with Philip II. It was only Henry II's unexpected death and the changed diplomatic position of France which led to a revival of French attempts to entice Portuguese cartographers and pilots. In 1565 Charles IX went so far as to retain André Homem as his own Cosmographer.⁸⁹

⁸⁸L.C.Wroth, 'An Elizabethan Merchant and Man of Letters!' Huntington Library Quarterly No. 4, August 1954, p.310.

⁸⁹PMC. Vol.II, p.67.

A key figure in these activities was the French Ambassador in Madrid, M. de Fourquevaux, and his friend Francesco d'Albagno, a native of Lucca who traded regularly between La Rochelle and Lisbon. Fourquevaux was deeply involved in securing the services for France of André Homem, Antão Luís, Tomé Homem, Bartolomeu Velho, Francesco d'Albagno, and in obtaining other navigational information via Seville. An example of how this espionage was operated is given by the events following Albagno's contact with Bartolomeu Velho in Lisbon in April 1566. Convinced of Velho's abilities Albagno suggested to the King of France that he should take Velho into royal service, enticing him to leave Portugal with a guarantee to maintain his wife and children in Lisbon. Thus on 4th January, 1567 Fourquevaux informed Catherine de Medici that d'Albagno had spoken of a new land, "proving it with charts and true speeches". Meanwhile d'Albagno had persuaded Father Fernando Oliveira who had earlier served on French ships as a pilot and written such works as Arte da guerra do mar and Livro de Fabrica das Naus and Ars Nautica, to emigrate to France.⁹⁰ Fr. Fernando Oliveira left Lisbon on 24 June, 1567 probably with Bartolomeu Velho. Nothing further is known of Fr. Oliveira, but Velho shortly afterwards produced his 'Principio de verdadeira Cosmographia e geographia universal' in Paris, dedicating it to Charles IX.

⁹⁰PMC Vol.II pp.90-91.

In his preface Velho wrote of himself as

"by the intercession of Francais d'Albagno of Lucca, and in accordance with your Majesty's instructions, to have left his native land and his wife and children and all his property to come and serve your majesty and principally to show you those parts of the unknown lands which are of great importance and consequence".⁹¹

Unfortunately for France, the Habsburg Ambassador cracked this cartographic espionage, perhaps through Da Silva's intelligence from London in 1567, though the Spanish Ambassador in Lisbon certainly saw some of Albagno's letters and letters from the King of France authorising Albagno's actions in Lisbon. This led the Spanish Ambassador in Lisbon to invite Fr. Oliveira to Lisbon. Then when the latter left suddenly Andrea d'Albagno, the brother of Francesco, was arrested in Lisbon and accused of complicity in the flight of cosmographers to France. It was at this time that Caldeira and certain other exiled cartographers were entrapped by the combined activities of the Habsburg Ambassadors in London and Paris and eventually executed.⁹²

⁹¹PMC Vol.II, p.103. The 'Cosmographia et geographia universal' never seems to have been presented to Charles IX, but rather to have been rededicated in a different hand to the Duke of Tuscany. The title page carries this rededication FRANCISCO MED. MAGNO DVCI ETRVIAE IOHANNES ANDREOZIVS PATRITVS LVCENSIS LIBRUM HUNC DICAUIT MDLXXVI.

⁹²PMC Vol.II p.67. M. de Fourquevaux wrote to his King Charles IX saying

"two other Portuguese came from England were taken at Bilbao: one is called Andre Hanné. I do not know the name of the other. It is said that they were going to Portugal to spy for the English".

All this was too unstable a basis on which to build up an influential group of exiled Iberian pilots such as grew up in London. It forced the French to look to their own resources more, and in particular to the Protestant maritime communities in Brittany and Normandy. In these circumstances Nicolas de Nicolay achieved a new respectability, tutoring the French Admiral, the Duc de Joyeuse (no doubt on the recommendation of his Florentine predecessor Admiral Leo Strozzi, who saw Nicolay's worth demonstrated during the exercise to carry Mary Stuart from Dumbarton to France as a small child). Nicolay dedicated the Rutter of the North, stolen from the English in 1547, to the Duc de Joyeuse in 1583, having established his reputation as a cartographer of the first rank in France, by his maps of the French provinces, and by a further manuscript copy of the stolen rutter made for the Cardinal of Lorraine, Charles of Guise.⁹³

However, it was still detailed knowledge of Portuguese cartography and navigational achievements which the French most wanted; so it was that the changing political circumstance led to the rise of the well-read Frenchman, André Thevet. He became the Cosmographer Royal after Velho's death, and

⁹³ Nicolas de Nicolai Navigation du roi de ecosse Jacques V autour de son Royaume recueille et redigee en forme de description hydrographique, avec les additions du dit Nicolay touchant l'art de naviguer. Paris, 1583. The copy for Cardinal Guise prepared as a manuscript survives in the Biblioteque Nationale. "Navigation de la Mer: alentour de Royaume de Eccoce ... Premierement composer pay Alexander Lyndesay Eccosoy ... avec augmentation par Nicolas de Nicolay ... Geographe du Roy."

encouraged publication of various navigational works. He himself was the author of a widely read work Les singularitez de la France Antartique autrement nommée Amerique, et de plusieurs Terres et Isles decouvertes de nostre temps published in Paris in 1558. This book contained extracts from a large number of European sources as well as his comments. His experience included a trip with Villegagnon to Brazil in 1555, whilst he also managed to acquire a copy of the Portuguese rutter by Manuel Alvares of the Indian Ocean made in 1538.

It was the emergence of men as well versed in navigational matters as Thevet which gave Charles IX the chance to change policy for political reasons after Velho (the famous Portuguese cartographer who had done so much for the French) died in Nantes unexpectedly in 1568. Charles IX seized the chance to improve diplomatic relations with Philip II, as for other reasons he needed better diplomatic relations with Spain.⁹⁵ So on May 28th, 1568 Charles IX wrote to Philip II telling him of Velho's death and asking in that context for the

⁹⁴For the rutter itself see inside cover and first page, NMM. MS. 35-0103C/P31. André Thevet lived from 1502 - 1590 and seems to have owned this book for he has signed and dated it 1563 and 1567.

For other French works of this date, one has to look to Dieppe where Desliens was working. An example is in the N.M.M. MS. 35-9925C/P2 A world map on vellum inscribed "A Dieppe par Nicholas Desliens 567." There are also works by Desliens and various products from La Rochelle and St. Malo produced between 1577 and 1584.

release of Andrea d'Albagno. Charles IX, desperately hard-pressed financially in the middle of the second civil war, and even more so when involved again in armed struggle in 1569, changed policy over navigational espionage and agreed to the Habsburg request to repatriate the renegade Francisco Dias Mimoso in 1569.⁹⁵ These events mark the increasing internal concerns of the French monarchy as it pitted all its efforts to tackle the political, religious and military problems at home. It could no longer afford the luxury of patronising navigators and cartographers interested in overseas matters. Thus it was that until the seventeenth century it was the Huguenot communities, in close contact with the English and Dutch Protestants and the Sea Beggars, who kept alive this interest in oceanic and coastal navigation. Their contacts and the evident alliance of Spain with the Catholic League, led the Protestant French sailors to attack Spanish shipping and steal charts and other aids as part of the struggle to break Spain's oceanic arteries to the New World and her supply of military aid to the Army of Flanders. The consequence of this hostile attitude to Spanish and Portuguese shipping was that there was no voluntary improvement of either's navigational technology by exchange of such learning until after 1600.

As the professional navigational contacts of the maritime community with the French and English dried up during their worsening diplomatic relations of the seventies and eighties, so Philip sent a steady stream of instructions to the archdukes from Spain, urging them to greater efforts in recruiting Dutch pilots to guide Imperial fleets across the oceans.⁹⁶ Dutch pilots had established their reputation as cheap and safe carriers from northern Spain, via entrepôts in Antwerp and later Amsterdam to all the Northern European parts of the North Sea and Baltic. Their reputation for safety was based on their mastery of the traditional skills of the coastal pilot. From 1532 they began to use rutters printed in their own language with woodcut views of coastlines. There is no known version of the Baltic views that appeared in 1543, but Cornelius Anthonisz's Onderwigsinghe vander zee om stuermanschap ti leeren . . . printed at Amsterdam in 1588 does survive at Harvard. Other contemporary works by Cornelius Anthonisz included Heir keghint die Carte van die Oostersee See , and Caerte van Ooslant .⁹⁷ However, there is no

⁹⁶C.H.Carter, The Secret Diplomacy of the Habsburgs 1598-1625, Columbia University Press 1964, p.35.

⁹⁷D.Howse, The Earliest Printed Charts 1485-1569, Ingrid and other Studies, N.M.M., Monograph No. 36-1978, pp.16-17.

coincidence in the fact that the first of all these Dutch rutters covered the voyage from Spain to Holland Die Kaert van der see printed in 1532. Among the Dutch sailors of Enkhuizen who first went to sea with such rutters and traditions were Lucas Janszoon Waghenauer, Dirck Gerritsz and Jan Huighen van Linschoten.

After 25 years at sea Waghenauer was able to spend his retirement after 1572 in compiling a book to help seamen around the coasts of Europe. By 1584 his perusal and amendment of many manuscript charts and pilots' note books had enabled Plantin to produce charts of the coasts of Europe from the Zuider Zee to Cadiz. After they had been engraved on copper plates by Joannes a Doetecum, they constituted the first printed sea atlas with charts and sailing directions assembled systematically in one book using a common set of signs and symbols designed to give a mariner all the hydrographic information he needed about a specific area, even to the soundings in particular channels at low tide.

98 Lucas Jansoon Waghenauer and Anthony Ashley The Mariners Mirrour wherein may playnly be seen the courses, heights, distances, depths, soundings, floudes and ebs, rising of rocks sands and shoalds, with the marks for thentrings of the Harboroughs Havens and Ports of the greatest part of Europe: their several traficks and commodities Together with Rules and instrumētes of Navigation. First made and set fourth in divers exact seacharts, by that famous Navigator LUKE WAGENAR of Enchuisen, And now fitted with necessarie additions for the use of Englishmen by Anthony Ashley. Herein also may be understood the exploits lately achieved by the right Honourable the L. Admiral of England with her Maties Naucie and some services don by that worthy Knight Sr. Fra. Drak.

The idea of a leading line may well have been borrowed from Aelbert Haeyn's "Amstrelamsche Zee Carten" finished in 1585 whilst the details of symbols are on p.1 'A short Instruction of the forme and fashion of Buies, Beakons and other
 " marks

Waghenaer deliberately enlarged certain coastal stretches to permit the showing of difficult harbour and river mouths in great detail. The work was dedicated to William the Silent and did not acknowledge debts to Iberian practice. It was greeted with enthusiasm, and encouraged Waghenaer to complete a second part in 1585 under the title Het tweede deelvenden Spieghel der Zeevaerdt inhonde de gheheele Noortsche ende Oostersche Schipvaerts.⁹⁹ This brought him a grant from the States General of £500 so useful did they consider it.

The first Latin edition appeared in 1586 as the Speculum Nauticum having been translated by Martin Evaerts. He dedicated the first part to Queen Elizabeth and the second to the King of Norway and Denmark, Frederick II. In 1586 a copy of this work, brought to England by ambassadors from the Low Countries, so impressed Lord Charles Howard, the Lord High Admiral, that he laid it before the Privy Council, complete with its 35 page navigational treatise which showed much of Iberian origin but in very concise form. Ashley's edition

⁹⁹ Lucas Jansz Waghenaer, Speighel der Zeevaerdt, vande navigatie der Westerche Zee, Innhoudende alleda Custe va Vranckrijck Spannen en t' principaelste deel van Engelandt, in diuersche zee Caertē begrepe met den gebruijcke van dien, numet grooter naesticheijt bij ee vergadert in ghepractizeert, Door Lucas Jansz Waghenaer Pilot ofte Stuijрман Residerende Inde vermaerde Zeestadt Enchuysen. Cam privilegio ad decennium. Reg., 1583 Ma.¹⁶⁸ et Cancellaire Brabantie.

Ghedruet lot Leyden Christoffel Plantija voor Lucas Iansz/Waghenaer van Enkhuyzen Anno MDLXXXV.

See also D. Howse and M. Sanderson, The Sea Chart, David and Charles, Newton Abbot, 1973, pp.40-43.

records that Waghenaeer's work was

"esteemed by the chief personages of the grave counsell worthy to be translated and printed into a language familiar to all nations".¹⁰⁰

Accordingly they instructed Sir Anthony Ashley to supervise the translation and re-engraving of the charts with English cartouches, dates and in some cases the engravers' names. Those names reveal how England benefited from exiles from the Low Countries, frightened by Spanish deeds in the homeland. Theodor de Bry, Jodocus Hondius, Johannis Ruttinger, and Augustine Ryther completed their tasks by 1588 when the Mariners Mirrour was published in London with a full translation of the navigational treatise. So influential was this compilation that until the eighteenth century the English would refer to sea atlases as "waggoners", a fine testimony to the various traditions of hydrography which Waghenaeer had mastered.

The spirit of approach to navigation had changed vastly by Waghenaeer's time compared with that of eighty years previously, yet the spirit of Waghenaeer's approach was the vital ingredient that would permit England, Holland, and to a lesser extent France and Denmark to mount expeditions properly equipped with navigational aids, to the Far East where they would learn the detailed secrets necessary to sustain trade with areas that were formerly part of the Portuguese empire. That

¹⁰⁰ R.A.Skelton, A Bibliographical note to the facsimile edition of the Spieghel der Zeervaerdt, T.O.T. Amsterdam, 1964, pvi.

spirit informed the navigational interchange of the next forty years, and in Ashley's translation the "exhortation to the Apprentices of the Art of Navigation" reads as follows:

"For that which any man either young or olde exerciseth, searcheth out for himself, sticketh faster in memory than that which he learneth of others. Notwithstanding let him not neglect, nor shame to enquire of the Master of the Shippe, and other men exercised in the study, the situation of countries, the courses upon several poynts, the depths, soundings and elevations of the Pole, the practise of the crosse-staffe and Astrolabe. The which two are the principall instruments (next to the compass) that belong to safe and skilfull seafaring".¹⁰¹

¹⁰¹ Ibid. f.A2.

Chapter 6PART IIAsian influences and the slackening of official
Iberian navigational policies

Orthodox Portuguese policy on maritime trade in the east was expressed by one of the greatest oriental scholars of sixteenth century Portugal.. In the first volume of his Décadas da Asia , João de Barrós wrote:-

"It is true that there does exist a common right of all to navigate the seas, and in Europe we acknowledge the rights which others hold against us, but the right does not extend beyond Europe, and therefore the Portuguese as lords of the sea by the strength of their fleets are justified in compelling all Moors & Gentiles to take out safe-conducts under pain of confiscation or death. The Moors & Gentiles are outside the law of Jesus Christ, which is the true law that all must keep under pain of damnation to eternal fire. If the soul be so condemned what right has the body to the privileges of our laws?"¹

Trade between certain ports, for example Goa-Macao-Nagasaki and trade in certain commodities, especially spices, was undertaken for the benefit of the Portuguese crown or its nominees. Thus the Arabs and Gujuratis, who since the days of Cheng-Ho had dominated the carrying trade of the Indian Ocean, were virtually ousted by the Portuguese as a matter of policy. Unlicensed ships, particularly such Muslim traders, were liable to be seized or sunk by a Portuguese navy, that after Almeida's victory at Diu in 1507 was virtually unchallenged for a century. But from the first they were dependent on Arab navigational information.

However, the reality of the Portuguese crown's claim after 1501 to the title of "Lord of the

¹Needham Science and Civilisation in China Vol.4, Pt.3, p.515.

Conquest, navigation and Commerce of Ethiopia, India, Arabia and Persia² was steadily undermined. However, despite the large purpose-built carracks used by the Portuguese, and the superiority of these ships and their guns over traditional Asian naval craft, despite the many able Portuguese captains, and despite the addition of new forts at Ternate, Soler and Mombasa to their original strongpoints and entrepôts at Goa, Malacca and Hormuz, the Portuguese Asian empire would ultimately succumb to the direct maritime challenge of the English and Dutch in the seventeenth century. It is not surprising that one power should be tested by pirates and other interlopers before being ousted by others acting in alliances, however uneasy, and from envy of the gains Portugal had made from her Asian empire.³ More interestingly one also asks how was it that the Portuguese were able to control so big an empire in Asia with so few resources sent out from Portugal, and what elements in the balance changed to cause the undoing of the Portuguese position.

²The first use of this title by the Portuguese king was in a letter dated August 1499 to the Cardinal Protector, D.Jorge da Costa, in Rome.

³P.Padfield, Tide of Empires. Decisive Naval Campaigns in the Rise of the West, Vol.1, 1481-1654, Routledge, Kegan Paul. London 1979, pp.16-17.

The key to understanding the fate of the Portuguese seaborne empire in Asia lies in the control of the sea route from Europe via the Cape of Good Hope to India and beyond. An Italian Jesuit making this outward journey in 1574 said it was "without doubt the greatest and most arduous of any that are known in the world".⁴

Yet any serious naval challenge by another power to the Portuguese Asian empire had to sail along this route because the dangers of routes south of the Americas were so great. Maghalaes-Godinho discussed the defence of this route, and his comments may be translated thus:-

"Until 1586 the security of the Cape route was assured, considering everything, in a very satisfactory manner. Only three shiploads were pillaged".⁵

He noted that Drake's action in overpowering the "São Philippe" in 1587 caused widespread consternation in Portugal because it was the first vessel of the Carreira da India to fall into enemy hands. Thereafter from 1586-1638 Portugal would be forced to fight five major naval battles which accounted for about a fifth of her losses by sinking in that period.⁶ All this suggests it is to the navigational safety,

⁴C.R.Boxer, 'Some Second Thoughts on the Tragic History of the Sea 1550-1650', Hakluyt Society, Annual Report for 1978, p.1.

⁵Magalhaes-Godinho, L'economie de l'empire portugais. S.E.V.P.E.N., Paris, p.668.

⁶Ibid. pp.668-71.

rather than to the military safety of the Cape route that we must look for the explanation of the most significant part of the explanation of Portuguese losses.

Several historians have discussed ship movements and the safety of spice cargoes, but not with the navigational aspects in mind. Donald Lach follows R.Ehrenburg in his text based on figures formulated in 1910. Lach cites the figures of 168 sailings from Lisbon for Asian ports over the whole sixteenth century, and the fact that up to 1579 only about 10% of the ships were lost whereas between 1580 and 1612 only 63% got back safely.⁷ Lach also quotes a table of Whiteway, published in 1899.⁸ Whiteway's figures probably overstress the dangers of the voyages and the numbers of ships remaining in the East.

⁷D.Lach Asia in the Making of Europe Vol.1, Pt.1, p.140 based on R.Ehrenburg Ostindische Handelsgesellschaften in Hand wörterbuch der Staatswissenschaften VI: 1910.pp. 949-950.

⁸Ibid. Lach takes Whiteway's figures from The Rise of Portuguese Power in India Westminster 1895

Period	Ships leaving Portugal	Ships staying in India	Ships to be accounted for	Ships that return to Lisbon
1497-1579	620	256	364	325
1580-1612	186	29	157	100

Note that Whiteway's figures perhaps overstress the dangers of the voyages, and the numbers of ships remaining in the East, which, using Maghalaes-Godinho's tables number between 262 and 185. The discrepancy is partly accounted for by 67 ships which returned to port rather than finish their voyages.

<u>Years</u>	<u>Departures from Lisbon</u>		<u>Returns to Port</u>	<u>Wintering</u>	<u>Losses</u>	<u>Arrivals in the Orient</u>	
	<u>Total</u>	<u>Yearly average</u>				<u>Total</u>	<u>Yearly average</u>
1500-1509	138	13 or 14	1	24	9	128	12 or 13
1510-1519	96	9 or 10	2	15	4	90	9
1520-1529	76	7 or 8	1	14	14	61	6
1530-1539	80	8	5	2	6	69	7
1540-1549	61	6	2	11	4	55	5 or 6
1550-1559	51	5	7	10	4	40	4
1560-1569	49	5	4	0	3	42	4
1570-1579	54	5	0	7	3	51	5
1580-1589	56	5 or 6	6	1	3	47	4 or 5
1590-1599	44	4	6	5	3	37	3 or 4
1600-1609	68	6 or 7	6	6	13	49	5
1610-1619	56	5 or 6	7	3	5	44	4
1620-1629	67	6 or 7	13	4	13	43	4
1630-1635	18	2 or 3	0	1	0	16	2 or 3
TOTAL	912		60	103	84	772	

Years	Ships Departing for India and Malacca Total	Ships Departing for India Annual Average	Returns to Port	Wintering	Losses	Arrivals at Lisbon Total Annual Average
1501-1510(not 1507)	> 64	7	?	?	7 or 8	> 56 6
1511-1520(neither 1516 nor 1520)	> 56	6	?	?	1	> 55 6
1521-1530(not 1521)	> 37	4	?	?	1	> 36 4
1531-1540	?	?	?	?	2	? ?
1541-1550(not 1546)	> 46	5	?	?	5	41 4
1551-1560	45	4 or 5	1	4 or 5	12 or 14	30 or 32 3
1561-1570	> 37	4	1	8	3 or 4	30 or 32 > 3
1571-1580	44	4	?	3	1	43 4
1581-1590	47	4 or 5	1	1(?)	5	41 4
1591-1600	39	4	?	3 or 5	16	23 2
1601-1610	31	3	2	2	4	25 2 or 3
1611-1620	30	3	2	1	4	24 2
1621-1630	22	2	?	3	6	16 1 or 2
1631-1635	12	2	?	2	3	9 2
TOTAL	> 510		7	11 or 13	70 or 75	438

These statistics compiled from figures of Figueiredo Falcão (1612) and Barreto Resende (163) and have been edited by Maghalaes-Godhino

Sasseti put the matter in better perspective when he wrote from Cochin in 1558. Noting the loss of roughly one ship in ten he compared it with the Mediterranean where reliance was still placed on a different navigational tradition. He said that it was less dangerous to go from Lisbon to India than from Barcelona to Genoa.⁹

Maghalaes-Godinho used this point in his authoritative survey published in 1969. He took up the point of Joel Serrão's that 1580 was a turning point for the worse in the navigational sphere as well as the political.¹⁰ The former had based his work on the statistics of the Secretary of State, Figueiredo Falcão, compiled in 1612. These he supplemented with data from Barreto Resende Tradado Dos Viso Reis (1497-1636), Couto's tenth Década, and an appendix from Duarte Gomes Solis's work of 1622, and several other sources. In view of Maghalaes-Godinho's comment that there has been little serious and critical study of these figures, they are reproduced on pages 253-260.¹¹

These figures show that losses were worse on the return journey (15%) than on the outward journey from Lisbon (11%). Certain trends are also apparent, for example the rising scale of losses from 1520 to 1560, followed by a marked improvement. After 1580 decline again sets in,

⁹ Maghalaes-Godinho, op.cit. pp.665-6 inc.footnote.

¹⁰ Joel Serrão Em Toruo das condições econômicas de 1640. Vertice nos.88-91, Coimbra, 1950

¹¹ Maghalaes-Godinho, op.cit. pp.672-3 for table of ship movements.

accelerating through the '90s and still at a disastrous level until 1610. There is then an improvement, followed by yet another decline. Also apparent is the fact that a very large proportion of Portuguese ships did not return to Portugal. These facts and trends are shown in a table compiled using Maghalaes-Godinho's figures as above. It seeks to relate ship movements, losses and the navigational developments, and in particular the quality of cartography as employed by the Portuguese in any one decade. Obviously factors such as storms would be important, but the Portuguese were aware of the safest and most useful weather conditions in both the Atlantic along the Cape San Roque arc and the Indian Ocean with the monsoons. Thus between 1500 and 1635 87% of departures from Lisbon were made in March and April and over 60% between March 14th and April 9th. It explains the mid-century decline of standards and losses in cartography from 1520-1560 when Diogo Ribeiro was almost alone in adopting charts corrected for variation.¹² The table shows the improvements following the cartographic work of the Luso-Asians, Lazaro Luís and Vaz Dourado who lived, worked and sailed around the Indian

¹²Diogo Ribeiro's chart was made in two parts in 1529 and also contained beautiful drawings of astrolabes and quadrants.

Ocean. Examination of column C also suggests trends in the flow of navigational information to and from Portugal. With many ships remaining in the east, so many manuscript charts, rutters and manuals must have stayed there with them. Similarly the very high flows to Portugal in mid-century probably ensured that local eastern knowledge and improved charts reached the Armazén da India in Lisbon. Cortesão has shown in 1536 Diogo Botelho Pereira, and in the 1570s Vaz Dourado both went to Lisbon where they continued to make charts as they had in the east. Vaz Dourado, however, returned to Goa to die there in 1581, within five years of Linschoten's arrival.

Maghalaes-Godinho described the Asian background against which these exchanges took place thus:-

"The Portuguese encrusted themselves into the worlds of the Orient, installing themselves everywhere as "casados", fitting themselves into local regional interests, and giving themselves over to local or inter-regional operations".¹³

Aspects of this are to be seen in the way they conducted trading voyages from Goa to Indonesia, China and Nagasaki.¹⁴ Most notably, as far as this study is concerned, it was seen in the mixed marriages which produced cartographers

¹³ Maghalaes-Godinho, op.cit., p.783.

¹⁴ C.R.Boxer, The Great Ship from Amacon. Annals of the old Japan trade, 1535-1640. Centro de estudos historicos ultramarinos. Lisbon, 1959.

such as Erédia, Lazaro Luís and Vaz Dourado. Their births implied the breaking of the standards as set down by Barrós, and which condemned all but trading contact with the Gentiles. On account of the beauty and quality of the charts made by Lazaro Luis and Vaz Dourado, their reputations quickly rose. Improvements they introduced, such as the lobster-like configuration of Japan based on a Japanese "gyogi" style chart, were officially adopted at Lisbon, and can be seen on charts approved between 1560 and 1590. On the other hand, because the Portuguese had no trading interests in the Philippines until the Union of Crowns, erroneous stylised representations appeared on Portuguese maps until the 1580s, even though a Portuguese voyage had passed close to them in 1545. Examination of the figures for Portuguese losses at sea shows that whilst the influence of local Asian information was at its height in the first two decades of the sixteenth century, the Portuguese used local pilots in exploring Indonesian waters, and then between 1560 and 1590 when charts were being prepared by what might loosely be termed a cartographic school in Goa, Portuguese losses on the Cape route were at their lowest. Safety was becoming dependent on the skills of Asians and Luso-Asians.

However, by the time that Vaz Dourado died, Iberian attempts to maintain a censorship and tight commercial secrecy around information of navigational significance were beginning to fail, and the deficiencies in that policy were becoming evident. The same bureaucratic controls on the issue of charts as existed in Lisbon could not be applied throughout all of the ports of the Asian littoral frequented by Portuguese ships. Indeed, as we have seen, the Portuguese were active participants in a free interchange of such information, because they gained so much, and made tangible progress in safety through them.

Realising that an effectual policy of commercial security was vital especially in respect of navigational "know-how" and detailed rutters for sailing to and around Asian waters, stultified Iberian bureaucracies failed to notice what was happening around them. Without thought, they were attempting to maintain high levels of security classification on navigational information for long, perhaps they hoped, indefinite periods. However, they were not able to operate such a policy within a 'closed' system. In addition to the interchanges and espionage directed at such information in Europe, we must remember the Spaniards did not awake to the potential significance of other powers obtaining the training manuals of navigation used in Seville

until certain passages were cut from a manual printed in 1558. Through these manuals and with the help of pilots and cartographers in exile from Portugal and Spain, the seamen and aspiring gentlemen of Northern Europe could learn about celestial navigation, and acquire thereby the technology that could get them to Asian waters. Once they could reach Asian ports, they too would have access to those Asian sources of information which, by virtue of their extent and traditional attitudes, the Portuguese administrations could not close. Northern Europeans would then have their own access to the various Asian traditions of coastal and celestial navigation.

As the Protestant powers of Northern Europe did not feel bound by Papal dictates, all that was required to displace the Portuguese from their Asian possessions once the techniques of oceanic navigation had been mastered by northern Europeans, was a sufficiently determined entry by the seamen of northern Europe. The factors creating this resolve arose from the animosities between Catholic and Protestant powers, particularly the war between Spain and the Low Countries and England, where many seamen of the two latter powers were fighting those of Spain and Portugal. Doubtless the resolve of James Lancaster, who

sailed east to reach Achin in September 1592, was vastly strengthened by his upbringing on the Iberian peninsula, where he developed deep animosities towards the Spanish and Portuguese. Before he returned to Achin again in 1602 with the first voyage of the English East India Company, he had been preceded by some even more determined and ruthless Dutch voyages made with the help of English pilots.

The factors which encouraged the Dutch and the later English to make such voyages were reports from their countrymen on the wealth to be earned in Asian trades. The most significant accounts were by Jan ^{van} Huighen/Linschoten. While Lancaster explored the East in 1591-4, Linschoten, having been shipwrecked aboard a Portuguese ship on the Azores, had two years to sort out his ideas on the last fight of the Revenge and his experiences since joining his brothers in Seville in 1576. This time included his experiences in the service of the Archbishop of Goa in India from 1583 to 1589. While in India, he interested himself not only in Indian life and customs, but set out to collect information about their cities, trade and navigation. Thus one reads in his works translations of Portuguese rutters that were actually circulating in Goa, just as the statistics we examined suggested. Later other Northern Europeans

extensively copied Linschoten's writings. For example Purchas in His Pilgrimes wrote of Linschoten's interest in the pilotage arrangements in "the River of Goa".¹⁵

The first Dutch reaction to Linschoten's information was to take Linschoten on a voyage to discover a North-East passage to Asia. On his return from this unsuccessful voyage under Willem Barents, Linschoten completed the accounts of his travels for publication in Amsterdam. In them he commented that the Portuguese seemed to have lost the stomach for fighting and the wish to promote discoveries, all of which strengthened the Dutch resolve to challenge the Portuguese on the Cape, and to a lesser extent the Spanish route via Magellan's straits.

Faced with the problem that the Spaniards had left open a back door (that which allowed Northern Europe to print the contents of their manuals) the Iberians could not stop pilots such as Barents carrying these manuals on their attempts to reach Asia.¹⁶ Furthermore, once in

¹⁵S.Purchas. His Pilgrimes. Vol.II. Book X, chapters 33 and 34, pp.1760 and 1761.

¹⁶Barents's third attempt to find the N.E. passage was fatal, but all his instruments, charts and books including Pedro de Medina's manual were preserved in the ice to be discovered intact in 1871.

Asia they could hardly stop their rivals passing through the front door and obtaining Asian information in Asia. So whereas in the 1570s a presentation of the Chinese atlas Kuang Yu T'u drawn by Lo Hung Hsien, was a rare gift to Philip II, by the mid-seventeenth century its information was quite commonly available because another copy had been obtained by John Saris in Bantam in 1614 and was subsequently printed in Purchas's His Pilgrimes, in 1625.¹⁷

As if to emphasize the changed context, the English, Dutch, and to a lesser extent the French and Danes sought and obtained trading concessions from Asian rulers. The terms of the letter from James I to the Emperor of China reveal much about attitudes. An extract from it reads thus:-

"To the High and Mightie Monarch, the great Emperour of China, & etc., Greeting
The Report of the greatnesse of your power and dominion in those Easterne parts of the World, hath stirred up a great desire in our Subjects to undertake a Voyage, into your Countrey to sollicite your friendshippe, towards the settling of a Trade and Commerce with your people,

¹⁷S.Purchas, op.cit. Vol.III, Book II, chapter 7, p.401. "The map of China taken out of a China Map printed with China characters, illustrated with Notes, for the understanding thereof".

as they have already done with dyvers other Nations, as farr dissident from you".¹⁸

The Portuguese failed to deter such European incursions by naval means, and could do little about the increasingly common practice of Asian rulers to appoint non-Portuguese experts in navigation and cartography to privileged positions at their courts. However, they tried to choke those Asian contacts they had previously relied on, so as to deprive their European rivals of such information. To this end they actively discouraged exploration and the efforts of men like Erédia. In 1610 the Viceroy advised the King about the proposal that Erédia be made Cosmographer Major of India, in addition to the Cosmographer Major resident at Lisbon, saying that

¹⁸Letter of James I to the Emperor of China. Dated at the Palace of Westminster 7th February 1613 /1614/.

This illuminated manuscript, probably written by Edward Norgate, Clerk of the Signet Extraordinary, was used in the establishment of diplomatic relations with China in 1616. A photograph of the text appeared in Sotheby's Sale Catalogue of The Celebrated Library of Boies Penrose, Esq. F.S.A., F.R.G.S. The Second Portion M-Z. Travel and Exploration, Navigation and Trade. Tuesday, 11th. Nov. 1971. Lot 290 and plate opposite p.112. Note also that the Court Book Vol.III (I.O.R. B/1/5) p.60 records instructions given to Mr. Bell to collect royal letters for the rulers of China, Japan and other Asian powers. This entry is for 14th March, 1614.

See Volume II Illustrations, Fig.26.

"the office of Cosmographer Major which Manuel Godinho de Erédia asked for is unnecessary and things he spoke of [Australia] are of no significance".¹⁹

However, as the Portuguese turned their backs on Asian sources (with the notable exception of the Teixeira family of cartographers operating in Lisbon) so their standards of navigational safety slumped. Desperate to raise safety standards, but retain the advantages of controlling information from Lisbon as far as possible, they permitted the printing of rutters, but insisted on tight control of the stocks of Reimão's rutter, lest they fall into the hands of foreigners who might thereby profit.

Other steps taken during Lavanha's period of office were aimed at reviving Portuguese standards of safety; for example Reimão was made Pilot Major of India before taking the new viceroy to India in 1608.²⁰ Lavanha himself tried hard and even attempted some measures of counter espionage against the Dutch.

¹⁹PMC. Vol.IV, p.44.

²⁰PMC, Vol.IV, p.82. Reimão sailed to India in 1608 with the new Viceroy, Rui Lourenço de Tavora, with the title of "Pilot Major of India", an appointment which might have prompted Erédia's letter of 2nd February 1609. However, though Reimão did make another return trip in 1614-15, because he never stayed long enough in Asia to constitute a serious security risk, he perhaps was preferred to Erédia who had every reason to stay in Asian employment.

All these ~~steps~~ and the cost of mounting expeditions to the Far East ensured that the northern Europeans realised that good navigational information needed to be carefully gathered, organised and stored. The Dutch were good at this and organised a cartographic office to serve the newly formed United East India Company from the outset.²¹ It was run in turn by Petrus Plancius until 1608, by Augustin Robert from 1608 to 1617 and from 1617 to 1633 by Hessel Gerritszoon. By contrast the English East India Company does not seem to have been so careful. The Standing Orders of the English East India Company suggest the Treasurer was responsible for the valuable documents, and the Pilot for matters of navigation on the Thames.²² The Court Book of the Company on 29th January 1600[1] records that

²¹ As early as 20th April 1602 the Chamber of Amsterdam ordered Petrus Plancius to make accurate descriptions of all the places in the East Indies suitable for trade and to make the information available to themselves and other Dutch Chambers. Plancius's long standing interests made him the obvious choice for the new post. See G.G.Schilder. "The Organisation and Development of the Dutch East India Company's Hydrographic Office in the 17th Century." 6th I.C.H.C. Greenwich, 1975, p.2.

²² The Lawes and Standing Orders of the East India Company. 1621 Gregg International, (Reprint) 1978, para. CXIII, 234. "Mr. Pylot" was responsible not only for pilotage as far as Gravesend but also for the masts, cordage, hire of workmen, the repair of ships and moorings along the Thames insofar as this was required for Company ships.

"Mr. Hacklutt the historiographer of the viages of the East Indies - was required to sett down in wrytyng a note of principall places in the East Indies, where trade is to be had to th[e] end the same may be used for the better instruccion of our factor in the said voyage".²³

Later on 16th February the Court Book records Hakluyt's reward was agreed by the assembly to be "tenne pounds and xxx s for 3 mappes by him provided and d[e]liver[e]d to the Company".²⁴ However, though they tried to keep a register of letters and other material writings, it was found that certain journals wanted in 1614 could not be found.²⁵ Accordingly they resolved that

²³India Office Records, Court Book of the East India Company, Vol. I, B/1/1, p.59.

The East India Company minutes are at the end of a book which also contains Levant Company business. This suggests its origins as a company were as an outgrowth of the Company of Levant Merchants, but it may also be because Sir Thomas Smith was governor of both companies in 1600. Richard Hakluyt is first mentioned at an assembly of committees which the volume records as taking place on 16th October 1599 (p.10.)

²⁴I.O.R. Court Book I. B/1/1, p.67. 16th February 1600.

²⁵The first entry in the Court Books about this is for October 6th 1609. I.O.R. Court Book II B/1/3, p.142. The next I.O.R. Court Book III B/1/5, p.309, December 13th, 1614 says that certain journals could not be found. The Company's first Secretary, Richard Wright, first mentioned on 8th October, 1600, may have kept them until his dismissal on 15th March, 1614 as recorded in Court Book III, B/1/5, p.65. This was interesting because Richard Wright is shown by this entry to have enjoyed the additional advantage of an upbringing in Spain and Portugal.

See Volume II Fig 29

all journals should first be written into the Company's books before being lent to anybody. Nobody was to consult them without the approval of the appropriate committee. However, this had little effect for on 30th August, 1615 the Company's Court again instructed no lending of journals was to be permitted "before the copies of them be entered in their books, whereby the journals themselves have been lost, to the great prejudice of the Company".²⁶ On the other hand, there is reason to believe that Edward Wright, when Captain Downton recommended to the East India Company as "an excellent mathematician and engineer",²⁷ who had "gathered great knowledge in the universities and effected many worthy works in rectifying works formerly smothered", was so good a "library-keeper" that he impressed both Prince Henry and Prince Charles.²⁸ Downton

²⁶I.O.R. Court Book III, B/1/5, August 30th, 1615. Note that by 1621 the Laws and Standing Orders of the Company required the Treasurer (op. cit.), p. 8-9 to look after some such items. The appropriate entry for the Treasurer reads "They are to have the Custody of His Majesties Letters Patents to the Company: also the Orders, Letters, Directions and other writings of his Majesty, the Lords of his Counsell, and other great officers; together with letters from the East India Company in Holland and coppes of the severall Answers made unto them".

²⁷I.O.R. Court Book III, B/1/5, March 14, 1613/147, p. 60.

²⁸I.O.R. Court Book III, B/1/5, July 7th, 1615, p. 443.

was clearly thinking of Wright's brilliant theoretical contributions to navigational advance, especially the treatise he had written in 1592 only five years after becoming a Fellow of his Cambridge college. This treatise, first presented in draft to the Earl of Cumberland after Wright's return with John Davis to Fayal, was subsequently published as "Certaine Errors in Navigation" in 1599.²⁹

In fact Edward Wright was appointed to give an annual course of lectures on navigation to the company after Sir Thomas Smith and Mr. Wolstenholme ceased to subsidise this in 1614.³⁰ He was also expected to examine journals of the Company's navigators and "to perfect their plottes".³¹ Indeed, his greatest contribution to the art of navigation was to appreciate the errors in current cartographic projections, and the faults built into charts based upon compass bearings uncorrected for variation. Though Wright had allowed both Blundeville in

²⁹Edward Wright, Certaine Errors in Navigation, Arising out of the Ordinarie erroneous making or using of the Sea Chart, Compasse, Crosse-staffe and Tables of declination of the Sunne, and fixed starres detected and corrected By E.W. , Valentine Sims, London, 1599.

³⁰I.O.R. Court Book III, March 14th, 1613[14] p.60.

³¹Ibid.

His Exercises , published in 1594,³² and Barlow in The Navigators Supply published in 1597,³³ to use parts of his work, he was furious to find that, having entrusted a draft to Abraham Kendall, tutor of the future Duke of Northumberland,³⁴

³²M. Blundeville, His Exercises, containing six treatises, the titles whereof are set down in the next printed page, which Treatises are verie necessary to be read and learned of all young Gentlemen that have not been exercised in such disciplines, and yet are desirous to have knowledge as well in Cosmographie, Astronomie, and Geographie, as also the Arte of Navigation, in which art it is impossible to profite without the help of these or such instructions. To the furtherance of which Art of Navigation, the said M.Blundeville speciallie wrote the said Treatises and of meere good will doth dedicate to all the young Gentlemen of this Realme , John Windet, London, 1594.

This work was written largely for the instruction of Blundeville's friends at the Inns of Court. It utilised information drawn mostly from Cortes's manual and brief account of Drake's circumnavigation.

³³William Barlow The Navigators Supply, Containing many thinges of principall importance belonging to Navigation, with the description and use of diverse Instrumentes formed chiefly for that purpose, but serving also for sundry other of Cosmography in Generall. The Particular Instruments are specified on the next page , G.Bishop, R.Newberry and R.Barker, London, 1597.

Barlow argued for the establishment of a set of lectures on navigation in London. These materialised when Sir Thomas Gresham's will was put into effect after the death of his widow in 1596. The City of London Corporation and the Mercers Company followed the provisions of Sir Thomas Gresham's will set out in 1579 and established Gresham College in 1598. There lectures on navigation were provided through the maintenance of two professors at a salary of £50 per annum.

³⁴D.W.Waters, The Art of Navigation in England in Elizabethan and Early Stuart Times. N.M.M., Greenwich, 1978, p.221.

had been plagiarised and sent to the Earl of Cumberland for comment. Worse still, he was not immune from opportunist commercial espionage by Jocodus Hondius, who copied without acknowledgment Wright's projections of the four continents and published them in Amsterdam.³⁵

³⁵W.G.Hellings. Copy and Print in the Netherlands. An Atlas of Historical Bibliography. North Holland Publishing Company. Amsterdam, 1962, p.38.

Jocodus Hondius was an emigré from the Netherlands, resident in London from 1583-4 until he returned to the Netherlands in 1593. He was followed there by his English friend Emery Molyneux, in 1596 and 1597, one or other of them also taking the copper plates of the globes. Molyneux died between July 1598 and April 1599. Hondius secured publication of Wright's work and seems likely to have done the smuggling after completing the work for which William Sanderson had paid over £1,000. Emery Molyneux, whose name, like Hondius's, also appears on the only two globes to have survived in their original state (at Petworth House) seems to have had a relation in whom the English East India Company maintained interest until 1614.

See also two exhibition catalogues The Dutch in London. Catalogue of an Exhibition held at the London Museum 1971, p.5, and Sir Francis Drake. An Exhibition held to commemorate Francis Drake's voyage around the world 1577-80, British Museum Publications Limited, 1977, pp.80-83.

All this served to show what the Iberians had already discovered, that it was difficult to keep original and useful navigational ideas and information secret for long. Indeed, Edward Wright himself followed Philip III of Spain and advocated the idea of a large endowment for research into longitude.³⁶ Wright also saw the advantage of a well organised hydrographic service, both to ensure safe keeping of journals, and charts, and to permit instruction. To achieve this, items were "reduced to heads to be readily found upon occasion".³⁷ As we shall see, the Dutch were quite successful in learning from Iberian mistakes and imposing a considerable degree of commercial security, even secrecy, upon their improved instruments and charts. The English East India Company also tried to do this, for example, instructing George Waymouth in April 1602 that he

"shall not discover the secrets or course of his proceeding in the voyage to any other person or persons whatsoever than to the said Governor, deputie and comitties".³⁸

³⁶D.W.Waters, op.cit., p.223.

³⁷I.O.R. Court Book III, July 16th, 1614, p.166.

³⁸I.O.R. Court Book I, April 10th, 1602, p.96.

The English East India Company, unlike the Iberians, were anxious to promote the discovery of a Polar passage, so they agreed in 1601 to pay Waymouth £100 to buy instruments and £500 if he should discover such a passage.³⁹ Three of the warrants to Alderman Campbell for the expense of purchasing these instruments survive. The last of them reads

"Warrant is given to Ald. Campbell, treasurer of the voyage to the north west to pay unto Robert Grynkin for watches, compasses, Runnyng Glasses and instruments for the shippes uses the sum of xxxli sterling".⁴⁰

In this commitment we see how hard English merchants and companies strove to equip their ships with the best navigational instruments they could buy. This marks, however, the end of the social rise of the professional navigator who could in the sixteenth century obtain both very large payments and command of his ship merely because of his navigational skill. It was soon apparent that men like Mr. Wentworth, who had retired to the country with a reputation

³⁹I.O.R. Court Book I, September 1st, 1601, p.84. Waymouth was very interested in navigation, completing by 1604 a manuscript, B.M. Additional MS 19,889, "The Jewell of Artes", which with many drawings described the use of the back staff, quadrant, cross-staff and astrolabe, and included both the original and final forms of John Davis's staff.

⁴⁰I.O.R. Court Book I, May 3rd, 1602, p.99.

as a good navigator could not expect a command from the East India Company just for that skill.⁴¹ As the Court of the East India Company became more experienced, they sought in their commanders not just professional skill, but an air of authority. An idea of the model they might have had in mind is to be gained by examination of the picture of a Dutch navigator dated October 23rd, 1624 and now in the National Maritime Museum. He is holding a pair of dividers to the latest Bleau globe, and stands near a rolled and coloured chart of the East Indies which lies on the floor. He is very smartly dressed.⁴² The Court Book of the English East India Company expands on this theme over the case of M. Harris. It notes of the Court:-

"They were acquainted that one Captaine Harris belonging to my lord Privy Seal is like to pressed upon them, for a chief commander. But answer was given him by Mr. Governor the Company expect in a man to be qualified for such a place for their service, to be partlie a Navigator, partlie a Merchaunt to have knowledge to lade a shippe, and partlie a man of fashion and good respect".⁴³

⁴¹ I.O.R. Court Book III, B/1/5, p.52

⁴² Portrait of a Navigator with dividers and globe, attributed to Hendrick Van der Borch (1583-1660), National Maritime Museum, Navigation Gallery, N.R. 2/X/68.

⁴³ I.O.R. Court Book III, B/1/5, p.52.

As they strove to improve navigational performances, so we also see the English prepared to throw themselves into any interchanges which might prove useful. Hence their rather uneasy alliance with the Dutch until the massacre at Amboyna in 1623. Their commitment to the notion of interchange is seen in another guise in 1606, forty years after the first Huguenots began settling in London in the wake of persecution by the Spanish administration of the Netherlands. That year there appeared "The Dutch Schoole Master. Wherein is shewed the true and perfect way to learne the Dutch tongue to the fartherance of all those which would gladlie learn it".⁴⁴ Its value was clear in the context of the flood of Dutch maritime literature published at Amsterdam.

The cost of the English and Dutch research efforts makes interesting comparison with Spanish spending on ineffectual longitude research. It suggests an English commitment to discovery and trade which by the early seventeenth century seems to have been lacking within the Iberian Empires. In Portugal there was in maritime

⁴⁴Merten le Mayre. The Dutch Schoole Master Wherein is shewed the true and perfect way to learne the Dutch tongue to the fartherance of all those which would gladlie learne it. George Elder, for Simon Waterson. London, 1606. A facsimile of the Bodleian Library copy has been produced by the Scholar Press, 1972.

circles an obsession with navigational safety which seemed almost to sap the confidence necessary for oceanic voyaging. Typical of this mood were the comments of Aleixo da Mota, Pilot Major of the Carreira da India. Writing about 1625 he said

"that the latitudes of shoals and islands are not always accurately marked on the charts, and there are others which are not marked at all".⁴⁵

Concerned as they were about falling safety standards, there is scope to wonder how much their problems were compounded by imperial commitments which meant it was hard for them to find the necessary finance, ships, men and cargo in time to sail at the optimum times of year - times which became known to both pirates and to the navies of their European rivals. Richard Flecknoe, a Catholic English priest, offered a passage to India on a Portuguese ship in 1650, declined saying

"Not one Portugal ship in three returns safe from the voyage, whilst not one in ten of the Hollanders ever miscarries. The doubling of the Cape of Esperanza being only dangerous at some seasons of the year, which seasons they never avoid (by their own confession) so unwise men, or so ill mariners are they".⁴⁶

⁴⁵C.R.Boxer, Some Second Thoughts on the Tragic History of the Sea. Hakluyt Society, Annual Report for 1978, p.6.

⁴⁶Ibid., p.2.

Did this reputation come about because the Portuguese talked themselves down, or does the explanation lie more in the very nature of the Iberian presence in Asia, or in the nature and traditions of the Asian interchanges of navigational information?

There is a certain scope to wonder in the light of various comments by Dutchmen whether the Portuguese had ceased to try. An explanation of the Portuguese failure to keep up a flow of information from Eastern sources to Lisbon may well be explained by the observations of the very perceptive Dutch Governor General at Batavia, Antonio Van Diemen, who wrote to his superiors in Amsterdam that by 1642

"Most of the Portuguese in India [Asia] look upon the region as their fatherland and think no more about Portugal. They desire little or no trade thither, but content themselves with the interport trade of Asia, just as if they were natives thereof and had no other country".⁴⁷

So one asks did the Portuguese and Spanish navigational agencies become too dependent on high quality Asian interchanges of information?

The results of a century of interchanging such navigational information will be examined in the ensuing chapters on the nature of the Asian interchanges.

⁴⁷C.R.Boxer, Four Centuries of Portuguese Expansion, 1415-1825, University of California Press, 1969, p.54.

Chapter 7

The Arab Interchange

European pilots trading to Mediterranean ports in the middle ages were well aware of the competence of Arab masters conducting similar trades. The principal ports of Italy, the Holy Land, North Africa and the Iberian peninsula were the main points of contact. However perhaps the most open interchange took place in Norman Sicily, where al-Idrīsī presented Roger II of Sicily with a superb geographical manual known as the Book of Roger describing the Arab lands and trade routes from China, India to North Africa, the Mediterranean, and the Atlantic Ocean, so short a step from his native Ceuta.¹

It was, however, the Iberians who were the first really significant beneficiaries of navigational information from Eastern sources and traditions. This interchange began through the Arab presence on the peninsula, and along the northern and western shores of Africa. Through Arab learning they had direct contact with earlier attempts to fix geographical co-ordinates by celestial observation in India, Egypt, China and Greece. Certainly the Arabs were also

¹ Abū 'Abadallah al-Sharīf al-Idrīsī (1099-1162), was born at Ceuta of an Alid family, and later studied at Cordova, before embarking on his extensive travels through Arab lands, and the compilation of his great geographical work Nuzhat al-Mushtaq, (more commonly known as the Book of Roger because it was presented to Roger II in the last year of his reign, 1154.)

heirs to traditions of navigation in the Mediterranean by the ancient Egyptians, and to the voyages from the Red Sea and Persian Gulf where reed boats seem to have facilitated oceanic voyaging to India since 2000 BC.² The Arabs were also heirs to Greek and Roman information about the Indian Ocean and its monsoon pattern and to the traditions of local pilotage mentioned in works like the Periplus of the Erythrean Sea and the writings of Cosmas Indicopleustes.³ These texts closely investigated by W.W.Hyde and E.G.R. Taylor show the high quality of Greek astral and geographical knowledge was exploited for navigational purposes by the three dozen ships involved in the Indian trade in

²Archaeological evidence for trading between the middle east and India is particularly evident in the Persian Gulf in the form of copper objects and other items particularly evident in Bahrain and Oman. The voyage recently made by Thor Heyerdahl in "Tigris", a reed boat constructed in the Iraqi marshes suggests that suitable cargo carrying boats could have been built. However the voyage demonstrated the need for improved steerage and navigational aids. (BBC2 9 pm, Feb.10-16, 1979).

³W.W.Hyde. Ancient Greek Mariners. Oxford University Press 1949 pp.169-249.

E.G.R.Taylor, Haven Finding Art. Hollis and Carter, London 1971, pp.40-63.

About 400 years separate the Periplus of the Erythrean Sea written by a Graeco-Egyptian about 60AD and Cosmas Indicopleustes, a native of a Red Sea port very familiar with the Indian trade, though not himself a sailor.

See G.W.B. Huntingford. (Translated and Edited) *The Periplus of the Erythrean Sea* The Hakluyt Society. London. 1980.

Strabo's time.⁴

The Arabs who retained many of these classical texts in their great libraries at Baghdad, Alexandria and Timbuktu, were interested in these subjects partly because their religion demanded this astronomical knowledge to permit prayer facing Mecca at the correct time. The Koran gave another reason: "He [Allah] it is who hath appointed for you the stars, that ye guide yourselves thereby in the darkness of the land and sea. We have made the signs distinctive for those that have knowledge".⁵

⁴ Strabo, whose geographical works were widely read again by the sixteenth century, gave useful information about the Arctic circle, measurement of distances, latitudes, the use of winds for direction, tides, quicksands and voyaging into the Indian Seas.

Some of the more significant Renaissance editions of Strabo's Rerum Geographium were:-

Strabo Latine Venice 1480 (In Appulia) ex-Berghem.

Strabo Latine Bartholmeu de Zanis ex Josie Sinclair Venice 1511

Strabo in Latinam linguam versa a Gregorio Trifernate Guavino Veronese Paris 1512

Strabo Graece Aldus. Venice 1516.

Strabo ab Euarino Veronese e Gregorio Trifernate (ut putatui) erus sed recognitus emendatus ab Conerado Heresbactico . Basle 1523

Strabo Latine ex versione Euarini Veronerisis & Gregori Trifernatis, sed recognitione Conradi Heresbactia, ex officina Civionis . Basle 1539.

Strabo Graece & Latine ex emendatione Marec Hoppen Basle 1549

Strabo Graece & Latine ex versione M. Guihielmi Xylandri, cum emendatione et notis, Basle 1571.

Strabo Graece & Latine cum notis Isaaci Casuaboni Geneva 1587

Strabo Graece & Latine cum notis Isaaci Casuaboni Paris 1620

⁵ E.G.R.Taylor. Haven Finding Art, p.126.

The astronomical texts preserved by Arab users seem to have been much more widely studied in Europe, once translated into Latin, than Arab geographical texts. Ptolemy's *thirteen volume treatise* usually known by its Arabic name Almagest, was translated into Latin in the twelfth century by Gerard of Cremona, a student of Arabic working at Toledo. During the thirteenth century it became accepted by schoolmen and astrologers, as an improvement on the Aristotelian system and as discrediting the flat earth theories of Cosmos Indicopleustes, thanks to its popularisation by Sacrobosco (John Holywood) in his De Sphera Mundi.

Other important Arab astronomical texts to find their way to Spain were the tables of Muhammad ibn Jābir al-Battānī, famous in Europe as Albategnius, now in the Escorial, and the treatises by Abū Ma'shar, called Albumaser in Europe.⁷ Abu Ma'shar's works were widely known in Europe and the East. His Madkhal, was a very popular introduction to astrology which, together with several astronomical texts, has been preserved in manuscript in various European libraries. One astronomical text of his was translated into Latin by the Dalmatian Hermanus Secundus and much later, published as Introductionum in Astronomiam.

⁶ J.H. Parry, The Discovery of the Sea, Wiedenfield and Nicholson. London 1975 p.67.

⁷ Muhammad ibn Jābir al Battānī was a Sabian from Harran. He lived at Raqqa on the Euphrates and took his observations between 882 and 900. The resulting tables found their way to the Escorial, where they were translated by Plato Tibertius, to be published at Nuremburg in 1537. See Huart A History of Arab Literature, Khayats. Beirut, 1966, p.296

This contained an astrological theory of the tides that remained popular for several centuries, no doubt because of its attractive diagrams and illustrations.⁸

An instrument which served both the astronomical and astrological interests of the Arabs and later the Europeans was the astrolabe. Though both astronomer and astrologer could use the astrolabe to determine the position of stars and the sun, the astrologer also used it to interpolate the positions of the planets for a given date in relation to the astronomical Houses of Heaven. The fact that the astrological scales were frequently engraved on the back of surviving Arab astrolabes, and the fact that many of the early European printed treatises on the astrolabe contain lengthy chapters on its astrological usage, testify to the continued European interest in that technology which would at once foster astronomical and astrological ends, even though it was developed by the Arabs against whom they had long campaigned.

Proctor's research has suggested it was first developed in Alexandria by a man called Theon about 375. upon whose work the writings of John Philoponus and Serevus Sebokht seem to have been based.

⁸ Abū Ma'shar Ja 'far ibn Muhammad died in 885. The translation by Hermanus Secundus entitled Introductio in Astronomiam, was printed in Augsburg by Erhard Ratdolt on 7th February 1489. See The Celebrated Library of Bois Penrose removed from Barbados Hill, Devon, Pennsylvania, Sotheby's Catalogue for sale on 7th June 1971, lot 3, p.6.

The word 'astrolabe' is adopted through old French from the Medieval Latin 'astrolabium' and from the Greek, astrolabos (αστρολάβος) as used in Ptolemy's Geography 1.2.II with reference to the instrument. It is not as yet known whether this is a Byzantine interpolation of the twelfth century date, or the original second century text.

Whereas all these men lived in or near Alexandria, tentative evidence of the transmission of the astrolabe is provided by the fact the Byzantine Ammonius is said to have used one about AD 500.⁹ However, it does not seem to have been known outside the Eastern Mediterranean ports until the Arabs had captured Alexandria in 640 AD. The Persian, Abū-l-Hussain, wrote a treatise on the astrolabe in 984, about the same date as the making of the earliest European astrolabe which is of the 'maghibi' (Spanish-Arabic) type.¹⁰ This European exemplar differs from Eastern astrolabes in that the scales on the back included a Zodiac/Calendar scale instead of normal astrological and lunar scales.¹¹ As such it seems to have been specifically designed for European needs. About the same time treatises on the astrolabe were being written in Spain by such scholarly mathematicians as Abū'l-Qāsim al-Ghāfiqā who finished his treatise in 1026.¹² Also at this time the Arabs, having established control of most of the Iberian peninsula, began to establish such centres of learning as Cordoba in 970 and later Toledo, Seville, Saragossa and Valencia. Among the early Europeans sent to Spain to complete their education was Gerbert (930-1003) who became Pope Sylvester II, and was to

⁹ Ammonius, son of Hermeas, died in AD 484. He was the master of Simplicius and Damascius who were exiled by Justinian I and went to the Court of the Persian king, Chosroes. They worked with the Edessan scholars whom Chosroes commanded to translate into Persian as many classical works as possible. These exiles returned to live unpersecuted under Justinian I as part of the peace terms imposed by Chosroes in 533 AD.

¹⁰ Abū l-'Hussain 'Abdal-Rahmān al Sūfi of Rai was an astronomer in the service of Buhwaihīd Prince Adud al-daula who died in 986.

¹¹ D.V.Proctor *Astrology and the Astrolabe* Ingrid and other Studies, N.M.M. Monograph, No36, 1978, p110

¹² See Huart A History of Arab Literature, p.297.

continue his links with Spain. He is supposed to have owned the astrolabe now preserved in the Museum of the History of Science in Florence. A treatise by Gerbert deposited at St.Ripol, seems to have formed the basis of the description of the astrolabe written by Hermann the Cripple about 1050. A Jewish scholar, Petrus Alfonsus of Spain, visited Henry I and taught astronomy to Walcher Prior of Malvern who was one of the first Englishmen to own an astrolabe. Another Spanish Jew, Abraham Ibn Ezra (1092-1167) shortly after coming to London in 1158, wrote a treatise on the astrolabe.¹³

Robert of Chester was informed enough to be able to conduct correspondence with the Dalmatian Hermannus Secundus about the astrolabe in 1147.¹⁴ He adapted the latter's tables to London where he lived between 1147 and 1150, and translated the algebra of al-Khawizimi into English, though it must be said Adelard of Bath had already translated al-Khawizimi's arithmetic into Latin. All these links were to prove invaluable for later astronomers and navigators.

Eastward transmission of the astrolabe from Arab lands was not so influential. An Arab astrolabe was taken to Peking in 1267 from the Persian observatory of Marāghah. However the type of observations which Jamal al- Din tried to teach the

¹³D.V.Proctor *Astrology and the Astrolabe* N.M.M. Monograph No.36-1978, p.110. I.A.Abrahams The Legacy of Israel ed. Bevan and Singer. Oxford Univ. Press, 1927.

¹⁴*Ibid.* p.111.

Chinese was not adopted into normal Chinese practice. The first certain users of astrolabes in the Far East were the European sailors and the Jesuits who arrived there in the 16th century.¹⁵

Arab sailors may well have taken astrolabes to China any time from the ninth century onwards, but it seems highly unlikely that Arab sailors used them at sea before the fifteenth century. By that date, however, Fra Mauro, who seems to have known far more than most Iberians about Eastern navigational practices of his time, could add an inscription to his famous map, very near two ocean-going junks depicted sailing across the Indian Ocean, stating:

"The Ships or Junks which navigate these seas carry with them an astronomer who stands alone on the high [poop] with an astrolabe in hand. He gives orders concerning navigation".¹⁶

That the Arabs had developed the astrolabe for seaborne use is recorded by João de Barrós. The latter, describing the encounter of the Portuguese and the pilot Malemo Cana off Malindi in 1498, said:

"On Vasco da Gama showing him a great astrolabe of wood, which he had with him, and others of metal which served to measure the height of the sun, the Moor exhibited no surprise ..."¹⁷

¹⁵ See chapter "The Chinese Interchange".

¹⁶ J. Needham. Science and Civilisation in China. Vol. IV, pt. 3, p. 572.

¹⁷ Extract from Décadās da Asia, by João de Barrós, Bk. IV, chapter 4, in translation by G.M. Theal. See G.M. Theal, Records of South Eastern Africa, Vol. VI, p. 185.

All these circumstances strongly suggest that European understanding of the use of a simplified astronomers' astrolabe at sea was not the result of an interchange of information in the Indian Ocean, but was the result of the interchange of knowledge about the astrolabe originating from its introduction to Spain by the Arabs in the ninth century. Proctor has suggested the fact the kingdoms of Leon, Aragon and Navarre were never quite conquered by the Arabs facilitated this exchange.¹⁸ By about 1280 the construction of planispheric astrolabes was established in northern Europe, though it would be a further two hundred years before the Portuguese solved the problem of simplifying it sufficiently for marine use.

The Portuguese were using the mariner's astrolabe at sea by 1481. The instrument used may well have consisted of a simple wooden circle with alidade, suspended from frames and therefore rather bulky and unwieldy for seaborne use. Except on very calm days such observations were uppermost in the minds of sailors trying to use the early and large wooden astrolabes. This is shown by João de Barrós in his description of the wooden astrolabe suspended from a trestle which Vasco da Gama used at St. Helena's Bay in 1499. Barrós says they had to land for water and to take the latitude of the sun

"since the navigators of this kingdom had been using the astrolabe for only a short time for navigation they did not have much faith in sighting the sun aboard

¹⁸ D.V. Proctor *Astrology and the Astrolabe* N.M.M. Monograph No.36-1978, p.110.

ship because of its heaving."¹⁹

Yet these astrolabes were the most advanced of the Iberian instruments of celestial navigation, and the Portuguese seem to have been proud of them above all their other aids. On land such astrolabes do seem to have permitted accurate measurement of astral features. However at sea wooden astrolabes would not have been as good as brass ones made in ring form with a heavy balancing weight at the bottom to counteract distortion through the ship's motion.²⁰ Malemo Cana's

¹⁹ B.W.Diffie and G.D.Windus Foundations of the Portuguese Empire, 1415-1580 University of Minnesota, 1977, p.139.

A description of the early use of a wooden astrolabe to observe a solar eclipse on 3rd March 1337 on land is given in R.G.W.Anderson The Mariners Astrolabe, The Royal Scottish Museum 1972, p.4.

²⁰ Europeans gradually came to appreciate some points about the weighting, and size of astrolabes suitable for use at sea. Thomas Blundeville in his famous textbook for navigators wrote that

..."broade Astrolobes, though they be thereby the truer, yet for that they are subject to the force of the wind, and thereby ever moving and unstable, are nothing meet to take the altitude of anything, and especially upon the Sea, which thing to avoyd, the Spaniards do commonly/^{make} their Astrolobes or Rings narrow and weighty, which for the most part are not much above five inches broad, yet do weigh at least foure pound, and to that end the lower part is made a greate deale thicker than the upper part towards the ring or handle."

Extract from 1638 edition, Squance Library, Durham. For 1st edition in Six Treatises, 1593, see bibliography. Thomas Blundeville - Mr. Blundevil His Exercises, contayning Eight Treatises ... Which treatises are very necessary to be learned of all young Gentlemen, that have not been exercised in such disciplines, and yet are desirous to have knowledge as well in Cosmographie, Astronomie, Geographie, as also in the Art of Navigation, in which Art it is impossible to profit without the help of these or such like instructions. John Windet, London, 1638.

Sizes of known astrolabes vary from 127 mm. to 508 mm. and masses from 384 to 10,170 grams. R.G.W.Anderson The Mariners Astrolabe Royal Scottish Museum 1972 p.5.

cool reaction to Da Gama's astrolabes may well have been justified for the Portuguese seemed to esteem their large wooden astrolabe more highly than small metal ones, while it is probable that Da Gama's brass ones had no special balancing masses. The longer Arab familiarity with astrolabes suggests theirs would have incorporated heavy balancing masses. Thus the Arabs preferred different and lighter instruments, where the inaccuracies resulting from a tired arm holding the heavy astrolabe, and errors due to parallax in using an alidade so far from the eye, might be avoided.²¹

All this must have been quite a technical shock to the Portuguese, who would not have encountered such levels of technical understanding along Atlantic or European shores. However, greatly to their credit, they did strive thereafter to learn all they could from the oceanic navigators of the Indian Ocean and points further east. Similarly the Arabs, like the Portuguese, learnt much from contact with foreign navigators and adopted much from them.

²¹ See illustration of the Use of an Astrolabe, Fig.8.

Many Arab navigational aids known to have been used in the Indian Ocean in the sixteenth century show debts to aids of various provenances but all significant for the enrichment of that navigational information available through international interchange. The range of instruments may be appreciated merely by a glance at the illustrations of various exemplars in a manuscript presently held by Istanbul University.

That manuscript confirms that small and simple quadrants²² were in regular maritime use before Sernigi wrote to Lisbon in 1499 describing how Arabs navigating across the Indian Ocean "trusted to observations with wooden quadrants".²³

Sernigi's observation was enlarged upon later by João de Barrós when describing the exchanges between Vasco da Gama and Malemo Cana. The pilot is quoted as saying to Vasco da Gama

"... some Red Sea pilots were accustomed to use brass instruments in the form of triangles and quadrants with which they found the height of the sun and principally of the stars which they used most in navigation".²⁴

The Portuguese knew how to describe this quadrant for it had been in use in Europe for 400 years, the earliest known reference being 1086.²⁵ During

²²David Divine. Opening of the World, Collins, London, 1973, as illustrated p.78

²³D.Lach. Asia in the Making of Europe, Vol.1, pt.1, p.156.

²⁴João de Barrós Décadas da Asia Bk.IV, chapter 4. Translation by G.M.Theal Records of South Eastern Africa Vol.6, p.185.

²⁵R.E.Latham. Revised Medieval Latin Word List Oxford University Press. 1973, p.385.

their exploration of the west coast of Africa the need for celestial observations became critical as they needed to sail far out into the Atlantic to ensure their return to Lisbon. In 1456-7 Diogo Gomes sailing to Guinea said "I had a quadrant when I went to those parts. I marked on the scale the altitude of the Arctic Pole".²⁶ This is the first known reference to the use of a quadrant at sea, predating reference to the Arab use of marine quadrants. However, because it was even more difficult to steady the plumb bob, or avoid the motion of the ship, if a fixed quadrant were used, it is likely the Arabs used them only to confirm their position in sheltered waters in port or on land.

A sixteenth century woodcut by Roigny, used by the Parisian printer Badius, dateable to 1524, possibly even 1513, shows two Moorish navigators attempting to fix the position of their haven from celestial observations made with quadrants. One has a fixed quadrant suitable for sun sights, the other a portable quadrant with which direct observations of star heights or the sun's height would have been made. All three observers have come ashore for the sake of accuracy, just as the Portuguese sailors did when accuracy was critical, to observe the stars above the high poops of their ship. This ship is clearly a Portuguese ocean going carrack on the evidence of

²⁶E.G.R.Taylor. Haven Finding Art 1971 p.159.

its lines and its lateen mizzen.²⁷ The engraving therefore strongly suggests the international interchange of technology by 1520.

However there is evidence the Arabs learnt about the use of quadrants from the Persians in the tenth century.²⁸ Abū 'l-Wafā al Būzjānī, a notable Persian student of Ptolemy and a geometrician, used a fixed quadrant of radius 22 feet, which would have given the astronomer very accurate measurements, as early as 995. Upon reputations such as his, observatories established at Junda-Shapur, Baghdad, Damascus and Marāghāh had become well-known as far away as Mongol China, so that the instruments set up by Kuo-Shou-Ching in China about 1276 owed much to Arab tradition.²⁹ If the Arabs could impress the Chinese, celestial observers both at sea and on land long before themselves or the Europeans, with their quadrants they are more likely exporters of this instrument than the Europeans whom they met using it at the end of the fifteenth century off East Africa.

It needed a combination of better understanding amongst sailors, better metal working techniques, and a more scientific approach by instrument makers before

²⁷ Macrobius, Somnium Scipionis ex Ciceronis libro de republica sexto excerptum Badius, Paris 1524 (edition), fol.1 Engraving by Roigny, St.Chad's College Library, Durham.

These Moors are probably not local scientists because the nearby town is falling down, but the ship at anchor is sound. A further point is that if they were local astronomers they would not need to fix their meridian by using a standing staff, centre left. See Fig. 31.

²⁸ Huart. A History of Arab Literature, p.297.

²⁹ J.Needham Science and Civilisation in China Vol.1, p.239 and Vol.3, pp.332-3.

the quadrant could be significantly improved beyond the standards of early 16th century Portuguese and Arab instruments. That improvement only came with the wider dissemination of knowledge about the scientific side of navigation through printed manuals. Then alone was it possible to make sensible improvements to quadrants such as adopting the dotted transversal lines first suggested by Richard Chancellor about 1552, and the improvements suggested by Wright, Waymouth and Gunter in late 16th century England.³⁰

Aware of the quadrant's defects, Arab navigators developed a much simpler, but very effective instrument, the "Kamal". It was an instrument that saw regular use in the Indian Ocean for a thousand years, examples of use being noted and drawn by Congreve in his study of the native mariners of the Coromandel coast in 1850.³¹ In the Kamal a knotted string was held taut between the mouth at one end, and a little board, one of nine in a set, held at the end of an outstretched arm so that the little board fitted the gap seen between the horizon and the Polar Star, or one of the Guard Stars (al-Farkadain).

³⁰J.Needham, Science and Civilisation in China, Vol. 3, p.296.

³¹H.Congreve, 'A brief notice of some contrivances practised by the native mariners of the Coromandel Coast in navigating, sailing and repairing their vessels', Madras Journal of Literature and Science XVI, Jan.-June 1850. Cited by Teixeira da Mota opposite p.55 in 6th Colloque Internationale d'Histoire Maritime. Lourenço Marques, 1962. S.E.V.P.E.N., Paris, 1964.

Three different types of kamal have been identified. One type consisted of a cord with a series of sliding wooden blocks of dimensions calibrated in "finger heights" or "isbas". The type Congreve observed had the cord knotted behind one little board and a long cord with a series of knots at predetermined distances along the cord. The little board was held in the left hand so that the observed star just seemed to peep over it. Readings were subject to erroneous measurement because the cord used to measure the height ran to the mouth thereby recording errors due to parallax. The single board with knots corresponding to "isba" heights had the drawback that it was unuseable in higher latitudes than those of the region where it had been made. In the third variant the cord was stretched to the eye to reduce the optical error.

We cannot be sure which of these types was given to Vasco da Gama by his East African pilot, or even whether this was the first sight the Portuguese had of the instrument, but certainly the Portuguese were sufficiently impressed to get John of Galicia to test it on the next voyage to India. Cautiously Teixeira da Mota has claimed the Portuguese began to use the kamal at the very end of the fifteenth century, calling it the "tavoletta", or the "balestinado mouro".³²

³² Teixeira da Mota. 'Methodes de Navigation et Cartographie Nautique dans l'Océan Indien avant le XVI^e siècle'. 6 Colloque Internationale d'Histoire Maritime 1962 pp.53-4.

The newness of the instruments seems sure for on Cabral's voyage via Brazil to India in 1500, his astronomer John of Galicia clearly struggled to master the new instrument. He wrote a letter, translated thus:

"... it seems impossible to me to take the height of a star on the sea, for I labour much at it and, however little the ship rolls, one errs by four or five degrees, so that it cannot be done except on land. And I say almost the same thing about the kamal [*tablas de la India*] for it cannot be taken with them save with very much work, for if your Highness knew how they all disagreed in inches, you would laugh at this more than at the astrolabe".³³

However, familiar with the kamal, the Arabs do not seem to have had these difficulties.³⁴ Recently two detailed studies of the accuracy of the stellar observations taken by Ibn Majid and al-Mahri have shown Arab measurements to have been remarkably accurate for the Arabian coast, the west coast of India and the Malacca Straits. They made very few other errors of latitude, although currents, swells, monsoon conditions etc. had led to dead reckoning errors in the longitude of various destinations in the Indian Ocean.

³³This account, together with Barros's reference to Malemo Cana's instrument "consisting of three tablets" [see Theal p.185], suggests the use of kamals of the first type by the Arab pilot from Malindi who helped Vasco da Gama to Calicut.

See also Cabral. The Voyage of Pedro Alvares Cabral to Brazil and India Hakluyt Society 2nd Series No.LXXXI. 1937, introduction p.39 letter of John of Galicia to the king 1st May 1500

³⁴H.Grosset Grange. 'An Arabian Sea Chart of the Middle Ages'. Journal of Navigation. Vol.28 No.4 pp.434-448 especially figures 1 and 2.

G.R.Tibbets. Arab Navigation in the Indian Ocean before the Coming of the Portuguese Oriental Translations Fund. VOL.XLII Royal Asiatic Society. Luzac London 1971.

The ability of Arab navigators to determine the latitude at sea with so simple yet accurate an instrument seems to have vastly impressed the Chinese with whom the Arabs had been in trading contact since the ninth century. It is quite likely that it was a rather similar instrument that was used in 1403 to take those celestial sights at sea referred to in the Shun Feng Hsiang-Sung as being made all the way from the Yangtze to the Persian Gulf.³⁵ A set of guiding star stretch boards very similar to the boards used on Arab kamals are described by Li Hsu in his Chieh An Lao Jen Man Pi printed in 1606.³⁶ This set of twelve tablets would measure altitudes between $1^{\circ}36'$ and $18^{\circ}56'$, where the unit (a chih) was between $1^{\circ}34'$ and $1^{\circ}38'$, a unit identical with the Arab "isba", mentioned in the fifteenth century texts of Ibn Majid and Suliaman al-Mahri.

However we cannot be sure whether this Chinese instrument incorporated a solid shaft like the cross staff, first described as a surveying instrument in China in 1085, and in Europe in 1321.³⁸ It therefore

³⁵Shun Feng Hsiang Sung (Fair Winds for Escort) describing Cheng Ho's voyages. See chapter "Chinese Interchange" for further discussion.

³⁶See chapter "Chinese Interchange" footnote 18.

³⁷H. Grosset Grange. An Arabian Sea Chart of the Middle Ages JIN 28, No. 4, p. 436.

³⁸J. Needham Science and Civilisation in China Vol. 3 p. 567.

is likely the Arabs exchanged information and details of how to make and use a kamal with the Chinese, and then with Europeans at least a hundred years later. The Arabs did not adopt the more accurate cross-staff aligned to the eye and calibrated with far more precision than a knotted string, or pass details of the Chinese model to the Europeans, because they seem to have learnt about the cross-staff from the Europeans only in the sixteenth century. This impression is confirmed by the fact the Arabs adopted the word al-balisti in the sixteenth century. The Portuguese called their cross-staff the "baletrista", or more rarely the "balhestilla", or the "balestinha".³⁹ As the earliest known reference to the nautical cross-staff is 1514, it suggests the Portuguese were prompted to adapt their cross-staff by their experience with the kamal, while the Arabs, appreciating the drawbacks of the kamal, began to use the nautical cross-staff.

This remarkable Arab competence in celestial navigation so impressed early European writers on the Indian Ocean, that Marco Polo, Nicolode Conti and Fra Mauro specifically said the magnetic compass was not in use by Arab pilots. This is undoubtedly wrong, and indeed an Arab manuscript of 1282, the Book of the Merchant's Treasure, treating of the Knowledge of Stones describes a primitive floating magnetised needle, saying that is used "when the night is dark

³⁹D. Waters. The Art of Navigation p.54.

and they cannot see the stars ... ⁴⁰ However, this type of magnetised floating needle, said to have been used by Syrian sea-captains, could not have been mounted on a wind rose, like European and Chinese compasses, or have been so strongly magnetised as to last an oceanic voyage without further use of a lodestone. It was thus inferior to the Mediterranean-type compasses from which European pilots never took their eye. Thus it is not surprising that Arab sailors with their competence in celestial observation, and sailing in a region of largely clear skies, except at the height of the Indian Ocean monsoons, should have preferred their celestial aids. Even so, the compass had a useful role on Arab ships before the Europeans arrived on the Indian Ocean because Ibn Majid who wrote in 1494-5 says:-

"Consider carefully the Pole Star by night, and place it in the same way as you would determine the [Pole] to be by day when using the compass".⁴¹

In the same seas off the East African coast the anonymous narrator of Vasco da Gama's voyage of 1497-9 said of the local ships at Mozambique:-

"Their mariners have Genoese needles [magnetic compasses] by which they steer, quadrants and navigating charts".⁴²

⁴⁰ E.G.R.Taylor Haven Finding Art pp.126-7.
G.F.Hourani Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times Princeton 1951 p.109.

⁴¹ G.R.Tibbetts. Arab Navigation p.192 for Ibn Majid. The Eighth Fawid of Kitab al Fawā'id fi usul 'ilm al-bahr w-al qawa'id . Biblioteque Nationale. MS 2292.

⁴² V.Stefannson "Great Adventures and Explorations from Earliest Times to the Present Day as told by the Explorers themselves". London, Robert Hale 1947, p.176.

In defining a course to be steered whether determined by kamal, quadrant or compass, they would have used a thirty-two point wind rose. Fifteen points were named after fixed stars, with the addition of North and South. Some rhumbs show Persian origins, and it is noteworthy that a few Mediterranean compasses are marked 'Garbino' instead of 'Libeccio' for South West. This usage clearly reflects misunderstanding of the Arab and Persian names for the rhumbs.⁴³

However, the overall concerns of the navigator in steering a course to his destination in the Indian Ocean were largely determined by the meteorological facts of the monsoons, the worst of which the Arabs sought to avoid while exploiting their change of direction to permit easy return voyages. The anonymous narrator of Cabral's voyage speaks of Arab exploitation of the monsoon pattern thus:-

"The ships of this land navigate only from October or November, until the end of March ... In the month of November the ships of Mecca leave Calicut with spices and carry them to Vida [Jeddah] which is the port of Mecca. And from there they carry them to Cairo and Alexandria".⁴⁴

⁴³ E.G.R.Taylor. Haven Finding Art p.98.
G.F.Hourani. Arab Seafaring p.107.

⁴⁴ Cabral. The Voyage of Pedro Alvares Cabral to Brazil and India, Hakluyt Society 2nd Series No.LXXXIpp.82-3

It is to Ibn Majid's *rahmāni* of 1495 that we must look for the guidance which underlay these remarks about sailing seasons. If it is examined it shows both suggested departure times, and the time taken by particular voyages across the Indian Ocean. It says:-

"Travelling from Ceylon and the Maldives is possible until the 70th and 80th days [up to 10th February] although it is a gamble in some years by the 80th, and the same from Malacca, Pegu and Siam. But from Java, Sumatra, Malacca and Janassari to Bengal sailing takes place from the 90th to 140th days (20 Feb.-11 April) and even to the 160th day. From Sauf (Champu) and China to Malacca, Java, Sumatra, Palambang and that area they travel in al Tirma, meaning the spring of the year, ie the first 100 days of the year and enter Malacca after the departure of the fleet for Calicut They meet the ships coming from Hormuz and Mecca and the latest ships reach Malacca (from Sauf) on the 120th (22nd March)."⁴⁵

The history of Arab *rahmāni* or rutters provides some most illuminating facts about the interchange of navigational information in the Indian Ocean. The earliest reference to them is by al-Maqdisi at the end of the tenth century, when he wrote about the circumstances of their compilation.

"I was thrown in to the company of men - captains, pilots ... agents and merchants - who, bred and born upon it, possessed the clearest and fullest knowledge of this sea, its anchorages, its winds and its islands. I plied them with questions concerning its position, physical peculiarities and limits. I have also seen in their possession sailing directories [*dafātir*] which they constantly study with implicit confidence."⁴⁶

⁴⁵G.R.Tibbetts. Arab Navigation p.223 for Ibn Majid The tenth Faw'id of Kifab al-Fawā'id fi usul 'ilm al-bahir w-al-qawa'id.

⁴⁶Al-Maqdisi wrote about 985 and is relating his experience of journey around the Arabian coasts in Ahsan-al-Taqāsīm fi ma 'rifat al-Aqālim. See Hourani Arab Seafaring p.107.

The rahmāni took a different form from the geographical works of Ibn-Khurdadhbīh,⁴⁷ who wrote about the stages of his journey from the Persian Gulf to China, and Al-Masūdi, who prided himself on his interest in the sea, seamen and their languages as gathered on his voyages to India and East Africa.⁴⁸ The rahmāni were in a format designed by Persian sailors.⁴⁹ Indeed the word itself is taken from the Persian "rahnāmch". These works may have retained their traditional Persian form because, while the writing of geographical treatises would have been considered a worthy occupation for the Arab conquerors, navigation as an inferior profession is likely to have been left in the hands of Persian navigators of Siraf. In his Kitab al-fawā'id fi usul 'ilm al-bahr wa al-qawa'id, Ibn Majid punningly acknowledged his debt to "three Lions" of the tenth century and their rutters". About their pilotage he wrote

"Their principal science consisted in descriptions of the coasts and their extent, mostly below the wind [ie east of Ceylon] and on the coasts of China [not visited by Ibn Majid]. But those ports and cities have disappeared as their names have changed; they are therefore no use at all to our time, which has derived truth from our science and experiences and discoveries as set forth in this book".⁵⁰

⁴⁷ Ibn Khurdadhbīh Kitab al-Masālik w-al-Memalik c.850.

⁴⁸ Al-Masūdi Murūj al-Dhahab wa Ma'ādin al Jawhar c.947.

⁴⁹ The Persians were fine sailors as is attested in Chinese sources. They reached China, and indeed a Chinese pilgrim reports his journey on a Po-sse ship sailing from Canton via Sumatra in 671.

⁵⁰ G.F.Hourani Arab Seafaring p.108. The pun is with a captain named Layth ibn Kahlan, almost certainly a Persian by birth.

All this knowledge of celestial observations and far-distant waters was of little value, as Ibn Majid realised, if mistakes were made near land, hence the need for coastal descriptions and perhaps shore sighting pigeons after Persian practice. Even more important was the quality of local pilotage services and the marking and provision of aids at harbour entrances. After the famous example of the Pharos at Alexandria, the Arabs did provide beacons to light their harbour entrances and warn ships from dangerous shallows. Mas'ūdī said that three wooden scaffolds holding beacons were erected at sea to warn ships off the shallows at the entrance to the ports of Abbādan and Basrah.⁵¹ The Arabs also had a long and excellent tradition of local pilotage. Ibn Jubair, a pilgrim to Mecca from Grenada very interested in nautical skills and terms, described his entry to Jeddah on 4th July 1183 thus:

"On Tuesday morning the wind was blowing against our entry to its harbour, the entry of these anchorages in any case difficult to accomplish because of the numerous coral reefs and winding channels: so we were able to see the art of these captains and sailors in managing the 'jalbah' among them; it is extraordinary how they bring them in like a rider on a horse which is sensitive to the rein and easy under the bridle;"⁵²

⁵¹ G.F.Hourani, Arab Seafaring, p.108. The Khasabat beacons are also recorded in the Chinese rutter Chau Ju-Kua (see Chinese Interchange).

Abū l-Husain Muhammad Ibn Jubair, born in Valencia, settled at Grenada but left on his pilgrimage to Mecca in 1182. He went back via Malaga to Ceuta and Fez where he taught before dying in 1217. See Huart, History of Arab Literature, p.304.

⁵² G.F.Hourani, Arab Seafaring, p.122.

Ibn Majid himself stressed the need for a policy of using the local knowledge of pilots if you were ignorant of a particular coast or harbour. Speaking of the east African coast south of Mozambique he advised that south of Mozambique the reefs were so dangerous that if you did not know them, only the experienced local pilots could direct you safely.

This was exactly the coast for which Vasco da Gama was so anxious to obtain the services of local pilots. He failed off south eastern Africa, but Camoëns records that further north,

"our joy was great to come at last on a people that knew the art of navigation, from whom we might count on getting some news of what we sought. And so indeed we did".⁵³

This negro people was recorded as having a smattering of Arabic, but not all the Arab pilots off East Africa would helpfully put their skills at the disposal of the Portuguese.

There were dangers in complete reliance on Arab pilots largely because of the deep religious enmities to be overcome. Some Arab pilots, as João de Barrós records, tried to sabotage Da Gama's northern progress from Mozambique. One tried to shipwreck Da Gama, and then jumped overboard, as de Barrós records "either because of the hatred he bore us, or because the sheik had so commanded".⁵⁴

The Portuguese soon learnt that navigational information was not going to be given away, but that

⁵³ Camoëns, The Lusíads, Penguin, 1973, page 135.

⁵⁴ João de Barrós Décadas da Asia Bk.IV, Chapter V, translation by Theal in Records of South Eastern Africa

it had its price. João de Barrós records that when the ruler of Mozambique sent Vasco da Gama two pilots "who seemed skillful in their method of navigation", the reaction of the captain was to offer them each a reward of a coat dyed in cochineal, and 30 mictials of gold (which was about 14,000 Portuguese reis). Even this was not enough to buy their allegiance as events proved.⁵⁵

Another method to obtain such co-operation was the torture of captured Moorish pilots. João de Barrós again records this being applied to one of the treacherous Moorish pilots who, though he jumped overboard, was later recaptured.⁵⁶ The likelihood was, however, that under torture the expedient of tempting information would be offered by the victim to satisfy his torturers. Thus this same Moor is recorded as telling of "gold and spices from Sofala to Calicut", but is not recorded as giving any practical navigational information.

Despite these problems the Portuguese long remained keen to utilise the expertise of Arab pilots. This attitude must have owed much to the invaluable help given to Vasco da Gama by the pilot provided through the friendly King of Malindi. Not only did Vasco da Gama gain thereby the services of an excellent pilot, he was able to sail with an easier mind than hitherto because as Camoëns later wrote:

⁵⁵Ibid, p.175.

⁵⁶Ibid, p.175. For the value of captives as sources of information, see Cabral, The Voyage of Pedro Alvares Cabral to Brazil and India. Hak.Soc. 2nd Series No. LXXXI, pp.62-3.

"This time he had a pilot above suspicion of double dealing, who straightaway showed that he knew his job ..."⁵⁷

Important as that spirit of co-operation would prove in the long term, it must however pale beside the value of the information exchanged on one occasion described by João de Barrós, i.e. the sight of an Arab chart of the Indian Ocean. No words can better João de Barrós description of the state of the cartographic knowledge and techniques of the two traditions, Arab and Portuguese, and the way the Portuguese adopted the Arab chart as their model.

"Vasco da Gama was very pleased he had collaborated with him [Malemo Cana] for [the Moor] had shown him a chart of the entire coast of India, plotted in the Moorish style, i.e. with close meridians and parallels and without wind rhumbs. And since the square formed by these meridians was very small, it was possible to chart the coast with great accuracy using North/South and East/West rhumb lines, and without the complication of loxodromes that characterise our charts, and which serve as sources for other charts."⁵⁸

This was not the first Arab chart to be seen by a European, for as Needham has shown, Marino Sanuto, a Jew attached to the last Crusade to the Nile delta, produced in 1306 a map of Palestine based on a ruled grid. Similar principles were used in the chart seen by Vasco da Gama.⁵⁹ However unlike the reaction in the 16th

⁵⁷Camoëns, The Lusíads, Penguin, 1973, p.142.

⁵⁸João de Barrós, Décadas da Asia, Bk.IV, Ch.VI. Amended version of Theal's translation as above, p.185.

⁵⁹The map of Palestine by Marino Sanuto was included in Liber Secretorium Fidelium Crucis see J.Needham, Science and Civilisation in China, Vol.III, p.564 and compare with Plate LXXII.

century, medieval European cartographers did not adopt the grid lines, even though the Arabs continued to use them in maps such as those by Hāfiz-i Abru. Nor did Europeans seem to take much notice of an improving Arab idea of the world's geography typified by the disc map of Nāsir al-Dīn Tusi made in 1331.⁶⁰ They continued to use their traditional T-O type maps, which were also produced by the Arabs. In this way traditionalism, accommodated the world descriptions of al-Mas'ūdī and Ibn Khaldūn. By reference to the "Book of Roger" which al-Idrisi had compiled from Arab sources, some traditional Arab outlooks were combined into medieval European maps.⁶¹

⁶⁰ Abū Ja'far Nasir al-Dīn al-Tūsī (1210-1273) was a pupil of the Shīite Najm al-dīn Ja'fai al-Hillā. Nāsir al-Dīn Tūsī accompanied his sovereign the Mongol Emperor Hulagu on campaigns during which they pillaged many famous libraries gathering thereby a large private library, which would otherwise have been destroyed. Using this library he wrote many important works and edited others. He edited an edition of Ptolemy's Almagest, called the Tadhkira, and drew up some astronomical tables based on Persian works which he called Zij Ilkānī (Imperial Tables). His map was drawn on a disc with its centre on Mecca, showed the African continent, the Red Sea and Persian Gulf and suggests knowledge of India, though of no point further east or north east, though China is marked and named. Europe is shown and the Baltic and Scandinavia figure clearly. The Iberian peninsula is called "al-Andulasia". This map is now preserved at Beirut. For further details on his career see Huart, History of Arab Literature, pp.321-22.

⁶¹ Abū Zaid Abul-Rahman Ibn Khaldūn An Introduction to History. The Muqaddimah. Translated from the Arabic by Franz Rosenthal. Edited by N.J.Dawood. Routledge and Kegan Paul, London, 1969. Second Prefatory Discussion pp.49-53. (Map of al-Idrisi is omitted).

The contrast between fourteenth and sixteenth century European reactions to Arab charts is highlighted by the way Arab influence can be seen in the navigation charts of the Indian Ocean produced after Vasco da Gama's voyage. The first extant map drawn after Da Gama's voyage to show Arab influence is the famous 'Cantino map' smuggled out of Lisbon in 1502. It showed a dense gathering of legends for places east of India, not yet reached by the Portuguese, and following Arab and Chinese traditions the height of the pole star is given for various locations. It may well have been based on the very map De Barros described for not only is the peninsular shape of India shown, Ceylon and Madagascar are shown, the former markedly reduced from the size on Ptolemaic maps, the latter appearing for the first time. Its representations of the seas west of Ceylon were adopted for the charts by Contarini of 1506, Vesconte de Maggiolo (1504) and for the 1505 planisphere of Pesaro. The long, broad single arm of the Cantino representation of Malaya contrasts clearly with the blunter representation of India on the Genoese chart of Nicolò de Canerio, though Canerio lived in Lisbon between 1502 and 1504. The woodcut map on the title page of Itineriū Portugallésiū & Lusitania e India compiled by Montalboddo Fracanzano in 1508, (Fig 4) shows the truncated form of India, as does the map by Johann Ruysch bound into the 1508 edition of the Geography of Ptolemy. The 1513 edition of Ptolemy's Geography was based by Waldseemuller and his colleagues at St. Die, on the Canerio chart, itself copied

from the Cantino map.⁶²

Arab influence, however, is most clearly seen in the Portuguese maps. It is to be seen in the Egerton Atlas of 1511, but more clearly still in the map by George Rienel dated to 1510. The latter included comments on Malacca, not yet visited by the Portuguese. Later charts by Pedro Rienel show continued Arab influence in the way the east Indian archipelago follows the erroneous alignment described by Ibn Majid. Again the map of the two Rienels made in Lisbon in 1519 excludes loxodromes and gives the Maldive Islands that same erroneous north-west to south-east alignment which João de Barros said was shown on many Moorish charts.⁶³

The explanation of these errors can only be found in the esteem with which Moorish charts were regarded by the Portuguese. The attitude of Tomé Pires when compiling his Suma Oriental was typical when he said "What I say of these islands I have learnt from the Moors, from their charts which I have seen many times".⁶⁴

Though no Arab marine charts of the sixteenth century are known to survive, when Grosset Grange

⁶²D.Lach, Asia in the Making of Europe, Bk.1, Vol.1, p.220.

⁶³Teixeira da Mota 'Methodes de Navigation et Cartographie Nautique dans l'Océan Indien avant le XVI siècle'; pp.78 to 81 and figs. 3 to 7 in "Travaux du sixième Colloque International d'Histoire Maritime et du Deuxième Congrès de l'Association Historique International de l'Océan Indien", Lourenço Marques - August 1962, S.E.V.P.E.N., 1964.

⁶⁴R.A.Skelton, Explorers Maps, Spring Books, London 1970.

attempted to reconstruct an Arab sea-chart from the directions given in Ibn Majid's works, he noticed that observations of the Red Sea and Omani coasts were exceedingly accurate. He noted surprisingly the same degree of accuracy for observations in the straits of Malacca, but beyond there accuracy deteriorates rapidly. Accuracy corresponds closely with Ibn Majid's statement that the Arabs did not frequent the Bay of Bengal, but sailed regularly as far as Malacca. Commenting on their course, as recorded by Ibn Majid for such voyages to Malacca, Grosset Grange said in 1974 that "for lack of a better guide, a small sailing vessel might gladly draw inspiration from them [Ibn Majid's works] today".⁶⁵

Grosset Grange in attempting a task very similar to that which Pires faced about 1510, found that the star heights, or "isba" readings corresponded very closely with the working assumption Pires used of a standard 'isba' equivalent of $1^{\circ}36'$ (or five fingers to eight degrees). Generally Grosset Grange found an equivalent of $1^{\circ}39'$ a more useful figure for general application, though he noted the real difference in latitude between some points referred to was as low as $1^{\circ}30'$.⁶⁶ If we recognise that Ibn Majid did not understand the progressive error introduced into his work by the precession of equinoxes, during his life, (errors he could only attribute to observational differences between experience and

⁶⁵Grosset Grange 'An Arabian Sea Chart of the Middle Ages', Journal of Navigation, Vol.28, No.4, October 1975, p.445.

⁶⁶Ibid. pp.436-7.

youthful inaccuracies in observation), we can see why the Portuguese in trusting Arab navigational information, copied Arab errors.

The Moor encountered by Vasco da Gama is often thought to have been Ibn Majid, the famous Arab pilot who lived from about 1432 to about 1500. Ibn Majid wrote several fine treatises on the techniques of navigation and the responsibilities of the pilot, notably the Fawā'id, the Hawīya and the Sofaluja. The Turkish Admiral and writer, Sidi Ali Celebi, who had been in charge of Sulaiman the Magnificent's Indian Ocean fleet in the mid 16th century, knew Ibn Majid's works and incorporated them in his al-Muhit, [the Encompassing], an Arabic name for the Ocean. Through Sidi Celebi modern historians had their first access to those Arab sources available to the Portuguese in the sixteenth century. Until the translation published in the 1830s by Baron Joseph von Hammer Purgstall (who discovered two copies of Sidi Celebi's books, one in the Museo Borbonica in Naples, and the other in

Constantinople which he bought) nobody had thought the Arabs committed much detail about their practices to paper, except for a few charts mentioned incidentally by Velho and Barrós. The valuable information was thought to have been communicated verbally or through translators when pilots met.⁶⁷ Indeed, Ahmed Ibn Majid had thought the best way of describing the sea was "by way of mouth".

Ibn Majid was thought to be much the most important of these contacts, but his fame among European scholars was based on De Sacy's translation of two Yemeni manuscripts by Qutb al-Dīn al Nahrawālī (1511-82), where it was stated after the Portuguese reached East Africa they

"continually sought information regarding the crossing of this sea until a skilful sailor named Ahmed ibn Majid put himself at their disposal: the leader of the Franks called Almilandi [i.e. Almirante Da Gama] had become friendly with him and used to become intoxicated with the Portuguese Admiral. This sailor being intoxicated showed the route to the Admiral, saying to the Portuguese:

'Do not approach the coast on this part, steer straight for the open sea; you will then reach the coast [of India] and be sheltered from the waves'.

When they followed these directions, a large number of Portuguese ships avoided shipwreck and many ships reached the sea of Western India".⁶⁸

⁶⁷Ibid. p.435.

⁶⁸G.R.Tibbetts, Arab Navigation in the Indian Ocean before the Coming of the Portuguese. Oriental Translation Fund, New Series, Vol. XLII, Royal Asiatic Society. Luzac, London, 1971, p.9.

This account, found in Portugal, is corroborated in several respects by other sixteenth century Portuguese accounts. The anonymous author describing Vasco da Gama's voyage of 1497-9 says da Gama "begged the Sultan of Mozambique for two pilots" through a sailor the Captain Major had with him, and who formerly having been a prisoner among the Moors, understood their language. The sultan agreed. After these pilots deserted da Gama at Mozambique

"a Moor with his little son came on board one of our ships, and asked to be allowed to accompany us, as he was from near Mecca and had come to Mozambique as pilot of a vessel from that country".⁶⁹

This last man fits the description of the pilot and writer Ibn Majid much better than the man described variously as "the Christian pilot whom the King [of Malindi] had sent us", and the "Gujerati Moor". The writer Ibn Majid was an Arab Bedouin from the Najdi highlands of Arabia. The Portuguese writers by the time they wrote up the voyage knew the difference between Arabian and Indian Muslims, referring to them respectively as 'white' and 'black', so they would have been unlikely to be so wrong over Ibn Majid's origins.⁷⁰ Ferrand noted that the name of the pilot

⁶⁹V.Stefannsson Great Adventures and Explorations from the Earliest Times to the Present as told by the Explorers themselves . London. Robert Hale. 1947. p.177. Quotations translated by Ravenstein A journal of the first Voyage of Vasco da Gama , Hak. Soc. 1898.

⁷⁰Pedro Alvares Cabral The voyages of Pedro Alvares Cabral to Brazil and India Hak. Soc. 2nd Series, No.LXXXI 1937, p.63.

was not given in any Portuguese account, but only nicknames such as Malemo Cano, Malemo Canaqua, etc. Malemo is a corrupted form of the Arabic mu'allim or 'ocean going pilot' and canaqua is the Sanscrit for 'kanaka' or astrologer. 'Malim' was also the standard sixteenth century Malay for pilot. Ibn Majid bewailed the arrival of the Portuguese in the poem preserved at Leningrad, but did not blame himself. Thus we can agree with Tibbetts that Ibn Majid's name was invoked because of his fame as a navigator and because Qutb al-Din wanted a well-known scapegoat.⁷¹ It probably was a 'Gujerati Moor' who helped Vasco da Gama to India, or just perhaps a Malabari Christian returning home. Certainly the Christians of St. Thomas were initially regarded by the Portuguese as well travelled and friendly, until the nature of their heresy was understood.⁷² The anonymous account of Vasco da Gama's first voyage to India mentions the presence of small Christian groups in the East African ports.⁷³ Certainly Vasco da Gama's pilot from Malindi differs from the pilots offered by the ruler of Mozambique, in that the pilot from Malindi was not anxious about providing for his family until the monsoon cycle permitted his return to East Africa the following December.⁷⁴ All this further supports the conjecture that the pilot Vasco da Gama met was a Malabari trained by long experience in Muslim vessels.

⁷¹G.R.Tibbetts, Arab Navigation, pp.9-12; Grosset Grange, 'An Arabian Sea Chart of the Middle Ages', J.I.N., 28, No.4, p.436.

⁷²Geddes, History of the Church in Malabar. London, 1713

⁷³V.Steffannson, Great Adventures, pp.7-9.

⁷⁴João de Barros Décadas da Asia, Bk.IV, Chapter IV,
see Theal op cit. p175.

The knowledge of this pilot, and that shown in the works by Ibn Majid represent the acme of professional skill amongst Arab navigators trained in their native traditions. It is therefore no accident that Ibn Majid wrote so much about the professional codes of behaviour of the "mu'allim", and included so many statements about his personal skills and accomplishments which might be seen as arrogance. However, if we examine the performance of his contemporaries, his competence is outstanding and explains why his personal reputation as a pilot was still revered by Arab pilots of three hundred years later.⁷⁵

Three contemporary Arab pilots are mentioned in Ibn Majid's own works, but the allusions to Ali al Hubbi, and Sheikh Abd-al-Rahman are too brief to permit judgement of professional skill.⁷⁶ Ibn Majid's two references to Muhammad b. Mar'i al-Iskandarani, highlight their faulty navigational technique, while his references to certain Red Sea captains, seem by implication to show how incomplete was their theoretical knowledge beside Ibn Majid's.⁷⁷

In 1511 another mu'allim called Sulaiman b. Ahmad b. Sulaiman al-Mahri produced perhaps the clearest of all the Arab navigational works on the traditional skills, though it had no original content.⁷⁸

⁷⁵G.F.Hourani, Arab Seafaring, p.108.

⁷⁶G.R.Tibbetts, Arab Navigation, pp.229,232,239 for the Eleventh Part of Kitab al Fawa'id by Ibn Majid.

⁷⁷Ibid, p.7.

⁷⁸Ibid, pp.41-44.

The clarity of this work, the Umda stemmed from the careful thought a practising pilot had given to the structure of the work. The Umda began with general navigational theory and explained why the heavens appeared to revolve, as well as the technical terms to be used. It then covered the topic of the Indian Ocean giving such compass bearings as would help a pilot attempting to coast along its shores, and then a list of latitudes for Indian Ocean ports together with the times of monsoons for those attempting to make the longer voyages. A navigator would have found the full list of sailing directions for the whole Indian Ocean so useful that it seems that the Umda's author must have been a pilot himself.

However, Sulaiman al-Mahri was not satisfied with the Umda, and later in his life he produced two further manuscript works expanding his treatment of certain details, correcting a few mistakes in compass bearings and "qyas" (latitude measurements) and adding passages on such matters as cyclones. The revised manuscript that dealt with observations and bearings and such detailed practical points was entitled Mirhaj al-fakir fi 'ilm al-bahr al-zakhir, while its twin dealing with points of navigational theory in more detail was called Tuhfat-al fuhul fi tamhid al usul. It is in the Tuhfat, and in its sequel, a very padded out version of the Tuhfat, that perhaps the

first effects of the Portuguese presence in the Indian Ocean began to show. In particular the latter work suffers from the disadvantage that it was too involved and padded to be of use to a practising navigator at sea.

Within ten years or so of their arrival in the waters off the Asian shores of the Indian Ocean, the Portuguese had stifled the independent carrying trade of the Arab ports and communities there. Many Arab pilots probably took Portuguese service on the larger Portuguese ships. Other Arab pilots were no doubt out of regular work, as maybe Sulaiman al-Mahri was when writing his later works which follow literary rather than practical traditions.

It is also clear that within this same ten years the initial phase of interchange between pilots from East Africa and Arabia, yielded to the Portuguese almost all the information they sought, for thereafter the Portuguese seem more interested in what they usefully could learn from the Muslims of India, Java and Malacca.

The Arabs however continued to learn, though at the academic rather than the practical level, from the Portuguese. In compiling his world maps in 1513 and 1526, Piri Reis sought to bring senior Ottoman officials up to date with the discoveries of European sailors. In doing this, he produced some of the most accurate projections of American coasts made in the sixteenth century. Undoubtedly these maps depended on Portuguese charts and the portolan

tradition, a debt which Piri Reis acknowledged in the inscription he added to one map saying that he had utilised "an Arab chart of the Indies and a chart made by four Portuguese from old plans of the Sind, India and China".⁷⁹

Another example of Piri Reis's efforts to make known European knowledge was the introductory poem of the second version of his Book of Sea Lore.⁸⁰ It is significant he rose to the post of Admiral in charge of the one fleet that posed any threat to the Portuguese in the Indian Ocean in the mid-sixteenth century. He was not alone in these efforts, for Sidi Ali Reis ibn Husain, who was to succeed him in 1553 was also similarly interested in both the navy and navigation.⁸¹

Sidi Ali Reis ibn Husain, also known as Sidi Ali Celebi, established his own credentials in the Mirat ūl-Memalik (Mirror of the Countries).⁸² He wrote:

⁷⁹ 'Ocean Indien et Mediterranean' 6me Colloque 1962; Article by Texeira da Mota "Methodes de Navegation et Cartographie Nautique dans l'océan Indien avant le XVI siècle", p.74.

⁸⁰ Andrew C. Hess The Forgotten Frontier. A History of the Sixteenth Century Ibero-African frontier. University of Chicago Press 1978, p.190.

⁸¹ Sidi Ali Reis Ibn Husain Mirat ūl Memalik in translation by A. Vambury. The Travels and Adventures of the Turkish Admiral Sidi Ali Reis in India, Afghanistan, Central Asia and Persia during the years 1553-1556. Luzac, London 1899. Chapter II, pp.3-5.

⁸² The identification of Sidi Ali Reis ibn Husain as Sidi Celebi, and the same author as Baron Von Hammer Purgstall discovered was made by the Turkish editor of the Mirat ūl Memalik, see p.XVIII of Vambury's translation 1899. The work first appeared in Istanbul in 1895 for the Ikdam Library as a work of ancient authors viz:-The Mirror of Countries, written by Sidi Ali Reis and edited by Ahmed Djevedel, editor and proprietor of the Ikdam newspaper. Printed by permission of the Ministry of Public Instruction in the Printing Office of Ikdam 1313. Original in Gulbenkian Library, Durham 1895.

"I had always been very fond of the sea, had taken part in the expedition against Rhodes under the Sultan Suleiman, and had since had a share in almost all engagements both by land and sea. I had fought under Khairaddin Pasha, Sinan Pasha and other captains, and had cruised about on the Western Mediterranean Sea, so that I knew every nook and corner of it. I had written several books on astronomy, nautical science and other matters bearing upon navigation".⁸³

His works included treatises on the astrolabe, the quadrant, the parallels and chart making; a pamphlet on nautical science, the Mirat-ül Kainat (Mirror of Creation). As he himself described in the Mirat ü'l Memalik he was unable to finish his mission and bring back the 15 galleys of the Egyptian fleet that Piri Reis had taken to Basrah to avoid destruction by the Portuguese fleet. After success in a preliminary skirmish, his fleet was all but destroyed off Ormuz by the Portuguese, and he limped into the Port of Guador in Baluchistan. Then Sidi Celebi's account of 1554 shows that though some Muslim sailors turned their skills to use as pirates in the Indian Ocean, his request to Prince Pjelaled-din at Guador still elicited "a first class pilot ... devoted to the interests of our Padashah".⁸⁴ During this voyage with the Guador pilot, whirlpools were encountered as well as storms, and the pilot declared the three ships to be wrecked between Din and Daman off Fisht-kidsur. This proved correct as to position but they finally made the Daman in their galley despite the fact the monsoon broke and created severe

⁸³Sidi Ali Reis, Mirat ü'l Memalik (Vambury), p.5. Khairaddin Pasha, more commonly known as Barbarossa, was the terror of Mediterranean ships and coasts in mid-century.

⁸⁴Ibid. p.16.

difficulties. The actions taken by Sidi Ali Reis ibn Husain reveal much about the navigational skill that they deployed after their near shipwreck. He says that

"after duly taking note of tide and current, and having made a careful study of the chart,* I came to the conclusion we could not be very far off the mainland".⁸⁵

The knowledge of Sidi Ali Reis ibn Husain was then crucial for his study of European charts enabled him to interpret a loxodromic chart and conclude they were near enough the shore to limp into Daman.⁸⁶ It was clear proof of the value of loxodromic charts adopted from Europeans.

The experience of the voyage and his accumulated knowledge of points of both Arab and European technique, led him, while cogitating on his plight in Ahemedabad to write a major navigational work on points of value in sailing the Indian Ocean entitled al-Muhit .

The Muhit was based largely on the Umda of Sulaiman al-Mahri, indeed large parts have been transcribed word for word. Other parts are based largely on the Tuhfat and the Qiladal al-Shumush, which gave the mathematical formulae for calculating according to Solar, Muslim, Coptic, Byzantine and Persian years,

⁸⁵Ibid, p.22.

* A marginal note by Vambury says a literal translation would read "studying the strokes and lines of the compass".

⁸⁶Ibid. p.23 reads as follows in translation by Vambury

"During all this time we never once saw the sun by day, nor the stars by night, we could neither use our clock nor our compass and all on board anticipated the worst".

important because sailing dates for the Indian Ocean were nearly always given in days after the Persian Nairūz. On the basis of his background and certain mistakes in translation, Tibbetts has dismissed Sidi Ali Celebi, more commonly known as Sidi Ali Reis ibn Husain, as a civil servant rather than a skilful navigator.⁸⁷ Tibbetts gives no credit to Sidi Ali Reis ibn Husain for his perception of the value of both the Arab and European navigational instruments, or for expanding the Umda to describe methods of determining latitude with the astrolabe and the quadrant. In section 4 of chapter 7 of the Muhit he included a compilation of maps and charts, something new to Arab navigational treatises and undoubtedly learnt from Portuguese practice. In another section on the Americas he states that one of his informers was "an active Portuguese mariner" who had gone to Constantinople and offered his services to the Padisha, and been well rewarded because of his knowledge of the sea and celestial observation.⁸⁸ In another section on Sumatra he developed the idea that by using astrolabe or quadrant one could determine geographical co-ordinates and thereby fix one's position on the chart.⁸⁹

⁸⁷G.R.Tibbetts, Arab Navigation, p.44.

⁸⁸Teixeira da Mota, "Methodes de Navigation et Cartographie Nautique dans l'Ocean Indien avant le XVI siècle 6me Colloque, p.82.

⁸⁹Ibid, p.81 says

"On devrait determiner la coordinnée de chaque point au moyen de l'astrolabe ou du cadran, et aussi tracer une carte, compte tenu des distances géographiques, qui porterait toutes les hauteurs par îles et region du monde pour chaque point, pour pouvoir s'orienter d'apres cette carte".

From 'Le Mohit' by Sidi Ali Reis ibn Husain.

Thus by his death in 1572 he must be credited with an important and discriminating role in the interchange of Arab and European ideas.

Other efforts to inform the Muslim world of European discoveries and technology became increasingly desultory. During 1572 ali Marcar Reis constructed a world map showing regions reached by European discoverers, while in the reign of Hurad III selected portions of geographical works printed in Europe describing the Americas were translated and presented to the Ottoman Court.⁹⁰ However the learning of Piri Reis was despised after his execution (due to his flight to Basrah), and the value of other attempts to broaden Turko-Muslim outlooks went largely unappreciated for the Ottomans were preoccupied with traditional areas of westward and landward expansion. Careful navigational learning from the Europeans seemed inappropriate to Muslims embattled against European powers and undergoing a marked reversion to religious orthodoxy.

Andrew Hess has shown that this religious reaction took public form during 1580 with the destruction of an astronomical observatory in Constantinople. Seyh ul Islam argued then that the attempts to measure the movement of heavenly bodies had caused the plague of 1579-80, and by extrapolation that other matters not in conformity with received wisdom, (in other words the new European geographical

⁹⁰ Andrew C. Hess The Forgotten Frontier. A History of the Sixteenth Century Ibero-African Frontier. University of Chicago Press 1978 p.191.

knowledge of the world), had dangerous consequences for public order. This could not be reconciled with learning European navigational technology.⁹¹

If then the scholarly Admiral Piri Reis was to be ignored, the maritime hero of sixteenth century Muslims was Dragut, leader of the corsairs at Algiers until his death in action at Malta in 1565. However, in the tribute of the French Admiral Jurien de la Gravière where Dragut's navigational skills were highlighted, we see that Muslims kept alive a rather different type of respect for the navigator's skills. Jurien de la Gravière wrote of Dragut Reis, who had learnt his skills as a galley slave:-

"Dragut was superior to Barbarossa. A living chart of the Mediterranean, he combined science with audacity. There was not a creek unknown to him, not a channel he had not sailed. Ingenious in devising ways and means when all around him dispaired, he excelled above all in escaping by unexpected methods from situations of great peril. An incomparable pilot, he had no equal in sea warfare except the Chevalier Romegas".⁹²

The type of Muslim sentiments which led to the admiration of Dragut resulted in relative decline in the quality of Arab navigational expertise. However it must be remembered that it was a decline relative to the Portuguese who had eagerly absorbed Arab information, whereas Muslims did not adopt much Portuguese knowledge. An extract from the journal of Sir Thomas Roe dated 21 July 1615 says that when a native pilot from Mogadishu was encountered, in addition to

⁹¹ Ibid. pp.191 and 192.

⁹² Ernle Bradford The Siege of Malta 1565 Penguin 1966, p.86. Jurien de Gravière, son of the Napoleonic Admiral, began his naval service in China. In 1871 he became Director of the Hydrographic Department of the French Navy.

speaking Arabic he spoke Portuguese. He had clearly learnt Portuguese to serve the area's principal oceanic power, but the skills he offered were as traditional as ever. Roe records the man was "skillful in the coast and the lying and bearing of lands both in course and distance". He possessed a nautical chart on parchment, "lyned and graduated orderly" but which showed several errors compared to Roe's chart, and used some very old fashioned terms, and very little that was European.⁹³

However the spirit of the interchange of navigational information in the waters of the Indian Ocean was genuine in many Arab lands. It was not only a one way interchange benefiting Europeans. Arabs were on occasion anxious to obtain European technology. In 1611, the Arab governor of Mocha, Mahomet Aga, utilised his position of strength having captured the commander of the English ship "The Trades Increase". From him the Aga demanded a compass and a small map of the world.⁹⁴ An interesting correspondence between Sir Henry Middleton, Femell and the Aga ensues.⁹⁵ Middleton agrees the Aga should have a map of the world by William Speed depicted in two hemispheres, but he will not release a compass until he discusses who it is for and whether it is deserved. When on 22nd May 1611 Femell tells Middleton that the compass is for the Malek of the Great Dabul's ship he adds the hint about Portuguese interests in the area "if the Portugals

⁹³Teixeira da Mota 'Méthodes de Navigation et Cartographie Nautique dans l'Océan Indien avant le XVI siècle' 6 Colloque, p.72.

⁹⁴India Office Records E.3.1. Original Correspondence from India with Collateral Documents originating at any place between England and Japan from 1603 to 1708. Vol.1. (No.57), f.89.

⁹⁵Ibid. E.3.1.(No.57a) f.89. It should be noted that all Femell's letters after Mar.20th are dated one day too late.

seek to work us out we must endeavour to keep ourselves in".⁹⁶ Confronted with this circumstance Middleton replies to Femell stating that though he as Commander had not brought any compasses to sell, he was nevertheless content to send one to the Aga for it would do him good.⁹⁷ The fact that Middleton agreed to this concession amongst other things, led after to a softening of attitudes by the Aga. Thus after six months' detention, it could be reported that by 26 May the terms for Middleton's release had been agreed.⁹

It might be fair to say the long and valuable interchange of navigational technology between the Europeans and Arabs benefited both up to 1620, even though the Europeans seem to have gained more than Muslim powers from this interchange. However, various Asian maritime communities, in particular the Indians along the Malabar coasts owed as much to methods they would be taught by Arab seamen as their Muslim counterparts. Thus the Indian interchange needs to be examined more fully to permit a sounder long term judgement of just how much the Portuguese benefited from Muslim sailors familiar with the whole route from Sofala to India and Malacca.

⁹⁶Ibid. E.3.1. No.65 f.101.

⁹⁷Ibid. E.3.1. Nos.66, 67, ff.102-105.

⁹⁸Ibid. E.3.1. Nos.70, 71, 72, 73, ff.106-109. Note that W.N.Sainsbury Calendar of State Papers Colonial. East Indies. 1513-1616. London. Longmans, 1861, though useful, no longer gives accurate references to these letters as the letters have been renumbered by the India Office Library. The modern numbers are given here.

Chapter 8

The Indian Interchange

Much is known about the skills of Indian navigators of Rome's heyday when the Jatakamala of Arya Sūva and the Periplus of the Erythean Sea were written as detailed sailing instructions and guides to the harbours of the Indian ocean. The former contains a description of a Boddhisattva who operated as an Indian ocean pilot, stating that he "possessed every quality desired in such a one..Knowing the course of the celestial luminaries he was never at a loss with respect to region of the ship".¹ The Periplus gave a very detailed account of the various hazards of the shallow gulfs of Baraka and Cambay, which lie open to the south west monsoon. It was for this reason the local ruler kept a number of fishermen in his employ who could act as pilots and bring boats up channel. This mention in the first century A.D. is the earliest known reference to local pilots operating as a formal service.² Strabo spoke of the employment of an Indian trader as a guide to Eudoxus of Cyzicus on a journey from Egypt to the mouth of the Indus.³

However, it became progressively rarer for Indians to stray so far from their home waters to the west. By the time of the Muslim invasions, travel to foreign lands was believed to bring disastrous consequences which could not be expunged. This Hindu attitude was a measure of a growing xenophobia and

¹Tibbetts, Arab Navigation, p.1.

²E.G.R.Taylor, The Haven Finding Art, p.60.

³Ibid.

distaste for foreign travel, that permitted the ensuing Muslim domination of India's trade and navigation up to the time the Portuguese arrived.⁴ At the beginning of the sixteenth century Barbosa noted that India's trade was almost wholly controlled by foreign and semi-foreign Muslim merchants using Muslim pilots such as those who revealed the route from Africa to India to the Portuguese.⁵

It was not that Hindu merchants lacked selling skills for they were able to conduct a very active internal trade, as Barbosa records they could compete on equal terms in South East Asia at Avas Malacca. Further examination reveals that east coast Indians, such as the Chitties of Coromandel were keener voyagers than west coast Indians, with the exception of those at Cananore. Basham has tried to explain this by saying that India's shipbuilders failed to match the rate of technical progress achieved by the Arabs and Chinese. Consequently Indians could not produce ships to take them abroad as cheaply as the Arab and Chinese ships arriving in India's ports.⁶ This conflicts with Barbosa's information that many Muslims chose to live in Indian ports and some merchants among them owned and operated their own fleets, especially out of Calicut, Bangala and Goa. Barbosa

⁴ A.L. Basham, The Wonder that was India, Sidgwick and Jackson, London, 1958 p.231.

⁵ See 'Arab Interchange', p.303

⁶ Note in 1511 Albuquerque sent 50 Javanese shipwrights from Malacca to raise the standards at Cochin.

332

also noted that the Mapillas (descendants of Arab colonists by their union with local women) living in Malabar, owned the large ships that controlled the coastal trade.⁷

Sernigi writing in 1499 noted the methods in use before Da Gama returned from India among these Moorish navigators of India who "do not guide themselves by the Pole in navigating the Gulf [Indian Ocean] but trust to quadrants of wood".⁸

Sernigi writing to a Florentine friend in 1499 spoke of the foreign knowledge of Calicut inhabitants. They 'have some knowledge of Prester John, but not much because he is far away'. They also knew something about their Chinese visitors who had written their sailing instructions in terms of distances from Calicut.⁹

"It is about 80 years since there arrived in this city of Chalicut certain vessels of white christians who wore their hair long like Germans and no beards, except round the mouth They landed wearing a cuirass, helmet and visor, and carrying a certain weapon like a sword on the end of a spear.... Every other year they came back with 20 to 25 vessels. They [the Indian informants] were unable to tell what people they were nor what merchandise they bring into the city"¹⁰

⁷C.G.F.Simkin, The Traditional Trade of Asia, Oxford University Press, London 1964.p164.A.Barbosa, Secretary of the Portuguese factory from about 1500-1517, and master of the Malabar tongue.

⁸Sernigi's letter was written to a Florentine merchant in July 1499 from Lisbon. It was published in the collection of Fracanzano da Montalboddo in 1507, the 'Paesi novamente ritrovati' (Vicenza). It was republished in 1898 in an edition by Ravenstein. 'A Journal of the First Voyages of Vasco da Gama'. Hak. Soc. Old Series, Vol.CXIX, London 1898.

⁹J.V.Mills, translation and editing of Ma Huan, Overall Survey of the Ocean Shores, Peking, 1618. Hak. Soc. Extra Series, 1972. pp.50-57.

¹⁰J.Needham, Science & Civilisation in China, Vol.IV, pt.3, p.508. Sernigi thought the 'white christians' were Germans or Russians, but modern writers agree that they were Chinese. The destructive hand weapon, or 'gisarme' was in fact the Chinese (chi'). The voyages described are those of Prince Cheng Ho made in 1402-22 and described by Ma Huan and others.

It would seem that the native Hindus, in contrast to the Muslims and Christians of St. Thomas were not interested or knowledgeable about their maritime visitors. Furthermore the Indian mariner was resourceful and by no means lacking in courage, sailing the sea was always regarded as hateful and desperately perilous. His xenophobia, religious prejudice and fear served to ensure his contact with the more advanced navigational methods in use aboard Arab and Chinese ships was never close enough for him to learn how they managed oceanic voyages with greater economy and safety.

Indian reaction to the Portuguese arrival was rather different. A manuscript now in the India Office Library describes this from the Indian angle.¹¹

"In the year of Jaliha 904 on the 6th of Karkodan 672 three of the Fringies ships came to Padrang Kollam. It being in the monsoon, they anchored there and came ashore. They went to Korikote, where they learnt all the news of Malabar. At this time they did not trade, but returned again to their own coasts." Portugal¹¹

The Portuguese reported that they were accorded a warm welcome by the Malabari Christians of St. Thomas

¹¹ India Office 194 MSS Eur. B19, 15 pages. 'Translation of a Wsih of the Portuguese landing in India'. The original is said to have been written in the Malabar language on the leaves of a Brab tree. It was given by the Venkatycotta Royali, one of the Tamong family to John W. Wye on 19th August 1800. Wye's translation is quoted here from European Manuscripts in the India Office Library Vol. II part II section I, p. 707.

who sought Portuguese protection and sent a present to the King of Portugal.¹² One report of Vasco da Gama's voyage to Calicut in 1497-1498 suggests he even had a Christian pilot for the last stretch from Malindi to Calicut, though the other accounts suggest it was a Gujerati Moor.¹³

The coming of the Portuguese, and their rapid military victories ensured their mastery of the Indian Ocean trade. Their naval victory at Diu in 1509 broke the vicious circle that had retarded Indian progress in matters of navigational technology. As the Chinese by 1500 no longer sailed regularly west of Malacca Portuguese mastery was mainly achieved at the expense of the Muslim maritime communities of India. It was effected through the annual deployment of two Portuguese fleets in the gulf of Cambay to patrol the west coast of India as far as Cape Comorin. They used a pass system to put down the Malabari pirates and protect Portuguese traders.

Tomé Pires writing in the 'Suma Oriental' suggested it was necessary to moderate Albuquerque's policy once Portuguese hegemony was established in order to preserve the wealth and maritime skills of the Indian ports, that made possession of Indian ports

¹² Michael Geddes, A short history of the Church in Malabar from the time of its being first discovered by the Portuguese in the year 1501 until the celebration of the following Synod in the year 1599, London, 1713, pp. 3 & 4.

¹³ Tibbetts, Arab navigation before the coming of the Portuguese, Royal Asiatic Society, Oriental Translations Fund, Luzac, London. 1971. p10

so worth while to Portugal. Speaking of the Deccan and its port of Dabhul he said:

"It was a rich and honoured port of call and a good port with many ships; and Your Highness treated these ports so ill they were destroyed ... The way is open for it [the maritime community of the Deccan] to be lost beyond recall, or for Goa to become the greatest place in the World".¹⁴

There were a number of skilled oceanic navigators in such communities who could be utilised by the Portuguese. An idea of the number of local pilots that knew the route to Malacca is given by Pires.

"Four ships come every year from Gujerat to Malacca ... And from the city of Cambay one ship comes every year".

Of the Bengalis he wrote

"These people send four or five ships and junks to Malacca and to Pasé every year, while from Malabar there come every year in Malacca three or four ships".¹⁵

The Viceroy Almeida also appreciated fully the value of local pilots. His assistance to Sequeira's venture aimed at the capture of Malacca was based on his own appreciation that local pilotage would prove critical. He therefore acquired native charts from Hindu and Chinese pilots, showing the reefs and shoals to be avoided and the best ways between Malabar and Malacca. Those purchases gave the Portuguese access to a large amount of astronomical guidance as well as information on the worst infestations of pirates.

Besides giving Sequeira these documents, he also selected dependable Hindu pilots to accompany his best

¹⁴Simkin pp.163-5. Barbosa noted of the Malabar Moors at this time "Now there are it may almost be said, none, and these that are do not live independently". Lach, Vol.1, part 1, p.369.

¹⁵Simkin, p.165.

fighting men in well provisioned ships. These Hindu pilots established such a reputation in Portuguese service that when Albuquerque sought the personnel for an expedition to the Moluccas, the fourth ship of Antonio d'Abreu's fleet was put in the charge of a trusted Hindu, Nakoda Ismael.¹⁶

Cartographic skills too were probably practised in these Indian cities before the coming of the Portuguese and certainly afterwards. Thus Sernigi notes that in Calicut "there are many excellent painters ... of figures as well as of other subjects".¹⁷ Cartographers were often referred to as painters because they practised such crafts to illustrate their charts. The first certain reference to an Indian-made chart came in a report submitted shortly after the Junta of Badajoz-Elvas in 1524. There Pedro Ruiz de Villegas speaks of "carta que hizo aqud Hector, aco que de Coimbra, hecha en la India en un pergamino de puerco".¹⁸

Similar skills were practised by Diogo Botelho Pereira, who was born in India at the time of Viceroy D.Francisco de Almeida (1505-9). Diogo Botelho Pereira was the subject of lengthy references by historians who were stressing not only his skills at making sailing charts but his general nautical skill for he had made a remarkable voyage in a small pinnace from Diu to Lisbon in 1535-6. He was the illegitimate

¹⁶ Charles McKew Parr, So Noble a Captain. The life of Ferdinand Magellan, Robert Hale, London, 1955, pp.65-6 and p.92.

¹⁷ D.Lach, Asia in the Making of Europe, Vol.I, pt.1, p.156.

¹⁸ P.M.C. Vol.V, p.180.

son of Antonio Real, who had been Captain of Cochin during in Almeida viceroyalty, and Iria Pereira who was one of the first three Portuguese women to arrive in India.¹⁹

Before his death in 1554 Diogo Botelho Pereira probably had a marked influence on other cartographers practising in India at the time, including Luis do Rego, Lazaro Luis and the rather younger Vaz Dourado. All that is known about Luis do Rego is that he was making sailing charts in Goa in 1545, because he stated that in a letter to the King written in 1545. Little more is known about Lazaro Luis except that he was a Luso-Malayan by birth and was a well travelled sailor.²⁰ However he is the first Luso-Asian cartographer by whom work has survived. His atlas of 1563 is in several respects a great improvement on those produced in Europe. One example reveals the value of his seagoing career. On his map of S.E. Africa he had added the legend: "it has not the Islands of Amber because they do not exist - I have sailed over them very often and never saw them".²¹ This is a reference to islands allegedly discovered by Pimentel in 1527 and which were shown on the Lisbon made charts of Lopo Homem (1554), Diogo Homem's of 1558, Velho's of 1561 and Lasso's of 1590. However, it is in his representations of the Far East that his most interesting

¹⁹ P.M.C. Vol.V., p.180; Vol.III, p.5; Vol.IV, p.27.

²⁰ P.M.C. Vol.III, pp.113-5, Plates 98 and 211-226.

²¹ Ipsi, Plate 215.

contributions were made, generally markedly more accurate than Lisbon-made charts.²² He also initiated the crescent like representation of Japan. His improved charts may go some way to explaining the markedly reduced rate of loss amongst Portuguese ships sailing to and from India, particularly on the return journey to Lisbon.²³

However the prestige of his Luso-Indian contemporary Vaz Dourado, 1520-80, stood even higher. He was born in Diu to a gentleman of the Bedchamber, Francisco Dourado and an Indian mother. There is evidence to suggest he went to Coimbra University in about 1537, just before the first four pure Malibari students were sent to Lisbon to study for the priesthood. The first certain mention of him is in a report on the second siege of Diu in 1546 which records "Fernaõ Vaz Dourado burnt in the legs". His bravery had earned him the reward of 30 pardaoes. He was again mentioned in a military dispatch of 1554 and a rutter of about the same date where the following reference is made concerning the journey "from Cochin to Bengal" (the port of Chittagong)

"When going from Arakan to Bengal ... do not make for the sea until Bacala /Maiskad/ that is 23 leagues from the point which looks like Cape Ramas, for this route was taken by Fernao Dourado when he went with Vasco da Cunha".
[i.e. either 1543-4 or 1547]²⁴

²² Ipsi. Plate 217.

²³ 'Asian influence and the slackening of/ Iberian official navigational policies', p. 260

²⁴ P.M.C. III, pp.3-41, gives biographical details of Vaz Dourado's career, whilst plates 241-347 show the quality of his cartography.

If it was an honour to be mentioned in the same breath as one of Portugal's most distinguished Vice-roys, he seems to have been closely connected with two others, D.João de Castro, alongside whom his sister was buried, and D.Luis De Ataide who arrived in India on 10th September 1568 and returned to Lisbon on 6th January 1572 only to be reappointed in July 1577 and depart for India once more.

Seven splendid marine atlases in manuscript form are known today two of which are dated from Goa 1568 and 1580.²⁵ The 1568 atlas has specially detailed maps of Japan in its crescent or lobster like shape, and another of Ceylon and all the other atlases have similar representations following Lazaro Luis's of 1563. In addition the 1568, 1570 and 1571 atlases have cosmographical details and tide tables for high and low water "for the coast of India". However the 1575 atlas shows different tables, which turn out to be those for the west coast of Iberia, along with the arms of and a dedication to King Sebastian.²⁶ Teixeira da Mota has suggested this indicates that Vaz Dourado's reputation may have been very high perhaps due to patronage by D.Luis de Ataide. The Viceroy may have wished to take Vaz Dourado with him to Lisbon and back again in 1577. He might have been secretly taken to Lisbon for cartographic consultations, because thereafter the Velho-type representation of Japan is dropped in favour of his, though this was in fact a

²⁵Ipsi. Plates 241-347.

²⁶British Library Additional MS 31317 "Universales et integra totius orbis hidrographia ad verissimam Lusitanorum traditionem descripta Fernando Vã", 1575. Fol. 19 contains these tide tables.

regression in accuracy. The 1575 atlas has no tide tables to suggest its place of manufacture but does contain an odd chart for 1569, perhaps as Teixeira da Mota suggested, taken to Lisbon for the purpose of cartographic discussion. Some features suggest Vaz Dourado had a traditional type of Gyogi style Japanese map to copy.²⁷ As a local product it might have helped sway Lisbon's opinions, until they too got one later in the 1580s. Vaz Dourado's reputation was also doubtless advanced by the sheer beauty of his painted illustrations in these charts.

Another testimony to the quality of the charts made in Goa is given by the Indian pilot Gaspar Manuel de Villa do Conde who said in his rutter of 1594

"De Goa até a ponta de leste de ilha de sacotorá, conforme a conta do mestico Mateus do Rego, qui foi mui certo em suas obras, ha de derrota 360 léguas. A mesma ha nos de Pero Rodrigues, que usou sempre dos padrões de Mateus do Rego, e esta derrota tenho por mais certa, que das cartas do reino, segundo a experiencia tem mostrado quando vimos de Portugal que se acaba a derrota, en terra tarda 2. 3. dies".²⁸

This half-caste 'mestico', Mateus do Rego, perhaps the son of Luis do Rego, was operating in Goa along with Pero Rodrigues in the latter part of the sixteenth century. It was probably Mateus do Rego who was referred to in an eighteenth century manuscript that stated the "padrões des Cartes de Marear feytas pello Mestico de Goa que sam as milliores".

It was probably another 'mestico' that Cornelis Claesz referred to as the 'expert master of navigation in Goa' and that the States General of Holland

²⁷ H. Nakamura, *Les Cartes du Japon Monumenta Nipponica*, Vol. II, 1937, pp. 100-23

²⁸ P.M.C. Vol. V., p. 180

referred to in granting Claesz his letters patent to "print or draw" an atlas of Asia "made by a competent master of navigation in the East Indies" in 1592. The text of the grant also mentions

"such twenty five sea charts as he obtained by the direction of Mr. Petrus Plancius, but at his own expense from Bartolomeo de Lasso, Cosmographer to the King of Spain".²⁹

This last letter suggests that Indian information had got into undesirable hands from the Iberian point of view. The fact that there is only one other contemporary reference to Indian-made charts after it by the pilot João Ramos in 1600 who says he plotted his course on a "chart from India",³⁰ suggests that the demise of Indian cartographic production was part of the Iberian attempt to tighten up on the security risks in the East. Such charts as these Luso-Indians made only added to problems of security created by the fact more Lisbon-made charts were required for the passage to India than for the return passage. It was only too likely that some would remain in the great trading cities of India, where it was only too easy for foreigners to see, copy or buy them and thus learn how to break the Iberian monopoly. As Foulke Greville said in 1600 "At Goa there is great resort of all nations, who are suffered by the Portuguese to live after their own manners and religions, but are ruled under Portugal law".³¹ He noted that the situation was similar in Dieu, Cochin, Narsinga, Orixen(Orixa)

²⁹ Sir Francis Drake. *An Exhibition to Commemorate Francis Drake's Voyage around the World 1577-1580*. British Museum Publications, London 1977, p.87. See also footnote 42 of this chapter.

³⁰ P.M.C. Vol.V, p.180.

³¹ *Calendar of State Papers Colonial East Indies. 1527-1616*, N.Sainsbury. p.104. No.266 Foulke Greville to (Secretary) Robert Cecil. 10th March 1600. 4pp. East Indies Vol.I. No.18.

and Bengalen (Bengal) and in neighbouring areas and cities at Aracan, Pegu, Siam, Tanass ria and Queda . As local Gujeratis were increasingly used on the great carracks leaving Goa for Macao and Nagasaki it was not too difficult for a commercial spy or seaman to reveal the practical access routes to these trades.³² Given that many Iberians had gone to India to make their fortunes they were prey to the temptation of revealing the craft secrets of the navigator or cartographer for a price. The existence of high quality Luso-Indian cartographic productions was a luxury the Portuguese could afford only so long as they could keep skilled northern European navigators and seamen far from positions where they could see such information and ideally back in Europe. The many merchants from Northern Europe who served passages did not constitute such a risk, because they had not read and practised the skills revealed in the Iberian navigational manuals that were only translated after 1554.

Not so with the Dutchman Dirck Gerritsz who found his way to India by ship in 1562 and stayed for 26 years making voyages between India and Japan, before he finally chose to return to Enkhuizen with Jan Huighen van Linschoten in 1589. His knowledge gleaned from Portuguese and Asian pilots saw publication at the end of Lucas Jansz Waghenaeer Thresoor de Zeevaert at Leyden in 1592, and was incorporated in Linschoten's collection of eastern navigational

³²C.R.Boxer, The Christian Century in Japan, University of California Press, Los Angeles (1974 ed.) p.128.

material published in 1595 and 1596.³³ Gerritsz would later pilot a Dutch fleet back east in 1598.

Another to take advantage of the laxer Portuguese security before 1600 was Jan Huighen van Linschoten also from Enkhuizen like Gerritsz and Waghen³⁴ naer. As a youth of 16 he set out for Spain where he stayed six years between late 1576 and 1582 as he was "so addicted to see and travel into strange countries" He then followed his half-brother Willem Tin into employment in Portugal's East-Indian fleet arriving at Goa on 21st September 1583. Soon after arriving he sought the release of John Newberrie, Ralph Fitch, William Leedes and James Stay, who had come to spy out Portugal's commercial secrets, and been arrested at Ormuz as spies in the pay of Don Antonio.³⁵ He secured this with the aid of his friend Bernard Burchbeck of Hamburg and Thomas Stevens the Jesuit. While Fitch went on to make a very dangerous journey with a few sea passages to Malacca (reached February 1588) and thence back to London via India and the Persian Gulf Linschoten never ventured further than Cape Corientes but learnt much more useful navigational information.

³³F.L. Waghen³⁴naer (1533/4-1606), Thresoor de Zee-vaert, F. Raphelengius, Amsterdam, 1592. Section 4 contains a summary of eastern routes taken from Drake and Linschoten accounts published by Hakluyt in 1589 and from Dirck Gerritsz and from Linschoten whose parents lived at Enkhuizen and passed on certain information and from an unidentified source on Portuguese routes to the East.

³⁴Linschoten, His Discours of Voyages into ye East & West Indies Devided into Foure Bookes. John Wolfe. London 1598, Book 1, p.4.

³⁵Michael Edwardes, Ralph Fitch, Elizabethan in the Indies, Faber, London, 1972, pp.44-5.

Linschoten was above suspicion as a clerk in the service of the Archbishop of Goa, and many a time used the opportunities he got to learn more about the East. He had the cartographers in Goa to see, and many Portuguese and Asian pilots awaiting their next passage to consult. The result was that he could make one of the finest collections of navigational materials about the East in existence. It had great political importance because it served as the chief guide to the Dutch and English fleets in their early expeditions to the East, and in their successful attempts to wrest the mastery of the Indies from the Iberians.

Linschoten tells us that he took especial pains before his return from Cochin on 21st January 1589 to obtain the Roterios of the best Portuguese pilots, with the result those who subsequently used it noted its quality. John Davis sailing from Japan to China in 1613 found "Jan Huyghen's book to be very true, for thereby we directed ourselves setting forth from Firando".³⁶ The 600 folio pages of the English edition that are devoted to such information reveal several of his Lusitanian sources by name. Others of the 65 separate accounts merely state that the information was given "by another Portugall pilot", or occasion-

³⁶C.R.Boxer, "Portuguese Roterios 1500-1700", Mariners Mirror, 1934, p.178.

ally an Asian or North European sailor.³⁷

Thus chapter five gives details 'Of the navigation and course from Lisbone to the East Indies written and set down by the Kings Pilot, called Rodrigues de Lagos, a Portugall'.³⁸ Chapter seven gives 'The course or navigation from Cochin to Portugall written by Rodrigues de Lagos'. These were probably compiled using Vicente Rodriguez's two rutters made between 1570 and 1590. Chapter two gave Diego Affonso's account of the voyage to India from Lisbon. In chapter 36 he cited an account of the voyage his friend Dirck Gerritz made on a Portuguese ship sailing between Macao and Nagasaki, written by the pilot of that ship in 1585.³⁹ In chapter 21 he noted Chinese practice on the voyage from Siam to China saying "the Chinars that sail from Sion to China, pass by the North Side of Pulo Wy, and when they are tight over against it, they run eastward".⁴⁰

³⁷Linschoten. Discours, Bk. 3, Ch. 8. This part is entitled 'The navigation of the Portuguals into the East Indies, containing their travels by sea unto East India and from East India into Portugal, also from the Portugal Indies to Malacca, China, Japon, the Islands and Java and Sunda, both to and fro and from China to the Spanish Indies, and from thence back againe to China, as also all the coast of Brasilia and the havens thereof'

With a description of the firme land and the islands of the Spanish Indies lying before it called Antillas, together with navigation of Gabo De Copo Gonsalves to Angola, in the coast of Ethiopia, with all the courses, Havens and Ilands, Depthes, Shallowes, Sands, Droughts Riffes and Cliffs, with their situations, also the times of the yeares when the winds blow with tokens and knowledge of the tides and weather, water and stream on all Orientall coastes and Havens as they are observed and set downe by the Kings Pilots in their continual and dayly viages. Translated out of Dutch by W.P. Pepysian Library 2100.

³⁸Op.cit. Chapter 5.

³⁹Op.cit. Chapter 36. Discussed further in Japanese Int-

⁴⁰Op.cit. Chapter 21, pp.346-7. Zerchange chapter.

This he noted was slightly different from Portuguese practice because they kept to the south of this island and Pulo Condor. Yet he knew the Chinese ran "the same course to Pulor Condor, which they see upon the North Side".⁴¹ Lastly there were his own voyages to and from India in the first book of his Itinerario.

This superb collection of material also contained Plancius's world chart of 1594 and five nautical charts engraved by Van Langren, one of which showing the Far East is dated to 1595. This shows that they were added to his compilation after his return and while he faced the great problem of editing the mass of material he had available. Their striking similarity to charts made by Bartolomeu Lasso in Lisbon. Two atlases at Hatfield House and Paris, suggest that they were engraved from the 25 special sea charts Cornelius Claesz obtained by the direction of Mr. Petrus Plancius, but at his own expense from Bartholomeo de Lasso.⁴² Other Iberian information incorporated by Linschoten appears to have come from the Lusiads of Camoëns and Juan González de Mendoza who is the only contemporary author actually cited in his text.⁴³ Lach has suggested he also incorporated Fredici's account of the Orient and the official Jesuit account of the Japanese mission to Europe.

⁴¹Ipsi.

⁴²P.M.C. IV, plate 378. Hatfield Atlas. Plate 380. Paris Atlas. Also on p.88 the text of the Dutch States General's grant is given.

⁴³D.Lach. Vol.I, Part I, p.201.

In 1594 the States General of Holland granted Linschoten the right to publish this collection and the rest of his material. It was the navigational information which appeared first as the Reysgheschrift van de Navigatien der Portugaloyers in 1595. It was followed by a full edition of his own journeys and description of the coasts of Africa and America, as well as the original and vital navigational information of the Portuguese rutters. The full edition was entitled Itinerario voyage ofte schipvaert van Jan Huighen van Linschoten naar Oost - ofte Portugales Indien in 1596.⁴⁴

It was soon translated into other European languages, into French and German in 1598, Latin in 1599, and French in 1610. The English edition which is now exceedingly rare and valuable was translated by William Phillip and published in London under the title John Huighen van Linschoten, His Discours of Voyages into ye Easte and West Indies. Its contents were very rapidly incorporated by Hakluyt into his Principal Navigations in 1598-1600, When Foulke Grevil wrote to the Queen's Secretary on March 10th 1600 he acknowledged his sources saying that he had

⁴⁴ Jan Huighen van Huighen van Linschoten, Itinerario, Voyage ofte Schipvaert van Jan Huyghen van Linschoten oost ofte Portugaels Indien inhoude een coste beschryvinghe der selver selver landen ende Zee-custen met aenwysinge van alle de voornaemde principale Havens Revieren hoecken ende plaetsen tot nocht toe vande Portugesen ontdeckt ende bekent: Waer by ghevoecht zijn niet alleen die Conterfeytsels vande habytten drachten ende wesen so vande Portugesen aldaer residerende als vande ingeboornen Indianen ende huerte Tempels Asgoden Huysinge met die voornaemste Boomen Druchten kruyden Speceryen ende diergelijcke materialen als ooe die manieren des selfden Dolches so in hunnen Godts-diensten als in politie en Huys-houdinghe:maer ooe een corte verhalinge van de Coophandeligen hoe en waer die ghedreven en ghevonden worden met die ghedenckweerdichste geschiedenissen voorghevallen den tijt zijnder residentie aldaer. Amstelredam by Cornelis Claesz, op't Water, in't schruf-boek by de oude Brugghe Anno CIXCVI

"made these collections out of Osorius, Eden's Decade and specially out of the voyages of John Huighen".

Thanks to Linschoten, Greville was able to write a report on aspects of Portuguese security policy such as the stationing of their fleet at Cape Guardafuy [Gardafui] at the entrance to the Red Sea to "lie in wait for Turkish ships who venture to traffic without their licence". Foulke Greville's report led directly to the establishment of the English East India Company.

We know Cornelius de Houtman took the Reyghes-chrift on his voyage of 1595 to the Far East and that Linschoten himself was persuaded to participate in Dutch attempts to find an Arctic passage to the Orient in 1594 and 1595. He advised the Dutch to attack the Portuguese monopoly through the undefended Sunda Strait to Bantam, and it proved very sound advice from the Dutch viewpoint.

The Iberians however were horror struck at the implications of the Indian interchange of navigational information at which they had once turned a Nelsonian eye, much to the benefit of their own cartographers and navigators. It became part of their policy to stifle such interchanges thereafter. Hence they would discourage the attempts of Erédia and Quirós to improve navigational knowledge through voyages of discovery. They seem to have halted the production of sailing charts in India and to have kept their techniques and instruments away from the local Indian Muslim sailors after 1600 except on the Nagasaki route, though even there the Chief Pilot probably retained the charts and instruments himself.

⁴⁵As footnote 31.

⁴⁶Congreve, 'A brief notice of some contrivances practised by the native mariners of the Coromandel coast in navigating, sailing and repairing their vessels', Madras Journal of Literature and Science XVI Jan. June 1850

Thus when Congreve visited the Coromandel coast where the Portuguese had been entrenched longest, he noted the native mariners in 1850 were using the traditional Arab instruments such as the Kamal and not the better European instruments developed and used after 1500.

The only official exception to this policy existed as between Spanish and Portuguese pilots. The English were quick to spot this exception for the East India Company's Court Minutes record on 24th January 1614 the Deputy Governor was told:

"that galleons which are sent out of Spaine are pilotted by Portugalls, and manned by 2000 Spanyards who intend to take Majore where the fflemings have a fort, and so proceed to the Castle da Maine and from there into the East Indies ..."⁴⁷

Nevertheless the Iberians appear to have been reasonably successful in tightening their control of navigational information circulating in India after 1600. But the horse had bolted and the Portuguese had lost their Eastern monopoly after 1600 through the existence of the Indian interchange of navigational information prior to 1600. Linschoten's Itinerario which encapsulated the results of that interchange was a standard book carried on Dutch and English East Indiamen throughout the 17th century.

The Portuguese Conselho da India threatened the death penalty for anyone who translated or caused to

⁴⁷Court Book 1613-15. India Office Records B/1/5, p.20. This makes an interesting comparison with the Instructions given to Rui Gonçalo de Sequeira in March 1613.

be translated any information in the rutter of Gaspar Reimao printed in 1611, for they were well aware of the risks if such good information fell into foreign hands.⁴⁸ On one notable occasion they did seek to export false information in a rutter. Philip III's Cosmographer Major Lavanha, issued a double set of instructions on 24th January 1610. One set described 'what is to be done by the Pilot going to India in the Dutch ship' and says exactly how the Portuguese pilot was to conduct nautical espionage. Lavanha felt the Portuguese reputation as navigators was so good amongst the Dutch (thanks to Linschoten) that it could be used to mislead the ignorant. Thus he also issued a set of instructions that were to "appear" to be observed between Cabo Negro and the Cape of Good Hope.⁴⁹

In attempting to meet the challenge of the Dutch in Asian waters the Portuguese dared not ignore the navigational safety of the "India route". Consequently they continued to rely on the Lisbon cartographic office, and on the strictly controlled issue of printed rutters. Those documents were now based exclusively on Portuguese information for they now trusted no foreigner to guard their secrets. By so doing they hastened the obsolescence of their information and methods, and thus surrendered yet another advantage to their European rivals, who could already deploy superior naval forces in Asian waters.

⁴⁸Opinion of the Conselho da India about the secrecy to be observed in the printing of the rutter by the pilot major Gaspar Ferreira Reimão, 28 Feb. 1611. P.M.C. Vol.IV, p.82.

⁴⁹Lavanha's instructions are cited in sections 15 and 16 on p.65 of P.M.C. Vol.IV.

Chapter 9

The Indonesian Interchange

The Indonesian archipelago looked naturally to the sea for its communications and trade. Its history shows evidence of continual cross-fertilisation between these maritime peoples and the technology of foreign visitors. The dominant local maritime community were the Javanese, but the area by the early 17th century showed influences emanating from China, India, Arabia and Europe.

Before written records were kept, local navigational knowledge was good enough to permit voyages as far as Polynesia to the east and Madagascar to the west. Of routes used at that time only those across the northern part of the Indian Ocean remained to be written up in Arab sailing directions such as those of Ibn Majid.¹

We have noted how the Arabs used cartographic and other information to facilitate their regular voyages to Indonesia. It is not therefore surprising to find that between the eighth and fifteenth centuries, the period of their maritime mastery of the Indian Ocean, they should establish their cultural influence in Indonesia. Marco Polo is

¹ Grosset-Grange, An Arabian Chart of the Middle Ages, Journal of Navigation, Vol.28, No.4, 1975, p.447. Grosset-Grange postulated that Arab charts in marking Karmadnona (The Sea of Darkness) actually represented the area through which Indonesian migrations to Madagascar took place. The nature of the area's name and Ibn Majid's reluctance to guide sailors near it was due to the fact that its winds permitted only an east-west movement, useless for trade. For the Polynesian movement, see the chapter on the Pacific Island Interchange.

the first to record this, writing of his visit to Sumatra in 1292. Describing the north Sumatran port of Perlak as it was when visited by his Chinese fleet he said

"By reason of the many Saracen merchants who frequent there with their ships, who all keep the law of Mahomet, they have converted them all to the abominable law of Mahomet".²

Fifteenth century Europeans were also impressed by the prestige that followers of Mahomet enjoyed in Eastern Asia. Thus Conti found it necessary to embrace the Islamic faith before he could travel to Malacca, Java and the Moluccas in the 1440s. On his arrival, Conti was witness to two developments. Since 1389 Islam's power had notably advanced as the sway of the Javanese kingdom of Majapahit declined. It was a process accelerated by the diplomatic actions of the early fifteenth century Chinese Admiral, Cheng Ho. This Chinese prince gave strong diplomatic and military support to the emergent Muslim city of Malacca. Subsequently Malacca would grow to be the area's principal economic entrepot and port, a development that the Portuguese enhanced after conquering it in 1511.

The Portuguese attitude to the Muslims after their bloody seaborne conquest of Malacca in 1511 was unusual, for it showed less Christian fervour than normal. Vlekke has shown how their missionary effort concentrated on the Moluccas, but even there they failed to curb Muslim expansion.³ They often

²Collis, Marco Polo, Faber, London, 1950, p.142.

³B.H.M. Vlekke, Nusantara, Harvard University Press, 1925, pp.69-90.

chose to support intolerant Muslim rulers against more tolerant rulers. On arrival in Java the Portuguese found but four towns were in Muslim hands, but six years later only the island of Bali off Java's east coast remained free of Muslim influence. That such rapid progress could have taken place beneath the nose of the Portuguese fleets cannot be easily explained except by considering whether Portugal had a motive to encourage the trend.

An obvious motive was that communication of vital navigational and trading information with Muslims was easy, because the Portuguese had already established a tradition of such interchange. However, the Muslim presence brought special maritime benefits in Indonesia, for not only did it facilitate access to Javanese maritime traditions, it enlivened them as well.

Whereas sailors on Portuguese and some Arab ships were paid, time and cost were no object to Javanese sea captains because the crews of their junks were slaves. In 1514 Pires noted how this resulted in Javan voyages becoming very roundabout, so that a voyage from Malacca to the Moluccas might take three years. Muslim merchants more interested in profit than the way of life tended to quicken these flows, and press the discovery of more direct routes, just as the Portuguese would do later.

Even before they sailed to Java the Portuguese appreciated the high reputation of the Javanese as navigators and shipwrights. In 1511 Albuquerque had dispatched 60 Javanese shipwrights from their colony at Malacca to repair Portuguese ships in Cochin.⁴

⁴D.Lach, Asia in the Making of Europe, Vol.I, Book2, pp.585-6.

About 1526 Captain Andrés de Urdanetta said of the Javanese "They have many junks which they navigate to all parts". Barbosa, later to be eloquent in his praise of these skills, and Barros felt the Javanese owed more than a little to the Chinese in developing such skills. In a brilliant review of such evidence Professor Horridge has, however, shown that there was little interchange of ship design and building methods between China and these islands. He shows that the Javanese did not adopt the junk but continued to build traditional types of boat.⁵

Needham has suggested the Chinese began sailing to Java about 350 B.C.,⁶ but there was never extensive Chinese migration to Indonesia. Many Chinese sailors were wrecked in the area, in particular off the treacherous coasts of Sumatra. Small islands off the Borneo coast were occupied by Chinese soldiers in their abortive attempt to capture Java in 1293. At the same time a gang of Chinese pirates began operating from the mouth of the Musi river. These Chinese intermarried with local women and so passed on their cultural influence to reinforce those trading links developed by Chinese sailors visiting the Philippines, Java, Bali, Borneo and Sarawak. Later accounts

⁵G.A.Horridge, The Design of the Planked Boats of the Moluccas, N.M.M. Monograph, No.38, 1978, pp.4-9.

⁶8ième colloque de histoire maritime, p.160. Needham suggests extensive influence by the Chinese in Javan navigation, but also Javan influence on Chinese sail design. Vlekke, Nusantara, p.52.

included the Shun-feng hsiang-sung (Fair Winds for Escort) copied about 1620 from fifteenth century information and sailing directions for the voyage from Java to Timor.⁷ Similar information appeared in the Ying-yai sheng-lan, Overall Survey of the Ocean Shores, written by Ma Huan. This last book gave the names of many ports where maritime interchange took place, and stressed again the Muslim influence, alongside the Chinese and Javans. Not only did it mention the ports visited by Cheng Ho, Tuban, Gresik and Surabaya where they stayed four months in 1431, it described the journey to the mouth of the Palembang River (Sumatra) "whence ships came from all places" Ma Huan then described the journey to Malacca, where Cheng Ho had established a maritime depot and supply centre, that would form the basis of a permanent centre of maritime technology and navigational knowledge.⁸

A Chinese rutter and/or sailing directions most probably provided the basis of the earliest European rutter for the voyage from Malacca to the Canton River. It was compiled at Malacca by Francisco Rodrigues, just as the Portuguese under Jorge Álvares were entering the Canton River for the first time in 1513. That Rodrigues's rutter ran from Malacca to Canton but not in reverse suggests its owner was a resident of Malacca. Armando Cortesão[~] has suggested it was copied from a Chinese rutter.⁹

⁷Bodleian Library, Oxford. Lat. MS. Ov. 145 (Fair Winds for Escort). See also J.V.Mills, Overall Survey of the Ocean Shores, Hak. Soc. Extra Series XLII, 1970, pp.329-341.

⁸J.V.Mills, *ibid.* pp.46-7.

⁹P.M.C. Vol.1, pp.79-81.

J.V.Mills, commenting on the distances given in this rutter by Rodrigues, notes distances between places were expressed in terms of *jãas*, *jãos* or *jaaos*, and on that basis suggested Rodrigues's information came via a Malay.¹⁰ As these distances measured in "jaos" were not mentioned in other Portuguese navigational works, Mills felt the word was adopted into Portuguese use by Rodrigues from a local word, the Malay "jauh" meaning distant, as a measure of time. Such a measure would also explain the *jao* as quoted by Rodrigues in several instances did not correspond to fixed distance like normal European measurements of distance. Knowing the "jauh" was the equivalent of the Chinese "keng", or a nautical watch of 2.4 hours, Mills was able to show the great similarity of measurements given the Chinese Shun-feng hsiang-sung in terms of "keng" and distances given in Rodrigues for the same journey in terms of "jãos". Thus a journey from Malacca to Pulau Pisang was quoted as taking 10 keng by Ma Huan and 10 *jãos* by Rodrigues.

Equally we must not ignore the similarity of the Portuguese for a Javanese "jão" with the name of Rodrigues's measures, especially in view of the known and close contacts of the Portuguese and Javanese navigators in Rodrigues's time in the Far East.

¹⁰ J.V.Mills. op.cit. pp.349-50.

Albuquerque was responsible for the initial contact of Portuguese and Javanese navigators. In November 1511 he sent António de Abreu to explore the Moluccas, and amongst the crew's number were Pires, Francisco Rodrigues, the young man who was to make the first European charts of the area east of Malacca, and two Javanese pilots.¹¹ On this voyage the traditional Javanese route that meandered along the northern coasts of Java and around the islands of Indonesia was followed. On the basis of knowledge acquired on this voyage Pires would suggest a quicker route to the Moluccas via Singapore, the south coast of Borneo to Bantam Island in the Celebes and thence to the Moluccas.

In 1512 however, Pires and Rodrigues were more concerned to record details of the area, which were written up in the Suma Oriental, so long kept secret by the Portuguese that parts of it concerning the Moluccas and Java were not seen by unauthorised non-Portuguese until the nineteenth century. Rodrigues's contribution to the Suma Oriental included a lot of nautical rules for problems like determination of the sun's declination, the use of the compass etc., a chapter explaining how to navigate by the stars, and two rutters, one for the journey to Ethiopia from Europe and another, already discussed, from Malacca to Canton.

¹¹ This order is recorded in a letter of Albuquerque to the King of Portugal written on 20th August, 1512 and quoted by Cortesao in P.M.C. Vol.1, p.80.

There were 26 charts in Rodrigues's book but four sheets are left blank. The first nine charts were copied from Portuguese types and show no special originality. Original features do appear in the next four which cover the area between Africa and Malacca including a good map of the western entry to the Malacca straits.¹² By the time he made these charts in 1513, Diogo Lopes de Sequeira, Varthema and Albuquerque had all visited and sent back descriptions of the area. Jorge Alvares had set off for China where he would reach the Canton River in 1513. Until De Abreu's expedition, which carried Rodrigues, set out from Malacca, in December 1512, the inscription on Jorge Reinel's chart of 1510 represented all the Portuguese knowledge which was available for navigation. Reinel said it was "A large and vague archipelago which causes great fear because it is not known how far these islands reach".

The six charts that Rodrigues compiled as he sailed to the Moluccas along with two Javanese pilots were of inestimable value. He included a large scale map of the Malacca Straits, a map of North East Sumatra, Liga and Banka Island, and North West Java, a map of East Sumatra, West Java, South West Borneo and Banka Island, a map of eastern and north-eastern Borneo, east Java, Madura, Bali, Lombok and Sumbawa, and yet another showing the eastern end of this archipelago with the Moluccas.¹³ Other charts he made for

¹²P.M.C. Vol.1, pp.91-6. Plates 34-6.

¹³A.Cortesão, The Book of Francisco Rodrigues,
Hak. Soc., 2nd Series, CXXXX 1944, Fig.3, plate 3.

the Gulf of Tonkin and South China with some offshore islands were of equal value.

Another feature of Rodrigues's compilation was a section that included panoramic drawings of the coasts. They extended over 69 folios and show quite varied features, though the last 24 show only the outlines of beaches and points. They cover Rodrigues's return journey from Banda to Malacca, and show the land almost continuously as it appears from Alor to western Java. These drawings are still easily identifiable today using modern profiles. These beautifully drawn views also provide an insight into the nature of the area showing birds, the natives, trees, plants, pagodas towns and live volcanoes. Such features were unknown in Portuguese cartography until then, though outside Portugal they were paralleled in Europe by the woodcut coastal profiles of the Breton Pierre Garcie Le Grant Routier et Pilotage compiled in 1489.¹⁵ The adoption of such features is more than suggestive of local influence from the Javanese pilots who followed the coasts on their slow trading voyages.

Javanese influence on Rodrigues's products is confirmed by a remarkable letter written on 1st April 1512 by Albuquerque to the King of Portugal. With it he enclosed a chart which he said could be taken as "a very accurate and ascertained thing". From it Rodrigues was said to have traced his maps, which would remain one of the best kept secrets of the

¹⁴P.M.C. *ibid.* Fig.36.

¹⁵D.W.Waters, Rutters of the Sea, Yale 1967, for three facsimiles of such rutters.

Portuguese maritime agencies, being unpublished until the Viscount de Santarém reproduced them in facsimile in 1849. Cortesão has suggested that the Javanese chart was compiled by a Javanese cartographer who had already seen a Portuguese chart by 1512, and copied what was new to him. In similar spirit and trusting the integrity of his source Rodrigues copied features new to him from his Javanese original. This is how the presence of Brazil on the Javanese chart is explained. Albuquerque's letter of 1st April, 1512 shows how thrilled the Portuguese viceroy was to get hold of such local information, with a friendly interpreter present. The letter describes the native information as

"a large chart of a Javanese pilot, containing the Cape of Good Hope, Portugal and the land of Brazil, the Red Sea and the Sea of Persia, the Clove Islands, the navigation of the Chinese and the Gores [inhabitants of the Ryu Kyu Islands], (16a) with the rhumb and direct routes followed by the ships, and the hinterland, and how the kingdoms border on each other. It seems to me, Sire, that this is the best thing I have ever seen and that your highness would be very pleased to see it. It had the names in Javanese writing, but I had with me a Javanese who could read and write. I send the piece to your Highness which Francisco Rodrigues traced from the other, on which your highness can see where the Chinese and Gores come from, and the course your ships must take to the Clove Islands, and where the Gold Mines lie, and the Islands of Java and Banda, of nutmeg and mace, and of the land of the King of Siam, and also the end of the navigation of the Chinese, the direction it takes and how they do not navigate further. The main chart was lost with the Froil de la Mer. (16b) With the pilot and Pero de Alpoim, I discussed the meaning of this chart, in order that they could explain it to your highness; you can take this piece of chart as a very accurate and ascertained thing, because it is the very navigation by which they come and go. The Archipelago of the island called Celate, which lies between Java and Malacca, is missing". (16c)

¹⁶PMC. Vol.1, p.80.

(a) C.R.Boxer, Christian Century in Japan.

(b) This was the old ship in which Albuquerque was wrecked.

(c) Chinese pirates had long infested Singapore and were known there from Cheng Ho's days. Celates was the Malay word for "sea robbers".

Thus we have good evidence for the cross-fertilisation of European and Javanese navigational technology. It would continue because Java was the ideal kind of community for this to happen, for as João de Barro's said, it had "a great throng of navigators". The Javanese who had allied with the Portuguese at the sack of Malacca in 1511 brought the Portuguese into contact with Chinese navigational traditions as this letter has shown. That particular contact, it is suggested, was already in evidence not only in the markets at Malacca, and in the use of junks by de Abreu, but in maritime contacts between practical navigators both in the Malacca straits and on the quays at Malacca.

One suspects that once the Armazén da Guiné e Índia were in possession of Rodrigues's and Pires's works and the traced chart of the Javanese pilot sent by Albuquerque, they became cocksure in their cartography through over-reliance on his carefully drawn maps and profiles. They accepted Pires's division of the area into areas of crucial importance, Sumatra, Java and the Moluccas, and areas of lesser interest in Borneo, China and the Philippines.

The Portuguese did compile evidence about the Moluccas very carefully for the Badajoz-Elvas junta of 1524, called to decide whether the Moluccas were on the Spanish (Pacific) side of the meridian fixed in 1524 or on the Portuguese side. However they carefully did not allow Rodrigues's information about this area to circulate. Ramusio noted as he researched for his famous volumes that he was officially denied access to those parts of the Suma Oriental concerned with these islands, though he was allowed access to information concerning Borneo, the Philippines and China. In the event Ramusio in 1550 had to rely on non-Portuguese information. The best Portuguese information to reach the printing presses was contained in Barro's works but even this was clearly of limited value to navigators. Barros, talking of the size of Sumatra, is about right if his errors are averaged out, but a figure 300 miles out for the length of Sumatra, as his was, is really not good enough for navigation. Following Pires who said Java was one island divided by a river, Couto said in 1615 erroneously that Java was two islands. Outside Barros the best account to reach print was

Castanheda's. This was based largely on the interrogations carried out by Duarte Barbosa in India after Albuquerque's conquest of Malacca, though he also made mention of Pires and Rodrigues. He published the first book of his História do descobrimento e conquista d Indies Indien pelos Portuguezes in 1551,¹⁷ but very few were ever sold because it offended high office holders and had to be withdrawn from circulation. Couto claimed this was the result of a royal command and that Castanheda was accused of being excessively fond of the truth. Volume 9 was not published until 1929 having been found in manuscript in the papers of Maffei in Jesuit archives at Rome. The tenth volume is of unknown whereabouts. Volumes 2 and 3 were published in 1552 and the rest including a revised volume 1 in 1554.

Further references to the archipelago were made in the Commentarios of Afonso Dalboquerque, written in 1557 by the famous viceroy's son. A Luso-Indian from Goa, Jorge Lemos, wrote his Historia dos cercos describing the siege of Malacca in 1574 and 1575 and upsets in Sumatra in 1579.

¹⁷D.Lach. Vol.1 (1), pp.187-8.

However, by the late 16th century the best accounts of the area were appearing outside Portugal, even though they owed much to Portuguese sources. This came about because of the disappointments that seemed to dog the careers of two Portuguese trying to make their fortunes under Almeida's regime in the East. They were Ferdinand Magellan and Francisco Serrão. Portuguese chroniclers would subsequently impute motives of treachery to these two in all their references to the two men's careers in Portuguese service in the East that began in 1505.

Those years spent in Portuguese service brought invaluable information and contacts for Magellan and Serrão. Magellan and Serrão first saw Malacca in 1509. On that visit to Malacca Magellan brought a native slave, Enrique. Enrique proved to have a mastery of local languages as spoken in the Philippines and throughout Indonesia, and was able to acquire Portuguese. Enrique would accompany Magellan through India, Portugal, Morocco, sustaining his ambitions to return to the East and then following him into Spain's service and on his voyage of circumnavigation. On the eve of Magellan's departure from Seville in August 1519, Enrique was promised his freedom from the day of Magellan's death. After Magellan's death in the Philippines he was not granted this by the Portuguese so he deserted to the native ruler who had recently become Spain's enemy.

Enrique by this time had made some very useful contacts through his knowledge of the local Tagalog and Vizayan dialects. He had been able to communicate with the local kings from the first encounter in the Philippines. He doubtless helped in the enquiries made as to the location of the island where the sample spices shown to Magellan's crew actually grew. The natives explained that these islands were near. He acted as interpreter to another king of Mindanao, during display and counter displays given by the King and Magellan of their relative wealth and power. On one of them Magellan showed the king his sea chart and ship's compass, and explained how he had discovered the strait that facilitated his oceanic passage to the islands of the king's domain.¹⁸ The king expressed great wonder at these. When the fleet left for Cebu this king supplied Magellan with pilots for the voyage. They reached Cebu on 7th April, 1520 but because Pigafetta's account was written as his memory for the exact location of islands faded, it is impossible to disentangle the route he followed through the Philippine Islands.

After Magellan's death and some months of semi-piratical ventures, Magellan's expedition now under the command of Sebastian del Cano arrived in Tidore in November. By then Magellan's cousin or friend Francisco Serrão, with whom Magellan had been in continual and unofficial contact, before

¹⁸ Roditi, Magellan of the Pacific, Faber, London 1972, p210.

setting off from Seville in 1519, had himself been dead about eight months due to poisoning by the ruler of Tidore. Barrós stated that much of Serrão's extraordinary correspondence later came into Portuguese hands, and was presumably destroyed. Serrão had, since his arrival in Ternate in 1511, established himself in an important position at court as an adviser on foreign policy. He had secured Ternate's allegiance to Portugal, which left the rival ruler of Tidore open to the Spanish on their arrival in 1521.

The Portuguese, always aware of the threat, had tried to prevent it materialising not only by diplomatic pressure in Europe, but by sending fleets to intercept the Spanish off the Cape of Good Hope, Cape Saint Mary, (south of the River Plate estuary in South America). They later asked Lopes de Sequeira to send six ships from India. This was only discovered by the Spanish expedition when they met at the court in Tidore, Pedro Alfonso de Covosa, who had been trying to organise Portuguese control of the Moluccan trades from the only Portuguese base in the area at Banda. For the moment in 1521 Del Cano was permitted to load spices, and return with much practical information about the East. It gave new strength to Spain's claim to the Moluccas and symbolised the new route that had broken the Portuguese monopoly of information on how to get to this rich area. Thereafter the Spanish foothold at Tidore established by Del Cano would necessitate much more vigour in Portuguese control of the area.

At first, as we have seen, the Portuguese were sceptical about the Spanish claim despite the fact that Pigafetta's account was based on the navigators' journals, and included amongst its copious details was a list of common Philippino terms, with their Portuguese equivalents. The Portuguese gave Pigafetta a frosty reception on his visit to Lisbon in 1523.

This Portuguese reaction was in marked contrast to the general European reaction following Pigafetta's first presentation of an oral summary of the voyage to Charles V at a reception in Valladolid. Shortly after that, the Mantuan Ambassador to Castile noted that Pigafetta had returned with a day by day account of the voyage. After further visits to the French Court, Mantua, Vicenza and Rome, he completed his written account. Backed with a letter from Marchese Francesco Chiericati of Venice, he set out to publish his work in Venice in 1524.¹⁹ Almost at the same time Dom João III of Portugal received António de Brito's letter confirming the Spanish account of their voyage to the Moluccas. This put João III under intense pressure to try and settle the disputed claim to the Moluccas.

Consequently efforts were directed in both Spain and Portugal to producing appropriate evidence to back the rival political claims to the Moluccas. This is the background to the use of Pigafetta's account at the Badajoz-Elvas Junta and to the encouragement given by Peter Martyr, the great

¹⁹Lach. op.cit. Vol. 1, Bk.1, pp.173-5.

chronicler of Spain's American ventures, to the young Maximilian of Transylvania. The latter interviewed Sebastian del Cano, who had circumnavigated the world, and wrote an account soon published in many languages. Juan Sebastian del Cano's reminiscences formed the basis of the De Moluccis Insulis published at Cologne and Rome in 1523 and Paris in 1525. D.W. Waters thinks Francis Drake may have carried a copy of this or Pigafetta's account on his circumnavigation in 1577-9.²⁰

Before Drake's visit to the Spice Islands, a French voyage undertaken with the backing of a great merchant and governor of Dieppe, Jean Ango, was undertaken. The ships belonged to Jean Ango. Jean and Raoul Parmentier were in command while the navigators were Pierre Crignon and Pierre Maucier, who took along two interpreters of the Malay tongue. They had to beat a Portuguese blockade but reached Ticon, a port on the west coast of Sumatra, on 1st October 1529. The Parmentier brothers died of fever and the survivors formed a fear of the skill of Sumatran merchants. On their return Pierre Crignon put together a collection of Jean Parmentier's poems

²⁰D.W. Waters. The Art of Navigation in England in Elizabethan and Early Stuart Times, N.M.M. 1978, p.536.

Maximilian was the natural son of the Archbishop of Salzburg and his tutor was Peter Martyr d'Angheria, President of the Council of the Indies.

and secured their publication as a record of the voyage. The Description nouvelle des merveilles de ce monde was published in Paris in 1531, but the journal of Crignon which might have been of greater interest remained unpublished until 1832.²¹

In the mid-sixteenth century all these first-hand accounts of the Indonesian islands were included in the great travelogues produced by Ramusio Eden, Oviedo, because of the dearth of Portuguese material or for lack of much up to date information from northern Europe. For 50 years after the Parmentier brothers' voyage the Portuguese were to be free of the risks of information they wished to restrict reaching the ears and charts of northern Europeans. The Portuguese could thus afford to concentrate their efforts on restricting knowledge of Indonesian seas to European outlets. Because of this they were unable to deny Drake, Cavendish, and Houtman access in the East. They trusted the formidable barrier of distance, and the lack of information about a very dangerous coast, full of islands, islets, reefs, and dangerous currents, would be sufficient discouragement. They did do a little to build up the naval fleet based at Malacca and built a fort at Ternate after Magellan's visit.

When Drake arrived there in 1579 the Portuguese had been expelled from their fort at Ternate, and the King of Ternate was again seeking friends in his struggle against the King of Tidore. Thus on 14th November 1579 Drake was promised a warm welcome at

²¹Helen Wallis in a paper entitled 'Dieppe Maps', given to the Third International Reunion for the History of Nautical Science and Hydrography, suggests Jean Rotz's source for "The Boke of Idrographie" was one large map made by Pierre Crignon, using information gained at Ticon including a vague reference to Java la Grande, or Australia.

Ternate, but warned "that if he went to Tydore before he came to Ternate, the King would have nothing to do with us, because he held the Portugall as hisemie. The King himself came with boats and canoas to our ship, to bring her into a safer road than at present".²² We know the King "was moved with great liking towards us and sent one generall with special message, that he should have what things he needed". However, we do not know if this included navigational help or pilots. There was, however, one who offered intelligence about the Far East, Parsaos, who was from the province of Pagia in China. He told Drake much about China and begged him to visit China. Drake declined. A further reason to doubt whether navigational information was exchanged is offered by the fact that n Celebes, far from Ternate the "Golden Hind" grounded on a shoal on 9th January 1580.

After this Drake visited Baratere Island and Java Major "where arriving, we found great courtesie," but again probably little of navigational significance unless they learned of the old Indonesian route direct to the African coast. The Javans did warn Drake of the coming of a Portuguese fleet, and he needed little more incentive to set out across the Indian Ocean for his next landfall, the Cape of Good Hope. Unfortunately, the maps Drake made in the East are now lost, though we know they were initially presented

²²T.W.E.Roche, The Golden Hind, Faber. London. 1973. p.158 and fig. opposite p.136.

to Queen Elizabeth I. On his return many crude world maps purported to show this route, but were of little practical use. Perhaps the best of that genre was Nicolas van Wythe's map printed in 1582 which was corrected and approved by Drake himself.

Cavendish like Drake surprised Spanish shipping in the Pacific before reaching Indonesia. He met two Portuguese there in March 1588 but luckily for him no Portuguese fleet. He told these Portuguese that he had sunk 20 Spanish ships and that England was at war with Spain and looking after the Portuguese pretender to the throne, Dom António. Happy to learn this they then told Cavendish much about the interior of Java, and its customs and trade.²³ Cavendish was also able to communicate with the Javanese through the services of a Negro captured from the Spanish ship "Santa Anna" off California. This man's fluency in Morisco, or Arabian, is mentioned in Pretty's account of the voyage.²⁴ However, again we know of no specific navigational help given to Cavendish in Indonesia.

In contrast a vast cartographic harvest resulted from Cornelius De Houtman's Dutch sponsored voyage to Bantam in 1596.²⁵ The famous Pieter Dirkszoon

²³Hakluyt, Principal Navigations, Hakluyt Soc. Extra Series, Vol. XI, pp. 339-41.

²⁴Ibid. p. 337.

²⁵There was no formal leader to this expedition, so the four captains continually quarrelled. In effect the leadership came from the chief merchant Cornelius de Houtman who in 1595 had only just been released from a Lisbon jail. He got imprisoned again in Bantam in 1596 and later took his revenge by capturing a Javanese vessel and damaging Bantam. After 2½ years only 89 out of 254 men returned to the Netherlands in August 1597.

Keyser was the Chief Pilot, while among the lesser known supercargo were two men, now known for their cartographic skills, G.M.A.L.Lodeswijcksz and Martin Llewellyn.²⁶ On reaching Bantam, Houtman met a skilled Portuguese pilot on 25th July, 1596. This encounter with Pedro d'Ataide was recorded shortly afterwards thus:-

"Among the Portugeze, there was one that was born in Malacca, of the Portugeze race. His name was Pedro Truide or Pedro de Tayda, who was a famous pilot, and not only frequented but made charts of all the coasts, and maps of all the islands in the East Indies, a man well seen in travelling and one that had been in all places of the world. He was our good friend and every day came to talk with our captains, saying, You do not well that you make no more haste to take in your lading, you shall have no better cheap wares, and withal shewed us many things; whereupon the Portugeze hated him and not long after he was murthered by sixteen ruffians about noon as he lay upon his bed".²⁷

We thus see^{an} obvious breach of official Portuguese cartographic restrictions, not only in the locally made maps made by d'Ataide, but in his preparedness to tell the Dutch of such things. It was probably only the threat of similar violence deployed by Government officials which deterred more navigational espionage.

The Dutch took full advantage of the opportunity presented in Indonesia. The greatest Dutch geographer, Petrus Plancius, acknowledged his debts to Pedro de Tayde

²⁶ Tony Campbell, 'Martin Llewellyn's Atlas of the East 1598'. A paper presenting the discovery of this atlas at Christ Church Library, Oxford. The paper and biography of Martin Llewellyn was presented to the VI International Conference on the History of Cartography, 7th - 11th September 1975.

²⁷ As quoted by Cortesão from A briefe Description of a voyage performed by certain Hollanders to and from the East Indies, with their adventures, translated out of Dutch into English by W/illiam P/hillip ff.18v-19v. London 1598. P.M.C. Vol.IV, p.3.

with some familiarity as he spoke of "het boeck", "de schriften" and "de compascarten". This information was rapidly published by Cornelius Claesz as the Nieuwe caerte op Java geteeckert, probably in 1598 about a year after the return of this unhappy venture.²⁸

Thirty-two out of forty-nine names appearing on Lodeswijcksz's map are innovations, having never appeared before on Portuguese charts. Because of this Campbell claims it marks a transfer of cartographic initiative from the Portuguese to the Dutch every bit as dramatic as the commercial change. It assumes its full importance when it is realised that despite a revival of Portuguese cartography under Eredia's inspiration, only 80 new names appeared on all maps of Java drawn between 1550 and 1620.²⁹ Lodeswijcksz's map was also outstanding in that with 49 names it appears very different from those earlier Portuguese maps that never carried more than 23. All these new names were in Portuguese or native forms and none in Dutch. Subsequently Lodeswijcksz's names taken from d'Ataide appear in most early 17th century maps of Java. It was only after 1620 that Java was redrawn much more accurately by Hessel Gerritsz and these names began to disappear.³⁰

²⁸ G.M.A.L. Lodeswijcksz, Nieuwe caerte op Java geteeckert. Published by Cornelius Claesz at Amsterdam in 1598. The maps were engraved by Baptista a Doeteçhum.

²⁹ Campbell, Martin Llewellyn Atlas of the East 1598, p4.

³⁰ Though L. Houtman returned along Java's south coast, the first European to do so, its erroneous form was not corrected until Gerritsz's chart of 1618. J.C.H.C. Greenwich 1975

Over 20 of the new Lodeswijcksz names also appear on the maps by Martin Llewellyn (1598), Gabriel Tatton (1600) and William Bleau (1608). Because they are markedly better than any charts of Java dated before 1618, their debt to D'Ataide's knowledge must be enormous. Other maps showing a large number of Lodeswijcksz's names are the Van Langren world map of 1600, the Mercator-Hondius map of the East Indies dated 1606 and the maps by Lavanha, Spain's Cosmographer Royal, illustrating the Javan coasts in 1615. On the basis of this we might surmise that D'Ataide gave the Dutch at one stroke a 20 year lead in matters of navigation along a notorious coast.

If Campbell is correct to contend that Llewellyn must have gone with De Houtman in 1595-7 in order to verify the claim in the Donors Book of 1634 at Christ Church, Oxford that he had made the atlas "by his own hand, according to his own observations", he must have known what to look for along the coasts of Java, Borneo and Sumatra from D'Ataide. Llewellyn's charts were large scale 24" by 36" and covered in 15 maps the area between the Cape of Good Hope and Japan on the same scale of one inch to 90 miles. They were thus large enough for practical use at sea, though this set is unlikely to have been used at sea for all its charts had their latitude gradations trimmed off by the early seventeenth century binder.

However, though they have remained in Christ Church since 1634, they, together with Gabriel Tatton's chart of Bengal to Florida, dated 1600, represent the transmission of the best Iberian knowledge to London via Bantam.

The Dutch were great beneficiaries of weak Iberian security in the East Indies,³¹ and they would continue to take such opportunities. The English, through the East India Company, and Captain Saris in particular, were presented with another such opportunity in 1613. Captain Saris obtained an original Chinese map of China "at Bantam of a Chinese in taking a distress for debte owing to the English merchants". This map would be taken back to London, along with one sent by Adams to Captain Spalding in Bantam. From there Captain Saris took them to London where he gave Purchas the Chinese one. It was published in His Pilgrimes in London in 1625 and later by Gotard

³¹ Samuel Purchas, His Pilgrimes, London, William Stansby for Henry Fetherstone, 1625. Vol.3.

The Saris/Chinese map is reprinted by Purchas between pp.436 & 7 as "Map of China". Note that it is markedly better than J.Hondius's map on p.437. See also R.A.Skelton, fig.114 and p.179.

The Chinese maps comprised two leaves of the Atlas by Lo Hung-Hsien called Kuang Yü Thu (Enlarged Terrestrial Atlas) printed in China in 1555.

See also Chinese Interchange chapter.

Arthus and Theodore de Bry in Frankfurt in 1628.³²

It was a sign of the times after 1600 that Portugal's most able cartographer operating in the East Indies after D^aAtaide, should base his work and discoveries on Malay, Javan and Dutch sources, rather than exclusively Portuguese works. This man, Manuel Godinho De Erédia,³³ was one of the four children of a romantic marriage contracted in 1548 between Helena Vessiva, daughter of the Javan King John of Macassar and João de Erédia Aquaviva, descendant of an Aragonese noble. Manuel Godinho de Erédia was born in 1563 and educated at the Society of Jesus in Malacca, and then went to the seminary at Goa to study art, philosophy, mathematics and other sciences. He then entered the order in 1579 but left in 1580 under a cloud because his superiors disliked his desire to make new discoveries and travel. He then took up

³²Another such opportunity to utilise local knowledge was taken by Fredrick De Houtman who compiled a word list of Malayan and Madagascan words and their equivalents. This was translated by Captain Spalding of the English East India Company as Dialogue in the English and Malaine languages first written in Latin and Malaian and Madagascan tongues, by the diligence of G.Arthusius /or rather taken from F.de Houtman's Spraecke unde Woordboeck under Maleysche ende Madegaskarsche Talen/ and now translated into the English tongue by A.Spalding. Eng. or Malayan, Felix Kingston, London, 1614.

See also M.Gothardus Arthus, Indiae Orientales, Pt.V. pp.57-60: Declaratio et explicatio Vocabulorum Malacorum et Javanicorum, cum Numens Moluccanis . Durham Chapter Library, F.11. ³⁴.

³³For Erédia's career see P.M.C. Vol.IV. pp.39-69.

cosmography at Goa, when Vaz Dourado, that famous cartographer was still at work in Goa. Erédia too says he devoted himself to drawing a map of the East Indies and Asia which he submitted to Philip II. Then on 14th February, 1594 Erédia's greatest wish was nearly achieved for he was ordered to proceed on the discovery of Meridional India (i.e. Australia), but his project was long delayed by negotiation with Viceroy D. Francisco da Gama over whether he should start from Timor, Ende or Sable. Erédia also wanted the title of "Descobridor pava a empresa do Ouro". When Erédia finally settled the terms of his departure, the Dutch had begun blockading Malacca and so the cartographer was retained to draw maps and plans of the strait and the hinterland for military purposes.³⁴ The Portuguese had lost their interest in his discoveries, and with it the will to improve charts.

Erédia used this time, his background and local knowledge to amass a body of interesting knowledge about voyages made by local peoples.³⁵ In

³⁴ P.M.C. Vol. 4, p. 44.

12.3.1623. The Viceroy of India Comt D. Francisco Da Gama to the King

"... Manuel Godinho d'Erédia is dead, and I knew him from the other time that I governed this state, when he gave me some of these papers of his discoveries and I always thought them to show little ground for putting capital into them: and now (as it seems to me) even less as we have little for that".

³⁵ P.M.C. Vol. 4, p. 41 & 49, quote from ff. 54-7 of Declaram de Malaca: e India Meridional: com: O: Cathay: cin iii Tract: ordenada: por: Emanuel Godinho: de: Eredia. Dirigido: a: s: C.R.M. De: D: :Phel. Reg. de Ispa N.S. 1613.

1601 King Chiay Masuiro of Java had set sail southwards for Luca Antara, to the certain knowledge of Erédia. Erédia also spoke of a certificate from 4th October, 1601, in which Pedro de Carvalhis tells of a voyage made by the natives of Sabo to Luca Veach. These voyages were no doubt similar to the annual fishing visits made by the Macassarese and by the Buginese to Australia until formal relations were broken off by the Australian government in 1907. In 1610 Erédia sent his servant to confirm that this voyage could be easily made. As we know it was only 400 miles from Timor to Darwin and therefore possible that Erédia's claim to knowledge of (Australia) Meridional India was based on his knowledge of such fishing voyages. He claimed the grant of his commission as 'descobridor' was given at the King's request by Laurenço de Tavora,³⁶ because he knew of more southerly lands.

His claims as 'descobridor' are partly reinforced by his cartographic notebook completed some time between 1615 and 1622. It includes maps of Meridional India and Java Minor, as well as the south coast of New Guinea, where his information probably came from Spanish charts of Torres's voyage at Manilla from 1607 onwards.³⁷ He had also obtained plans of

³⁶A claim to be the discoverer of Australia, "Meridional India" was made by Erédia in his "Summario da Vida", but it cannot be substantiated. Indeed it is contradicted by the evidence of official letters, if not by his maps. P.M.C. Vol.4, p.41.

³⁷P.M.C. Vol.4 Plates 412 and 419 and notes on pp. 53-60. The Atlas Miscellany of 137 maps compiled between 1615 and 1622 now in Lisbon has been largely reproduced in P.M.C., plates 414-422. It is a style quite different from standard Portuguese cartography.

South American ports, probably via the Spanish in the Philippines, and included his copies in the notebook.

Two hundred and eleven maps by Erédia are known and extant. Some are of particular interest in illustrating the interchange of navigational information. His New Hydrographical table of the sea of new lands to the south made in 1602 shows voyages made from Java to Timor and three voyages to the south of Timor to Luca Antara (Australia), one by the 'Balis', one by the 'fishermen', and one by the Sinas.

His map of Banda made in 1601 and now in the Hague is in more standard mould. It was based upon Javanese charts, as an accompanying letter said.³⁸ That letter was written from Guerce (Grisee in Java) on 20th June, 1602 by Nicolau de Montalegre to Andre Furlado de Mendonça. A few days afterwards it and the map were captured from a Portuguese carrack sailing from Goa to Malacca.³⁹ The catalogue of the Hague library identified it as 'a reproduction of a Portuguese map found by Admiral Van Heemskerck in a Portuguese carrack.' The original is among the deposited documents of the Amsterdam Chamber of the V.O.C.

The very fact that access to vital local information could just fall into Dutch hands in the Far East, alerted them to the dangers of others getting

³⁸ P.M.C. Vol.4, Plate 411A and notes p.47.

The 1601 map has the number for its original of Kol.Arch.n^o4464 (Amsterdam Chamber).

³⁹ Nicolau de Montalegre said he sent "a paper on which are painted the Banda Islands, which as I have already written to you, I took from the drawings of a Javanese, who knew them very well, and with the painting and embellishment by Manuel Godinho." The extant copy is in the Algemeen Ryksarchief, The Hague, class mark "Supl Culal, Naber. n^o245."

their information. Erédia for one certainly did use Dutch maps in compiling his charts, referring to Petrus Plancius's maps of 1594 and Joanes Baptista Vrient.⁴⁰ Very obviously the beneficiaries of Portuguese cartographic information circulating in the East Indies they were determined to not make the same mistakes as the Portuguese and yet maintain the possibility of fruitful contact with local knowledge.

The solution adopted by the Dutch East India Company to this problem was to create their own Javan cartographic office. In 1618 the Chamber of Amsterdam told the East India Company Governor, General Coen, that they had supplied ships with large scale charts to be used in the waters from Bantam to Japan. Ships returning to Holland were obliged to hand their Far Eastern charts to the fleet master in Bantam, and after 1620 to him in a new office at Batavia. In this manner the Chamber of Seventeen in Amsterdam hoped to solve several problems. They avoided the security risks and costs of sending out vast numbers of charts from Amsterdam. As each ship carried a standard stock of 34 small and large scale charts for the voyage from the Texel to Batavia the numbers involved alone would have presented a considerable problem of control, for many were at sea at any given moment, and an overall check of stock was virtually impossible

⁴⁰ His atlas miscellany refers to "Pet rus Plancius" and Baptista Vrient in the Orbis terrarum and universal maps". Baptista Vrient is quoted in context of Java Minor and the Dutch map of the Mare Lantchedol. His reference to Petrus Plancius must refer to the 1594 maps that appeared in Linschoten's Itinerario of 1596. Some copies had a title that mentioned Joanes Baptista Vrient.

given the time needed to pass such information from Amsterdam to Batavia or in reverse. The likelihood of accidental loss, shipwreck, or capture by enemy action was sufficient to cause worry even before the possibility of deliberate attempts by foreigners to obtain such charts was considered. Certainly the Chamber was well aware of the value of Portuguese charts from which they had learned so much, but equally they did not want to make similar mistakes in their commercial security precautions. However, it was in financial terms that they first justified the running of a cartographic office in Batavia, and because the man hours invested in their stock of manuscript charts was vast. Such was the background to their comment in a letter to Governor Coen in 1620, saying that through this office and activity of the fleet master in Batavia they hoped to be relieved of the burden of sending so "many of the valuable charts to India".⁴¹

In addition to the possibilities of stock checking and stock reduction offered by the establishment of the Batavia office, there was the added benefit that the office was sited conveniently for the local cartographic and maritime traditions of the Javanese and other native Asian traders, to be fully and quickly exploited in correcting and improving charts of the archipelago and indeed of much of the Far East.

⁴¹ Dr. G. G. Schilder, *The Organisation and Development of the Dutch East India Company's Hydrographic Office in the 17th century*. Paper for 6th International Conference on the History of Cartography 1975, Greenwich, page 9.

The English were undoubtedly jealous of the cartographic information acquired and protected so well by the Dutch, especially after the disaster at Amboyna in 1623, which in practice marked their exclusion from the area for purposes of regular trade. In 1648 Pinkerton's account of Captain Pelsaert's famous voyage to disaster off Western Australia in 1629 included the comment in its introduction that

"It has appeared very strange to some able judges that the Dutch should make so great account of these southern countries as to cause a map of them to be laid down in the Stadthouse of Amsterdam, and yet to publish no description of them ... they have taken all imaginable pains to prevent any relations from being published which might invite other nations to make attempts this way".⁴²

What did not emerge, even in 1648, was the extent of Dutch improvements to navigational instruments based on Iberian designs. This only emerged when Pelsaerts's ship was investigated by Jeremy Green's team of underwater archaeologists in 1965. There were globe rings identical with some of Bleau's globe of early 17th century date, a pair of brass compasses, an astrolabe of traditional type, accompanied by one of new design identical with the semi-spheres~~or~~ half astrolabes preserved at Skokloster Castle and in the Kronberg Palace, Elsinore.

Yet another tribute to Dutch development of Iberian instrumentation was Green's discovery of the earliest known protractor, preserved so near the "Southern

⁴²Vilhjarnur Stefansson, Great Adventurers and Explorers, R.Hale, London, 1947, p.654.

Route".⁴³ This route involved deviating from the old Portuguese route to India and sailing due east from the Cape of Good Hope avoiding the monsoons, until Western Australia was sighted, before a north westerly course was taken to pass through the Sunda Straits to Batavia itself. Hendrick Brouwer had pioneered it in 1613 and it had been adopted as the safe official route by the V.O.C. in 1617 even though it led to a few disasters like Pelsaert's.⁴⁴

Nevertheless the very presence of the "Batavia" in those waters in 1629 showed how far the Portuguese had let their earlier cartographic and commercial lead slide into decline. The letter of 27th March, 1629 written by Philip IV to D. Miguel de Noronha, Count of Limahon, Viceroy of India which we have already seen⁴⁵ shows that this was because the Portuguese failed to recognise the significance of the Indonesian interchanges, and that far too late they realised the true strategic value of the navigational information they gleaned from interchanges so near the goal of envious Europeans, the Spice Islands themselves.

⁴³D.W.Waters, The Navigation and Instruments of the Batavia, Dutch East Indiamen 1629. 8ième Colloque d'histoire maritime. Beirut, 1970, pp.505-15.

⁴⁴J.N.Green, 'The V.O.C. ship Batavia wrecked in 1629 on Houtman Abrolhos Australia', International Journal of Nautical Archaeology and Underwater Exploration, Vol.4, No.1, 1975.

⁴⁵See Chapter IV the Decline of Iberian Navigational Services 1586-1620, footnote 62.

Chapter 10The Pacific Interchange

To the east of Indonesia a quite different encounter between European navigators and native mariners took place. Much to the surprise of sixteenth century Europeans coming from America with the Southern Pacific trade winds at their back, the Pacific Ocean was found to contain great island chains inhabited by several groups of neolithic people. Despite their technical deficiencies, these island peoples all showed remarkable maritime skills and the experience of oceanic navigation. Nearly every European visitor in the sixteenth century, even those compiling matter of fact navigational journals, were moved to write about the skills of these mariners. In the sixteenth and early seventeenth centuries the Spaniards facing the many problems of the Pacific crossing turned to these islanders, or even local South American pilots, to fill the gaps in 'their' knowledge.

Though the Portuguese and Spanish arrived on the fringes of the Pacific with seemingly better navigational instruments and better celestial knowledge, they found their methods inadequate to solve the problems of Pacific navigation. The vastness of the Pacific and its many scattered islands presented a huge challenge to navigators. It was even more daunting because the Spaniards had at first no knowledge of the wind and current systems of the Pacific, nor did they realise until Quirós's voyage of 1606 just how much their compasses were subject

to 'variation'.¹ Over voyages of several thousand miles, variation could play havoc with 'dead reckoning' estimates, because it introduced cumulative errors as neither speeds nor currents, nor courses, could be estimated with certainty. They came to trust their measurements of latitude once they had acquired sufficient knowledge of the southern sky. However, at first they could not even trust those readings because the tables contained in their almanacks were based on those of Zacuto and Regiomontanus. Those astronomical tables were based on the Ptolemaic theory of concentric heavenly spheres and on an estimate of the diameter of the Earth that was too small. It was thus virtually impossible to

¹The following observations of compass variation were made during 1606. Sources are mentioned in brackets. A compass point = $11\frac{1}{4}^{\circ}$.

February 5th	b. N.E. (Torres)
February 22nd	b. N.E. very nearly a $\frac{1}{4}$ (Torres)
March 21st	b. N.E. $\frac{1}{2}$ of $\frac{1}{4}$ (media quarter) (Quiros) ("some erring to NW by about $\frac{1}{4}$ others less")
May to June	Port of Vera Cruz to NE 7° (Quiros, Leza)
July 2nd	Equator to NE $\frac{1}{4}$ (Leza)
July 4th	to N.E. $\frac{1}{4}$ and $\frac{1}{2}$ (Quiros) "It has already been noted that the compass erred $\frac{1}{4}$ to NE and not it was checked to the Equator and found to vary more than a $\frac{1}{4}$ and $\frac{1}{2}$ to the NE (Manilla)
July 31st	Tropic to N.E. $\frac{1}{4}$ and $\frac{1}{2}$ (quarter of media) (Leza)
September 15th	to N.E. $\frac{1}{2}$ of $\frac{1}{4}$ (media quarter) (Leza)
September 16th	'Very slight' (Quiros)
October 6th	Tropic of Cancer, no variation (Leza)

This table is adapted from C.Kelly.
Vol.I p.54 La Australia Del Espiritu Santo, Hakluyt Society, Series II
Vol.CXXVI, 1966.

make accurate charts, or plot courses with any accuracy, using just Iberian instruments. This could lead to disagreements between navigators and masters, and even to mutiny.²

Magellan's pilot, San Martin, faced just such problems on the first European expedition to reach and cross the Pacific. San Martin expressed serious misgivings about his instruments and tables while he was still in the Bay of Rio de Janeiro. He had hoped to check his own daily observations against astronomical tables prepared by Regiomontanus and Zacuto, but as he progressed southward his observations became increasingly divergent from those predicted by his almanack. He rightly concluded his almanack was erroneous. Meanwhile as Magellan pressed southward in search of a strait that led to the Pacific, the Spanish officers of Magellan's fleet grew frightened, because they had enough celestial knowledge to appreciate San Martin's perplexity. Eventually the Spaniards mutinied at

²Journal of Fray Martín de Munilla O.F.M. for March 22nd, 1606 records

"There was some confusion due to the difference between the pilots' calculations of our position on their charts, as showed the distance sailed greater than others; also over the latitude they were in as well as the route which the General [Quiros] said he followed on another occasion when he came as chief pilot with the Adelanto Alvaro de Mendaña to colonise the Solomon Islands. He said this was the island of San Bernado. Others said it was called La Soldaria. Others again thought it was neither the one nor the other, but another newly discovered. This was most likely as the description the General had given did not fit the appearance of the island. And so each one marked it on his chart where he found it, intending to discover later where the error lay".

Munilla was correct for the island was Niulabita in 10° 45 S 179° 30'c. See Kelly Vol. 1, p.168.

St. Julian's Bay on 1st April 1520, only to be suppressed by Magellan's Portuguese sailors.³

Before Magellan even departed from Spain, San Martin and Ruy Faleiro had correctly foreseen that the Spaniards would need a method of estimating longitudes if they were to cross the Pacific with assurance. Ruy Faleiro suggested a method based on the measurement of distances between the sun, the moon and other planets that could be used without waiting for rare eclipses or conjunctions. When tried at the Rio Henedo in 1519, San Martin found the method erroneous. He concluded that it was due to poor tables. His South American experiences with astronomical tables led to his abandoning the method altogether. He did, however, get the chance to use the proven method of observing an eclipse of the sun on 11th October, 1520.⁴

³Edouard Roditi, Magellan of the Pacific. Faber, London 1972, pp.172-185. Note also that his Portuguese chief pilot Estevão Gomez tried to rouse some officers after the mutiny in September 1520 to abandon their search for a strait and sail via the Cape of Good Hope to the Moluccas. Gomez later deserted Magellan, sailing the San Antonia back to Seville with the news that the sought for strait had been found. Later acquitted of mutiny, Gomez was knighted for the discovery of the strait by King Charles V in 1534.

⁴Documentos Ineditos. 'Memoria solare la tentatives hechar y Princos efreidor en espana al que resolvere el problema de la longitud en la mer' by D.Eustaquio Fernandez de Navarette Vol.121 pp.92 and 105. San Martin took much information from Ruy Faleiro, the Portuguese, who planned the expedition with Magellan. In 1517 astronomer and geographer Ruy Faleiro deserted to Seville from Lisbon and he brought along his brother Francisco Faleiro, author of a navigation manual Tratado del esphera y del arte del marear Seville 1535. It contains the first printed discussion of declination and is one of the rarest books on navigation.

However an eclipse was too rare an event to facilitate the regular measurement of longitude that was wanted on a long ocean voyage. Magellan's fleet was not the first to suffer because it could not fix its position. It was not until the mid-eighteenth century that longitude could be found to an accuracy of $\frac{1}{2}^{\circ}$ using Tobias Mayer's tables, or chronometers invented by Harrison and Le Roy.

As the very size of the Pacific Ocean highlighted the technical deficiencies of their navigation, so sixteenth century Spaniards had to seek other guidance. They did this by building up their written records of Pacific voyages and by consulting local traditions amongst Pacific mariners. It is here proposed to examine those local traditions to show the nature of their navigational knowledge and experience, and then to show the chronological build up of Spanish information that utilised such sources. It will also be shown how later Northern European sailors, such as Drake and Cavendish, were only able to manage Pacific crossings because they captured Spanish information and experienced pilots, or seamen from the Pacific Islands.

The most advanced maritime powers to border on the Pacific were the Chinese and Japanese. Their traditions certainly record the dominant feature of the Northern Pacific meteorological system, the Sub-Arctic or North Pacific Current that ran east-west above latitude 38°N . Indeed it is now normally known by its Japanese name as the "Kuroshio Current".

The Chinese knew it as the "Wei Lü".

Chinese exploration of the Pacific was never extensive because they preferred the richer trade routes to the South and South West. However, it was of long standing. In 219 BC Hsü Fu of Ch'i and others made a request of the Chinese Emperor saying:-

"In the middle of the Eastern sea there are three magic mountain isles, Pheng-lai, Fung Chang and Yung Chou, inhabited by immortals. We beg to be authorised to put to sea, after purification and accompanied by young men and girls to go forth in search of these islands. The Emperor approved this petition and despatched Hsü Fu with several thousand young men and maidens to go and look for the abodes of the immortals in the Eastern Ocean".⁵

This bears an extraordinary resemblance to some Polynesian traditions of their magical fatherland, though there is no ethnographical evidence for Polynesia being settled by the Chinese. A later Chinese work would suggest Chinese mariners fought shy of their Great Eastern Ocean and its dangerous currents. Chou Ch'i-Fei wrote in 1178 in the Ling-Wai Tai Ta:-

"I have heard say that in the Great Eastern Ocean there is a bank of some myriads of 'li' in length and nearby in the Wei-Lü, the place where the waters pour down into the Nine Underworlds. In times gone by a certain ocean going junk was driven by a great westerly wind to within hearing distance of the roar and thunder of the waters of Wei Lü of the Great Eastern Ocean. No land was to be seen. Suddenly there arose a strong easterly wind and so the junk was saved."⁶

It is not beyond the bounds of possibility that the Chinese could have used their junks and the prevailing westerlies to reach America. In

⁵Needham Science and Civilisation in China Vol.4 part 3, p.552.

⁶Ibid. Vol.4, part 3, p.550.

more modern times Chinese junks have occasionally been cast up on Hawaii's shores.⁷ Some anthropologists say the inhabitants of Eastern Polynesia may also have come this way across the North Pacific before going on to the Marquesas, Tahiti and New Zealand. By 1565 the Spaniards appear to have learned of the Kuroshio current through Pacific sources, probably Micronesian ones, for the ships of Arellano and Urdanetta deliberately sailed north of the Mariana Islands in 1565 when attempting the east to west crossing that year.

Heyerdahl belittled the navigational skills of the Melanesians suggesting

"Even men of the pre-mechanical age could move in one direction as easily as the other so long as they travelled on land or over short stretches of water".⁸

Malinowski, however, had stressed the maritime skills of the Melanesians in his book "The Argonauts of the Western Pacific".⁹ He noted the Melanesians had extensive trading areas. The Motu extended from Port Moresby around the Papuan Gulf and along the 500 miles of eastern and central New Guinea. 'Kula' trading encompassed the Crusades, Woodlark Islands, the Trobriand Archipelago, the d'Entrecasteaux, New Guinea and Rossel Island.

⁷Kelly. Vol.1, p.80 cites works by E.S.C.Handy, C.Hedley and J.Hornell.

⁸T.Heyerdahl American Indians in the Pacific London, Allen Unwin 1952, p.53.

⁹B.Malinowski Argonauts of the Western Pacific London, K.Paul, 1922 chapters 4-11.

He noted that those involved in Kula trading always proceeded straight to their destinations for fear of hostile welcomes.¹⁰ They made the maximum use of prevailing winds and currents. In 1922 Malinowski noted:-

"The natives have no need of even the most elementary knowledge of navigation. Barring accidents they never have to direct their course by the stars. Of these they know certain outstanding constellations, sufficient to indicate for them the direction should they need it. They have names for the Pleiades, the Orion and the Southern Cross, but knowledge was localised in the village of Wawela, and handed down the maternal law of chiefs".¹¹

Malinowski noted Kula traders never sailed more than six miles, or out of sight of land, but other Melanesians must have done so to settle an area covering New Guinea, the Bismarck Archipelago, the New Hebrides, the Solomon Islands and Fiji.

However, little resulted from the Melanesian contacts made by the first Iberian visitor, De Meneses. This Portuguese had sailed his ship along the coast of New Guinea in 1526, even though he was then to the east of the meridian debated at Badajoz-Elvas. The remaining Iberian visitors were all Spaniards.

Alvaro Saavedra made the first official sighting of New Guinea and ran into the teeth of the north east trade winds in 1528. Forced to return to the Moluccas, he tried a more southerly course and sailed along the northern coasts of New Guinea for 1,500 miles. He then changed course near New Britain to the North and sailed into

¹⁰Ibid. p.222.

¹¹Ibid. p.224.

Micronesia. Next to arrive were Hernando de Grijalva's crew, who after murdering their captain, came to grief on the shores of New Guinea in 1537. Later visitors would include Mendana who in 1568 reached the Solomon Islands, and again when he reached Santa Cruz in 1596 with Quirós. Later Quirós would return yet again to L'Australia del Espiritu Santo in 1606. His chaplain, Munilla, wrote of the Melanesians whom he encountered on Quirós's expedition in 1606

"every single day in order to deceive us, they came without weapons and sent ahead boys and women who cunningly beckoned to our men, while the rest lay in ambush".¹²

It was a pity he did not know that in Melanesia the presence of women invariably signifies peace. Torres wrote of Espiritu Santo's natives that

"they did not any time wish to make peace with us, and though we frequently conversed together and made them presents never with their goodwill did we set foot on shore".¹³

It would be interesting to know if Torres, who had an excellent relationship with the natives of Tuamaco, took Melanesians onto his ship. Certainly the local knowledge of a 'Motu' would have helped him thread the dangerous shoals and reefs that abounded in the strait he threaded between New Guinea and Australia in 1606.¹⁴

¹²Kelly Vol.1, p.210.

¹³Ibid. p.87.

¹⁴G.C.Ingleton. 'The first Navigation of Torres Strait. Some Comments'. Journal of Navigation. Vol.31, No.2, May 1978, pp.231-243.

Iberian contacts with the Micronesians were rather more fruitful. Spaniards sailing from South America with the trade winds at their backs, had to pass the Mariana Islands if they were bound for the Philippines and China whereas for the Moluccas they had to pass archipelagos settled by Micronesians that stretched for over 4,000 miles.

The peoples who first settled in Micronesia had an even more complex ethnographic background than the Melanesians, and must have been much finer navigators than the Melanesians to have struggled vast distances against contrary trade winds and the violent tropical storms and settled an area stretching from Indonesia, via the Bismarck Archipelago to the Marshall Islands. On the way they brought definite Indonesian influences, such as canoe-forms, house-forms, betel chewing and pottery to the Bismarck Archipelago and the Marshall Islands.¹⁵

Polynesian traditions are evident in the fine account of the navigational skills of the Gilbert and Ellice islanders by Arthur Grimble. He reviewed the genealogical evidence for the migration of these people and their far distant origins in the west, twenty-five and thirty generations before. It was in the west that old kings and 'bu-n-anti' - "the breed of ghosts" had originated.¹⁶ Now, however, they looked to

¹⁵ Heyerdahl, *American Indians in the Pacific* pp. 15-16 & 50-54.
¹⁶ A. Grimble *Return to the Islands* London, John Murray, 1957, pp. 49-58.

Samoa for their ancestors, and dreaded being swept westward by the South Eastern trade winds.

Thus Grimble wrote:—

"So as not to stay outside the limits - especially windward limit of safety when they navigated beyond the sight of land, generations of fishermen and voyages built up a system of 'betia' or seamarks, by which if only a man knew enough of them he could be sure of his position in relation to any island of the Gilbert group. These sign-posts in mid-ocean might be shoals of fish, flocks of birds, masses of floating weed, or merely the way certain fish, or birds or weeds, behaved. They could be shapes of waves, or their size or direction of frequencies; they could be lines of driftwood, or shining streaks on the face of the waters, or conditions of atmosphere, the high or low visibility, or even the smell of air, ranging from land scents to the 'bu-n-anti' the stink of ghosts, that told you how near you were drifting to the western point of no return. Impalpable for the most part to any average European, these 'betia' were as clear and significant to the ordinary Gilbertese fisherman as a bent blade of grass or the displacement of a twig under-foot might be to a tracker of the Australian bush".¹⁷

Later in his account of the voyage with an old pilot from Tarawa, Grimble noted:—

"A compass was another of the things he could do without. He had his guiding stars for every night of the year and every state of wind or current, he said, and these with his sense of smell made him independant of white men's inventions".¹⁸

Amongst the Gilbert and Ellice islanders and the inhabitants of the Marshall Islands familiarity with natural signs, the stars and the 'feel of the sea' was and still is cultivated from an early age in the children. On the island

¹⁷Ibid. p.57.

¹⁸Ibid. p.55.

of Arorae in the Gilbert and Ellice Islands a primitive navigation school has been discovered within a large hut. Every group of stars was marked in the thatchwork of the roof, and the young navigators were expected to learn there the relative positions of the stars. Only when they had thoroughly mastered these spatial relationships were the young tutees taken to the eastern beaches to watch the rise of constellations through the night.¹⁹

To help position finding through observing the stars a 'sacred calabash' was used, a primitive forerunner of the bubble sextant. A simple bowl was drilled with a series of holes placed midway between the bottom and top or rim. A slightly larger hole was bored above these holes, and a notch made in the rim opposite before the bowl was filled with water up to the level of the ring of holes. The navigator then tried to view the Pole Star through the viewing hole, the holes being a simple precaution against the navigator failing to keep his calabash horizontal. If the Pole Star fell exactly on the rim and no water spilled he knew he was in the same latitude as his starting point where the calabash was made. The only known calabash of this type was found on Hawaii.²⁰

¹⁹A.B.A.Hutson, The Navigator's Art, Clark Doble and Brendon Ltd. Plymouth 1974, pp.23-24.

²⁰Ibid. pp.25-27.

The Marshall Islanders used a very different type of navigational aid in conjunction with their knowledge and 'feel' for the changes in the oceanic swells. These diagrammatic guides, erroneously but popularly known as 'stick charts', were designed to represent the pattern of intersections of oceanic swells caused by islands in the path of currents. In other words they were land finding aids for use in interpreting the area's swell pattern. These aids were made of palm ribs bound together with sennuit, and upon which were also placed and bound stones and other items which represented islands. Their makers of necessity considered the position of those islands that caused the distinctive changes in oceanic swell, but the finished product did not always bear a resemblance to the real spatial relationship of the islands. The 'mattang' type which David Lewis considered the only truly traditional type did not show spatial relationships of the islands, but the 'meddo' and 'rebbilib' types did. Lewis thought the latter types though quite traditional in construction perhaps betrayed evidence of interchanges with Europeans before the first serious study of these aids was made by Captain Winkler of the German Navy in 1899.²¹

²¹David Lewis The Voyaging Stars. Secrets of the Present Island Navigators . Collins. Sydney, 1978. pp.118-20.

Most of the other types of navigational aid deployed in Oceania were land based, for example the pairs of tall poles erected on the island of Arorae. If a given pair were aligned they would enable a canoe setting out for an island perhaps 80 miles away to begin on the correct course. The pairs to be aligned for Nikunau, Onotoa and Tamana were different and were carefully set out. They have been discussed in detail by David Lewis as part of his wide ranging study of these islanders and their navigating skills.²²

It was just such skills and knowledge which the Spaniards sought as they too tried to make island hopping voyages against the pattern of the trade winds.

Magellan's voyage was the first to contact the Micronesians. Magellan, however, was not enamoured of those islanders because after a harrowing journey across the Pacific he found the inhabitants only too willing to steal his remaining supplies. In exasperation he called the islands the 'Ladrones' and set out to punish the thieving islanders. In the ensuing punitive expedition Pigafetta spent much of his time observing the islanders. In this Journal Pigafetta made extensive reference to the maritime skills of these islanders. He noted much about the native culture, including the fact that the

²²David Lewis We, the Navigators Australian National Press 1972. See the Appendix pp.316-322.

main recreation of both sexes was making inter-island journeys in their canoes and catamarans. He was fascinated by their boats and the handling skills of the islanders as they mobbed Magellan's ship.²³ Many of the Spaniards who later followed Magellan to the Philippines would make Guam a port of call to water and revictual, so that Guam would develop quite differently from the rest of Micronesia.

Saavedra in 1528 aboard the 'Florida' sighted many islands of the Admiralty and Marshall Groups. The crew of the 'Florida' landed at Eniwetok in the Marshall Islands and noted the tight skin of the inhabitants, their painted arms and black hair. The islanders welcomed the Spaniards with dancing and singing. The crew stayed eight days before they left, only to be blown by the South Eastern trade winds that the islanders dreaded, back to the Moluccas.

Hernando de Grijalva met his death in 1537 setting out from Mexico to cross the Pacific. He sighted the Gilbert Islands,

²³Richard Hakluyt Principal Navigations edition Hak.Soc. Series Vol.XI p.327. Pretty's account of Cavendish's voyage states of Guam "where the Spaniards do put in to water, sayling between Acapulco and the Philippines. In which isles of the Ladrones they find fresh water, plantans and potato roots".

but was unable to give sufficient reassurance to his crew to prevent his being murdered before the crew were wrecked off New Guinea.

Ruy Lopez de Villalobos also failed to return across the Pacific to Mexico having reached the Moluccas in 1542. On the way he came across the small island of Fais, a short distance east of Ulithi on 23rd January, 1543. He did not anchor there, but the native Micronesians came out in boats making the sign of the cross and saying in Castillian "Buenos dias, matelotes". He also reported at the same latitude, but 35 leagues to the west, another large island, which there is good reason to suppose was Ulithi.²⁴ However, who taught these natives Castilian is a mystery. Was it Grijalva or Saavedra, or a Portuguese expedition?

Although no other Portuguese voyages are recorded as contacting the Micronesians, it is possible that a Portuguese, Diogo de Rocha, may have sighted Ulithi on 1st October 1525. That year, according to the Portuguese chronicler Galvão, Diogo de Rocha and the pilot Gomes de Sequeira were driven at least 900 miles off course, having gone to look for gold in the northern part of Celebes.

²⁴William A. Lessa Ulithi: A Micronesian design for living Holt Richard & Wilson N.Y. 1966, p.5.

The most useful of Spanish navigational discoveries in the Pacific was the secret of how to get back again from the Asian coasts to America. It was learnt by following the Micronesian convention of island-hopping, where the information of their stick and stone charts could be used to best effect. It was achieved in 1565 by a member of the expedition that went to colonise the Philippines. Miguel de Legaspi, who led that expedition, was instructed to find the best return route to America. Prior to 1565 nobody had made a return voyage, though Villalobos, according to his chronicler, Juan Gaetano, had reached Hawaii from the Spice Islands. Legaspi took as pilot Andrés de Urdaneta, a survivor of the 1525 Loisa expedition to the Spice Islands. Whereas Loisa had failed to return, Urdaneta had survived and taken up holy orders. He was a skilled navigator, who would get credit for the official discovery of east-west Pacific crossing in 1565.

However, it was the 40-ton 'San Lucas' which, despite being far the smallest ship in Legaspi's fleet, made this significant voyage from 'East to West' first. She was captained by a disreputable nobleman, Alonso de Arellano, and had got separated from the main fleet after only a fortnight's sailing but arrived in the Philippines some weeks before Legaspi and his

main colonising fleet. The mutilated log-book kept by Arellano, and his pilot Lope Martin, then records how the epic crossing began on April 22nd 1565. He set out from the Philippines with the aid of south-westerly summer winds. He reached the Mariana Archipelago, and then changed course to follow this Micronesian Archipelago to the north. Island-hopping in the true Pacific tradition, he came to the coast of Japan. He skirted Japanese shores where the Kuroshio current was well known before following this eastward flowing current to America where he made a landfall on July 17th. He then sailed to Acapulco.²⁵

Urdaneta, on board the 'San Pedro', followed a similar route and reached America on September 18th. Subsequently historians gave Urdaneta sole credit for their enterprise, because they said he followed a plan. Arellano, however, was charged with disobedience and defection. On further examination of Urdaneta's so called 'plan', it becomes clear that he may well have relied on Portuguese information about the Pacific. One of the paragraphs in Legaspi's sailing orders issued by Presidente y Oidores on 1st September 1564 enjoined him to maintain good relations with the Portuguese and try

"to see the cartas de marear [sea charts] which they use in navigation, and if you can get hold of some of them, even by

²⁵ John Gilbert 'Charting the Vast Pacific' in Eastern Islands, Southern Seas Aldus Jupiter. London 1973, pp.217-219.

buying them then you should do so, or at least obtain a copy of them".²⁶

We know that the Portuguese did indeed make charts of the Pacific after De Rocha's Micronesian voyage, for example, the huge planispheres of Diogo Ribeiro made in 1528-9 at Lisbon.

During Spain's voyages to Polynesia there were two notable interchanges. These took place after the northern Pacific return route had been discovered. Had it not been for the lure of a legendary unknown southern continent across the Pacific contact with local cultures might have lessened. All contemporary map-makers, even outside Iberia, were confident that a great land mass did exist to the south of known land masses, because they reasoned it was necessary to balance the continents of the Northern Hemisphere and keep the globe steady. They called it "Terra Australis Incognita".

Pedro Sarmiento de Gamboa, a noted historian, mathematician, astronomer and navigator from Galicia persuaded the Spanish government to mount an expedition with the express purpose of

²⁶C.R.Boxer, South China in the 16th Century Hakluyt Soc. Series II Vol.CVI 1953 p.lxv for translated quotations from President of Mexico's instructions to Legaspi dated 1st September 1564.

searching for Terra Australis. Through his familiarity with Inca legend he was convinced that it stretched from a point south of Magellan's Strait, north west to the equator. So, by sailing West South West from Callao he would find it. This fitted with the Inca legend of their great conquering leader Tupac Yupanqui, who conquered lands to the west in the mid-fifteenth century and brought back trophies, many black skinned prisoners and much metal wealth. It also accords with a remarkable manuscript account given to Captain Francisco de Cadres by an aged Quechua Indian just before the departure in 1567 of Sarmiento de Gamboa and Alvaro de Mendaña. They had orders to sail to the islands referred to in Inca legends.²⁷

Initially Mendaña in 1567 sailed on the same course as Gonzales in 1770-71, west-south-west, but failed to sight the three peaks of Sala y Gomez and Easter Island, seen by Gonzales.

²⁷ Heyerdahl, American Indians in the Pacific, pp. 557-569.

Cadres's report runs as follows:

An Indian named Chepo said to be about 120 years old was asked:

Cadres: From whence the said Indians crossed to the said islands?

Chepo: From Puerto de Arrica and Puerto de Ylo.

Cadres: How many days does it take the said Indians to perform the voyage?

Chepo: After two months journey they reach a desert island called Coatu, in which there are three high mountains and many birds.

Cadres: On proceeding to the said islands, on which side do they have the red desert island?

Chepo: On the left.

Cadres: What is the name of the first island after the desert island?

Chepo: It is called Quen and is thickly populated; the name of the reef is Queentique.

Mendaña failing to find land after 26 days, changed course to sail between the unsighted Tuamotus and Marquesas in late December. All Mendaña encountered was, therefore, one tiny part of the Ellice group and the Solomon Islands after 82 days.²⁸

Mendaña felt he had discovered the southern continent, but in two days he learnt it was an island that he had called Santa Ysabel. He then proceeded to build a 5 ton brigantine, the Santiago, and explore the nearby islands of Malaita, Guadalcanal, Choiseul and San Cristobal. After an unprofitable and often violent encounter with the natives he took the advice of his pilot, Gallego, to return home immediately on account of the ship's declining seaworthiness.²⁹

Gallego and Mendaña had obviously found out about the Kuroshio current before they left for South America as they deliberately sailed north via the Marshall Islands as far as lonely Wake Island (San Francisco). Then they sailed north east into the belt of westerly winds above 40°N and were able to sail easily eastwards to the American shore because of the Kuroshio current.

Good though the local information initiating the voyage was, it was felt to be an inconsequential voyage. A Spanish official writing to King Philip II wrote:-

²⁸ Gilbert, op.cit. Eastern Islands, Southern Seas, Aldus, London 1973 pp.221-224.

²⁹ Kelly Vol.1, p.6.

"In my opinion the islands they discovered were of little importance, although they heard of better lands, for in the course of these discoveries they found no specimens of spices and the natives were naked savages".³⁰

Mendaña felt otherwise about the venture, and despite the jealous recriminations of Sarmiento de Gamboa whom he had pipped to the command of the expedition, set out to plead a case for a return voyage. His plea at Madrid succeeded in 1574, but after three years of further preparations he was jailed for a trifling offence just as he was to set off for Peru. Because of the opposition of the Peruvian Viceroy, Mendaña had to wait eighteen years before he could again set out for the Pacific Islands.

By the 1570s the Spaniards felt they had discovered the important additional knowledge they needed for profitable Pacific navigation and a share in the Oriental trade via the Philippines. Indeed they had sufficient knowledge for galleons of ever increasing size to ply with valuable cargo between Manilla, Acapulco or Nicoya and Lima.

An indication of the cartographic information available is provided by Lopez de Velasco's two Pacific charts produced after he had published the results of his questionnaire in the Geografía y Descripcion Universal de las Indias. The first of the charts entitled "Demarcacion y Division de las Indias", covered the Pacific, America and the Far East while the second was a more detailed

³⁰Gilbert, *ibid* p 224.

chart of the East Indies and the Solomon Islands, entitled Descripcion de las Yndia de Poniente.³¹ Various features of these charts suggest that Velasco may have had access to Gallego's account. The grid pattern of these charts might suggest borrowing from Chinese or Pacific practice, but in all probability reflects the longitude finding problem. Officially the islands found in 1567 were said to be 600 leagues from Callao. If the official Spanish equivalent of $16\frac{2}{3}$ leagues to an equatorial degree is used, the islands were marked in the official place. However Velasco says he used a scale of 20 leagues to an equatorial degree, and indeed by this method produced a more accurate answer. Such a clever compromise was no help to the navigator, who was probably better served by manuscript charts and accounts.

The Spanish charts used in this way are difficult to reconstruct before Quiros's time

³¹ C. Jack-Hinton. The Search for the Islands of Solomon, 1517-1838. Clarendon Press, Oxford. 1969, pp. 88-9. This work also makes interesting reference to four manuscript versions of a seventeenth century chart by Pedro Baena, one owned by Arthur A. Houghton in New York, another being M.S. 2957 in the Biblioteca Nacional, Madrid. The chart of the Solomons perhaps also reflects the 'official' problem faced by Velasco in siting the Solomons correctly for the Baena chart of those Islands carries the inscription: 'Estas yslas todas esta de la parte de la Linea Equinozial de sele siele hasta catorze Grados de Altura - y estan un mil y ciento y setenta leguas del puerto de Callao'. (All those islands are to the south of the Equator between 7° and 14° of latitude and are 1,170 leagues from the port of Callao).

but impressions may be formed on the basis of Gio Babbista Mazza's Americae el Proximar Regionum Orae Descriptio of 1583, engraved for publication by 1589.³² Further clues, given through Asian interchanges may be gleaned by examining the atlas of Bartolomeu Lasso completed in 1590.³³

The Spaniards did try to improve upon their charting of the Pacific, but almost all this effort seems to have been based on a report which Fr. André de Urdanetta gave to Fr. Andrés de Aguirre, and which was subsequently sent via the Archbishop of Mexico to King Philip II in 1584. The report had originally been compiled by an Armenian trader whose ship had been separated from Urdanetta's in 1565, and which then encountered two islands whose rulers were very friendly and fabulously rich.³⁴ As these islands had been found about 40° north on the east-west crossing several subsequent Royal instructions were issued asking that the crossing be lengthened to permit exploration and charting of those islands. Pedro de Unamuno did explore several uninhabited islands in 1587. Later, Philip III asked Vizcaino to investigate the possible existence of the Strait

³²C. Jack-Hinton op.cit. p.92.

³³Bartolomeu Lasso. Este libro de Cosmographia de navegar fey Bartholomeu Lasso Año de 1590. See "Indian Interchange" Chapter.

³⁴Warren L. Cook. The Flood Tide of Empire. Spain and the Pacific North West 1543-1819. Yale University Press 1973, p.15. Note also that in 1592 one Juan de Grijalva, wrote:- "arriving at the port of Acapulca, Father Urdaneta drew a chart with its winds and routes, points and capes so well that it is still followed today". Sir Francis Drake. B.M. Catalogue 1977, p.86.

of Anian and a possible more southerly strait near New Mexico, by a royal order issued in 1602.³⁵ This seems to have been closely related to the tales of Juan de Fuca who reported the more southerly strait, probably the Gulf of California. Michael Lok who gleaned the details of Fuca's report in Venice and subsequently bequeathed them to Samuel Purchas, seemed far more enthusiastic than the Spaniards in urging exploration on this basis.³⁶

There were several reasons for this attitude amongst the Spaniards. The whole route from Manilla to Acapulco was fraught with dangers, so that over 30 galleons would be lost between 1565 and 1815, even though after 1593 the number of such ships permitted to cross was restricted to two a year. Mystery still surrounds the fates of the San Juanillo (1578), the San Juan (1586) and the San Antonio (1604). Mortality on average amongst the crews of the Manila galleons was often as high as 40% and the sufferings of the crews on voyages that could take up to eight months from

³⁵Navarette Documentos Inéditos 15 p.234-35. In the letter of Felipe III to Pedro de Acuna, governor of Manilla, Feb.16 1602 the expediency of capturing the Isla del Armino as a defensive base and depot for the Manila galleon is discussed.

³⁶S.Purchas, His Pilgrimes, Fetherstone, London, 1625, V3 p.849 for 'A note made by Me, Michael Lok the Elder, Touching the Strait of Sea commonly called Fretum Anian in the South Sea, through the North West passage of Meta Incognita'.

Note Juan de Fuca's strait is today shown on the other side of America at 48°N 125°W.

Manila to Acapulco were terrible. Lured by the relatively high wages paid for these voyages, and the prospect of vast profits, the Spanish felt the risk acceptable.³⁷ They felt trans-Pacific voyages could only be made with the specialised knowledge of a few experienced pilots, or otherwise disaster would ensue just as it had followed many of their early attempts.

They were very nearly correct in this view, but they had reckoned without Drake and Cavendish and a deliberate English policy of forcible capture of charts and pilots.

Drake was not just interested in capturing treasure; he realised how valuable Iberian navigational information was. The written testimony of a Portuguese pilot, Nuno da Silva, deliberately taken prisoner by Drake and admitted to his counsels stated:-

"The first thing he did when he captured a vessel was to seize the charts, astrolabes and mariners' compasses".³⁸

³⁷C.R.Boxer, *The Manila Galleon, 1565-1815. History Today* 1958, pp.538-548.

They felt secure in the enjoyment of a monopoly of navigational knowledge and consequently the traders' profits, because of their treaty with the Polynesians in the Far East, and because of the great dangers of shipwreck to anyone entering via Magellan's Straits. Even if they entered that then large armed galleons could physically destroy interlopers off the American coast.

³⁸D.W.Waters *The Art of Navigation in Elizabethan and Early Stuart Times*. London 1958. Appendix 1. pp.535-6.

Da Silva described how Drake inflicted this treatment on him off the Cape Verde Islands in February 1578. When Drake captured Spanish ships, he took the pilots with him until he had exhausted their knowledge. Thus he captured Juan Griego at Santiago on 8th February 1579 and took him as far as Callao. There he captured a ship bound for Lima, of which Da Silva said:-

"Drake took out of her only the bread, some hens and a hog and the pilot, an old man".³⁹

Between the 1st and 6th March he took possession of the famous treasure ship, Cacafuego, before dumping three useless pilots in place of her cargo of silver. Then on 20th March he made a most significant capture of a frigate which carried two pilots, Martin de Aguirre and Alonzo Sanchez Colchero, both very experienced on the 'China route'.

These last two pilots were returning from the new base for the China trade at Nicoya to Panama where they were going to deposit their books, charts, instruments and letters in the Royal Audiencia. Drake disbelieved Colchero's initial claim to be an old shellback, because being fluent in Spanish he could read the letters Colchero carried. Thus Da Silva could testify that Drake took with him the ship and one of the pilots, named Colchero, with the letters, papers and map which he had with him. Among the letters were those from the King of Spain to the Governor

³⁹Ibid. p.536.

of China. These Drake prized highly, saying he would take them to his Queen. Among the maps were the sea cards ('cartas de marear') by which the voyage was to be made. The pilot was acquainted with the China route and Drake consulted him about matters concerning navigation.⁴⁰

Drake could thus make his decision about a Pacific crossing with almost as much information at his disposal as any Spaniard had. It gave him another option and the chance to dumbfound his pursuers. He did not take the decision to cross the Pacific lightly, and initially was more inclined to stick to a route much discussed in Elizabethan England, the non-existent North West Passage. Da Silva reported how he approached the decision and the nature of the navigational aids he carried including those taken from Colchero and the charts and astrolabe taken from Da Silva himself.

"While in Guatulco Drake took out a map and pointed out on it how he intended to return by a strait which lay in 66°N and that if he did not find it, then by way of China. He carries three books of navigation, one in French [perhaps Nicolas de Nicolay's translation of Pedro de Medina's manual L'Art de Naviguer] one in English [either Eden's translation of Cortes's work The Art of Navigation, London 1561 or Bourne's Regiment for the Sea, London 1574] and another the account of Magellan's voyage in a language I do not know [either Maximillian of Transylvania's De Moluccis Insulis, Rome and Cologne, 1523 or Pigafetta's Le Voyage et Navigation, par les Espanolz et isles de Mollucques, Paris 1525]. He carries a book in which he writes his log and paints birds, trees and seals. He has a map of the world made in Portugal, but by whom I do not know, and some other maps which he said had been made in England. He is a very skilful mariner".⁴¹

⁴⁰ Ibid. p.536.

⁴¹ Ibid p.536

Even so Drake wanted Colchero to pilot him across the Pacific because he did not know the harbours and islands of the Pacific and China. Drake thus offered Colchero 1,000 ducats for his pocket, 50 pesos for his poor wife and time to write to her and the Viceroy of New Spain and Licentiate Palacios, explaining that he was detained on the "Golden Hind". In the end, however, he released Colchero in another ship which he had taken on April 16th, 1578.⁴²

Official Spanish reaction to Drake rested on the complacent belief that the secrets of the Pacific crossing were safe because the charts and pilots were so few and so restricted. It was not until later as they interrogated Drake's released captives that they discovered how he came by the necessary navigational information. It was symptomatic that the Spanish fleet pursuing Drake should turn for Panama at exactly the time that Drake captured Colchero at sea. The Licentiate Valverde, President of the Audiencia of Guatemala, gave several opinions to King Philip II explaining why Drake would not cross the Pacific. He said that it would mean Drake had then to sail around the world. This would be a long and difficult voyage, because his ship had only space to carry victuals for 80 men. Valverde also felt he would have difficulty evading the Portuguese fleets anxious to protect their own Eastern

⁴²A.E.W. Mason The Life of Francis Drake Hodder Stoughton pp.141, 168-72.

monopoly. When Valverde heard that Drake had landed the Portuguese pilot he was known to carry, he said of Francis Drake's decision:-

"Now it would have been in his interest to have taken him Da Silva further. For he was a friend of his and he would never have left him behind had he intended to return by way of China".⁴³

Valverde's attitude was typical of the Spanish administration's outlook on navigational matters in his generation. Administrators knew enough to realise the excellence of Portuguese methods and charts. Thus we have the President of Mexico, instructing Legaspi to obtain Portuguese charts in 1564, and the Viceroy of Mexico instructing Juan de la Isla in February 1572 to take particular care to seize Portuguese charts, if he should win a fight with the Portuguese ships off China.⁴⁴

The Spanish did not yet accept that the English had an equally great knowledge of navigation. There was something to be said for such a view because successful southern European crossings of the Pacific were only made by English navigators in possession of explicit Spanish information.

Thus we see that Drake, after he had sailed to about 40°N, and

⁴³T.W.E. Roche The Golden Hind cited report sent on 16th April 1580 pp.138-9.

⁴⁴C.R.Boxer. South China. p.lxx. Instructions of the Viceroy of Mexico for Captain Juan de la Isla. 1st February 1572.

"found not the land to trend as much as one degree towards the East, but rather running continually to the North West as if it were directly to meet with Asia" ⁴⁵

decided indeed to cross the Pacific. He thus came down to California. After a short stay near San Francisco with friendly Indians, he left on 23rd July, 1579. He left the Spanish route for the Philippines that parted company with the Californian coast about the 38th parallel, following the current that regularly took Californian Redwood trees as driftwood to Hawaii.

Two days later Drake found the islands now called the Farallon Islands. Noting that the cold wind still blew strongly from the north west, Fletcher reported that Drake chose to run for the Moluccas. Sixty-eight days later they sighted islands about 8° north of the equator. At first it was thought Drake had found the Ladrones, but now it is felt to have been one of the Palau group that was sighted.

Unfortunately details of this part of Drake's voyage are now poorly recorded. Drake's charts and illustrated log book were reported by the Spanish Ambassador in London as being given on Drake's return to Queen Elizabeth. They have since been lost. Two accounts do survive of the encounter of Drake and the peoples of the Pacific, but they are very brief. They both made extensive reference to the islanders' boat handling skills

⁴⁵ T.W.E.Roche, The Golden Hind, p.183.

and their sailing. It took Drake just three days to find his way out of this Archipelago, whence he had an uninterrupted voyage to the Philippines.

Thomas Cavendish achieved his Pacific crossing in 1587-8, by utilising Spanish knowledge in much the same way as Drake. Capturing a galleon from Manila, the *S. Anna*, off the Californian coast, he took much of its cargo and some selected captives.

" but before his departure, he tooke out of this great shippe two yong lads borne in Japon, which could both wright and reade their owne language, the eldest being about 20 yeeres olde was named Christopher, the other was called Cosmus, about 17 yeeres of age, both of very capacitie. He tooke also with him out of their ship, 3 boyes borne in the isles of Manilla, the one about 15 the other about 13, and the yongest about 9 yeeres old. The name of the eldest was Alphonso, the second Anthony de Dasi, the third remaineth with the right honourable the Countesse of Essex. He also tooke from them, one Nicholas Roderigo a Portugall, who hath not onely bene in Canton and other parts of China, but also in the islands of Japon being a countrey most rich in silver mynes, and and hath also been in the Philippines.

Hee tooke also from them a Spaniard whose name was Thomas de Ersola, which was a very good Pilot from Acapulco and the coast of Nueva Espanna unto the islands of Ladrones, where the Spaniards doe put in to water, sayling between Acapulco and the Philippines." 46

They would all provide useful knowledge, but none more so than the last captive, a Spanish pilot 47 known to Cavendish as Thomas de Ersola. It was from this pilot that Cavendish obtained his 'great map of China.' 48

46. R. Hakluyt *Principal Navigations*, Hak. Soc. Vol. XI P327

47. Thomas de Ersola was a pseudonym for Alonso de Valladolid. See D.B. Quinn 'The Last Voyage of Thomas Cavendish. The Autograph Manuscript of his own account of the voyage, written shortly before his death, from the collection of Paul Mellon, with introduction, transcript and notes by David Beers Quinn. Chicago University Press for the Newberry Library, Chicago, 1978 p14.

48. Ibid p14.

Cavendish, with Thomas de Ersola's guidance, took 45 days to reach the Ladrones (Marianas) from Aguiada Segura in California. When the island of Iwana (Guam) was reached on January 3rd 1588, Francis Pretty recorded it as lying in "13 $\frac{2}{3}$ " towards the North".⁴⁹ Thomas Fuller, who made navigational notes on the route as he went, reported that it lay "13 degrees and 50 minutes".⁵⁰ Cavendish saw the outrigger canoes of the natives and commented, but did not stop, probably because of Ersola's warnings about the thieving advances of the islanders and because it was a Spanish watering place. He sailed on like Drake directly to the Philippines.

First hand experience of the navigational difficulties of the Pacific, and access to Spanish information were to be the critical factors which facilitated all those Pacific crossings by northern Europeans that were successful before the late 17th century. Consequently few dared the voyage, outside the pilots of the Spanish 'Manila galleons'.

Those non-Spaniards who attempted the Pacific crossing included Oliver Noort, who completed the first Dutch circumnavigation of the world (1598-1601). Noort had on board Captain Mellis who had been on Cavendish's voyage in 1588. The other Dutch fleet that set off for the Far East via the Straits of Magellan in 1598 took William Adams from Limehouse as its Chief Pilot and Adams's friend, Timothy Shotten, as another pilot. Adams's

⁴⁹ Ibid. p.327.

⁵⁰ Ibid. p.369

ship alone survived and reached Japan, but his friend, Shotten, died on the way.⁵¹ Shotten was knowledgeable about the Pacific because Hakluyt had employed him to translate the letters of Thomas de Ersola that had been captured by Cavendish.

Many of the details of Pacific navigation that were discovered by Drake and Cavendish would appear in R. Hakluyt's edition of Principal Navigations that was published in 1598-1600. Particularly important in this context was the rutter of Thomas Fuller, which consisted of several pages of notes giving the latitudes of certain places observed along the way, soundings, descriptions of convenient harbours and their entrances, compass courses taken and distances travelled and a note on the variation of the compass of New Spain, in the Pacific and off the Moluccas.⁵² It also gave details of all anchorages used and how long they stayed, what victuals were available with the occasional brief description of the area around and local activities. Finally Fuller gave a description of the prevailing winds encountered all the way round the world.

Also important was Thomas Pretty's journal, which

⁵¹ India Office Records. Original Correspondence, Vol. 1, ff. 116-129. William Adams to my Unknown Friends, Japan, October 23rd, 1611.

⁵² R. Hakluyt. op.cit. pp. 348-76 for "Certaine rare and special memorials most properly belonging to the voyage of Mr. Thomas Candish next before described concerning the heights, soundings, lyings of lands, distances of places, the variation of the compasse, the just length of time spent in sayling between dyvers places, and their abode in them, and also the places of their harbour and containing, and the depths of the same, with the observations of the winds on several coasts. Written by Mr. Thomas Fuller of Ipswich, who was Master of the Desire of Thomas Candish in his aforesaid prosperous voyage about the world".

was rather better than the records of Drake's voyage made available in Hakluyt Principal Navigations .

Hakluyt appreciated the vital navigational importance of such Spanish information as underlay the successful English crossings of the Pacific. So hurriedly he inserted a brief account of both voyages for his 1589 edition of "Principal Navigations". For details of Cavendish's voyage he probably used a broadsheet purporting to be a letter from "Master Can[d]ish to the Right Honourable Lord Chamberlaine touching the success of the voyage round the world". The account of Drake's voyage printed in Hakluyt's 1589 edition was barely good enough for navigational use. It was printed after the rest of the 1589 edition and was inserted hastily between pages 640 and 644 and it did not appear in the book's index.⁵³

By 1600 Hakluyt had better sources available to him, including detailed accounts of Iberian navigational secrets gathered by Linschoten in India. Thus he could insert details given by the Spanish pilot Francisco de Galle of a voyage from Acapulco to the Philippines, Macao and Japan and back to Acapulco between 1582 and 1584. Hakluyt lifted this version of Francisco de Galle's journal from Linschoten's Discours as translated into English in 1598. Many similar details would also appear in seventeenth century European travel books published in the Low Countries between 1607 and 1627.⁵⁴

⁵³D.B.Quinn, Hakluyt Handbook . Hak.Soc.Vol.1.p.374. Details of Hakluyt's use of information derived from Linschoten is given by Quinn on p.445.

⁵⁴An example of such literature is Gothardus Arthus Indiae Orientalis , Frankfurt, 1607 . Part V, Books 6 , Durham Chapter Library F.II.35.

It was such information that provided the basis for another breach of Spain's monopoly of access to the Pacific routes. A security breach may have occurred over a chart of Magellan's Strait, made in 1585 by a Portuguese, where a pencil 'V' shape is drawn to the south of the Straits of Magellan.⁵⁵ This information was enough to initiate a Dutch voyage by a young adventurer, Jacob le Maire. His father Isaac had challenged the monopoly of the Dutch East India Company, and obtained a charter to trade via the Magellan Straits with Asia. Le Maire, encouraged by this, consulted an experienced pilot, Willem Cornelius Schouten. In the course of their subsequent voyage they passed the Magellan Straits and soon rounded Cape Horn. This was so named after their ship, the 'Hoorn'. Though Schouten died as they passed the Tuamotu group, unlike Magellan nearly 100 years before Le Maire's crew explored the islands fully. Nearly a month later on May 9th 1616, they sighted a double canoe and an island they named Cocos, present day Tafahi, in the northern Tonga group. Another island they called Vevraders Island, where they were lavishly supplied with provisions. On May 19th they found a good and pleasant anchorage at Hoornse Eylandten - now Futuna and Alofi in the Horn Islands midway between Samoa and Fiji.

⁵⁵ P.M.C. Vol.IV, p.23. The chart was made by an anonymous cartographer, perhaps Sebastao Lopes.

The Dutch visitors and the islanders got on very happily together. One of the Dutch company wrote of those two weeks that it was "as free and easy there as if we had been at home".

Le Maire then wanted to find Quiros's southern continent, but Schouten favoured a safer course to the north west and so to the Moluccas. Passing New Ireland on 25th June they found New Hanover and the islands later known as the Admiralty group, before they arrived at Ternate in the Moluccas on September 17th and Jakarta on October 28th.⁵⁶

Governor Coen at Jakarta was not prepared to believe in the new route, because it was organised as a sheer act of defiance towards the Dutch company's monopoly. Le Maire, Schouten and 16 of their men were immediately sent back in the custody of Joris Van Spilbergen. Their ship "Eendracht" was confiscated. Jacob le Maire died disillusioned on the return voyage, but his father, unwilling to let the matter rest, sued the East India Company. Two years later he succeeded in recovering the ship, cargo, and costs and established the existence of the passage bearing his name.

Against such a breach as the English and Dutch had made in their vital and valuable

⁵⁶ Gilbert, "Charting the Vast Pacific; Eastern Islands, Southern Seas, pp.247-52.

monopolies, the Spanish government and the Casa de Contratacion in Seville had to go on the defensive. They tried tightening their bureaucratic restrictions on instruments and charts sent from Seville, but this had little effect on events along the Pacific's extensive shores. Little could protect the Pacific pilots or their instruments and charts from forcible capture if European interlopers reached the Pacific shores. So the Spaniards tried to counter it by increased defensive provision, both on naval escorts and shore-based military installations. They also adopted a slightly different official stance towards their mariners in the Pacific. They tried extending their marine regulations along the American shores. They attempted to promote awareness of the dangers posed by interlopers and to arrange a warning system that stretched along the whole route of the Manila galleons. Official reaction also discouraged the outlook of the 'descobrador'.

By the late 17th century this would be acting against all that was firmly established on the western coast of America, outside government circles. Heyerdahl has reviewed the maritime

traditions and trans-Pacific voyages of the coastal Indian communities from the Kwakwaka'wakw and Bella Coola tribes north of Vancouver Island to the Inca maritime traditions of Peru and Chile.⁵⁷ Augmenting these native sources, a group of free-lance Portuguese had established in Peru a local reputation for providing the skills that were supposed to have been centred in the Casa da Contratacion in Seville. They included practising pilots, cartographers and instrument makers.⁵⁸

The earliest of these Portuguese navigators to offer such services was João Pacheco, who was sent by King Charles V to join a Pacific voyage of discovery departing on 24th February 1526. He planned to reach the Moluccas in 1535 from New Spain. Later he was found in the service of King Francis I of France. Next came Martin da Costa, who acted as pilot on Grijalva's expeditions to California in 1533 and from Peru to the Moluccas in 1536. Two anonymous pilots acted for Alvarado's expedition from Nicaragua to Peru in 1534. Gaspar Rico acted as pilot for Villalobos's ill-fated fleet on the voyage of 1542-5, while João Rodrigues Cabrilho discovered High California in 1542.

Sarmiento de Gamboa made use of a community of such people in Lima as he pursued his research

⁵⁷Heyerdahl, American Indians in the Pacific, pp.71-158.

⁵⁸P.M.C. Vol.III, pp.35-7 gives details of those Portuguese cartographers and navigators practising in Spanish South America. Especially notable amongst their products was the Atlas made for the Viceroy of Peru in Lima, probably in 1586. This is now (K3) in the Library of the Hispanic Society of America in New York.

in geographical, navigational and astronomical subjects. In the context of his attempt to measure latitude, using an eclipse of the moon at Lima in 1578, we learn that he referred to charts belonging to Anton Pablos, a native of Corsica, and Diego and Sancho Gutierrez. In a letter sent from Rio de Janeiro on 1st June 1585 he refers to a chart by Vicente Nobre,

"Por otra carta Portuguesa de un Vicente Noble cartero de Limo, esta Lima 4 grados mas occidental".⁵⁹

In the next generation we find Sebastio Rodrigues Sermiento, the pilot of a Manila galleon which explored High California in 1594, and the much more famous 'descobriador' from the slums of Lisbon, Quirós. Quirós first reached prominence when chosen as pilot by Alvaro Mendaña for his unfortunate voyage to the Solomon Islands in 1595-6. As the expedition's pilot he became Captain Major on Mendaña's death.

Before Spanish decisions could be enforced on this talented ex-patriated community of adventurers, suitable bureaucratic organisation had to be imposed. This was the role of the special bases at Acapulco, Nicoya, Panama, Lima and Callao, where navigational aids were supposed to be returned. In reality most of the navigational instructions issued came direct from the Viceroy's office. Despite the great Portuguese

⁵⁹Ibid. pp.36-37.

contribution only Francisco Domingues was officially appointed to a post, Cosmographer to His Majesty in New Spain, in 1570. He made maps of the New World and "instruments for China".⁶⁰

Seville and Madrid became increasingly aware of the dangers of these developments. Sarmiento de Gamboa arrived in Madrid after a voyage through Magellan's Straits that was designed partly to chase Drake, if he went that way, and partly to investigate ways to fortify the entrance to the Strait. In 1580 Sarmiento succeeded in persuading King Philip II at Badajoz of the value of establishing such a fort, and of improving Spanish charts. Sarmiento then went to Seville to correct the Padron-Real at the cartographic office there and to undertake detailed planning. When he sailed from Cadiz, he had done much to awaken navigational thinking in Spain. His fort failed, due to the fact that its garrisons died of extreme cold or starvation. (Ironically it was an Englishman, Andrew Merrick, who rescued the last survivor.)

However, ~~whereas~~ direct action failed to protect the Spanish Pacific monopoly, Spanish efforts to discourage the 'descobriador' mentality were more successful. That, however, was only achieved at the cost of progress in navigational information. Official Spanish attitudes could gain ground after the poor results of the 1575-6

⁶⁰Ibid. Vol.5, p.180.

voyage of Mendana and Quirós. There seemed little point in extending Spain's defensive responsibilities to the hostile Melanesians and by so doing weakening their defensive effort elsewhere by spreading it more thinly. In South America the 'descobriador' mentality was kept alive by the works of Sarmiento de Gamboa, Gabello de Balboa and Vargas Machuca. Machuca's book published in 1599 opened with the motto "By the sword and compasses, More and More and More and More". ⁶¹

Because of this discouragement of the 'descobriador' mentality in the 1590s and early 1600s, it took Quirós ten years of determined effort to secure government support for a return voyage.

Quirós's affection for the natives of Oceania led him to seek to overcome official discouragement by making his mission seem vital. To accomplish this he needed both friends in high places and active and moral support. He began by seeking such a platform at Rome in 1601. He secured there the Pope's support against King Philip III who had so far refused to back his plan. He also secured the support of Rome's geographers, mathematicians, cartographers and nobility because of his evident navigational expertise. Indeed he wrote a treatise on methods of navigation whilst in Rome. ⁶² The Duke of Sesa cited it when recommending Quirós to

⁶¹ J.H.Elliott. The Old World and the New 1492-1650. Frontispiece.

⁶² Kelly. Vol.I, p.52.

King Philip III as a skilful pilot, chartmaker and mathematician. The instruments he invented (one was to ascertain and correct for compass variation) were highly praised in Rome.

Such supporters enabled him to win the support of the Council of State at Madrid. With that alone he could overcome the official restrictions imposed by the Casa de Contratacion. Although the Casa wished to concentrate the skilled cartographers and instrument makers in Seville for reasons of security, it was forced to grant a dispensation to Quirós to take the skilled instrument maker Esteban Borgonon with him to Peru. Official strictness again caused Quirós to petition the Viceroy of Peru in 1605 to allow the construction of a compass to determine variation in Lima. The Viceroy approved the petition for this and other indispensable navigation instruments on 27th April 1605.

On 21st December 1605 Quirós set out with several skilled navigators, including two Portuguese, Gonsalez de Leza and Francisco Hernandez, as the Spaniard's chief pilot and Pedro Bernal de Cermeno as chief pilot, and as Admiral, Luis Váez de Torres. Quirós instructed them to depart from the orthodox methods of navigation. In his treatise he had suggested that the cross-staff and astrolabe were only useful if accurately used. As he felt navigation

was about where a pilot thinks he is, dead reckoning estimates, knowledge of how ships are handled, currents, winds and "other indicators" were stressed more than usual in "The Instructions" he issued on 8th January 1606.⁶³ The Journal of Fray de Munilla later had much to say about such indicators. They were obviously the result of his earlier Pacific experiences and are reminiscent of Grimbles' notes on Gilbertese navigational methods.

Quirós practised what he had preached with regard to relations with the natives of the Pacific shores in Polynesia, so Munilla was able to record significant navigational information. As Quirós lay off Tuamaco in the Duff Islands, he met a very friendly Polynesian 'caique' or chief, of whom Munilla said

"This caique was called Tomay [Tomai in Polynesian] and to establish good relations with each other, Admiral Luis Baez de Torres and he exchanged names. At the request of Admiral Luis Baez he stayed there with him all the time".⁶⁴

⁶³Kelly, Vol.1, pp.140-150 for Quirós 'Instructions' included with Munilla's Journal, pp.137-270. Note especially pp.148-150 for the 'other indicators'..

⁶⁴Ibid., Vol.1, p.188.

He later visited Quiros's ship and there Munilla reported that:-

"The General asked him if he knew other lands. He began to tell us of many, which were set down as he mentioned them, amounting to forty in all. When he was asked for information on Santa Cruz and about Malope the caique there, whom the Spaniards had bullied when on a previous occasion the Adelantado had gone to establish settlements in the Solomon Islands, he answered that he did know about it and that the Spaniards had themselves put to death the man who had killed Malope, because he did so while pretending friendship ..." 65

Among the islands which he named he told of eight inhabited by cannibals.

Juan d'Iturbe added more detail in his account of the voyage. After describing the construction of native outrigger canoes he said:-

"With these canoes they go out to sea and sail round all those islands, concerning more than sixty of which the caique Tomay gave much information; mentioning in which ones there were white people and in which blacks, and certain ones where there were cannibals. Those natives seemed to be great corsairs, and they must raid all those islands where they are accustomed to make captives of their neighbours ... They also gave information concerning the island of Santa Cruz which they [the Spaniards] sought. They called it Yudení. It would be distant from there about 5 days sailing in their canoes, which would make it some 60 or 80 leagues. They told of the sojourn which the Spaniards who went with Adelantado Mendaña made there" [The Solomon Islands, Melanesia in 1596.] 66

⁶⁵Ibid. Vol.2, p.284.

⁶⁶Ibid. Vol.2, pp.377-9. This also discusses the identification of the islands mentioned by Tomai.

Nearly all the islands that Tomai spoke of have been identified from various sources, but none was more significant to Quirós than a description of a large island to the south. Quirós assumed this would be his Terra Australis and followed Tomai's directions until he made landfall in the New Hebrides. When Quirós saw these coasts and the great Bay of St. Philip and St. James he felt he had succeeded in his work. He called it therefore 'La Australia del Espiritu Santo' and celebrated mass. He also invented a new order of chivalry, the Knights of the Holy Ghost, who were to help him fulfil his mission to the islanders.⁶⁷

He stayed three weeks there, but his contacts with the natives were rather unfriendly, resulting in several deaths. Little else of consequence happened and exchanges were valueless. It was only later that Prado and Torres learned that it was not the southern continent, but two large islands, later to be regarded as part of the New Hebrides.

⁶⁷For a full discussion of the missionary aspects of Quirós's voyage, and the opposition of the Franciscan friars he carried to the new order of chivalry Quirós created, see the Introduction of C. Kelly's work as already cited.

When Quiros attempted to supplement his knowledge of the area by personal exploration in his ship, he encountered a strong northerly wind and was unable to rejoin the other ships of his fleet in the safe haven of St. Philip and St. James. On June 11th he went onwards in a northerly direction but he was unable to reach Mendaña's Santa Cruz (the Solomon Islands) or make his intended landing in the Duff Group. Swept north to latitude 38°N and then north east, he reached the Kuroshio current, and turned for home where he arrived on 23rd November 1606.

The other ships continued to search for Quiros for two weeks. Then Prado & Torres opened their sealed instructions for such an eventuality. In them the Viceroy of Peru had directed that they continue exploring down to 20° South. They reached 21°S . before encountering a north easterly gale, which brought them back to touch the Louisiade Archipelago, home of the Kula people. High winds again caused Torres to change plan off the coast of New Guinea. He wrote in his journal:-

"I could not weather the east point, so I coasted along to the westward on the south side" ⁶⁸

He had entered the highly dangerous strait named after him by Dalrymple. As he negotiated the

⁶⁸ Gilbert, *op. cit.*, Eastern Islands, Southern Seas p242 See also footnote 14 of this chapter for details of an article on the Torres Strait by C.C. Ingleton as cited.

shoals, reefs and tides, he wrote in his
Journal:-

"Here were very many large islands and these appeared more to the southward. They were inhabited by black people, very stout and naked. Their arms were lances, arrows and clubs of stone, ill-fashioned".⁶⁹

(The southern islands were in fact the hills of Cape York, Australia's northernmost tip.) Though many of the Melanesians were unfriendly to Torres, he noted more civilised men at the western tip of New Guinea two months later. They had better armaments, some of Chinese origin and were called by Torres "Mahometans". From here he sailed to Banda, then Ternate, and finally he reached Manila on May 22nd 1607.

It is instructive to see what navigation information was officially submitted to the Spanish authorities about these events and how Spanish bureaucrats reacted.

After 1607 deliberate bureaucratic stickiness in effect stifled most Spanish voyages of discovery in the Pacific until the voyage of Gonzales to Easter Island in 1770-1771. This attitude was first seen in the welcome that Quiros received from the Viceroy of Mexico, the Marquis of Montesclaros in 1606. He demanded the immediate handover of the ship and all her contents to Treasury officials at Acapulco.⁷⁰

⁶⁹Julian Holland, "Lands of the Southern Cross" in Eastern Islands, southern Seas, Aldus p.342.

⁷⁰Kelly, Vol.1, p.106.

The Viceroy reported to his King that the friars, soldiers and pilots of the ship had lodged complaints against Quiros. The reception extended to Quiros and his reports through the first half of 1607 were progressively less friendly.

A rather different bureaucratic response was seen in relation to Torres and Prado in Manila. As soon as Torres handed his supplementary account and five charts to the Royal Audiencia they were secreted in the official archive at Manila. They remained there until discovered by English soldiers in 1762. So although Torres had sent copies of his report in 1607 to the Council of State and Quiros, his discoveries would not figure on later Spanish charts.⁷¹

Quiros however made active use of Torres's information even though the Council of State decided not to discuss it. By referring Quiros's memorials to the Council of the Indies for an opinion before considering them again, prior to the King's decision, they hoped to discourage Quiros.⁷² The President of the Council of the Indies resented the fact that the Council of State had ever interfered over Quiros's voyage of 1605-6. Thus, Lemos wrote

"consultation over Quiros' projects will be advisable on account of the understanding and experience it [the Council of the Indies] has in these matters, also other difficulties will arise like the present one, which is of no small account"⁷³

⁷¹Ibid. Vol.II, pp.353-5. Summary of what Luis Vaez de Torres wrote to Quiros from Manila on 15 June 1607. Received towards the end of August 1608.

⁷²Ibid. Vol.II, p.355. 'Consulta of the Council of State to the King'. Madrid 2nd August 1608. Translated from A.G.S.Estado 2638.

⁷³Ibid. Vol.II, p.355. Consulta of the Council, 12th July 1608. Translated from Estado 2638.

In addition to this row over jurisdiction, the Council of the Indies did have the very real anxiety about finding resources for the defence of America, the Philippines and more recently Ternate and the East Indies. It also had to seek the consent of the Portuguese administration. Thus they were bound to be sceptical of the benefit of extending their commitments by another voyage of discovery, such as Quirós and the Franciscans were proposing from 1611 onwards.

Against the scepticism of Lemos, and persistent criticism from some members of his 1606 expedition, Quirós used a summary of what Torres had told him in a letter from Manila written on 15th June 1607. Torres gave great prominence to the interchange with the native peoples of the Pacific, and the value of it, and Quirós wrote in his summary of 1609 as follows:—

"It is to be noted that what the natives of Tuamaco said by signs, and what Pedro the native said, and what I say in my own statements as may be seen in the first and second memorial, agree with what this letter said about Tierra Firme and many islands, with many of divers colours and for this, and all other reasons, it must be expected that what the natives have said about pearls and silver, and likewise the rest will be true ".⁷⁴

⁷⁴As footnote 71.

It was in the light of such information that the Council of the Indies concluded an accord with the Council of State, under which the new Viceroy of Peru on 19th July 1614 was to take Quiros with him from Madrid to Peru. However, the Viceroy wrote on 21st October 1614 that he only proposed to allow Quiros to leave from Callao with an expedition if the state of affairs in Peru was such as to make it opportune. Quiros left Madrid with the Viceroy on 9th September 1615 but died before he reached Peru, allegedly in Panama.⁷⁵ No subsequent Iberian had sufficient determination to persuade Habsburg Spain to support a Pacific voyage of discovery.

Having effectively killed the mentality of the 'descobriador', Habsburg Spain faced a major problem when it became urgent to verify the truth of Schouten and Le Maire's claim to have discovered the Cape Horn route into the Pacific. Details of the latter's voyage had been published in Amsterdam in 1618 as Schouten's Journael ofte Beschrijvinghe.⁷⁶ It constituted a particularly serious threat to the security of Spain's Pacific monopoly, because it contained

⁷⁵ Kelly, Vol.1, p.113.

⁷⁶ Willem Schouten, Journael ofte Beschrijvinghe van de wonderlicke reyse ghedeane door Willem Cornelisz Schouten ... in de Javen 1615, 1616 en 1617 etc. I Janz - Amsterdam 1624.

The relation of a wonderfull voiage made by W. Cornelison Schouten; shewing how south from the Straights of Magelan, in Terra del Fuego; he ... discovered a newe passage through the great South Sea, and that way sayled round the world. Describing what Islands, Countries, People and Adventures he found in his said Passage. Translated from the Dutch by W.P. [William Phillip] London 1619. T.D. for W.Newberry.

a chart of the Dutchmen's route across the Pacific to the Spice Islands, with details of cartographic insets showing Tierra del Fuego and Cape Horn, as well as the north coast of New Guinea.

However, as the Spanish administration had been so successful at discouraging the exploration and charting of new areas they had to call upon the equally hard pressed Portuguese administration to find the necessary finance, men, ships and cartographers from Lisbon to verify Schouten's discovery. This last Portuguese voyage of discovery ended in 1621 with João and Pedro Teixeira being taken from Lisbon to draw up charts based on the findings of the Nodal brothers.⁷⁷

Similarly Dutch voyages across the Pacific were effectively discouraged by Governor Coens' attitude that was designed to secure the Company's own chartered routes, until a return to the Pacific to undertake a scientific survey was advocated by Franz Jacobsz Visscher in 1642 in a Memoir concerning the Discovery of the South Lands.⁷⁸

So we see the Pacific interchange was one where the Spanish, with Portuguese helpers, progressively improved their navigational knowledge by even closer contacts with native Pacific navigational traditions. The gains made in such voyages of discovery had to be protected from dispersal to northern European interlopers so that the Spaniards could continue to enjoy the

⁷⁷ P.M.C. Vol.4, pp.23-4. See also footnote 70 of chapter "The Dissemination and Decline of Iberian Navigational Skills, 1580-1620".

⁷⁸ Major Early Voyages to the Terra Australis, Hak. Soc. 1859,

profits of the Manila route monopoly. This necessitated tightening security and the ending of Spanish voyages of discovery lest details of the news attract interlopers. It was a policy successful far into the seventeenth century, but achieved at the cost of advances in navigational knowledge and method. Apart from the raids on Mexico's west coast by the Dutch Admiral, Joris Van Spielbergen in 1615 and by Hugo Schapenham in 1624, seventy years of freedom from buccaneers was gained by curtailing the Pacific interchange of navigational knowledge after 1600.

THE CHINESE INTERCHANGE

Whereas in 1783 George Henry Millar saw the Chinese scientific achievements as retarded by isolation from technical interchanges,¹ more modern writers have suggested that interchanges between Chinese and European civilisations were significant. Recently effort has been lavished upon those early contacts of which Hakluyt wrote, such as the Franciscan interests and Marco Polo. Nevertheless, it was contacts and interchanges between Chinese seamen and others which were to prove most significant to themselves and to Europe. However, clear appreciation of this after the mid-seventeenth century was rare until M.G. Phillipe revived interest in Prince Cheng Ho's voyages of the fifteenth century. In two articles published

¹ George Henry Millar, The New and Universal System of Geography, London, 1783. For further comment on Millar's work see the Introduction, footnotes 39 and 40. On p.49 of his work Millar had said of China:-

"The reason that the Chinese fall short of the Europeans in their speculative sciences, does not proceed from any defect in their capacities or intellects (for they are acknowledged by all to be a most ingenious people), but from their situation, being separated so far from the rest of the learned world, and conversing with none but people so much inferior to themselves, it is rather to be admired that they have made such great advances in arts and sciences, than that they have gone no further. They have had no advantage by travelling, or any foreign assistance, their knowledge being defective when the Europeans first arrived".

in 1885-6, he examined their cartography and seamanship.² Hirth and Rockhill in their study of thirteenth century Chinese navigational methods and achievements suggested the Chinese first sailed into the Indian Ocean in the third century A.D.,³ while G.R.G.Worcester writing in 1940 claimed Chinese contacts with Europe by both land and sea were made as early as 650 B.C.⁴ Dr.Needham claimed Chinese ships sailed as far as Penang, in Malaya, in 350 B.C.⁵ and that in 219 B.C. they sailed as far as the Indian Ocean and Hawaii.⁶ During the reign of the Emperor Wu Ti from 140 to 86 B.C., a regular seaborne trade to a southern Indian town was established. Such a regular trade route depended on more sophisticated navigational methods than merely following the monsoon pattern.

²M.G.Phillips, "The seaports of India and Ceylon described by Chinese voyagers of the Fifteenth Century, together with an account of Chinese navigation", Journal of the Royal Asiatic Society, North China Branch, (New Series), no.20, 1885, p.209-226 and no.21, 1886, p.30 et seq.

³W.W.Rockhill and F.Hirth, Chau Ju Kua - His work on the Chinese and Arab Trade in the Twelfth and Thirteenth Centuries entitled 'Chu-fan-chi'. S.Petersburg, Impremière de l'academie des Sciences, 1911.

⁴G.R.G.Worcester, Junks and Sampans of the Yangtze, (First Edition 1940), 2nd Edition, Naval Institute Press, Annapolis, 1971. pp. 20-21.

⁵J.Needham, "Abstract of Material Presented at the International Maritime History Commission at Beirut, 1966" in Sociétés et compagnies de Commerce en Orient et dans l'ocean indien, Paris 1970, S.E.V.P.E.N. p.140. (The same material also appears as Chapter 4 of J.Needham Clerks and Craftsmen in China and the West, C.U.P. 1970, pp.40-70.)

⁶J.Needham, Science and Civilisation in China, Vol.IV, pt.3, p.552.

As early as 120 B.C. stellar observations were being confidently taken with sighting tubes and water levels by astronomers,⁷ but the competence of maritime users is more open to doubt for in 120 B.C. the Huai Nan Tzu says

"those at sea who become confused and cannot distinguish east from west orientate themselves as soon as they see the Pole Star".⁸

However, from this time onwards Chinese methods of navigation show slow, if not always steady advances. The titles of five navigational manuals appearing in a bibliography of the 1st century A.D.⁹ are early evidence of such progress. The works compiled by Chang Heng between 118 and 125 A.D., especially the Ling Hsien (Spiritual Constitution of the Universe) compiled in 118 A.D., show the emergence of an astronomical theory very similar to that advanced by Macrobius and Sacrobosco and which was still being taught to European seamen as late as the seventeenth century. The following extracts from the fragmentary remains of the Ling Hsien give an idea of the early competence of Chinese sailors in celestial navigation. Justifying his compilation, Chang Heng wrote:-

"Formerly the sage-kings, wishing to trace the ways of heaven, and to fix the sublime tracks (the paths of heavenly bodies), and to ascertain the origins of things, first set up a celestial sphere (hun thi) thus

⁷J.Needham, *ibid.* , Vol.III, p.302.

⁸J.Needham, *ibid.* , Vol.IV, p.563.

⁹J.Needham, *ibid.* , Vol.IV, p.560.

rectifying their instrument and establishing degrees (cheng i li thi), so that the imperial pole was fixed. All turned round the heavenly axis in a reliable way which could be studied. After this was set up and observed, it was seen that heaven had a normal regularity (chang). The sages had no preconceived theories and based their thinking on what the phenomenon showed. To explain these I therefore wrote the Ling Hsien ...

North and south of the equator there are 124 groups brightly shining and 320 stars can be named (individually). There are in all 2500 stars, not including those which the sailors (hai jen) observe. Of the very small stars there are 11,250. All have their influences on fate".¹⁰

By utilising such celestial knowledge, lead and line soundings, and the accounts of earlier travellers, the sea route to India had been made so safe that by 520 A.D. it was reported that the Himalayan route had been virtually abandoned. Continued attempts were made to improve this celestial knowledge, as was shown in 724 A.D. when the Chinese Astronomer Royal was sent to sea to observe Sun shadow lengths off Hanoi.

During the rule of the Sung dynasty from 960-1127 large and weatherly junks were making regular voyages to the Persian Gulf and East Africa. On voyages that took them far from the sight of land, the Sung navigators could rely on the indications of floating compasses for bearings, and for time on slow-burning incense sticks when weather prevented use of a nocturnal or a sundial. On their return to China they could even

¹⁰J. Needham, *ibid* ., Vol. III, p. 216. Note also Chang Heng described an Armillary Sphere about 125 A.D.

plan entry to one of the great ports, for tide tables had been compiled for Ningpo in 1026 and Hangchow by 1056.¹¹

The wealth earned from foreign trade caused the Sung Emperors to set up several maritime trade bureaux to regulate and tax the goods entering China's major ports. Such a bureau was established by T'ai-tsu in Kuang-tung in 971-2, and another followed in 1087 at Ch'uan-chow.¹² At first the Yuan dynasty copied these models so that by 1284 seven such bureaux were in operation. Chinese records like the Yuan shih, in describing their operations, provide evidence of many interchanges, some of which involved the interchange of navigational ideas and information between foreigners and the Chinese.¹³

¹¹J.Needham, op.cit.Vol.IV, part 3, p.492. This anticipates by 200 years the first European tide tables, compiled for London Bridge. British Library, Cotton MSS. Julius D.7.

¹²H.F.Schurmann Economic Structure of the Yuan Dynasty. Translation of chapters 93 and 94 and the Yuan Shih. Harvard University Press 1956. There is good reason to believe Canton had such a bureau early in the 8th century, for the T'ang government appointed their first trade commissioner in 715. See p.222, and pp.229-36 for the details of later bureaux. Their operation makes for most interesting comparisons with those regulatory activities of the Casas at both Lisbon and Seville. Though the latter were also operated to provide maximum financial benefit to their respective monarchs, these Chinese bureaucracies do not seem to have developed into such incubuses to trade and navigation.

¹³Ibid. Detailed sailing directions for the South China Sea are given on pp.119-123.

There were few other Asian peoples able to participate in interchanges of navigational information at the levels of sophistication evident in two Chinese manuscript rutters for the eastern shores of Africa compiled about 1178, or in the more famous Chu-fan-chih (Records of Foreign Peoples) written about 1225.¹⁴ However, the Arabs and their Muslim trading contacts were both able and willing to engage in such interchanges throughout Asia. Dr. Joseph Needham has argued that through the Arabs Europeans learned of the floating magnetised needle that was first developed in China.¹⁵ He also suggests that the "Dipper

¹⁴ W.W. Rockhill and F. Hirth, op.cit. See also criticisms of their translation by: P. Pelliot, T'oung Pao, 1912, pp. 446-481; J.J.L. Duyvendak, China's Discovery of Africa, A. Probsthain, London, 1947. These criticisms served to stimulate interest in the two rutters of 1178 as Chau Ju Kua's sources. One of these rutters by an anonymous author described the East African coast down to the Comoro Islands and the Mozambique Channel; the latter described the ports and life of Somalia. The main source was the latter rutter by Chou-H'ui fei, Ling-wai-tai-ta (Information on what is beyond the Mountain Passes). Duyvendak thought Chau Ju Kua used information available to him officially while he was Commissioner of Shipping and Foreign Trade at Ch'uan-chow. Op.cit., p. 14.

¹⁵ J. Needham, op.cit., pp. 562-3. This suggests that in 1090 Chu Yu described the compass in marine use by the Chinese. However, J.J.L. Duyvendak, op.cit., pp. 19-20 pointed to an error in Hirth's translation of Chu Yu's work, P'ing-chou-k'o-t'an, and thereby discredited the idea that Arab traders were the first to use the compass at sea, having seen it in use amongst Chinese geomancers. Chu Yu referred to Chinese ships when stating "The shipmaster for ascertaining his geographic position by night looks at the stars by day looks at the Sun, and in dark weather he looks at the south-pointing needle". Note also that E.G.R. Taylor, Haven Finding Art, Hollis and Carter, London, 1971, pp. 126-7, cites an Arab use of the floating compass at sea in 1242-3, but it was suspected that fifty years earlier its use was known in the Norman cities of Italy like Amalfi.

Observer" which in 1129 Lin Chih-Phing ordered every ocean-going ship from Fukien and Kuangtung to carry, stemmed from an Arab suggestion to fix together a traditional sighting tube and a quadrant.¹⁶ Interchanges between Arab and Chinese maritime communities reached a peak between 1250 and 1275 when the Commissioner of Merchant Shipping at Ch'uan-chow was a Chinese appointee of Arab or Persian descent named P'u Shou-Keng. He is known to have transferred his services to the Mongols and to have died a wealthy and respected Muslim patrician. In 1267 Jamal-al-Din journeyed from Maraghah to advise Chinese astronomers in Peking on seven different designs of celestial instrument including an astrolabe.¹⁷ Though the Chinese did not in fact adopt the astrolabe because the standard type of Chinese astronomical observation was not easily compatible with the astrolabe's graduated scales, various Chinese navigational guides and rutters suggest that later the Chinese and Arabs used an instrument of very similar form and calibration when taking stellar sights at sea.

¹⁶J.Needham, Science and Civilisation in China Vol.IV pt.3, p.575 for citation of the Sung Hui Yao Kao (Drafts of the Administrative Statutes of the Sung Dynasty).

¹⁷H.F.Schurmann, op.cit., p.109.

Several fourteenth and early fifteenth century rutters prepared by Chinese authors gave directions in terms of compass bearings to be followed for a given number of keng (watches of slightly less than $2\frac{1}{2}$ hours) until an alteration of course was necessary. A new course was then specified in terms of a compass bearing to a latitude specified in terms of the "chih", units which research has shown closely corresponded with an Arab unit, the "isba". The latter term reveals that the unit was a simple finger-breadth. Research on the unit has shown that it corresponded to an angular equivalent of $1^{\circ} 36'$, with occasional variation as low as $1^{\circ} 30'$ or as high as $1^{\circ} 40'$.¹⁸ We know the Arabs used Kamals to take such readings for the height of the Pole Star, the Guard Stars, and a few other constellations, and that the Chinese observed a wider range of other constellations but in the same units. As a result of a late sixteenth century revival of interest amongst the Chinese in their traditional ways of navigating, Li Hsu wrote a description of an instrument very like the Kamal.¹⁹ This we may presume had been in use for perhaps 300 years before Li Hsu's account was printed posthumously in 1606. Li Hsu's description has been translated thus:-

¹⁸ J. Needham, op.cit. Vol.III, pp.367-378.

¹⁹ H. Grosset Grange An Arabian Sea Chart of the Middle Ages, Journal of Navigation, Vol.28, 1975, No.4, pp.434-448.

"The set of 'guiding star stretch-boards' (ch hien hsiang pan) of Ma Huai-Te of Suchow has twelve plates in all, made of ebony, ranging gradually from small to large. The largest is more than seven inches square. They are labelled one 'chih', two 'chih' etc. up to twelve 'chih', all marked in fine script upon them, and they differ regularly just as a foot is divided into inches. There is also one ivory piece, two inches square and cut off at the corners so that it indicates (2 chih) half a chih, half a 'chio', one 'chio' and three 'chio'. This may be turned on one side or another facing you (in conjunction with one of the larger plates), and these lengths must be the measurements (required for right-angle triangle calculations according to the methods of the "Chou Pei" (Suan Ching) (Arithmetical Classic of the Gnomon and the Circular paths of Heaven)".²⁰

With a background of such similarity in their instruments it would not be surprising if navigational instruments and readings were exchanged between Chinese and Arab seamen. It also seems likely that both Chinese and Arab sailors utilised Chola charts for the Indian Ocean.²¹ Certainly we know Marco Polo saw Chola charts in use, and we know that later Ahmad Ibn Majid and Suliaman bin Ahmed possessed Chola sailing instructions. Through al-Idrisi we know there was a long tradition of close and direct interchanges in various seaports. For example, al Idrisi says that between 875 and 884 the Chinese moved

²⁰J.Needham, op.cit. Vol.IV, pp.574-5.

²¹Ma Huan. Ying Yai Shêng Lan. (The Overall Survey of the Ocean's Shores). 1433. Translated and Edited by J.V.Mills. Hakluyt Society Extra Series No.42, p.307.

their commercial centre to Zalej, an island off East Africa, and the other islands which belong to it

"entering into familiar relations with the inhabitants because of their equity, amenity of customs and aptitude for business".²²

That navigational information was exchanged would seem confirmed by Chou Ch'u-Fei's inclusion in 1178 of an account probably obtained in East Africa from an Arab sailor. This says:-

"Beyond the Ocean west of the Arabs, there are countless countries more, but the Mu Lan Phi is the one which is visited by the great ships of the Arabs. Its ships are the biggest of all. Putting to sea from the Tho-phan-ti in the Arab country one sails west for a full hundred days and so arrives ... If it [the ship] does not encounter favourable winds it does not get back to port for many years. No ship but a very big one could make such voyages. So nowadays 'Mu-Lan' ship is used [in China] for designating the largest kind of junk".²³

That such interchanges continued over many years is revealed by one of Ibn Battuta's comments made nearly two hundred years later. When staying at Sijilmasa, in southern Morocco, he discovered his host was the brother of a man he had met some years before in Western China.²⁴

²²J.Needham, op.cit. Vol. IV. p.495.

²³Ibid. p.475.

²⁴E.W. Bovill, The Golden Trade of the Moors. Oxford University Press, 1958, p.59.

Some Chinese had cultural backgrounds which opened more opportunities for mutually beneficial exchanges of navigational information. Admiral Cheng Ho's father was a well-travelled Muslim from Yunnan, who had visited Mecca about 1370. This probably served to make his son well aware of what might be learned from Arab sources, and underlies Cheng Ho's decision to take the Arab scholar Ma Huan with him on three of his longer voyages. It is most noticeable that of the 40 charts of the Wu Pei Chih which purport to record carefully the distances and compass bearings followed along various sea lanes betwixt the many ports visited by Cheng Ho between 1404 and 1433, the most accurate are those for the west coast of India, Arabia and East Africa. Similarly the stellar attitudes given for these ports are at their most accurate for the same region, especially as seen on the second of the four stellar diagrams, showing the positions in which various constellations had to be kept for the voyage from Ceylon to Kuala Pasi in Sumatra. We know that Chinese sailors had been making regular celestial observations in this region since Marco Polo described this in 1293, but the finger breadth units of the observations recorded the similarity of place names, and the similarity of errors (if these observations are compared with Sidi Celebi's al-Muhit of 1554

and the anonymous Chinese rutter of about 1510) suggest extensive interchange of Arab and Chinese information over a long period.²⁵

Research by Dr. J. Needham and more recent work by J. V. Mills now permits a brief description of the navigating officers and their work, as carried out on Cheng Ho's seven famous voyages.²⁶ On each ship but under the Master's supervision there was a Mate to direct the general administration of the ship, an officer called the huo ch'ang (fire chief) who superintended the compass, and a Taoist priest whose duties included both helping the Incense Keeper and ensuring that the votive incense never ceased to burn. Under them there was a helmsman with two reliefs and a chief linesman with a second linesman responsible for the ropes and taking soundings. Most important, however, was the fleet's central navigation office, which for much of the time was superintended by Lin Kuei Ho, the Chief Astrologer. His staff of four astrologers were responsible for predicting the weather, taking and recording astronomical sights, and for issuing revisions to the Chen Chung (Needle Manual) and to the T'u shih (sketch map) which were given to every master as standard issue. Such compilations must have resembled on the one hand the Wu Pei Chih maps and diagrams, and on the other that acme of fifteenth century

²⁵G. R. Tibbetts, Arab Navigation before the Coming of the Portuguese, Luzac, London, p. 44.

²⁶J. V. Mills, op. cit. p. 306. J. Needham, op. cit. Vol. IV, pt. 3, p. 491.

navigation manuals, the Shun Feng Hsiang Sung (Fair Winds for Escort). The latter, compiled anonymously about 1430, claims to be based on

"Charts of the direction of the compass needle and the guiding stars and a copy of the configuration of the islands in the sea. They were compared and corrected on repeated voyages".²⁷

How safe these aids made the Chinese voyages we do not know, but it is likely that ships detached from the fleet and deprived of the services of the central hydrographic office were at risk. We know ships were detached from Cheng Ho's main fleets. The fifth, sixth and seventh expeditionary voyages are particularly interesting in this respect. Despite vague details of the numbers of ships involved on the fifth in 1417-19 and the sixth 1421-22, Pelliot was able to identify that Chinese ships did reach Mogadishu, Brava and Malindi on the east coast of Africa.²⁸ On the seventh expedition further ships were detached to visit the African coast, and, after calling at Malindi, passed even further south during 1433. Some ships carrying ambassadors undoubtedly returned to China from all these voyages, but there is reason to believe in the light of subsequent Chinese policy that many ships did not return.²⁹

²⁷J.Needham, op.cit. Vol. IV, pt. 3, p. 572.

²⁸P.Pelliot, "Les Grands voyages maritimes chinois au début du XV^e siècle" T'oung Pao. Vol. XXX, 1933 p.299.

²⁹Ibid. pp.305-11.

Not only have some large hoards of Chinese pottery been found in Kenya and Tanzania, some early European evidence provides some insight into events on some East African ventures about which Chinese accounts are lacking. An atlas prepared for the King of Portugal between 1456 and 1459 has survived and bears details of further Chinese voyaging.

This atlas was compiled by Fra Mauro, who stood in a long line of Franciscans interested in China, and who included Andrew of Perugia, (Bishop of Zayton (Ch'uanchow) between 1323 and 1332). Three ships rigged in the Chinese manner are shown on Fra Mauro's map. One lies in the Indian Ocean west of Ceylon and has four masts, a transom bow and a prominent rudder, while another lies just to the north of it, and the third is shown off the Chinese coast towing another boat. These drawings are supplemented by two inscriptions, placed off the African coast. In the caption inserted off the East African coast, Fra Mauro wrote:-

"About the year 1420 a ship or junk of the Indies passed directly across the Indian Ocean on the direction of the Men and Women beyond Cape Diab and past the Green Islands and the Dark Sea, sailing thereafter west and south west for forty days and finding nothing but air and water. According to the estimate of her company she travelled 2,000 miles. Then conditions worsening she returned 70 days to the aforesaid Cape Diab". ³⁰

³⁰ J. Needham, op.cit. Vol.IV, pt.3, p.501.

In a more southerly caption Fra Mauro maintained that the Atlantic and Indian oceans joined south of Africa, just as the Arabs since Ibn Khurdadhbih had believed. This is in accord also with the map made in 1402 by the Korean Kwon Kuen. In a yet more southerly scroll Fra Mauro added this information:-

"Moreover I have had speech with a person worthy of belief who affirmed that he had passed on a ship of the Indies through a raging storm 40 days out of the Indian Ocean, beyond the Cape of Sofala and the Green Islands more or less south west and west. And according to the calculations of her astronomers, his guides, this person sailed 2,000 miles. Whence assuredly we may take him to be as sincere as those who say that they sailed 4,000 miles down the west African coast and back to Portugal³¹.

However, the value of such Chinese technology as could take the Chinese perhaps past the Cape of Good Hope, as Fra Mauro implies was possible, was called into serious question in 1433. A fragment of an account by Chu Yün-ming entitled Hsia Hsi-yang (Down to the Western Ocean),³² survives showing that some ships returned, but not enough returned to silence an anti-maritime action whose strength was seen in 1424 when Emperor Yung Lo died. But whereas the accession of Emperor Hsuan te in 1424, and his order of 29th June 1430 had facilitated Cheng Ho's final expedition (which lasted from 19th January 1431 until some ships returned on

³¹ Ibid. p.502.

³²

7th July, 1433), the deaths of this Emperor and Cheng Ho had by 1435³³ served to stop the departure of further major Chinese ocean-going fleets. This is confirmed from European sources such as the account of Sernigi who noted in 1499 that it was 80 years since traders (whose description we now recognise as fitting only the Chinese) had visited Calicut.³⁴

Controversy surrounds the reasons for such a reversal of policy, though it has been claimed that the cost in men, ships and money was intolerable to a China facing threats from the north west. Further controversy surrounds the issue of whether the official state archives were burnt or just hidden by Ta-Hsia, Vice-President of War between 1477 and 1480.³⁵ Such attitudes led not only to a rapid decline in the Chinese navy, but to decline in the whole marine sector of the economy.

This decline was reflected in the lack of much Chinese interest in navigational aids apart from those of direct value on coastal voyages. Declining numbers of navigation manuals were

³³J.V.Mills, op.cit. p. 6. Cheng Ho is traditionally supposed to have died and been buried in a tomb in Nanking in 1435.

³⁴See chapter Indian Interchange, footnote 10.

³⁵J.J.L.Duyvendak, China's Discovery of Africa, A.Probsthain, London, 1947, pp.27-8.

written, and even accounts of Cheng Ho's voyages slowed to a trickle. Once the first hand accounts of Kung Chen and Fei Hsin had described Cheng Ho's voyages and been printed in 1434 and 1436 respectively,³⁶ the vastly better account by Ma Huan, though completed about the same time, was not printed until 1451,³⁷ while the last of the works purporting to have actually been compiled by a member of Cheng Ho's expeditions was not printed until 1520.³⁸ This decline in interest was accentuated in the early sixteenth century by edicts which made it a capital offence to build sea going junks with more than two masts, and by a further edict that any ship's crew that set out to trade in multi-masted ships posed an unacceptable threat to national security because they would be communicating with foreigners.

However, some Chinese remained interested in foreign parts, and if they were lucky obtained a confidential licence from the government to

³⁶Kung Chen, Hsi-Yang fan-kuo chih (Records of Foreign Countries in the Western Ocean).

See J.V.Mills /Ma Huan, op.cit. pp.44-45 and 56-59.

³⁷Fei Hsin. Hsing-ch'a sheng-lan (The Overall Survey of the Star Raft). This was translated by W.W. Rockhill, Chu-lu hui-pien (A Collection of Records), S. Petersburg, 1915, Part II, p.73 et seq.

³⁸Huang Sheng tseng, Hsi-yang ch'ao kung tien-lu (Record of Tribute Paying Western Countries); see Needham, Science and Civilisation in China, Vol.III, p.559.

trade as far as Malacca at their own risk.³⁹

A few others retained an intellectual interest in other lands. While the traders sought reliable rutters and the other group sought knowledge of a more geographical nature, by the early sixteenth century they had to look outside China for it. It is in this context that the roles of China's older trading partners, the Wakō pirates, and the Europeans, take on their significance. As China's technical lead in matters evaporated, there grew up a different pattern of technical interchanges around the China Sea.

The only well-known local rutter prepared in the late fifteenth century utilising Chinese conventions belonged to an exiled Chinese in Malacca. This rutter clearly shows Malayan influences, for example in the use of jauh which seems to be the equivalent of the Chinese keng, while the fact it gives details only of the outward voyage from Malacca to Canton suggests it was not designed for the use of native Chinese.⁴⁰ In

³⁹ Juan Gonzalez de Mendoza. The Historie of the Great and Mightie Kingdome of China, and the situation thereof. Together with the great riches, huge cities, politicke government and rare invention of the same. White, London, 1588. Hakluyt Society Edition, 1854. Edited and Corrected by Sir G.T.Staunton, Vol.1, p.95. This system is in all respects the same as that applied by the Chinese since 1367, and which also covered the licences granted to the Tally Trade ships.

⁴⁰ J.V. Mills/Ma Huan, op.cit, pp.349/50.

A.Cortezão and A.Teixeira da Mota, Portugalia Monumenta Cartographica, Lisbon, 1960, Vol.1, pp.79-81.

fact it was most useful to Francisco Rodrigues who compiled a rutter for the same journey while in Malacca during 1513-14. Meanwhile, interested Chinese still wanting to sail and trade abroad had to seek foreign atlases and charts. In 1525 a Buddhist priest called Sosetsu obtained a Portuguese chart of the world and sent a copy to the Ouchi diamyō in Japan where it set a fashion for "sekai byōbu" (world maps) very different from the traditional "gyōgi-zu" form of Japanese map.⁴¹

Another facet of the naval problem caused by the Ming edicts of 1500, 1525 and 1551 was that China's emperors lost the ability to control the Tally Trade with the Japanese, and encouraged the re-emergence of the Wakō pirates.⁴² Whereas in 1405 Cheng Ho's navy had been able to secure the voluntary surrender of twenty Wakō pirate ships, by the sixteenth century these pirates had become endemic. The Fukien Gazetteer records the position in the early sixteenth century thus:-

⁴¹ H. Nakamura, "Les Cartes du Japon qui servaient de modèle aux cartographes européens au début des relations de l'occident avec le Japon" Monumenta Nipponica. Vol. II, 1939, p.119.

⁴² Masayoshi Sugimoto and David L. Swain, Science and Culture in Traditional Japan, AD 600-1854, M.I.T. Press. Cambridge, Massachusetts, 1979, p.152.

"At that time our coastal defences in Chekiang and Fukien had for a long time been obsolete. Only one or two in every ten fighting ships and revenue vessels had been retained ... They [the Wako and the Portuguese] followed closely on each other and started all sorts of trouble on the seas".⁴³

The Chang Chou Gazetteer records why at the same time the actions of Chinese bureaucrats could not curb these developments. It stated:-

"The literati and the people privately went out to sea to bribe the foreigners and entice the pirates; prohibitions did not deter them".⁴⁴

This was the background to the arrival of the first Portuguese under Jorge Alvares in 1513. By 1515 the merchant adventurer, Andrea Corsali, was able to write to the Duke of Florence from Malacca saying there was "as great profit in taking spices to China as in taking them to Portugal".⁴⁵ Duarte Barbosa wrote at the same time that the profits of such ventures to China were about 300%.

It was to secure firm monopoly control of such lucrative trades, and to protect them from information leaks to potential rival powers that the Portuguese decided to establish the trade on a more formal basis. Thus Lopo Soares de Albergaria, the Viceroy of India, turned to Tomé Pires, already famous for the Suma Oriental, to lead Portugal's

⁴³C.R.Boxer, South China in the Sixteenth Century, Hakluyt Society, Series II, Vol.CVI, 1953, p.xxv.

⁴⁴Ibid. p.xxiv.

⁴⁵Simkin, The Traditional Trade of Asia, Oxford University Press, 1968, p.166.

first diplomatic mission to China. He sailed with Fernão Peres de Andrade, who had been officially entrusted by King Manuel of Portugal with the discovery of China. In the early stages the mission promised well for future commercial interchange. The main fleet was allowed to trade peacefully in Canton while the detachment sent north also engaged in profitable trade at Fukien during 1517.

However, Simão de Andrade, who commanded the next royal fleet to reach China did not behave in so exemplary a manner, and managed to alienate the Chinese so far, that they took note of the complaints from the envoys of the deposed Sultan of Malacca. The full importance of the death of Emperor Cheng Te and the official mourning was not at first appreciated by the Portuguese mission and traders. Pirés was sent back to Canton without his promised audience in Peking and many of the Portuguese were imprisoned for attempting to trade in the duration of official mourning. The Chinese soon formed a hostile view of the Portuguese and in 1521-22 Portuguese ships were engaged and beaten by the Kuangtung squadron of the Chinese navy. This was followed by an imperial decree that prohibited any dealings with the barbarian devils or "fan kuei".

The Portuguese sought to evade this ban from the outset, and in connivance with the pirates, they were able to operate profitably despite official Chinese policy. The build-up of a Portuguese presence was vastly helped by the availability of rutters, such as the Malaccan rutter already mentioned. The Portuguese also found help available from expatriated Chinese mariners, local fishermen, and of course the Wakō. Popularly known as dwarf robbers or Japanese, the Wakō in fact consisted mainly of Chinese pirates, though about 30% of their number were Japanese.⁴⁶ It was amongst the Wakō that mastery of navigational skill was at its most evident, for this ensured their safety from pursuit. Through them the Portuguese quickly gained knowledge of safe but obscure winter anchorages and of the lucrative trading opportunities, whether legal or illegal. The most flourishing of the communities to grow from this interchange between the Portuguese and the Wakō were Shuang-hsu-chiang (Double Island Anchorage) near Ningpo, and Wu-hsü island which together with Yüeh Chiang formed the "Moon Anchorage" on the southern coast of the Bay of Amoy.

Portuguese grasp of the principles of celestial navigation learnt on their Atlantic voyages of the fifteenth century made them discriminating recipients of such aids to navigation

as they picked up through interchanges in the Far East. All this made the task of the Chinese Admiral Hu Tsung-hsien, who was charged in the middle of the sixteenth century with countering the pirates and their Portuguese accomplices, the more difficult. However, he realised that much of the pirate success in avoiding such destruction as befell them in 1548-9 was due to the Wakō having superior knowledge of the coasts compared with official Chinese knowledge. Part of his response to the situation was to support the formalised settlement of the Portuguese in Macau from 1557 and to set about improving the state of Chinese cartography as part of an attempt to revive those navigational skills which had waned so far since the days of Cheng Ho. He ordered the production of the Ch'ou-hai t'u pien (Illustrated Compendium of Seaboard Strategy).⁴⁷

To supplement the great collection of charts gathered and drawn for this purpose by Cheng Jo-tseng, Hu asked Mao K'un to write a preface that would incorporate some of the findings of the research Mao K'un had done in the official archives at Fukien and elsewhere.⁴⁸

⁴⁷British Library. OMPB. 15271 e. 1. Vol.1. This was exhibit C.4 in the exhibition held at the British Museum from 1st Feb. to 31st Dec. 1974. See Catalogue, Yolande Jones, Helen Wallis, Howard Nelson. Chinese and Japanese Maps, p.8.

⁴⁸J.V.Mills, op.cit., p.239.

After its completion in 1562 this work helped considerably in the mounting of successful naval operations to eliminate the pirates.⁴⁹

However, Hu's successes caused jealous officials to make accusations of corruption which, though never proved, did serve to reduce the power of Hu's old office. After Hu's death in 1565, his admirers who included the Emperor, became more evident and various posthumous honours were awarded. More significant still were the political and psychological consequences of the revival he sought in maritime interest. In 1567 an edict was issued which lifted many of the restrictions imposed in 1500, 1525 and 1551.⁵⁰ In conjunction with the Korean Admiral Yi Sūnsin, the Chinese navy were able to defeat the Japanese in campaigns which lasted from 1592 to 1598.⁵¹ In 1595 the true value of Hu's contribution was realised, and

⁴⁹Chaoying Fang writing in The Dictionary of Ming Biography 1368-1644. Ed. Carrington Goodrich and Chaoying Fang. Columbia University Press, 1976, p.637 takes the view that it was written to present Hu in a favourable light "perhaps intending to influence a favourable decision in the event of a trial" (for corruption). Amongst the charges of corruption was one that Hu permitted Mao K'un to purchase land technically belonging to the Hangchow Guard. This view takes no cognisance of the cartographic value of the work, and is based largely on statements in Chuan 9 of the work.

⁵⁰Masayoshi Sugimoto and David L. Swain, Science and Culture in Traditional Japan, AD.600-1854, Massachusetts Institute of Technology Press, 1979, p.152.

⁵¹Sang Woon Jeon, Science and Technology in Korea. Traditional Instruments and Techniques. M.I.T. Press, 1974, pp.216-8.

commemorated by his canonisation as Hsiang-mao and by his posthumous promotion to the rank of Assistant Commissioner of the Imperial Guard.⁵²

The psychological consequences of the navigational interest he sought to promote are perhaps best seen in Chang Hsieh's Tung Hsi-yang k'ao (Studies on the Oceans, East and West). Writing in 1618 Chang Hsieh gave sailing directions, compass bearings, soundings, rhymed weather predictions for voyages to Aden, Ormuz, Indo-China, the Moluccas and Japan and discussed relations with Europeans.⁵³ The conclusions of the ninth chapter which dealt with navigational skills and the Ship's Master were that:-

"Coming into contact with the barbarian people you have nothing to fear more than touching the left horn of a snail. The only things one should really be anxious about are the mastery of the waves and worst of all dangers, the minds of those avid for profit and greedy of gain".⁵⁴

The manner in which Hu had fostered this revival of navigational interest based on archival sources, yet also looking forward to a naval purpose, was long to leave its mark in a dualism evident in many of the works produced during the Chinese revival of maritime interest. Mao Yuan-i writing a preface for the Wu Pei Chih (Records of Military Preparations) which was comprised of

⁵²Chaoying Fang, op.cit., p.637.

⁵³L.Carrington Goodrich, Dictionary of Ming Biography, pp.77 and 78.

⁵⁴E.G.R.Taylor, Haven Finding Art, [1911 ed.] p.278.

information he inherited from his grandfather Mao K'un in 1601, said that the maps which extended over forty pages, recorded correctly the distances along various sea lanes as sailed by Cheng Ho. These he now inserted "for the information of posterity and as a memento of his [Cheng Ho's] military achievements".⁵⁵ Similarly the author of the seventeenth century edition of the Shun Feng Hsiang Sung said "If later people make copies from these originals, they will I fear fall into error". So he copied all its navigational details "in order to hand down to later generations the way of making good voyages".⁵⁶

Interestingly the Shun Feng Hsiang Sung was to arrive in the collection of Bishop William Laud probably while he was Chancellor of the University of Oxford between 1629 and 1633. As such it was only one of many navigational works to find their way into the libraries of English seventeenth century bishops.⁵⁷ It was not uncommon for the

⁵⁵M.G.Phillips. op.cit. for a map from Tenasserim to Ormuz and East Africa, see Vol.20, 1885, opposite p.226, and for Tongking to Nanking Vol.21, 1886, opposite p.42.

⁵⁶J.Needham, op.cit., Vol.IV, part 3, p.582.

⁵⁷This is particularly true of the libraries of the Archbishop of Canterbury and the Bishops of Durham.

libraries of important Europeans to contain a few Chinese texts though only a handful seem to have had much navigational significance.

The acquisition of Chinese texts was a matter of considerable interest to Spanish administrators in the East as Juan de Mendoza recorded. He notes that after Fr. Martin de Rada's mission to China in 1575-6 had failed, its members

"did incontinent prepare themselves for to depart from Manila, and bought there manie books to carrie with them, wherein was comprehended all the secrets of that kingdome; by reason whereof they might give large notice unto the royall majestie of King Philip. The which being understood by the Viceroy, who had set spies to watch their doings, did send them word they should trouble themselves in buying bookes, for that he would give them freely all such bookes as they would desire to have; the which afterwarde he did not accomplish: whether it was for forgetfulness or other occasion, as we have more at large declared unto you, we know not; yet did the viceroy send and demanded to see some of those books the fryers had bought".⁵⁸

A copy of the second edition of a Chinese atlas printed in 1536 survives in the official archives at Seville, suggesting the Spaniards too appreciated its significance.⁵⁹ Another atlas recorded as sent to Philip II from his Governor of the Philippines in 1574 was in a diplomatic bundle which included a chart of the island of Luzon in the Philippines, and similar information about the China coast, the Ryu Kyu Islands and Japan.⁶⁰

⁵⁸Gonzales de Mendoza, op.cit., chapter 29, Vol.II, p.95.

⁵⁹H.Nakamura, op.cit., p.104.

⁶⁰M.Destombes."Notes de cartographie Chinoise une carte chinoise de 1594 a la bibliothèque nationale". *L'Histoire et La Navigation*. Vol.93, part 1, 1976, pp.104-5.C.R.Boxer, op.cit., pp.lxi and lxii.
H.Nakamura op.cit. p.104

Proof that such items were not easily available from China is given by the fact that those gifts for Philip were gathered in the Philippines. The letter accompanying the Chinese atlas has survived, but the atlas itself seems to have been mislaid unless it was the 1536 atlas mentioned above. Another theory advanced is that it was the Kuang-yu-t'u.⁶¹ This was prepared by Lo Hung-hsien from an atlas prepared in manuscript by Chu Ssu pen between 1273 and 1337. Lo Hung-hsien had revised and enlarged it to form the Kuang-yu-t'u Atlas as published in 1555. Lo noted that Chu's map was too large and difficult to handle but since its grid was so precise, he had been able to reduce it to a suitable format for printing. It was still very influential at the turn of the 17th century as we shall see. The only other possible identification of the atlas sent to Philip is that it was a copy of the work prepared to reveal all China's safe havens so that the navy could clear them of pirates, the Ch'ou-hai t'u-pien of 1562 mentioned earlier.

⁶¹

C.R.Boxer, op.cit., pp.lxi and lxii.
 The Kuang Yü T'u Atlas by Lo Hung-hsien published in 1555 was based on Chu-Ssu-pen MS. map done for the Mongol Yuan dynasty between 1311 and 1320. Its quality stemmed not only from the Chinese cartographic tradition but also from intellectual contact brought about by the Mongols between China, Arabia and Persia. In 1541 Chu's MS. map was revised and enlarged by Lo Hung-hsien prior to its printing in 1555. Western knowledge of the interior of China was derived almost exclusively from the Kuang Yü T'u until the Jesuits undertook their great survey of China in 1756-9 (see) Howard Nelson 'Maps from Old Cathay', Geographical Magazine, 1975, pp.706-7.

The early Spanish-Chinese contacts were concerned with the eradication of dangerous pirates. In 1575-6 they had to attempt the capture of the notorious China coast pirate Lin [Ah] Feng, known to the Spaniards as Limahon. At first relations were promising as Limahon's capture seemed certain, but when he escaped relations soured, and Lavazares's plan to send two friars back to China with the returning mission were jeopardised.⁶² In fact the two friars were eventually embarked, only to be dumped on a nearby shore in Ilocos, and so Rada had to await the next Chinese mission to return home.

Rada was a great scientist, traveller and missionary and his time in China resulted in quite wide dissemination of knowledge about Chinese practices. Sadly many of his original manuscripts as brought back from China have been lost. Likewise many of the Chinese books he returned with have also been lost, among which were books:-

"For the making of ships of all sorts, and the order of navigation with the altitudes of every port, and the quantitie [calidad = quality] of every one in particular"

"Of the nomber and moorings of the heavens; of the planets and stars and of the operations and particular influences"

"Of the mathematicall sciences, and of arithmetick, and rules how to use the same"

"Of astrologie naturall, and judiciarie, and rules to learne the same, and to cast figures and make coniectures"⁶³

⁶² Juan Gonzales de Mendoza, op.cit., Chapter 24, Vol.II, pp.94-5.

⁶³ Boxer. op. cit. p.lxxxiv.

Gonzalez de Mendoza who compiled his famous book, Historia de las cosas mas notables, ritos y costumbres del gran reyno de la China at Rome in 1585, had never been nearer China than New Mexico.⁶⁴ So he drew on Rada's material

⁶⁴ González de Mendoza, Historia de las cosas mas notables, ritos y costumbres del gran reyno de la China, sabidas assi por los libros de los mesmos Chinas, como por relacion de religiosos, y otras personas, que an estado en el dicho reyno. Hecha y ordenada por el muy R.P. Maestro F. Juan Gonzalez de Mendoza de la order de S. Agustin, y penitenciaro apostolico a quien la Magestad Catholica embio con su real carta y otras cosas para el Rey de aquel reyno el año 1580. Al illustrissimo S. Fernando de Vega y Fonseca del consejo de su Magestad y su presidente en el Real de las Indias. Con un Itinerario del nuevo Mundo. Con privilegio y licencia de su Sanctidad. En Roma a costa de Bartholome Grassi 1585, en la stamps de Vincentio Accolti. 164 pages

Mendoza's book was widely read as the printing of various editions of it show. The Rome 1585 edition was followed by two editions printed in Spain at Madrid and Barcelona respectively in 1586, and another at Medina del Campo in 1592. Another Spanish edition was printed in Antwerp in 1596.

The book was also translated into several languages where it was as popular. Italian translations appeared first in 1586 as translated by Francisco Avanzo at Venice. They were published that year (1586) in Venice, Rome and Genoa, closely followed by three other Venetian editions in 1587, 1588 and 1589. In 1588 it was translated into English by Parke at the insistance of Richard Hakluyt himself. The English edition was dedicated to the navigator "Canish" [Thomas Cavendish] in 1589. In 1589 it was translated and published in German by Marcus Henning at Frankfurt. The first French edition was also published in 1589 by Luc de la Porte in 1589 at Paris. Subsequent editions in French appeared in Paris in 1600, in Rouen in 1604 and Geneva in 1606 and Lyon in 1606.

R. Parke's translation appeared, slightly amended by Sir G. Staunton as The History of the Great and Mighty Kingdom of China in the Hakluyt Society Edition, 1854, India Office ST. 461.

very heavily, in particular on translations that Rada had had prepared by a Chinese in Manila after his return from the expedition to China.

Mendoza did not really understand Chinese methods of navigation, in particular revealing his ignorance in commenting that

"Chinos doo governe their ships by a compasse devided into twelve parts, and doo use no sea cardes, but a briefe description of Ruter, wherewith they doo navigate or saile".⁶⁵

However, he knew much about the history of Chinese voyages, and the opportunities presented, especially to Portugal, by the sudden withdrawal from the Indian Ocean of the Chinese. He attributed this to the Emperor saying that under severe penalties his subjects return within a specified time. He noted that memory of them was strong in the Philippines and the Coromandel Coast of India, claiming that evidence "is clearly found in their histories and books of navigations of old antiquitie".⁶⁶

Another Spanish missionary who made even better use of his sources at this time was Bernardino de Escalante. He published the Discurso de la Navigation que los Portugeses hazen a los Reinos y Provincias del Oriente, y de la notica que se tiene de las grandezas del Reino de la China in Seville in 1577. In the dedication to Don Cristobal de Rojas y

⁶⁵Ibid. Hak.Soc.edition. Chapter 11, Vol.2, p.36.

⁶⁶Ibid. Chapter 7, Vol.1, p.94.

Sandoval, Archbishop of Seville, Bernardino de Escalante described his approach thus:-

"Concerning everything that is written about the Great Kingdom of China in this work, I informed myself with much diligence and care from trustworthy Portuguese [Fr. Gaspar de Cruz], who had been in the kingdom on commercial matters, and from the Chinese themselves who have come to Spain, from whom I took what seemed to me the most authentic material for this narrative".⁶⁷

He also noted in his final chapter that the prospects for the conversion to Christianity of China were good and that

"the Spaniards are now very well established there on Luzon and in the trade and intercourse between it and the mainland of China ...".

This final chapter also gave details of the Spanish route from New Spain to the Philippines (Luzon).⁶⁸

Bernardino de Escalante, Gonzalez de Mendoza and much later Purchas all based their work to some extent on the work of Gaspar da Cruz whose main work was first printed in Evora in 1569/70 under the title Tractado em que se cõtam muito por estêco as cousas da China . This work was probably known to John Frampton, who after a long career in Seville as an English merchant, returned to England in his retirement and translated certain important Spanish works into English. Amongst them were Pedro de Medina's

⁶⁷ Z. Swecker, "Early Iberian Accounts of the Far East", Ph.D. Thesis, Chicago, p.206.

⁶⁸ Ibid. p.207.

Arte de Navegar and Bernardino de Escalante's work.⁶⁹ In the preface of his translation A Discourse of the Navigation which the Portugals do make ... he revealed that he too knew of João de Barros's collection of Chinoiserie and in particular of the latter's possession of a "card geographical" from China.

Probably because of the nature of Portuguese involvement off the Chinese coasts, there is little literary evidence of interchanges of navigational information. One notable exception, however, was Luis Vaz de Camoões (Camoëns) who wrote of the early Portuguese attitude to Chinese influence. He was related to Vasco da Gama by marriage, and chose to write an epic poem about Portugal's discovery of India. Camoëns knew the sea lanes from Lisbon via Goa to Macao where he was resident from 1556 to 1561. By inserting references to the Chinese, he illustrated how, without command of the Chinese languages, Europeans could learn of Chinese navigational prowess by means of interpreters, such as the man Fernão Martins who understood Arabic, who were able to interpret African tales of men from the east who came in large ships, and returned "to a land where men's skins were white like ours".⁷⁰

⁶⁹ L.C.Wroth, "An Elizabethan Merchant and Man of Letters," Huntington Library Quarterly, Number 4, August 1954, pp.299-314.

⁷⁰ Luis Vaz de Camoëns, The Luslads, translation by William Atkinson. Penguin Books. London, 1952, p.135.

Significant as this channel of information undoubtedly was, there is little evidence of its extent. We are thus forced to rely on the few comments about the courses taken by Chinese ships which appear in the Portuguese rutters obtained by Linschoten, or the limited evidence for special cartographic knowledge of China, such as Luís Jorge de Barbuda obtained about 1580.

The best source of direct information about the interchange of Chinese cartographic evidence with the Chinese, is given by Purchas. In part III of His Pilgrimes he included a map of China engraved from an original map given to Richard Hakluyt by Captain John Saris in 1614. Purchas records this map measuring four feet one way and almost five feet the other, but that many of its characters were not understood. It was, he says, obtained by Captain Saris

"at Bantam of Chinese, in taking a distresse for debts owing to the English merchants; who seeing him careful to convay away a Boxe, was the more carefull to apprehend it, and therein found this Map, which another Chinese lodged at his house, lately come from China, had brought with him".⁷¹

71

S. Purchas, His Pilgrimes, Fetherstone, London 1626, Vol. 3, Book 2, pp. 401-2. See also the illustration.

Purchas knew enough of Chinese cartographic traditions to know that they had recently been altered by western contact, especially through the work of the Jesuit missionary Matteo Ricci. In 1625 Purchas included a vignette of Ricci beside this map, a format later copied by De Bry.

About the same time Wu Ching Ming's Commentary summarised the impact of European contact via Ricci's Jesuit mission writing thus:-

"For the monk Li [Matteo Ricci] who came to China from Europe has made a map of the whole world, for the people of his country and the Franks like to wander in far places. With regard to the South Polar Region no one has explored it, but it is important to note that from the north, east and west corners what the rest must be like. The monk has studied deeply with reverence for Heaven. The calculations which he has made of the size and the relative distances of the Heavens, the Sun, moon and stars are probably trustworthy and are here appended."⁷²

Ricci combined in his maps both Eastern and Western traditions, trying in particular to gain Chinese acceptance for European ideas on geography. However he had to compromise on some issues and Trigault noted in particular how Ricci

"altered a little of our plan for maps of the world, and by placing the first meridian of the Fortunate Islands at the margin right and left, he brought the Empire of China into the centre, to their great satisfaction/as that accorded with Chinese Sino-centric conceptions of the earth".

⁷²E.R.Hughes, The Invasion of China by the Western World. A. & C. Black, London 1937, p.xv.

Many of those maps may have been taken to sea after the 1602 map first appeared in print. In many ways these Chinese maps of the period were superior to European ones. The so-called David Globe made in China in 1623 showed the results of Torres's voyages long before information about them influenced European maps. Thus the strait Torres found between Australia and New Guinea is shown. It has been suggested by G.R.Crone that the tradition of two Javas, so long present on European charts of the area south of the Moluccas, may well owe its explanation to a garbled version of a Chinese discovery of Australia.⁷³ French navigators in the seventeenth century openly admitted to consulting Chinese documents, and to being interested in the productions of the Jesuit mission. This interest was later recorded by Flamsteed in his treatise on the history of navigation.⁷⁴

Destombes has shown that other Europeans were anxious to publish Chinese maps in the late sixteenth and early seventeenth century. Giovanni Borromeo (1544-1617) published one in his Relationi Universali. Other copies of Chinese maps in the Kouang yu t'ou of 1579 were made by Matteo Neroni in 1590 and soon found their way into the collections of the Duke of Orleans. The most recent

⁷³G.R.Crone, The Discovery of the East, Appendix 1.

⁷⁴J.Flamsteed, Pepysian MS 2184 as cited in the Introduction of this thesis, footnote 32.

find of a Chinese 16th century map in the Bibliotheque Nationale is another example of Chinese maps being collected in Europe by wealthy patrons.⁷⁵

Dispersal of Chinese information was vastly helped by such private collections of Chinoiserie. The earliest of these was found by João de Barros, and had great significance for the development of European navigational aids, though the Portuguese never permitted publication of his Geografia in which many maps included Chinese information. Richelieu and Montaigne also made large collections of Chinoiserie, as did royal personages such as Philip II and the Dowager Queen Catherine of Portugal.⁷⁶

It was the interchange of designs of instruments for navigation that was valuable to both sides. European practices in carrying more than one compass were to be adopted in China by 1637. Sung Ying-Hsing noted in 1637

"All these types [Chinese ships of all sizes] however, have in common two mariners compasses, one at the bow, the other at the stern to indicate the direction of the course."⁷⁷

⁷⁵M. Destombes, Une Carte Chinoise du XVIIe siècle, pp. 202-4. The map of Wang P'an was found recently. It was made by the personal protector of Matteo Ricci in Kwantung province.

⁷⁶D. Lach, Asia in the Making of Europe, Vol. II, pt. 1, p. 10-16

⁷⁷J. Needham, S.C.C., Vol. 4, pt. 3, p. 576. This citation is from Thien Kung Khai Wu [Exploitation of the Works of Nature]. The ninth chapter continues with a warning reminiscent of Indian, Arab and Iberian writings, stating "helmsman, crew and Master must be of good judgement as well as steadfast in the highest degree. Blind bravery is no use at all."

This practice so clearly adopted from Europeans, should not however obscure the broader point, that it was probably from the Chinese via other Asian intermediaries that the magnetic compass found its way into European technology. As such this serves to confirm Lach's point that

"Words, like techniques, products and fables, had migrated to Europe from Asia long before the establishment of direct and permanent relations".⁷⁸

However, while Lach provided a most useful appendix of words of Asian origin introduced into sixteenth century languages, he rightly notes that the more practically minded Europeans responded far faster than the speculative scholars.⁷⁹ Thus it is upon the sailors and artisans, cartographers, navigators, lexicographers, astronomers and alchemists that we have to look for the significant interchanges. For this reason the criticisms made of Lach's work by Mungelo, who expected to see a more philosophical and 'intellectual tongue' developing, are distorted by the fact that Mungelo looked with hindsight, in seeking and giving pride of place in the Sino-European understanding, to the Discours sur la théologie naturelle des Chinois completed by Gottfried Leibniz just before he died in 1716.⁸⁰

⁷⁸D.Lach. op.cit. Vol.II, pt.3, p.490. The appendix noted is on pp.544-553.

⁷⁹Ibid. p.396.

⁸⁰David E. Mungelo, "Some Recent Studies on the Confluence of Chinese and Western Intellectual History" Journal of the History of Ideas. Vol.XL, Oct.-Dec. 1979, No.4, pp.649-661, esp. p.653.

Mungelo noted in reviewing articles by Willard J. Peterson on the Chinese intellectual milieu that

"the first four decades of the seventeenth century were marked by an intellectual openness to new alternatives which later gave way to an inward turning toward traditional culture".⁸¹

Those years until 1640 saw a syncretism of western with indigenous elements which was as much the result of the type of changes initiated by Admiral Hu Tsung-hsien in the 1560s as the result of deliberate attempts of the Jesuits and their converts to adopt the highest linguistic and intellectual standards in their mission. The products of this can be seen at several levels.

Among the simpler products was the development of the type of sundial known by the Chinese as Yang Kuei (the foreign sundial). Such an exemplar was illustrated amongst the Jesuits' astronomical instruments in the Huang Ch'ao Li Ch'i Thu Shih, and which Needham has classified Type B.⁸²

Another example traced by Needham is the origin of a diagram showing a Plan of the North Polar Altitudes which seems clearly based on the diagram by the Jesuit Emanuel Diaz (Yang Mau-No) published in the Thien Wen Lueh in 1615.⁽⁸³⁾

⁸¹ Ibid. p.658.

⁸² J.Needham S.C.C. Vol.III, p.312, and Volume of illustrations.

⁸³ J.Needham, S.C.C. Vol.IV, pt. 3, p.578.

More interesting subjects of interchange were the ideas of Galileo's. Nathan Sivin has argued that administrative decisions of the ecclesiastical authorities in Europe prevented the Jesuits from giving a clear account of Copernican heliocentric theories until 1760.⁸⁴ However, until 1635 when news of the final Papal decisions against Galileo in 1633 reached China, some Jesuits had toyed with ideas which Pope Paul V had decided should be included within the Index of Prohibited Books as from 1616.⁸⁵ Amongst the Jesuits who followed Copernican theories were Michael Boym, the Pole who arrived in China in 1627, Nicholas Smogulecki, another Pole working at Nanking, and Wenceslaus Kirwitzer who had sailed to China with Johannes Terrentius in 1618, but died after only eight years there.⁸⁶ In this context, however, it should be noted that they were hamstrung by Papal decisions and so were only able to convey parts of the Copernican theory without its central cohesive idea of heliocentrism. Despite the earlier existence of Chinese heliocentric theories, the educated Chinese who studied

⁸⁴Mungelo. op.cit., p.657.

Nathan Sivin, Science and Culture in China. M.I.T. Press, Cambridge, Mass., 1974.

⁸⁵P.Moore, Watchers of the Stars. M. Joseph, London, 1974, pp.135-210.

⁸⁶J.Needham, Chinese Astronomy and the Jesuit Mission. China Society, London, 1958, p.9.

astronomy rightly rejected the Copernican system of calculation as presented because it seemed less logical than the system developed by Tycho Brahe, and which the official hydrographic agencies in Iberia were adopting.

The telescope, however, was an idea which found a receptive Chinese audience. The first reference to it in Chinese was made by Emanuel Diaz in the Thien Wen Lueh in 1615, where Galileo is said to have devised it because he "deplored the power of the unaided eye".⁸⁷ In 1618 Terrentius took a telescope to China which was eventually given to the Emperor in 1634, while in 1626 Adam Schall von Bell published a treatise on the telescope Yuan Ching Shuo (The Far Seeing Optick Glass). There is reason to believe William Bourne knew of the idea in 1572 when he completed his unpublished treatise On the Properties and Qualities of Glasses of Optical Purposes, and there is reason to believe Digges, Dee and Hariot in England knew of it before Galileo. The key to understanding its international transmission lies in the tremendously successful sales effort made by two Dutch lens makers from Middleburg and Alkmar.⁸⁸ Hans Lippershey and Zaccharius Jansen respectively seem to have successfully exported telescopes not only to English navigators, but also to Iberians, Japanese, and the Chinese via the Jesuit mission.

⁸⁷Ibid. p.8.

⁸⁸D.W.Waters, Art of Navigation in Elizabethan and Early Stuart Times. N.M.M. 1978, pp.298-9.

Although as Swecker noted, the materials created by the Jesuit mission baulk large,⁸⁹ their reports back to Europe provided a source only turned by rare scholars like Flamsteed. The great significance of other sources only becomes apparent when looked at through the web of European diplomatic intrigue. This web could even comprise espionage, as the remarkable copying by the English agent in Madrid of a Chinese map first printed in China in 1531 and reprinted in 1536. Part of this story is recorded on the back of the map itself, now in the British Museum, Map Library. Thereon the agent wrote "From Madrid, A^o 1609".⁹⁰

Such interest reveals how wrong Millar was in his estimation of the extent of interchange. It was, Mungelo said, "of vast dimensions and brilliant minds".⁹¹ Navigators were in the vanguard of the interchange of the sixteenth and seventeenth centuries. As the Chinese came to appreciate that safety at sea depended on the navigators' skills, so this interchange blossomed in the late sixteenth and early seventeenth centuries, and both the Chinese and Europeans learned much of value despite the difficulties of language and politics.

⁸⁹ Z. Swecker, op.cit., p.12.

⁹⁰ H. Nakamura, "Les Cartes du Japon qui servaient de modèle aux cartographes européens au début des relations de l'Occident avec le Japon". Monumenta Nipponica, 1939, Vol.II, pp.104-5.

These illustrations are reproduced in the volume accompanying this thesis.

B.M.Cotton MSS. Aug.1. ii. 45.

⁹¹ Mungelo. op.cit. p.649.

Chapter 12

The Japanese Interchange

The Japanese like their near neighbours the Chinese and Koreans, had established a long maritime tradition by the sixteenth century. Indeed they had such skill as to be able to win several famous victories over Chinese fleets. However in matters of technology they were greatly indebted to the interchange with neighbours and traders. We have already seen that Chinese navigational technology was carried all over the Orient. It clearly influenced the Japanese, but it must be remembered that the Japanese drew from many traditions. An early indication of this was the Sino-Tibetan copy of an Arabic world map, dated 733, taken to Japan in 858. Some Japanese copies of another map dated 805 also exist.¹

The Japanese clearly gained much from interchange with the Koreans. The latter, always anxious to assert their identity against two powerful neighbours who also had literary and artistic traditions made distinct contributions within those traditions. A Korean team of astronomers under Kwon Keun (Chhuan Chin) produced in 1395 the engraved star chart at the order of Yi Tai Jo (Li Thai Tsu), founder of the last Korean dynasty.² The ten astronomers working under Chhuan Chin based their chart on an inscribed stele map dating from 672. Their 14th century star chart was similar to the one embossed on a bronze

¹ C.R.Boxer The Christian Century in Japan 1549-1650 University of California Press 1974 p.133.

² J.Needham. Science and Civilisation in China, Vol.III, p.279 & Fig.107.

bowl belonging to a seventeenth century Japanese navigator.³ This seventeenth century bowl, though found aboard a junk in the 19th century, serves to show the nature of the close technical interchange of Korean and Japanese navigators.

Korean interest in navigational information was arguably at its height in the early fifteenth century. In 1416 they produced a rutter, the Sungson Chipchirok (Guide for Shipmasters).⁴ More interesting still was the atlas compiled by the Koreans, Li Hui and the monk from China, Chhuan Chin. It was based largely on Chinese information, the Hua-I Chiang-Li Li-Tai Kuo Tu chih Thu (Map of the territories of the One World and the Capitals of the Countries in Successive Ages).⁵ It is one of the world's earliest maps to use standard symbols for towns and ports. On it were shown about 100 place names in Europe and 35 from Africa including the Sahara Desert and the Cape of Good Hope correctly orientated. Alexandria was marked with a pagoda-like shape drawn beside in an attempt to represent the Pharos.

Attempts to show Japan diagrammatically owe much to the Buddhist priest from Korea, Gyogi Bossatsu. Gyogi went to Japan in the late 12th century and drew his first maps in the early 13th century. These maps are typified by the oval form given to each of Japan's 66 provinces. Later copies of these Gyogi-zu were produced with little

³Ibid. Fig.108. This bowl has two depressions in its rims to house compass needles. It is now in the Royal Scottish Museum.

⁴ Ibid., Vol.III, pp.554-6 & plates 223, 224, 225.

⁵ Ibid., Vol.IV, part 3, p.568, note 1.

alteration until about 1650. Among the more interesting are those reproduced in the Skukaisho (Encyclopedia of Court Etiquette) by Toin Kinakata (1291-1360) and supplemented by Toin Sunchiro in the fifteenth century.⁶ In a very erudite survey of Japanese cartography Professor H.Nakamura has shown that the Gyogi-zu deeply influenced the Portuguese charts of Japan drawn in the late 16th century by Fernao Vaz Dourado and Luis Teixeira.⁷

The Japanese also obtained information about Europe long before the Portuguese arrived. Professor Nakamura has shown that the Japanese Buddhist priest, Sosetsu, copied a Portuguese mappemundi in Hangchow about 1525 and sent it home to the Ouchi daimyo setting a fashion for sekai-byobu or world maps.⁸ Fifty years later the Jesuits exported to Japan large numbers of Ortelius's world maps from the 1584 Theatrum Orbis Terrarum to cater for this taste.⁹

⁶Hirosi Nakamura, "Les Cartes du Japon qui servaient de modele aux cartographes europeens au debut des relations de l'Occident avec le Japon." Monumenta Nipponica, Vol.II, 1939, pp.100-123; see especially pp.106-9.

An exemplar of this type published as late as 1650 was recently shown at the British Museum (OMP 16225 8).

⁷Ibid. pp.166-8.

⁸H.Nakamura, op.cit., p.119.

⁹C.R.Boxer. Christian Century in Japan, p.135.

Note also that from 1467 to 1547 the Ouchi household had a monopoly of Tally Trade with China which the Shogunate recognised in 1516. This explains the route taken by Sosetsu's map on its way to Japan. The Sekai-byobu or 'world map picture screens' dating from the Keicho period 1596-1614 were a curious hybrid developed from the Gyogi-zu traditions and Ortelius's maps as ordered by Valignano for the Japanese Jesuits.

Like the Koreans whose best maps showed nearby coasts and havens, the Japanese built up a fine knowledge of their own as well as Chinese havens. This knowledge enabled them to mount a serious piratical threat to the Chinese. These Wakō pirates besides figuring in Chinese writings also figure in Japanese literature. The Taishokan, a beautiful Japanese manuscript of the early seventeenth century, full of stylised ship pictures, tells of the inability of the Chinese Manko to protect the gifts he wished to send to the Japanese Emperor by his daughter. The Chinese after embarking are attacked by pirates and the most precious stone is lost.¹⁰

The Japanese naval threat to the area in the late sixteenth century rested on their intimate knowledge of the area's havens. They made good use of this in their landings along the Korean coast between 1592 and 1598 and were only repulsed at Chemulpo and Fusan Sound by the Korean admiral Yi Sunsin because of the latter's fire ships and the help of the newly built up Chinese squadrons from Shangtung, Fukien and Kuantung. Ironically it was Japanese navigational prowess that led to the late sixteenth century revival of Chinese and Korean interest in navigational and naval preparedness. It was clearly because Japanese knowledge of the China coast was so much better than official Chinese knowledge that the Chinese Admiral Hu Tsung-hsien

¹⁰ Taishokan, an early 17th century Japanese work of literature now in the Gulbenkian Museum, Durham. (Gulbenkian MS. 1962-144).

ordered the production of detailed charts of the China coast. The resultant work, the Ch'ou-hai t'u pien greatly facilitated China's defence against the Wakō pirates. Yet even at the height of the Wakō depredations in the 1550s only 30% of the Wakō are said to have been Japanese.¹¹ The Fukien Gazetteer said:-

"Evil people recklessly went out and traded with the Dwarfs /Japanese/ and the Fo Lang-chi /Portuguese/ and others".¹²

Thus we need to examine closely these Portuguese who were so deeply involved in piracy and illegal trading near Japan's coasts. In 1544 or 1545 Fernao Mendes Pinto claimed to have begun his opportunist travels in Japan. He was the author of an entertaining, if not always credible, account of these contacts, the Peregrinacam de Fernam Mendez Pinto.¹³ He certainly had no qualms about starting a trade in firearms, securing sales to various daimyos keen to purchase them for private wars and quarrels. In 1547 three more Portuguese opportunists involved in such trade or piracy were blown off course and actually landed in Japan;

¹¹ Masayoshi Sugimoto and David L. Swain. Science and Civilisation in Traditional Japan. AD 600-1854. M.I.T. Press, 1979, p.152.

¹² C.R. Boxer. South China in the Sixteenth Century. Hakluyt Society, 1953, Series II, Vol. CVI, p. xxv.

¹³ Fernão Mendes Pinto. Peregrinacãm de Fernam Mendez Pinto. Em que da conta de muytas e muyto estranhas cousas que vio & ouuio no reyno da China, no da Tartaria, no do Sornau, que vulgarmente se chama Siao no do Calaminhan, no de Pegu, no de Martauao, & em outros muytos reynos & senhorios das partes Orientais, de que nestas nossas do Occidente ha muyto pouca ou nenhua noticia. Et ambem da conta de muytos casos particulares que acontecerao assi a elle como a outras muytas pessoas. E no sim della trata brevemente de algumas cousas & da morte do santo Padre mestre Francisco Xavier unica luz & resplendor daquellas partes do Oriente & Reytor nellas universal da Companhia de Iesus. Escrita pelo mesmo Fernao Mendez Pinto. Pedro Crasbeeck. Lisbon 1614.

while the following year a larger party deliberately landed on Tanega.

Even though Marco Polo, Pires, Rodrigues had all mentioned Japan, and Lopo Homen and the Rienels had named it Pavioco Insula in their atlas of 1519, the first real contacts were undoubtedly made very unofficially by Portuguese pirates. Possible contacts are reported in 1534 and 1539. Our first concrete knowledge of European contact was the shipwreck of Fernão Mendes Pinto, Diogo Zeimoto and Christovão Borvalho in 1542. Professor C.R.Boxer is unwilling to give much credence to Pinto's claim as the latter was a notorious unprincipled brigand. Pinto certainly later met St.Francis Xavier in Japan after the latter had gone there "entranced with what he had heard of the newly discovered land" from Jorge Alvares in 1547.

Early Spanish contact with Japan is also recorded through Garcia Escalante Alvarado, chaplain of the fleet of Ruy Lopez de Villalobos who had gone to the Philippines and the Moluccas in 1542-6. He wrote down what he had heard from a Galician sailor Pero Diez, who had been in Japan aboard some Portuguese ship in 1544. Escalante Alvarado's report addressed to the Viceroy of Mexico was written in Lisbon in August 1548.¹⁴

After St.Francis Xavier's arrival in Japan in 1549, news of his religious and political successes was sent back to Portuguese India and Portugal, and served to increase the desire to put the sea route

¹⁴P.M.C. Vol.V, pp.170-8.

there into a more formal navigational record.¹⁵ The Commentarios of Afonso de Albuquerque spoke of Japan's wealth, and of its being the source of gold brought to Malacca. Dahlgren has produced a fine comparative record of how, under such an incentive, the cartographic representation of Japan improved during the course of the sixteenth and seventeenth centuries.¹⁶

However, this is far from showing the full story of the buildup of practical European knowledge about these islands, and further still from showing how the practitioners of both cultures exchanged knowledge. Some incidental light is thrown on this by C.R.Boxer's study of the Japan trade.¹⁷ This worked on the basis that European supplies of silver (often coming from America on the Manilla galleons from Lima) were exchanged in Lima and Japan for luxuries such as silks. The economic incentive for this trade was provided by the fact silver had a far higher value in the Far East than in Europe. Thus Europeans could afford many Eastern goods if they gave silver in

¹⁵C.R.Boxer, Christian Century in Japan, pp.401-5 for an English translation of extracts of the letter from Francis Xavier S.J. to the Jesuits at Goa, dated Kagoshima November 5th 1549.

¹⁶For a fine summary of the basic cartographic representations which could be grouped into six types before 1600, as grouped by Dahlgren, see P.M.C. Vol.V, pp.160-61 and E.W.Dahlgren, Les Débûts de la Cartographie du Japon, Uppsala, 1911, though this needs revision in the light of Nakamura's study, op.cit., footnote 6.

¹⁷C.R.Boxer, The Great Ship from Amaçõn . Annals of the old Japan trade 1535-1640. Centro de estudos historicos ultramarinos Lisbon. 1959.

exchange.¹⁸ Until the seventeenth century this was no problem for the merchants of Goa and Malacca and Macao were prepared to finance and participate in the three-cornered trade between Goa, Macao and Nagasaki. After 1571 a trade based on Spanish silver coming from Peru on the Manilla Galleons was easily fitted into this trade pattern. To safely and quickly accomplish these voyages good navigational knowledge of the seas and ports of the area had to be obtained.

In 1555, Duarte da Gama and Vaz de Aragão, who had already helped St. Francis Xavier in Japan, began the exchange of navigational information. In 1560 Manuel de Mendonca sailed for Japan using not European style vessels, but two junks. The Jesuit Padre Balthazar Gago described this visit to the ports of Bungo and Satsuma in his Cartas published in 1598.¹⁹

Though Travassos may also have visited Japan in 1570, no reliable written record of much navigational significance has survived before 1571. In

¹⁸ Thomas Mun. A Discourse of Trade from England into the East Indies Answering to diverse objections which are usually made against the same by T[homas] M[un]. Printed by Thomas Okes for John Pyper London 1621 (see especially pp.43-58).

A facsimile of this work of 58 pages is now available under the title East Indian Trade, Gregg International Publishers, 1968.

¹⁹ D.Lach. Asia in the Making of Europe. Vol.I, part 1, p.320.

that year the Captain Major for the voyage from Goa to Nagasaki was Tristan vaz de Veiga.²⁰ On arrival at Nagasaki, he decided it was one of the safest harbours. Thereupon he ordered a Portuguese pilot, and Padre Melchior de Figuerido to survey Nagasaki harbour.

This incident reveals the respect held by professional navigators for the learning and practical abilities of Jesuit missionaries, especially when they produced maps in collaboration with one of known skill in using the navigators' instrument. However, only too often maps could not be exclusively compiled in this way but depended on local information. A case of this is revealed by a Jesuit letter dated 1585 which says

"Last year came with me from China to Japan, an important Portuguese, curious to make such descriptions of new lands, called Ignacio Montero, who went with me to the city of Maico [Macao], he very diligently sought to get the truth about the line and figure as well as the length and breadth of Japan ... and Japan begins thirty degrees and a half north, as the said Portuguese found with an astrolabe, and goes up to 39° north, though he could not know for certain how much it goes up, because he could not get there, but according to information he got."²¹

Occasionally, however, the Iberians were rudely awakened to the deficiencies of maps constructed on the basis of such information. Hence it was that Rodrigo Vivero y Velasco, the Captain General of the Philippines, could write a vivid first hand account of the dangers of navigation in these waters in 1609 for he was shipwrecked on 30th September of

²⁰C.R.Boxer, The Great Ship from Amaçõn, p.66.

²¹P.M.C. Vol.II, p.128.

that year. One part may be translated thus:

"One could make a long tale of the tempests and dangers that we went through during the sixty five days that the voyage lasted, before coming to that fateful hour, and I know that one never experiences greater misadventures in the 'Sea of the North' [Atlantic] or in the Sea of the South [the Pacific Ocean]. But other dangers began when the ship broke its back on the reefs at the Point of Japan in $35\frac{1}{2}^{\circ}$ of latitude. All the mariners charts which are shown to anyone having to navigate these parts, have very prejudicial error, because the cape is shown in $33\frac{1}{2}^{\circ}$ ".²²

One could surmise that this was because Portuguese cartographers like Luis Teixeira copied too slavishly the stylised outlines of traditional Japanese cartography. Japanese charts were mostly representations in the Gyogi style, though they knew of European charts. In 1601 the Jesuit Alessandro Valignano wrote of the genre:

"Formerly the Japanese had their map of all these islands, but as they did not know about cosmography or about degrees, and heights of the Poles, they had nothing accurate or well drawn, nor did they know correctly their position and the latitude in which they were".²³

Valignano thus wanted to include a more correct map

²²Rodrigo de Vivero. "Relazion que hace Don Rodrigo de Vivero Velasco ..."

See Juliette Monbeig, Japon et du bon gouvernement de l'Espagne et des Indes. Traduit et presente par Juliette Monbeig. S.E.V.P.E.N. Paris 1972 p.3.

The Cape mentioned is Cape Noshima, which on Luis Teixeira's chart of 1595 is wrongly shown, just as Vivero claimed.

²³A. Cortesão Cartografia e Cartographos Portugueses dos seculos XV & XVI, Lisbon, 1935, Vol. II, pp. 361-3. Ignacio Moreira, sometimes known as Monteiro, or Montero searched through Kyoto for cartographical and cosmographical information with F. Valignano. This survey led to his suggesting Japan extended between $30\frac{1}{2}^{\circ}$ and 39° of latitude, far better than earlier estimates.

in his History of the Church in Japan in 1608, because he knew of the work of Ignacio Moreira. Moreira was identified in 1959 by F. Shutte as the same Montero mentioned earlier.²⁴

Ignacio Moreira's chart of 1581 had come to the notice of European cartographers through a mission the Jesuits organised. That mission left Nagasaki as a Japanese embassy to Pope Gregory VIII on 20th February 1582. The Ambassadors brought as a diplomatic present a copy of this map. It was formally presented by them to Francisco de Medici in Pisa as they were impressed by the Italian's interest in maritime matters, and in particular, charts. This map led to a redrawing of the Japanese coastline by Luis Teixeira in Lisbon. That knowledge was rapidly passed on. Luis Teixeira wrote to the famous Dutch cartographer Ortelius on 20th February 1592 saying

"The gentleman who is the bearer [of this letter] brings you two pieces of the description of China and Japan, the ones that have just arrived, truly drawn as they show".²⁵

When published in 1595 Teixeira's map represented a marked advance on the earlier representation by Vaz Dourado. Though this seems to be part of a major

²⁴P.M.C. Vol.II, p.128, also Plate 239 reproduces a transcript of Fr. Shutte's article in Imago Mundi, Vol. XV, 1959. See also The Calendar of State Papers, 1513-1617 Colonial. East Indies. Ed. N. Sainsbury, No. 822, for a letter of Richard Cocks to Lord Treasurer Salisbury written from Firando, Japan 1610. Cocks says in 1584 the Jesuits took three Japanese to Spain, giving out they were sons or nephews of the Kings of Bongo, Arima and Umbra. Knighthood was conferred on them by the King of Spain, with many rich presents from other princes, including the Pope; but in truth they were of base parentage and all the gifts were kept by the Jesuits for their own private benefit.

²⁵P.M.C. Vol.IV, p.43 & Plate 362B. The full text of the letter of Luis Teixeira of 20th February 1592 to Ortelius will be found in the Appendices.

breach in Portugal's restrictions on the dissemination of cartographic material, Luis Teixeira's map gave little advantage to its users for it showed exactly those features that brought about Vivero's shipwreck in 1608 on the Japanese coast.

In general, however, Portuguese regulations concerning the Japan trade were honoured more in the observance than in the breach. It makes a favourable comparison with earlier Portuguese activities off the China coast. This formality was so well observed because until the 1620s the Portuguese had secured a virtual monopoly of the carrying trade between Japan and China. Careful bureaucratic control of maritime practices could, as on the Cape route, also help make the fortunes of captains and pilots who thus had something to gain by observing the rules. Because very few other Europeans were in the Far East, few buyers of navigational secrets were available to an Iberian pilot. Most pilots kept log-books and their own rutters, though many are now lost. Captains filled all the posts aboard ships that required persons of proven navigational ability as can be seen from the lists of early voyages and captain majors examined by C.R.Boxer. However, this did prevent the interchange of men, skills and traditions between the Japanese and the Portuguese.

The Jesuit author of many letters on Japan, Fr.Luis Fróis, wrote from Malacca on 1st December 1555

that

"Last year we learnt from the ships that came here for China, that there were very great quarrels and disputes between China and Japan. A great fleet from Camgoxima [Kagoshima] had destroyed many places in China which were situated along the sea coast ... They say that these wars are so fierce they will not be appeased for many years. This discord between China and Japan is a great help to the Portuguese, who want to go to Japan, for as the Chinese do not go thither to trade with their merchandise, the Portuguese merchants have a great advantage in negotiating their worldly business."²⁶

On every visit there was plenty of time to learn from the local communities of the great Asian ports for a voyage to Nagasaki from Goa and back would take three years and included a spell wintering in Malacca, a year in Macao where white silks were contracted for, in addition to a lengthy stay at Nagasaki. The Captain Major in charge of the whole voyage was forced into such contacts because before 1623, he was responsible for the administration of the port of Macao and of the safety of the fleet. The other important figure on the annual Japan voyages was the "piloto-mor" (pilot-major), who was always Portuguese.²⁷ However, under him Chinese and Gujeratis were often taken as assistant pilots. European sailors were few, while the bulk were Eurasians, Lascars, Gujeratis and Negros.

The Portuguese used vast ships for the Japan trade ("Nãõ de Trato") which were lightly gunned and a real test of the skills of master, pilot and

²⁶As footnote 50. See also C.R.Boxer, South China in the Sixteenth Century. Hakluyt Society, Series II, Vol.CVI, p.xxxiii.

²⁷C.R.Boxer, Christian Century in Japan, p.128.

helmsman for they were notoriously unwieldy ships. These ships grew from 500 tonners in the 1570s to 2,000 tonners by 1600.²⁸ After 1618 due to the depredations of Dutch ships, Iberian trade was carried in small easily handled galliots or in "patexos", i.e. pinnaces. Occasionally ships of a frigate type under Portuguese command would sail with the galleons or "kurofune" as they were called by the Japanese. Chinese junks would also be used in these trading fleets despite their vast differences in design and handling characteristics.²⁹ The junks called "somas" by the Portuguese were of about 400-500 tons and would accompany the Japan fleet to Manila after the union of the Iberian crowns in 1580. Though accidents resulted from Portuguese commands of such ships, like the shipwreck off Formosa in 1582 of Bartholomeu Vaz Lanbairo's junk, this was not the result of Portuguese ignorance of how to handle Eastern style craft. In the case of the 1582 wreck it was the result of the pilot falling asleep before dawn. So good in fact were the handling and navigational reputations of the Portuguese that Japanese Shogun Toyotomi Hideyoshi obliged all his crack ships, the Red Seal ships, to carry Portuguese pilots until 1630.

²⁸ European shippers of the 16th century understood by one ton, space of 60 cu.ft. of cargo or space for a "tun" of wine.

²⁹ J. Needham, S.C.C. Vol. 4, part 3, pp. 409-16 and 588-655.

Northern Europeans had very little notion of the nature of this Japanese interchange until the early 17th century. One of the earliest and best northern European insights was provided by Linschoten's friend from childhood, Dirck Gerristzoon, who went to Japan as the gunner of the 'Silvas', a ship commanded by the Portuguese Francisco Pais in 1585. In 1596 Linschoten published the description of this voyage from Macao to Nagasaki as written by the Portuguese pilot.³⁰ Another of the accounts quoted by Linschoten was 'The description of a voyage made by a Portugal Pilote from Liampo to Japan in a Chinese Soma, that is a chinchon ship, with a description of the coast of Bungo, Miaco, Cacay and the Island of Toia, all counties of Japan'.³¹ Two other accounts of Japan voyages are given by Linschoten.³²

The next important Northern European contact was William Adams who arrived at Beppu Bay, Japan on the 19th March 1600. He had sailed in Dutch service as Pilot Major of a fleet of 5 sail "because he was desirous to make a little experience of the knowledge which God had given him". His earlier navigational experience in English service stood him in good stead from the moment of his embarkation in the Dutch ship 'Leifde', and in his subsequent Japanese career.

³⁰ John Huighen Linschoten, His Discours of Voyages into ye East and West Indies, Devided in Four Books. Printed in London by John Wolfe, Printer in the Honourable city of London. 1598. (Pepysian Library 2100). See Third Book translated out of Dutch by W.P. Chapter 36, p.392.(W.P. = ?William Philip).

³¹ Ibid. Chapter 31, pp.373-80.

³² Ibid. Chapter 32, pp.380-90. This is entitled Itinerary from Campacon to the Island of Japon and from the island of Firando with the description of them by another pilot. And Ibid. Chapter 35, pp.390-92.

William Adams [Addames] (as he mentioned in the famous long letter that led to the opening of commercial intercourse between England and Japan),³³ was born in September 1564 at Gillingham, Kent. He was then apprenticed for 12 years to Nicholas Diggines, a shipbuilder at Limehouse. In 1588 he served as master and pilot of a Her Majesty's ship, Richard Duffield, a victualler for the Armada campaign. By 1598 he had completed 12 years service as master and pilot for Her Majesty and Company of Barbary Merchants. He was hired by the Dutch East India Company as pilot major to a fleet of five ships, along with another English pilot, his friend Timothy Shotten. Adams's experience alone kept out of trouble that the four ships encountered as they nearly ran ashore off the Barbary Coast. After that

"It was resolved that each captain should compare the bearing of his pilot with the maps twice, or at least once a week, and discuss the position one with another".

They were forced to winter in the Straits of Magellan from the 6th April 1599 to the 24th September. Though he managed to revictual off Chile, he noted that the people were of good nature but

³³Letter of William Addames "to my unknown friends and countrymen, desiring this letter by your good means, or the news or copy of this letter may come into the hands of one or many of my acquaintance in Limehouse or elsewhere, or in Kent in Gillingham or Rochester", dated October 23rd 1611. Two copies of this letter were later brought to London for the East India Company. See Memorials of the Empire of Japan, edited by Thomas Rundall. Hakluyt Society Series 1, No. 4 1850, pp. 18-32.

India Office Records. Original Correspondence from India with Collateral Documents originating at any place between England and Japan from 1603 to 1708. E/3/1 ff. 116-129.

unwilling to trade by reason of the Spaniards. On the island of St. Maria they were ambushed, and left for Japan with scarcely enough men to wind up the anchor. By then, 27th November 1599, they were down to two ships with Adams acting as pilot of the 'Liefde'. They lost their consort "in a wondrous storm of wind as ever I was in, with much rain". They, like Vivero 10 years later, found not the Cape they sought, "by reason that it lyeth false in all cards and maps and globes". They finally sighted Beppu Bay, Japan and came to anchor on the 19th April 1600 "at which time there were no more than six, besides myself, that could stand upon his feet". Many people then boarded but did no harm "neither of us understanding the one the other". The King of Bungo befriended them and sent Adams to see the *Shogun*

Thereafter began the most interesting interchange, for though imprisoned at first, with the Portuguese and Jesuits calling for his death, the *Shogun* decided to spare Adams and execute his enemies. When finally allowed to return to his crew and ship he found that all his instruments and books had been taken. The *Shogun* ordered them to be restored, but Adams did not get them. Instead he was given 50,000 ryals to buy victuals. Despite the ambitions of many of the surviving crewmen who wanted to take command of a ship, the *Shogun* decided to retain them and feed them for four or five years. During this time the *Shogun* asked Adams to teach him geometry and mathematics and was so pleased "that

what I said he would not contrary". After several supplications Adams was told he would be the means by which both the English and Dutch should traffic in Japan, "but by no means would he let him go". The *Shogun* asked him to supervise the construction of these special ships, one of which was lent to Vivero in 1609 so that he might return with 80 men to Acapulco, Mexico. Adams reported that yet another of the ships he had made was sent to Acapulco in 1610, and was now in Spanish hands at Manila . In 1609 he organised the reception and treaty that the Dutch secured when two of their ships reached Firando

Noting that "the Hollanders have here an Indies of money and goods to trade," he presumed that he himself must be known to some of the English mariners regularly trading to the East Indies. He entrusted an accurate description of Japan to a Dutchman so that England too could enjoy trade with Japan, if an Englishman should ever get his letter.

Adams enjoyed so elevated a position in *Tokugawa* I eyasu's counsel that he could not only determine trade relations, but most maritime and navigational matters. Thus when a Spanish ship arrived at Yedo in 1611, *Tokugawa* Iyeyasu discussed the Spanish captain's request to take soundings of the harbour with Adams in order to hear what European powers did on receiving such requests.³⁴ The Spanish captain

³⁴C.J.Purnell "The Log Book of William Adams 1614-1619 and Related Documents". Transactions and Proceedings of the Japan Society Vol.XIII, Part II, London 1915, p.163.

had argued that he needed to know the coast in case of storms, but Adams said European countries regarded such acts as acts of war, and added that it was indicative of Spanish designs on Japan. The Emperor agreed and from this moment Iberian contacts began to sour. Rodrigues Girau in his annual letter of 1612 attributed the decline of the Jesuit and Portuguese position to the heretic English pilot. In 1614 the Jesuits were expelled and they sought to blame it on the English.³⁵

³⁵Calendar of State Papers Colonial East Indies 1513-1616. Ed. Noel Sainsbury. Longmans. London, 1861. Nos. 694, 822 and 825 give an idea of Adams's influence and his role in the expulsion of Jesuits. India Office Records. Original Correspondence from India with Collateral Documents originating at any place between England and Japan from 1603 to 1708. E/3/2, ff.115-8. Richard Cocks to the East India Company, 25 Nov. 1614. (Indorsed received the 19th May 1617 by the 'Dragon' from Bantam). Not only does Cocks's letter report the banishment of Jesuits from Japan, it reports that the 'Emperor of Japan' was ready to back Adams in an attempt "to find out the northern passage for England". Of Adams Cocks says "I find the man tractable and willing to do your worships the best service he may". The letter also gives an account of the Japanese military defeat in Korea 22 years before. India Office Records (O.C.) E/3/3, ff.147-52 and 153-62. Richard Cocks to the East India Company 25 Feb. 1616 and E/3/3 ff.163-4. Richard Cocks to Richard Westby at Bantam 25 Feb. 1616, both report further Jesuit banishments and the departure of the junk 'Sea Adventure' for Siam with Adams aboard. The former mutilated letter also describes several aspects of Dutch naval activity in the Far East, and the 'evil' of seamen being left in the Indies when European ships left Japan.

Under Adams's guidance Anglo-Japanese relations, and the exchange of navigational information might have prospered. The terms of the treaty signed by I eyasu were translated into English and granted to the name of the right honourable Sir Thos Smythe, governor of the East India Company, for the use of the 8th voyage, the privilege that the East India Company Merchants could freely enter the ports or empire of Japan, and abide, buy, sell and barter, according to their own manner with all nations. I eyasu also agreed to assist all ships in danger, and return what could be saved to the captain.³⁶ William Adams was taken into the East India Company service on 29th November 1613 at a salary of £100 a year.³⁷ Richard

³⁶India Office Records (O.C.) E/3/1, ff.194-195. "Translation of the Emperor of Japan's privileges granted in the name of the right honoured Sir Thos. Smythe, Governor of the East India Company, for the use of the 8th voyage".

³⁷India Office Records (O.C.) E/3/1, ff.203-4 "Contract made with Capt. Wm. Addames at Firando in Japan, the 24th of November 1613".

Cocks reported from Japan on November 30th Mr. Addames had sent a 'plot of Japan' to the Company.³⁸ Additionally Adams had mapped the entrance to straits near Yedo, believing it to be an ideal place to discover both the North East and North West Passages. In 1614 Richard Cocks sent back a Japanese almanack to Thomas Wilson, the Secretary to England's Lord Treasurer.³⁹ That the exchange of navigational instruments

³⁸India Office Records O.C. E/3/1, ff.205-8. 'Richard Cocks to the Governor, Deputy Committees and generality of the East India Company of England, in London, per the Clove whom God preserve'. 30 Nov. 1613. This letter contains much of navigational significance, including a report from the master of a Fleming pinnacle cast away on the coast of Borneo, that shoals stretched from there almost to the Celebes and especially near Macassar, "quite contrary to the form laid down in our plots or sea cards". The same letter again reports Adams's opinion that if ever the Northern passage was to be found, it would be from Japan. The Court Book of the East India Company (India Office Records, Court Book III) in the entry for 11 April, 1615 (f.411) records that the Company felt Adams was 'very fit to be employed' if their factors concurred, so they arranged to send their factors "a pair of globes" and maps.

³⁹Calendar of State Papers. Colonial, East Indies 1513-1616. Ed. Sainsbury. No.823. Richard Cocks to Thomas Wilson 10th Dec. 1614 reports his inclusion of an almanack from Japan which is reported missing by Sainsbury. Cocks did not know of the Earl of Salisbury's death in 1612. India Office Records E/3/2 ff.137-8 "Richard Cocks to the Company of Merchant Adventurers in England, resident in Middleburgh" 10th December 1614 reports sending "a Japan almanack whereby they may see the printing of letters and characters, and how they divide the year into twelve months". This almanack is also missing from the India Office correspondence.

was also hoped for is suggested by the letter of Cocks to Wickham, wherein Cocks says he is unable to obtain them for a variety of reasons, but not for lack of wanting to oblige.⁴⁰

Despite the possibilities of interchange via Adams and the English pilots, matters went wrong from the moment the English ignored Adams's advice not to settle at Hirado. Needham has claimed that even before 1637 the Japanese had a more useful interchange with the Dutch who introduced the Japanese to the dry-pivoted compass needle and then the compass card. They were soon seen on Japanese and Chinese vessels utilised in the bronze bowl type shown earlier which had pivots inserted into the depressions made, for its two compasses used dry pivots whereas floated needles had been the Far Eastern way for a millenium. Needham may have been influenced in taking this view by the Hai Kuo Wên Chien Lu (Record of things Seen and Heard about the coastal Regions) written in 1744, which contains a short passage comparing Chinese and Dutch methods of navigation.⁴¹

⁴⁰ Ibid. No.654 sent from Firando, September 18th, 1613.

⁴¹ Needham, op.cit., Vol.4., Part 3, pp.563-4.

Close as Japanese trading and maritime relations with the Dutch were, one must doubt whether exchanges of navigational information with them before 1620 were as valuable as the English and Iberian contacts.⁴² It must be remembered that it was Adams who had helped the Dutch establish their factory at Hirado two years before the English. Also it must be remembered that in all their early voyages to the Far East the Dutch had employed English pilots, such as Adams himself. Other English pilots such as Edmund Sayer, William Eaton, William Nealson, John Saris, John Totton, were all known to be interested in navigational matters and to be in regular communication with each other, and various factories of the East India Company. They also wrote regularly to London to give information to the Council of the East India Company, though the letters from Richard Cocks, Richard Wickham and William Adams were rather fuller in their descriptions of Japan and more common. In his first and most interesting letter, Adams specifically asked that "this letter may come into the hands of one or many of my acquaintance in Limehouse or

⁴²This subject has been reviewed by Seiho Arima, "The Western Influence on Japanese Military Science, Shipbuilding, and Navigation," Monumenta Nipponica, Vol.19, 1964, pp.118-45.

elsewhere or in Kent in Gillingham by Rochester".⁴³
 Most of the seventeenth century English makers of navigational instruments and charts also lived and worked on Thameside.

Such reports fixed the spirit of adventure in this London community, for it was the type of information travellers to Japan wanted.⁴⁴ No accounts were quite so well known as William Adams's. He had also visited the Ryu Kyu Islands in 1614-15 and 1618, Cochin China in 1617 and Tonkin in 1619, as his detailed log-book shows.⁴⁵

Nevertheless communication of such information to Europe was not easy. It had to await an English ship or a Dutch ship. John Jourdain's Diary of 1613 under April 16th and 22nd gives some idea of the difficulties. He reported that two men boarded his ship at Amboyna from a Dutch vessel.

"They told us newes of Mr.Adams which was in Jappon in great creditt with the King and was desirous of English ships to come theather, as they said he had wrote a letter and an English sayler which was in their ship to Mr.Spalding in Bantam, and had a letter in great secrett and to deliver it unto no mans hands but his".

Later Jourdain in sending a messenger back, nominally to buy bread aboard the Dutch ship reported

⁴³As footnote 33. p. 494.

⁴⁴E.G.R.Taylor. Mathematical Practitioners of Tudor and Stuart England, Hollis and Carter, London 1970, for map opposite p.162.

Michael Cooper. Richard Cocks, "English Merchant in Japan," History Today 1973 p .247-255.

⁴⁵C.J.Purnell. Op.cit. which reprints Adams's log-book, the manuscript of which survives in the Saville collection at the Bodleian Library.

"then finding an Englishman in the shipp which came from Mr. Adams from Japann, directed to Mr. Spalding at Bantam with a drought of the countrey of Japan".⁴⁶

Another problem dogging the interchange so far as the English were concerned was Jesuit activity. Cocks reported problems from the first. On November 30th 1613 seven mariners from the English ship Clove, newly arrived at Firando, deserted to Langasque where they took sanctuary in the "Papist churches". From there they were conveyed by the Jesuits to the Philippines.⁴⁷ These deserters may well have offered the Spanish useful information, at a time when the Spanish were incurring the active wrath of the Japanese that would culminate in the banning of trade between New Spain (Mexico) and Japan in 1615.⁴⁸ Much the same fate overtook the Portuguese at this time as they found the Emperor was no friend of theirs. Captain John Totton noted that the Iberians had done much to wreck English contacts as well. He wrote on December 4th 1616 the Japanese "cannot endure the Spanish priests, who are all to be banished out of the country".⁴⁹ The new Japanese *Shogun* *Tokugawa Hidetado* had much less time for all Europeans and was prepared to concede that the English should trade at Firando only. When Cocks and Adams went to entreat him to allow the English

⁴⁶ India Office, China Materials. Japan Supplement Volume, p.13.

⁴⁷ India Office Records. O.C. E/3/1, ff.205-8. Cocks to Governor, Deputy, Committee and Generality of East India Company in England in London per the Clove, whom God preserve. 30 Nov. 1613.

⁴⁸ India Office Records O.C. E/3/3, ff.104-5. letter of Richard Cocks, Dec. 6th 1615.

⁴⁹ India Office Records O.C. E/3/4, f.100, Captain John Totton to Benjamin Farie, Principal in Spain.

their old concessions, they failed.

Despite official dislike in Japan of the Jesuits, they managed to continue their traditional cultural and religious interests, including that in navigation. Following Fróis's arrival in 1565 the number of useful accounts reaching Europe blossomed.⁵⁰

As late as 1618 the Jesuit father Girolamo de Angelis was the first European to cross the Tsugaru Strait to visit the northern island of Hokkaido [Yezo]. There he was able to draw a map that accompanied his report to Rome. The map was drawn from Angelis's own observations, with Yezo on a larger scale than the main island of Honshu.⁵¹ It owes little to Japanese knowledge, but does bear an interesting resemblance to Adams's view that the area might be an entrance to a Polar passage. The name Anian is written on the American shore, but scales are much reduced to give an unreal impression of a north-west passage. Certainly such a map was at odds with the representation of the North Western coasts as standard copies of the padron réal.⁵²

⁵⁰Luis Fróis. "Brevis Japonicae insulae, descripti, ac rerum quarundum in ea mirabilium, a Patribus Societas Jesu nuper gestasum" Cologne 1582, Durham Univ. RXLIX H 12/3. Luis Froes "De Rebus Japonicis historica relatio", Mainz, 1599, Durham Univ. RXLC 27/3. Edited and translated versions of these are available as part of the "Three Severall Testimonies concerning the mighty kingdom of Coray" in R.Hakluyt, Principal Navigations. Vol.XI, pp.422-442. Hak.Soc.

⁵¹R.Skelton, Explorers Maps, Fig.III, p.165 & pp.178-9.

⁵²Calendar of State Papers, East Indies 1513-1616, no.660. Sir John Digby to James I from Madrid saying that the Spanish did not consider the North West Passage a matter of consequence and were glad to be free of this care. 30th March 1613.

It is, however, through an earlier Jesuit letter that some of the best evidence about the nature of the Hispano-Japanese interchange has come down to us. The same letter also shows the outlook of a provincial Japanese official at Urado. Fr. Juan Pobre wrote in part of his Istoria de la perdida y descubrimiento du galeon San Phelipe con el glorioso martirio y gloriosos Martires del Japon about the pilot's evidence to this tyrant. It reads thus when describing Masuda's questions.

"He [Masuda] then summoned the pilot and asked him how the ship had come thither and how the ship was steered. He was told by the sea card and astrolabe. He ordered them to be brought, and as he asked questions about the chart, the pilot replied, showing him the way from Spain to Mexico, from Mexico to Luzon and from Luzon to Japan. When he saw Japan so small upon the chart and could not believe it. And as the other land and seas which he saw were almost all those of our Catholic King, he asked how he owned so much and the pilot told him he had much more still ..."⁵³

Continuing his explanation of the chart which the Japanese later copied, Masuda asked whose were the Portuguese Indies. To this the pilot replied "Our King's" only to elicit the retort "Have you not got three Emperors". The pilot answered "No only one" to which Masuda replied "You lie". Fr. Juan Pobre then quoted Masuda as asking who was Don Antonio, where was England, and why did our king wage war on England and the Great Turk, "together with other questions whose drift the pilot did not understand."⁵⁴

⁵³C.R.Boxer, Christian Century in Japan, p.442.

⁵⁴Ibid. and C.R.Boxer, "Some Second Thoughts on the Tragic History of the Sea." Annual Report of the Hakluyt Society for 1978. Fig.4 as reproduced in the Volume of Illustrations accompanying this thesis.Fig. 56.

Yoshitomo Okamoto's study of Namban influence on Japanese painting, art and geography, has suggested that while it was likely Japanese merchants did see Portuguese charts in the safety of the Jesuit's residence, it was not until the return of the Kyushu daimyo's envoys from Europe that significant improvements in Japanese cartography took place. Valignano whose idea the mission to Europe was, says these daimyos actively communicated their experiences to him on their return. At Murotsu on 17th February, 1591, Mori Terumotu and the other daimyos visited Valignano and took especial interest in the maps, charts, globes and astrolabes shown by the newly returned envoys. These envoys also explained a map of Italy and a new plan of Rome to the visiting daimyos. Another way in which this interest in navigational matters, and Valignano's hopes to propagate Christianity mixed, can be seen in the inlaid laquer and mother of pearl Communion host box, which comprised an I.H.S. (Iesus Hominum Salvator) monogram at the centre of a perfect 32 point ring, exactly like the standard European compass roses first introduced about the time this box was made there.⁵⁵

⁵⁵Yoshitomo Okamoto. The Namban Art of Japan, translated by R.K.Jones. Weatherhill/Heibonsha. New York, 1972, pp. 80 and 90.

Also interesting are Namban views of Lisbon and Madrid, Rome and Constantinople, the first and last of which show features of considerable maritime interest. There are also several Namban charts illustrated in this volume. See especially pp.130-133. Also see C.R.Boxer. The Christian Century in Japan. p.265.

The early seventeenth century saw a deterioration of relations and maritime exchanges after Emperor Iyeyasu's reign. The influence of European navigational techniques on Japanese practice became undisputably established. Professor Boxer cites several early seventeenth century portulans still preserved in Japan. These charts are all painted on vellum and decorated with motifs such as the Quinas and the Cruz de Christo. Their windroses, compass lines, scales of leagues follow conventional Portuguese practice, but because their nomenclature is almost exclusively in Kana and because the Japanese and neighbouring coasts are far more accurate than on any known European map of the time, Boxer attributes them to native cartographers who learned their craft from Portuguese pilots or Jesuits.

We have already noted the adoption of the dry-pivot compass, but it was not the only instrument adopted from European practice. One of the more interesting adoptions was the half astrolabe for celestial sightings, illustrated alongside a traditional astrolabe. This type of astrolabe made possible a larger scale than that used on the traditional sixteenth century European astrolabes and represented the penultimate improvement of the European astrolabe. Made in the early seventeenth century, the first European example is one in the Kronberg Palace, Helsingor (Elsinore).⁵⁶ Another

⁵⁶ Søhistorisk Billedbog, Maritime History in Pictures, Helsingør, 1967. Danish Maritime Museum, Fig. 105.

exemplar was recovered from the Dutch East Indiaman, Batavia which foundered off the coast of western Australia in 1629,⁵⁷ while yet another may have been carried by Captain Waymouth in 1605.⁵⁸ However it is the careful illustration of this instrument in the Genna Kokaisho (Navigation treatise of the Genna era) written by Koh-un Ikeda in 1618 which is the most striking example of the level of advanced interchange of navigational technology in Japan.⁵⁹ It is closely followed in this by a description of the telescope only recently developed in Europe.

Companion works by Ikeda describe respectively the astrolabe, Jacob's staff, quadrant, sand-glass, compass, and 'sounding lead. The Genna Kokaisho and the Iho-Funanori (Western Art of Navigation) clearly show understanding of the limitations of western instruments.⁶⁰ The author of the Genna Kokaisho, writing in dialogue, puts into Ikeda's mouth a question of his Portuguese teacher, Captain Gonsalves. "Is there any method of obtaining the latitude when the sky is clouded for a short time just as the sun

⁵⁷ D.W.Waters, "The Navigation Instruments of the Batavia", 8me Colloque International de histoire maritime, pp.514-5.

⁵⁸ D.W.Waters, The Art of Navigation in Elizabethan & Early Stuart England, N.M.M., Greenwich, 1978, p.301.

⁵⁹ Koh-un Ikeda. Genna Kokaisho. Reproduced in edition by Saigusa Hiroto in Nihon Kagaku Koten Zusho (History of Science and Technology in Japan), Asahi Shinbunsha, Tokyo 1946. Vol.12, pp1-134

Also see the illustrations of the 32 point compass and the large quadrant and astrolabes reproduced from the Genna Kokaisho between pp.87 & 93 some of which are reproduced in the illustrations volume of this thesis.

⁶⁰ Torao Mozai, "Two Centuries of Nautical Instruments in Japan", Paper presented at the International Congress of Navigation held in Boston in August 1976. Reproduced in Journal of Navigation, Vol.30, No.2, May 1977, pp.306-10.

or star transits the meridian?" Captain Gonsalves replies "It is of course impossible, no one in the world can ever do it". Ikeda however anticipates the later ex-meridian method which with the aid of tables enabled the altitude of the sun or star on the meridian to be estimated.⁶¹

About 1622 the same Nagasaki seaman and professional diver completed the Funariori-Pirouto or (Navigator's Pilot). It was based on the Exames de Pilotos published in parts from 1608 to 1625 by the Portuguese cosmographer Major, Manuel de Figuerido.⁶² It included directions for far position finding at sea using the Pole Star, the Southern Cross, and the Great Bear and solar and lunar eclipses. Tables of declination are given for the years 1629-1688, and amongst the nautical terms and items described are star-charts, a world atlas, the Julian and Gregorian Calendars, the equinoctial, the tides and weather and the units of degrees, minutes and seconds. It contains a compass rose with 32 points transcribed from Portuguese into Kana script.⁶³ It further has a series of sailing directions from Nagasaki to various Southern Chinese ports carefully written in a mixture of Kana and Kanji but some terms are

⁶¹Ibid. p.306.

⁶²Manuel de Figuerido. Hidrographia, exames de pilotos Lisbon. 1609-1622.

See C.R.Boxer, The Christian Century in Japan, p.266
See chapter The Dissemination and Decline of
Iberian Navigational Skill (1580-1620) footnote 45.

⁶³See Illustrations Volume, II, Fig. 58.

transliterated in Katakana and few use Chinese characters phonetically.⁶⁴ As such it must rank as one of the most eloquent Asian tributes to the quality of the Portuguese roteiros, especially as it was compiled by a pilot who understood the technical significance of the interchange his own work encapsulated. There were further examples of interchanges but as later in the seventeenth century they were largely confined to cartographic improvements, so the production of Koh-un Ikeda's manuals can only be seen as a climax in the wider interchange of navigation technology between Europeans and Asians.⁶⁵

⁶⁴ The Bankoku Sozu (Map of the World), published in Nagasaki in 1645. This was drawn by a Nagasaki printer in 1645 and printed from five sets of wood blocks. Even after foreigners were banned (with the exception of the Dutch at Nagasaki) in 1638, this map was deemed convenient and useful. It employed the oval projection, a central meridian passing the coast of New Guinea, longitude and latitude graduations at 5° intervals, all adopted from the example of Fr. Ricci's world map of 1602. The vignettes of the couples in foreign dress clearly originate from Dutch practice.

See B.M. Maps 920-485.

⁶⁵ Arima Seiho. "The Western Influence on Japanese Military Science, Shipbuilding and Navigation," Monumenta Nipponica. Vol. 19 (1964), nos. 3-4, pp. 118-45. Masayoshi Sugimoto and David L. Swain, Science and Culture in Traditional Japan AD 600-1854, M.I.T. 1979, pp. 178-80.

Chapter 13CONCLUSIONS

Just before 1561, Francisco Guiccardini, who had never been outside Europe, wrote that the Portuguese navigational achievements were certainly marvellous for they were performed

"for a distance of 16,000 miles through seas which were all unknown, beneath other stars, under other skies and with other instruments, because on passing the equinoctial line [the Equator] they no longer steered by the North [Star] and, without it, they broke with the habit of using the compass [due to variation] and consequently they were able to reach other unknown lands with different languages, religions and customs quite savage and extremely hostile to strangers. However, notwithstanding the many difficulties, with time progress has been made and we are now so familiar with this navigation that whereas at first one was only able to perform the voyage [to India] in ten months, one can usually do it now with much less danger in six months. But still more marvellous was the navigation of the Spanish beginning in 1490 ..."¹

This judgement by such a discriminating contemporary, while reminiscent of Pedro Nunez's treatises is indicative of sixteenth century

¹ F. Guicciardini, La Historia d'Italia di M. Francesco Guicciardini Gentilhuomo Fiorentino. Divisa in venti libri Riscontrata con tutti gli altri storici, e Autori, che dell'istresse cose habbiano scritto, per Tomaso Porcaccini de Castiglione arretino, con un Guidicio fatto dal medesimo, per discoprir tutte le bellezze di questa Historia; e una Raccolta di tutte le sententie sparse per l'opera. E con due Tauole; una de gli Autori citati in margine, e l'altra delle cose notabili. Aggiuntoui la Vita dell'Autore scritta da M. Remigo Fiorentino. Pietro Maria Bertano, Venice 1616, p.173. [First edition Venice, 1561].

Europe's reaction to those technical advances towards proficiency in celestial navigation made by the Iberians. It was this proficiency which first permitted tolerably safe exploration of the world's oceans by Europeans, and created consequent opportunities for interchange of ideas and trade in goods. Carlo Cipolla in his significant work, Guns, Sails and Empires² argued that the European empires of the sixteenth and seventeenth centuries were based on the vast military superiority given over other peoples by the design and use of their ships and guns, a concept which included the deliberate development and use of naval cannon in amphibious actions. However, while we should not underestimate the great advantages of the carrack and galleon, we must note neither could have been deployed effectively outside European waters without the presence on board of men proficient in those techniques of celestial navigation developed by the Iberians, and supplemented so beautifully by the associated skills of their hydrographers.

The Portuguese established their initial lead in this technology⁴ by a conscious policy of gathering data of potential navigational significance from all over Europe, and gathering in Portugal, despite national frontiers, a coterie of the best scientific minds and mathematical scholars in Europe. Once this step had

²C.M.Cipolla. Guns, Sails and Empires. Minerva Press, New York, 1965.

been taken under the impetus given by Prince Henry the Navigator, D. João II of Portugal merely had the problem of encouraging the technical exploitation of contemporary theoretical knowledge by Portugal's aspiring navigators. The prospect of making exciting new discoveries by utilising such knowledge and mastering the use of the mariners astrolabe and quadrant in conjunction with declination tables, was a sufficient incentive. In Spain Ferdinand and Isabella soon came to similar conclusions while realising a formal training programme and an administrative structure like the Portuguese one was required. This explains the cédulas of August 6 1508 and March 22 1509 creating a school of navigation in Seville's Casa de Contratación.

Proud of their leading role in the discoveries of the 1490s and yet anxious to protect their discoveries, their technology and their trading opportunities in Asia, the Portuguese government soon realised they were in competition with Spanish patronage aimed at securing the services of that small group of skilled navigators, hydrographers and instrument makers who alone could make possible such voyages. Into this area of high stakes and research, scientific politics made its entrance with understandable, but ultimately retarding, notions of the need for commercial security.

The origins of ideas on commercial security may be found in the anxiety of medieval craftsmen not to set down full details of the methods they used. Concurrently, their trade guilds used their regulatory powers within the craft to protect the mystery and secrecy of their respective processes of production. Sometimes the purpose was to confine it within a town, but in other cases control was exercised nationally by a chartered company. Often these organisations brought substantial benefits to those within it and promoted advances in their craft. The hospitality they offered through international fraternities of craftsmen, e.g. the well known Feste du Pui, served to stop this organisational form from preventing the interchange of technical ideas. Indeed it is more than interesting that similar types of group can be seen emerging in the eleventh century in both western Europe and north-west Persia (Azerbaijan). As the Seljuk Turks advanced through Asia Minor, so they spread these institutions, just at the time when the Crusades began to entice some of Europe's craftsmen to the Holy Land. While at first these Turkish Futuvvet seemed religious, they soon became dominated by craftsmen and acted like guilds.³ Ibn Battuta certainly enjoyed their hospitality on his

³John Harvey. Medieval Craftsmen. Batsford. London 1975, pp.16-33.

journeys to China. It is likely that these organisations were important in the spread of some technologies from China and Eastern Asia, to Europe before Europeans made the direct sea passage. Taken together with growing trade between Arab merchants and Christians, such as was so important to the rise of Venice, there is reason to think they did much to foster an empathy between those involved in European shipmen's guilds and associated maritime trades. It may also have encouraged the atmosphere necessary for those maritime interchanges between sailors by which so much navigational information was, as we have seen, exchanged all along the Asian littoral in the sixteenth century.

Nevertheless to outsiders the Guild's type of commercial security seemed impressively free of leaks of information. A parallel could be drawn between the way Henry VIII sought in 1533 to prevent further English Pewterers from going abroad and teaching their trade secrets to foreigners,⁴ and the regulations imposed upon the Amazéns da Guiné, Mina e Indias in Lisbon. The difference was merely that whereas Henry VIII was prepared only to exile Pewterers and deprive them of craft status, Manuel I was prepared to declare the death penalty for anyone sending charts abroad from the Armazéns. We have noted

⁴Ibid. p.50.

how the Italians were conscious of this Portuguese outlook, and how successfully the Portuguese managed to maintain both a monopoly of the trading possibilities of their Asian discoveries until 1520, and such tight control of charts that very little of the Armazéns detailed material reached outsiders directly from the Armazéns before 1520. Indeed Portuguese security was quite successful until 1550, but thereafter the harsh regulations, bureaucratic restraints, and the lack of discrimination over which material to treat as highly secret, increasingly caused émigre Portuguese cartographers and navigators to sell their skills and knowledge to the emergent maritime powers of northern Europe in return for substantial payments.

The simple Portuguese system of issuing receipts for charts handed to outward bound pilots, and their attempts to correct standard charts provided evidence of a primitive system of records management in the Armazéns of Lisbon. This was the administrative basis of Portuguese attempts to impose commercial security. This system had the advantage of forcing the evaluation of data held at Lisbon into current, old but valuable, and misleading categories. [This last category comprised that which was destroyed, or published, or occasionally deliberately given to commercial rivals like the Dutch.] However, as part of this policy the Portuguese do not seem to

have marked their documents with security classifications, though all charts had to be signed and all navigational instruments made in Lisbon had to be stamped by the Cosmografo-mor before they could legally be sold. However it was neither this weakness, nor the economic pressure of demand for navigators in northern Europe, nor the problems of the Portuguese censors of printed material about Asia, but the simple fact that navigational knowledge is essentially international in character which was to prove critical. Until about 1550 the Portuguese could disguise this, perhaps even deceiving themselves about it, by the imposition of tight control on the hydrographical services centred in Lisbon so near the government. However it was an insoluble problem to control their mariners around the world, especially in Asian waters. Thus while international exchanges of such information were heavily restricted in Lisbon, they were operating freely, and greatly to the benefit and safety of Portuguese shipping in Asian waters. The Armazéns in Lisbon, well aware of the value of such exchanges, were keen to incorporate Asian information and ideas into their charts and the designs of navigational instruments, so much so that during the later sixteenth century the Portuguese became arguably too dependent on Asian sources. Not only were Gujuratis

employed as under-pilots on voyages from Goa to Nagasaki, Luso-Indians such as Vaz Dourado were brought briefly to Europe to compile atlases. The manuscript atlas in the British Library, "Universalis et integra totius orbis hidrographia ad verissimam Luzitanorum traditionem descripta Fernando Va",⁵ finished in 1575, is a product of this trend. Meanwhile something akin to a navigational school in the wider sense of the term emerged in Goa. Accolades to its products were provided in 1600 by João Ramos who wrote in the journal of the ship 'Conciecao', that he pricked a chart for the voyage from Cochin to Portugal both on the chart of the Armazém, and on a "carta da India". Similarly Gaspar Reimão, in two journals for the 'S. Panteleao', outward bound to India in 1595 and back in the 'Santa Maria do Castelo' in 1597, says he used Bartholomeu Lasso's charts alongside those of "the Armazém".⁶

It was, however, in Goa that the most significant breach of Portuguese commercial security took place, for it was there that Jan Huighen^{van}/Linschoten gathered from Portuguese pilots the rutters and charts which he was subsequently to publish in Amsterdam in 1596.

⁵British Library. Additional MSS. 31317.

⁶P.M.C. Vol.III, p.88 cites Quirino de Fonseca, Diaros da Navegação da Carreira da India nos annos de 1595, 1596, 1597, 1600, e 1603, pp.134-8.

A number of Portuguese or Luso-Asian cartographers practised in Malacca from the early days of Francisco Rodrigues to Manuel Godinho d'Erédia in the second decade of the seventeenth century. Not only was their local knowledge excellent, the knowledge which Erédia, like Vaz Dourado, displayed of the areas as far away as the Magellan Straits show that their sources of information were every bit as good as those available in Lisbon before 1620. It was this which rendered the help given Cornelius de Houtman by Pedro d'Ataide in 1596 so significant, though fatal.

That such outstanding examples of the interchange of navigational information should be the products of Luso-Asians was a result of a traditional understanding of the navigational problems of Asian waters, which was in its own turn a reflection of the much longer Asian traditions of celestial navigation and the free interchange of navigational information there.

Manuals of celestial navigation appeared in China from the time of the Han dynasty onwards. By the 7th century Chinese sailors, using the directions of earlier sailors, celestial observations, monsoon patterns, lead and line soundings and timekeepers based on slow burning incense, were making safe voyages to India and China where they encountered other traditions of oceanic navigation. Under the Sung rulers, the twenty-

four point compass, coastal charts, and tide tables were developed for seaborne use. All these aids were deployed with striking effect during Admiral Cheng Ho's voyages between 1404 and 1433, and helped his fleet to reach India, Persia, East Africa and in all likelihood (fatally) to round westwards the Cape of Good Hope in 1433. Though some contemporary accounts of his voyages survive, subsequent edicts of China's Ming rulers made such voyaging illegal, and led to declining interest in navigational aids until the mid-16th century.

The Japanese, like the Koreans, had established maritime traditions and navigational technology by the 16th century. Evidently Chinese and Japanese literature owed much to Chinese ways of navigating, and to those pirates who posed a serious threat to the area's shipping because their knowledge of the China Sea havens was so much better than official Chinese knowledge. Realisation of this disparity led Admiral Hu-Tsung-hsien, charged with eradicating this piracy, to order production of the 'Ch'ou-hai t'u pien' in 1562. The staff he asked to do this were the vanguard of China's reviving interest in navigational aids.

After 1513 the Portuguese participated in illegal trade and piracy in the China Sea, and learnt how to handle local junks, and hybrids like the 'Lorcha'. Concurrently they began to acquire detailed navigational knowledge of those waters

through this experience, and through interchanges in ports like Malacca where Francisco Rodrigues prepared a rutter for the voyage from Malacca to Canton by copying a Chinese one. Possession of such aids, plus knowledge of celestial navigation learnt on the Atlantic, and their awareness of Cheng Ho's voyages, made the Portuguese discriminating recipients of Chinese navigational information. Through diplomatic presents such as the Ming Atlas presented to Philip II in 1574, and the private libraries of men like João de Barros and Fr. Martin de Rada, Chinese books devoting special attention to navigation were translated and interpreted. Later northern European shipmasters acquired Portuguese digests of such Chinese information.

Such interchanges sparked new interest in China and in world maps by Matteo Ricci (1584-1603) who used both Chinese and European sources. The 15th century manual Shun feng Hsiang-sung was recopied in the late 16th century and the cartograms of the Wu Pei Chih were reexamined, and a preface added in 1621 prior to presentation to the Chinese Emperor in 1628.

Japanese interchanges with Europeans are also well recorded, partly because Jesuits skilled in navigation, left written accounts, and partly because the Japanese *Shoguns*, Hideyoshi and

Ieyasu were impressed with the skill of European navigators. Indeed Hideyoshi obliged all his crack Red Seal ships to carry Portuguese pilots, whilst Ieyasu after 1600 relied heavily on the English Pilot William Adams for advice. In Japan about 1620 a local Nagasaki pilot Koh-un Ikeda produced three navigation manuals, all distinguished by Iberian influence.

Although of much less significance by the mid-sixteenth century, interchanges with the Arabs had earlier been vastly significant to the development of celestial navigation. Some of the most significant ideas to reach Europe before 1520 came via the vast cultural seminar over which the Arabs presided. Later the significance of Ibn Majid's contributions cannot be overlooked, but after 1600, despite the efforts of Piri Reis and Sidi Celebi, the Arabs seem to have extracted much less of navigational value than other Asian powers from contact with the Portuguese. This is in part explained by their almost constant war against the Iberian powers whether in Asian waters early in the sixteenth century, or in the Mediterranean later. The kind of naval operations mounted from their Barbary Coast bases did not require the skills of the oceanic mariner, so their adulation was lavished on men like Dragut.

However, from an early date it is clear the Spaniards were gleaning much from Arab

mathematicians and astronomers, so that the state of navigational knowledge in Spain by 1490 owed much to them, possibly even the notion of an American continent if a Chinese source is correct. This enabled Castile, if not Aragon, to follow Portugal's fifteenth century advances, so that a clearly identifiable group of navigators (though in numbers fewer than in Portugal) was available to spearhead Castile's overseas voyages of discovery. Lagging slightly behind Portugal technically in the early sixteenth century, Castile was to begin the use of subterfuge, diplomatic channels and the prospect of rich rewards to entice Portuguese, Genoese and Englishmen with any special navigational competence into her service. This developed into a dangerous, often high-level international contest between European states. During Henry VIII's reign English involvement was confined to a few matters concerning Portuguese and French material and the patronage of Lisle, but with the return of Sebastian Cabot, formerly Charles V's Pilot-Major, England became deeply involved. Neither Edward VI nor Mary returned Cabot to Spain as requested, but in 1557 Robert Recorde in the preface of his Castle of Knowledge was persuading Mary to actively patronise astronomical knowledge because of the benefits it would offer to navigation. At the same time arrangements were

made for Stephen Borough to visit the navigation school of the Casa de Contratacion in Seville. That he did so as an honoured guest early in 1558 was a result of Mary's Spanish marriage. This would bear its most significant fruit in Elizabeth's reign when Richard Eden translated Martin Cortes's navigation manual into English. A most significant translation for the course of subsequent English navigational and maritime history, it gave Englishmen easy access both to simple celestial theory, the making and use of such instruments as the astrolabe, quadrant, cross-staff, and a detailed account of how to make nautical charts. It achieved vast sales and was important to the success of many of England's subsequent oceanic ventures. Like its twin, Pedro de Medina's Arte de Navegar, translated into French and Italian in 1554, English in 1578 and Dutch in 1580, its use would permit the emergent maritime powers of north-western Europe to look across the Atlantic and as far as the East Indies and China, to markets they could now safely aspire to reach. So soon as they reached the Indian Ocean or the Pacific they became parties to that much freer and enormously significant interchange of Asian navigational information from which the Spaniards were beginning to draw after they had mastered the east-west crossing of the Pacific in 1565.

While the value of navigational information to be gathered in Asian waters was not so immediately striking as the trading opportunities, it was as Linschoten and Purchas stressed, "the critical path". As the Dutch and English East India Companies realised this, they developed more sophisticated versions of the Portuguese and Spanish hydrographical services, which were to be characterised by attempts at imposing commercial security. The English were not so adept at this administratively as the Dutch who learned from Portuguese mistakes and weaknesses. Thus the V.O.C. attempted to control the circulation of their charts in the East by establishing a specialised cartographic office at first situated in Bantam and then in Batavia, where the majority of Dutch ships called.

Other sides of this great new Asian perspective became important in the late sixteenth and early seventeenth century. After the Union of Crowns in 1580, both the Portuguese and Spanish Empires became more *exposed* than ever before to activities of Protestant corsairs, privateers, and armed merchant ventures. It was now seen, as some Portuguese had long before foreseen, that much of their security in these empires had depended on their having, as far as European rivals were concerned, exclusive access

to the requisite navigational data. The dissemination of their navigational manuals, pilots and hydrographers around Europe after 1550 was soon to deprive them of this security, and open a direct naval threat. To counter this, because they could not build enough suitably equipped galleons, the Iberians had to rely on raising their safety standards and getting what ships they could to the East Indian theatre. Thus the standard of Portuguese and Spanish cartography remained high, but they had to try and disguise or close down their Asian sources, for these were now a clear security risk. In similar vein Philip III's Councils felt they could not afford to increase potential naval problems by financing voyages of discovery. Consequently their cartographic products failed to continue their improvement, and show signs of decadence. Enthusiasts for navigation like Quirós and Erédia are discouraged, and the research effort was devoted instead to the improving of existing charts with Iberian data. It sees the first Portuguese isogonic charts for the Indian Ocean, and particularly in Spain under Lavanha's impetus, the devotion of a considerable research effort to mathematical and instrumental ways to solve the one great gap in navigational know-how, the seaborne determination of longitude on a daily basis. In these efforts Spain was definitely in the scientific mainstream

of European science, just as her training methods for navigators had earlier been an enervating development. It is only to be regretted that Philip III's government took so little heed of Cespedes's advice that the solution of the longitude problem was impossible with existing knowledge, but that much was to be gained by a more thorough and stimulating training of pilots who were still doing traditional courses.

The Asian perspective also throws into focus some illicit circumvention of such guild-type restrictions as existed into the seventeenth century. Koh-un Ikeda's Genna Kokaisho, written from the teachings of a Spanish navigator, shows an uncalibrated astrolabe, identical to a similar uncalibrated astrolabe found in Ireland in 1845, but clearly of late sixteenth century date.⁷ These exemplars, one in the Japanese manual/^{by} Koh-un Ikeda, the other from part of Ireland where Spanish contacts continued until 1601, suggest that amongst the many ways customs and export controls were evaded in Seville was one which consisted in the export of uncalibrated navigational instruments. These, because of their lack of calibration, did not need to be examined by officials of the Spanish Casa, and thus found their way to such markets. Just as the Asian perspective shows how inappropriate commercial

⁷See Illustrations Volume.

security had become by 1600 within Portugal's hydrographic agencies, so pressure for greater safety in the Indian fleets led by 1608-11 to the printing of rutters, though only after Reimão's rutter had been considered in the Council of the Indies itself. This simple step to avoid copyists' errors was, however, taken with reluctance, and long after, as Luis Teixeira's chart at the National Maritime Museum shows,⁸ the Portuguese had started to copy printed Dutch charts of European waters like Spiegel der Zeevaerdt.

So just as the Asian perspective for the years 1500 to 1620 shows up so many of the underlying forces in the development of navigational and commercial interchanges, making possible the emergent world economy into the form we know today, so the first emergence of many of the modern attitudes towards navigational skill may be detected, like the use of latitude measurements. By considering it against its European background between 1500 and 1620, we can see why it was only then, rather than in the wake of Marco Polo's visit, that Europe's economy and science became fully linked with Asia's, for until 1500 Europe's seamen did not have the technology to get them into the Indian Ocean where they could have learned so much from the Chinese and the Arabs.

⁸N.M.M. MS. 39-9943C/P29. Luis Teixeira "Mar Antr & Dobra & Calais".

In this study of the history of navigation between 1500 and 1620 we must recognise the importance of unacknowledged contributions by the Asians, and the many technological spin-offs of interchanges of navigational information in Europe and Asia. Some of these patterns have since 1620 become obscure because they ceased to throw up useful information, or because, like the practitioners of Goa and Nagasaki, their numbers were few. Nevertheless they played an important part in the fate of the Portuguese seaborne empire. The Spanish overseas empire, still reliant on its maritime communications, but from the outset less reliant on commercial security in navigational matters and more on naval protection, survived. Spain kept running longer in that technological race in navigational aids which did so much to stimulate scientific outlooks in Europe. Nevertheless, learning by the mistakes of the Iberians, the technological lead in navigation had passed to the English and Dutch by 1620.

Thus, while the course of navigational interchanges before 1620 reveals a pattern of mutual technical benefits extending from Europe to the Far East, it also reveals how formative was the technology of navigation in determining some of the major political and economic events of the period from 1500 to 1620.

APPENDIX I

Documents illustrating the growth of English training in celestial navigation and oceanic navigation according to Spanish precedents:

Enrolled in

The Great Orphan Book and Book of Wills (No.1)
[Bristol City Record Office 04421(1)]

there are the wills of Robert Thorne, a great English enthusiast for Iberian methods of navigation, his brother Nicholas Thorne's will and a deed poll of the latter's son, Nicholas Thorne. Robert Thorne's will dated 17th May 1532 appoints executors for £1,000 "to be distributed and ordered as my executors shall deem best for my soul" (f.21) and is often taken to be the initial step in the foundation of Bristol Grammar School. However, the will of Nicholas Thorne (f.276) makes specific bequests "to the house of the Bartilmewe in bristowe aforesaide, towards the mayntenncce of the said schole ..." to the value of 200 ducats and £36 13s. 4d. for "garnishing altars, vestments and glassyng and reformyng of windows of ye schole chapel". It further states:-

"I bequethe to the house of Bartholmeo in bristowe aforesaid towards the mayntenance of the fore schole and to make a library in suche place as Sir John Barlow late deane of the dissolved house and colledge of Westbury on Trym, John Drewes and Francis Codrington of bristowe aforesaid merchauntes shall thynk moste best or meetest within

the house of the said Bartilmewe thirtie poundes sterling and more I give and bequeste all such bookes as I have meate for the said library, more my astrolabia which is in the keeping of John Sprynte poticary numbers of cartes etc. mapes and all such instrumente as in my house belonging to the scienn^c. [science] of astronomye or cosmogroie [cosmography]..."

The provenance of the astrolabe as Spanish is strongly suggested by the reference on the second page of the will (f.272) to Nicholas Thorne "my bastarde sonne now being in Biscaye". Further evidence about the relationships of these members of the Thorne family is given in the deed poll which begins

"To all whom it concerns Nicholas Thorne of the City of Bristol, merchant, brother and heir of Robert Thorne, late of the City of Bristol, deceased, son and heir of Nicholas Thorne, late alderman of the same city, deceased, brother and heir of Robert Thorne, late of London, merchant, deceased, sends greeting".

The fate of this library and the instruments was investigated by C.P.Hill, who wrote:-

"It is one of the minor disasters of the school's history that this collection of geographical material was allowed to disappear. Much of it existed as late as 1687, but all has gone since, and it is said that the astrolabe and other instruments were sold to porter for a few shillings".¹

A circular letter issued by Queen Mary on 26th July 1557 called upon the gentry to act as naval Captains. Later examples of that training in cosmography which fitted young gentlemen

¹ C.P.Hill, The History of Bristol Grammar School, Pitman. London 1951, p.14.

G.Connell-Smith, English Merchants trading to the New World in the early 16th century, Bulletin of the Institute of Historical Research, Vol.XXIII, 1950, pp.53-65

for careers at sea, emerge as it becomes clear that such education was necessary to understand celestial navigation as practised by the Iberians. About 1562, William Cecil, who had employed Richard Eden as his private secretary in 1552, specified the education of his ward De Vere was to include "From one untill two, Cosmographie".² Sir Thomas Cotton by the terms of his will proved at the Prerogative Court of Canterbury in 1585, gave his grandson "my scale of arms, my books, maps and cosmography and marine causes ... at Oxenhoth".³

Concurrently Richard Hakluyt was lobbying such influential people as Francis Walsingham and Sir Philip Sydney for establishment of formal training on Iberian lines. An extract of his 'Epistle Dedicatorie' to the latter survives in Richard Hakluyt's 'Divers Voyages touching the discouerie of America and the Ilands adjacent', London, 1582. It was transcribed by D.W.Waters

²Time table for De Vere. Durham University Paleography Dept. Photograph of Public Record Office. State Papers Domestic Elizabeth. Vol.26,no.50.

³J.H.Gleason, The Justices of the Peace in England. Oxford University Press. London 1969, p.21.

thus:-

"Whiche thing, that our nation may more speedily and happily performe, there is no better meane, in my simple iudgement, then the increase of knowledge in the arte of nauigation and breading of skilfulnesse in the sea men: whiche Charles the Emperour, and the king of Spaine that nowe is, wisely considering, haue in their Contractation house in Siuill, appointed a learned reader of the sayde art of Nauigation, and ioyned with him certayne examiners, and haue distinguished the orders among the sea men, as the groomes, which is the basest degree, the marriner, which is the seconde, the master the thirde, and the pilot the fourth, vnto the which two last degrees none is admitted without hee haue heard the reader for a certaine space (which is commonly an excellent Mathematician, of which number were Pedro di Medina, which writte learnedly of the art of nauigation, and Alonso di Chauez and Hieronimus de Chauez, whose works likewise I have seene), and being founde fitte by him and his assistantes, which are to examine matters touching experience, they are admitted with as great solemnitie and giuing of presents to the ancient masters and Pilots, and the reader and examiners, as the great doctors in the Vniuersities, or our great Sergeantes at the law when they proceed, and so are admitted to take charge for the Indies. And that your worshippe may knowe that this is true, Master Steven Borrows, nowe one of the foure masters of the Queene's nauie, told me that, newly after his returne from the discouery of Moscouie by the North in Queene Maries daies, the Spaniards hauing intelligence that he was master in that discouerie, tooke him into their contractation house at their making and admitting of masters and pilots, giuing him great honour, and presented him with a payre of perfumed gloues, woorth fiue or six Ducates. I speake all this to this ende, that the like order of erecting such a Lecture here in London, or about Ratcliffe, in some conuenient place, were a matter of great consequence and importance for the sauing of many mens liues and goods, which nowe, through grosse ignorance, are dayly in great hazerd, to the no small detriment of the whole realme. For whiche cause I haue dealt with the right worshipfull sir Frances Drake, that seeing God hath

blessed him so wonderfully, he woulde do this honour to him selfe and benefite to his countrey, to bee at the cost to erect such a lecture: Whereunto, in most bountifull maner, at the verie first, he answered, that he liked so well of the motion, that he would giue twentie poundes by the yeere standing, and twentie poundes more before hand to a learned man, to furnish him with instruments and maps, that woulde take this thing vpon him: yea so readie he was, that he earnestly requested mee to helpe him to the notice of a fitte man for that purpose, which I, for the zeale I bare to this good action, did presently, and brought him one, who came vnto him and conferred with him thereupon: but in fine he would not vndertake the lecture vnless he might haue fourtie pounce a yeere standing, and so the matter ceased for that time: howbeit, the worthie and good Knight remaineth still constant, and will be, as he told me very lately, as good as his worde. Nowe, if God shoulde put into the head of any noble man to contribute other twentie pounce to make this lecture a competent liuing for a learned man, the whole realme no doubt might reape no small benefite thereby."⁴

Richard Hakluyt continued to press that Spanish precedents be followed, and his preface to the third and last volume of the second edition of Principal Navigations, 1600 he petitioned Sir Robert Cecil to ensure notice was taken of the methods of the navigation school in Seville, adding an appendix to his work entitled:-

'The examination of the Masters and Pilots which saile in the Fleetes of Spaine to the West Indies. Written in the Spanish tongue by Pedro Dias a Spanish Pilot taken by Sir Richard Grinuile 1585.

'First they make suit unto the Pilot maior (who at this present is called Alonso de Chiauez) that he would admit them to examination, because they are naturall Spaniards, and sufficient for the same.

'Hereupon the Pilot maior commandeth the party to be examined, to giue information

⁴D.W.Waters, The Art of Navigation in England in Elizabethan and Early Stuart Times, N.M.M. 1978, p.542

that he is a mariner, and well practised in those parts about which hee desireth to be examined. And then immediately he bringeth fiue or sixe pilots before examined to giue testimonie that he is a good mariner, and sufficient to become a pilot, that he is a Spaniard borne, and that he is not of the race of the Moores, Jewes or Negros.

¶ Having made this information, hee presenteth it vnto the Pilot maior. And the Pilot maior seeing the information to be good, willethe the kings publique reader of nauigation (who is now Roderigo Zamorano) to admit him to his lectures. Whither there doe resort fourteene or fifteene persons that desire to be examined: and they come to a certaine house which the kings reader hath appointed vnto him for the same purpose, at eight of the clocke in the morning: and then they stay two houres, and two houres likewise in the afternoone: in one of which houres Zamorano readeth vnto them, and in the other they aske one another many particulars concerning the art of nauigation in the presence of the said kings reader: and him that answereth not to the purpose the sayd reader instructeth more perfectly, and telleth him how euery thing is. And this exercise continueth two months, during which time the examinees must not faile to bee present twise in a day, as is aforesaid.

¶ And having heard the kings reader those two moneths, they resort then vnto The hall of examination which is in the Contractation house, where there are assembled the Pilot maior and divers other pilots, to the number of 25 at the least; who all sitting there in order, the Pilot maior demandeth of him that would be examined, of what part of the Indies he desireth to be examined: Thereto the examinee answereth, that he would bee examined concerning Nueva Espanna, or of Nombra de Dios and Tierre Firma. And others that are not experienced in those partes, crave to be examined of Santo Domingo, Puerto rico, and Cuba.

¶ Then the Pilot maior commandeth the examinee to spread a sea-chart vpon the table and in the presence of the other pilots to depart or shewe the course from the barre of Sant Lucar to the Canarie-Islands, and from thence to the Indies,

till he come to that place whereof he is to bee examined, and then also to returne backe to the barre of Sant Lucar in Spaine, from whence he departed. Also the Pilot maior asketh him, if when he saileth upon the sea, hee be taken with a contrary wind, what remedie he is to vse, that his ship be not too much turmoiled upon the sea? And the examine answereth him aswell as he can.

'Then one of the other pilotes opposeth him about the rules of the Sunne and of the North starre, and how hee ought to use the declination of the Sunne at all times of the yeere: when the examine is bound to answer in euery thing that hee demandeth. Then another asketh him of the signes and markes of those lands which lye in his way to that hauen whereof he is examined. And then another demandeth, that if his mastes should be broken by tempest, what remedy hee would use? Others aske him, if his ship should take a leake, to the hazarding of the lives of himselfe and his company, what remedy he would find to stop the same with least danger? Others aske him, what remedy, if his rudder should chance to faile? Others oppose him about the account of the Moone and of the tides? Others aske him if a Pirate should take him and leave him destitute of his Chart, his Astrolabe, and his other instruments serving to take the height of the Sunne and of the starre, what course hee would take in that extremitie? Others demand other questions needfull for a mariner to know, which desireth to be a pilot. Unto all which the examine is very attentive, and answereth to euery particular.

'After they haue all asked him so much as they think expedient, they bid him depart out of the hall, to the ende that every one of them may seuerally bee sworne upon a booke, that they will speake the trueth. Then they put into a certaine vessell of siluer standing there for the same purpose so many beanes, and so many peason as there are pilots within the hall: and euery one putting his hand into the vessell in order, he that thinketh the partie examined to be sufficient, taketh up a beane, and he that thinketh him not sufficient, taketh up a pease. After all that all have taken out what they please, the Pilot maior looketh what voyces the

examine hath: and if he finde him to have as many voyces for him as against him, he commandeth him to make another voyage: but if he hath more voyces for him then against him, then they giue him letters testimoniall of his examination signed by the Pilot maior, by the kings reader, and the secretary, and sealed with the seale of the Contractation house. And vpon the receipt of these letters testimoniall, the new pilot giueth a present unto the Pilot maior, and the kings reader, for their gloues and hennies, euery one according to his abilitie, which is ordinarily some two or three ducats.

'And then he may take vpon him to be pilot in any ship whatsoever, vnto that place for which he was examined: and if he finde in the Indies any ship vnder the charge of a pilot not before examined, hee may put him out of his office, and may himself take charge of that ship for the same wages that the other pilot agreed for.

'The pilots wages for making a voyage outward and homeward is according to the burthen of the ship. If she be of 100 tunnes, hee hath 200 or 250 ducats: and if shee bee of 400 or 500 tunnes, he taketh for his wages 500 or 550 ducates: and if she be bigger, he hath a greater allowance: ouer and besides all which, he hath every day while he remaineth on land, foure reals for his diet. And the greater shippes are alwayes committed vnto the more ancient pilots, because they are of greater experience and better skill, then the yonger sort which newly take vpon them to be pilots.

'The pilot vndertaketh no farther travell nor care, but in directing the course or nauigation: for the masters of the ships take charge of the freighting and preparing their ships, and to pay the mariners, and to doe all things needefull for the ship; for the pilot commeth not vnto the shippe, untill the visitours come to visite the same, to see whether hee hath all things necessary for the voyage.

'The visitours are foure men which are appoynted by the king, and these are men of great vnderstanding: and they come to visite the shippes before they take in their lading, to see whether they be well prepared to make the voyage. And after the ships bee laden, they returne

again to visite them the second time, to see whether they haue all things necessary, according to the orders of the Contractation house: and whether they haue all their mariners, victuals, pouder, shot, and ordinance, and all other things necessary for the voyage. And if they want any thing, they charge them upon grieuous penalties, to provide the same before they set out of the hauen.

⁴The ships that goe to the Indies are wont eche of them to haue with them a Notarie, whose charge is to keepe a note of remembrance of all the marchandise which is laden in the ship, and to take the marks thereof, thereby to deliver the commodities in the ship to their particular owners, after they haue finished their voyage, and he serueth likewise to make willes, and other instruments, which are wont to be made by a Notarie, if any man chanceth to fall sicke. And his wages in eche voyage is as much as the wages of two mariners.

⁵The Generall of the fleetes vseth continually, after hee is arrived in the Indies, to send unto Spaine a barke of Auiso, to aduertise the king of the state of his arriual; And after the fleetes be ready to come home, he dispatcheth another pinnesse of Auiso to certifie them how the fleetes are now ready to set saile, with other particularities. There go with the fleetes two great ships, the one as Admirall, the other as Viceadmirall, of the burthen of 400 or 500 tunnes, which carry nothing but victuals and souldiers for the wafting of the rest of the fleete, and these are payd out of the marchandise which come in the fleete, after the rate of one in the hundred, and sometime at one and an halfe in the hundred ...

⁶Furthermore, that no Master nor Pilot may carry any Chart, nor Astrolabe, nor Cross-staffe, nor regiment, without they bee signed and sealed by the Pilot Maior Alonço de Chieues, and the Cosmographer the kings reader Rodrigo Zamorano ...

Written by me Pedro Dias borne in the Isle of Palma one of the Canaries, vpon the request and gratification of M. Richard Hakluyt, in February 1586.⁵

⁵R. Hakluyt. Principal Navigations, Vol. III, pp. 866-68.

APPENDIX 2

The Third Part, Arte of Navigation by Martin Cortes, 1561 edition, as translated by Richard Eden

"The Third Part, entreating of the composition and use of instruments and rules for the Art of Navigation."

"Chapter II of the composition of Cardes for the Sea. ...[f. lvi et seq.]

... For the draught, or making where of it shall be requisite to know two|things; whereof one is the right position of the places, or placing of the countreis and coastes, the other is the distances that is from one place to another. And also the Cardes shal have two descriptions. The one that answereth to the position, shall be the wyndes, whiche the mariners call lynes or poyntes of the compasse. The other that aunswereth to the distaunces shalbe the drawing and pointing of the coastes of the land, and of lands encompassed with sea. To paint the wyndes or lynes you must take the skynnes of parchment or large paper, of such bignes, as you will have the Carde to be. And in it draw two ryght lines with black inke, whiche, in the myddest shall cut or at divide themselves in right angles: The one accordyng to the length of the Carde, which shall be East and West, and the other North and South. Upon

the poynt where they cut make a center: and upon it, give a privie or hydde circle, which may occupie in maner the whole Carde. This circle, some make with leade that it may easily be put out. These two lines, divide the circle into foure equal partes. And every part of these you shall devide in the middle with a pricke or puncte. Then from one punct to another draw a right Diametrall line with blacke inke, and so shall the circle remain devided with foure lines into eight equall partes, which correspond to the eight wyndes. In like maner shall you devide every of ye eight into equall partes, and every part of these is called a halfe wynde. Then drawe from every point to his opposite diametrally, a right line of greene or azure. Likewise shall you devide every halfe wynde in the Circle into two equall partes. And from these punctes which devide the quarters you shall drawe certaine right lynes with reed inke, which shall also passe by the center, which they call the mother compasse or chief compasse of the Carde, being in the myddest thereof. And so shall come furth from the center to the circumference, 32 lines which signifie the 32 wyndes. Besyde these sayd lines, you shal make other equal distant to them, and of the selfe same colours, in this maner. From the pointes of the windes, and halfe windes, that passe by the center, draw certain right lines that pass not by the

center, but be equallye devided to those that passe by the center and of the same colours and equidistance as are they that passe by the center. And as these lines concurre together as well in the center, as in the poynts of the windes and halfe windes that are in the circumference of the circle, they shall leave, or make there other 16 compasses, every one with his 32 wyndes. And yf ye Carde be very great, because the lines may not go farre in sunder if you will make their other 16 compasses, you must make them between one and the other of the first 16 poynts, where the quarters are made with theyr wyndes as we have sayd. It is the custome for the most parte, to paynt upon the center of these compasses now a flowre or rose, with dyvers colours and golde, differencyng the lines, and markyng them with letters and other markes: especiallye sygnyng the North, with a floure deluce and the East with a crosse. This besyde the distinction of the wyndes, serveth also for the garnyshyng of the Carde. And this for the moste parte is done after that the coast is drawen and thus much suffiseth for the draught of the wyndes.

The situation of the places, Ports and Ilands in the Carde, according to their proper differences, consisteth in the particular and true relation of such as have travayled them. And therefore for this purpose it shalbe nedeful to have paternes of the coastes, portes and Ilands, which must be paynted on the Carde: And these of the best and most approved to be true. And not

only to have paterneſ well paynted, but alſo it ſhall be neceſſarye to knowe the true altitudes of the Pole, of certen principall capes, ports and famous cities. This done, they muſt be translated into certain thinne papers and transparent, that they may be ſeene through: and thoſe of the beſt and fineſt that may be had, annoyntyng them with oyle of lineſeede, and then drying them at the ſunne. Then take the paterne of the Carde that is to be translated: And take or ſtretch it forth upon a table. Then put the transparent paper upon the one ſide of the paterne where you will begyn. And the paper being made faſt upon the paterne with plommets of leade, or a little Wax, that may be eaſily taken off, you ſhall in the transparent paper marke with a fine penne one Eaſt and Weſt, and one North and South, or two, upon thoſe that are ſeene by the ſelfe ſame paper in the paterne. And this is called tracyng or translatyng. In like manner you ſhall trace all the Coaſtes, Havens, Ports, Lands, Cities, Capes and Ryvers, as appeareth in the paterne, unto the Rockes that come forth out of the Water, and the known Bankes. And becauſe this Paper doth not ſuffice, you ſhall put thereto another, and more as neede ſhall requyre. And begyn translation in one where the other endeth, untill you have translated all that you deſyre: Not forgetting to make in every one, Lines of North and South, Eaſt and Weſt, to ſerve for markes afterward. So that the line of North and South of the one paper may

joine close and even with the line of North and South of the other paper, that it is joyned by longitude.

And the paterne thus translated into these papers, you must putte the ruled or lyned paper or papers upon a playne, smooth and stedfast table, where you shal stretche them foorth, and make them fast with plomets or waightes, or nayle them to the Table by sydes and corners with small nayles. Then upon the said ruled paper, you shall put the paper that is translated from the paterne in that side or part that is correspondent from the paterne to the ruled Carde, so that the Lines of East and West, North and South of the translation, may be upon the Lines that aunswere to them in the ruled Carde.

This paper thus made faste by the one syde or parte, you shall by the other syde (that it may remayn in this place) put under it another fine paper, smoked or smyred on the nethermost parte (which is that that falleth upon the ruled Carde), either with a linke or with matches of pitch. These thus ordered and made faste one upon another, you shall make a stiele bodkin, or wyre with a smooth and blunt point, that it rase not or bore not the paper and with it you shall draw, pressing upon all the translation, and tracyng it with diligence and discretion, marking ever how much of it is translated from the paterne: saving wyndes or lines which the mariners call Rumbos, and so shall remayne all the impression of the smoke in

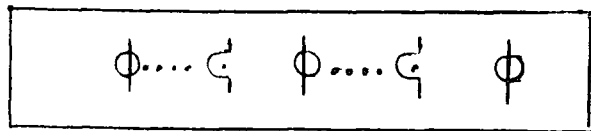
shall trace with inke; which beyng dry, you shall with crumbes of breade, make cleane from all the smoke, and so shall the coast appeare in the carde drawen with inke.

This done, then with a small penne shall you describe in the Carde, all the places and names of the coast in that part where they are, and as they are seene in the paterne. And fyrst, you must describe in red, the Ports, principall Capes, famous Cities, with other notable things, and the residue in blacke. Then shall you draw or paint Cities, Shippes, Banners and Beastes, and also mark the regions and other notable things. Then with colours and gold shall you garnishe and beautifie the Cities, Compasses, Shippes and other parts of the land. Then shall you set forth the coastes with greene, by the shore or bankes of the landes, and make them fayre to sight with a little saffron, or otherwise, as shall seme best. Likewise shall you describe certen letters with their significations in this manner.

B for a Bay, C for a Cape, A for an Angle
I or Y for an Iland, M for a Mountayne, P for a Port, R for Ryver.

Then in place where there is roome, or that is last occupied, you shall draw two ryght lynes equallye distant: and the one no further from the other than halfe a fynger, a little more, and so long, that between theym may bee marked

at the leaste three hundred leagues. And this the Mariners call the Trunke or Scale of Leagues, and place or use it in this maner. They take with the compasse a hundred leagues of the trunke of the lande or paterne that is translated. And they set them just betwene the two lines, and this space they part by the half, and rest in 50. And these devided by the half, they rest in 25. And the 25 being devided they rest in 12 leagues and a halfe. And marke them as appeareth in the demonstration followyng.



The Carde beyng thus made, then to graduate it or devide it into degrees, you must drawe three Lines which make right angles with the Lines of the East and West, equidistaunte to the line of North and South; and they also shall be North and South. These shall be drawn by the land of Azores or Soria, or nearer to Spaine or where the carde shall be less occupied. And for this purpose, the one line must be so farre distant from the other, that in the two spaces which they make, may marked, in the one the degrees, and in the other, the number of them, formable to the graduation of this paterne: as the numbers of degrees shewe East and West, with the ports, capes and coasts in their proper altitudes. And yf the carde have no graduation,

you shall take in the compasse of the truncke of the leagues, seven spaces of 12 leagues and a half, which are 87 leagues and a halfe. And these muste be devided into five partes, which come foorth at 17 leagues and a half for a part. And the foure partes taken in the compasse, make foure degrees; and devided into foure partes, every part is a degree, and is marked thus 

And if you wyll make the degrees at 16 leagues two terces or more: you shall geve to every degree so much space as the leagues comprehend. This graduation must begin from some one cape, whose altitude of the Pole is wel knowen. And the whole Carde beyng thus graduate, you must begynne, the number of the degrees from the Equinoctiall line, one, two, three, etc. toward the one pole, and the lyke toward the other; so that to the knowen Cape maye aunswere the number of his altitude. And so shall you do to the whole Carde. Also the equinoctiall line shall be marked in his proper place. And in lyke maner shal you marke the Tropykes accordyng as they are in the sphere. But forasmuch as in Spayne, Cape Sant Vincent is the principall; they begynne there to make graduations, and number it in 37 degrees.

APPENDIX 3

"A SEA GRAMMAR" With the Plaine Exposition of
Smiths Accidence for Young Sea-Men, Enlarged."

Written by Captaine John Smith, sometimes gouvernour
of Virginia and Admirall of New-England. (London
1627)

"Chapter XV

How they divide their shares in a man of Warre;
what Bookes and Instruments are fit for a Sea-man;
with divers advertisements for Sea men, and the
use of the petty Tally.

... For to learne to observe the Altitude, Latitude,
Longtitude, Amplitude, the variation of the
Compassse, the Sun's Azimuth and Almicanter;¹
to shift the Sunne and Moone,² and know the
tides, your Roomes (rhumbs) pricke your Card
say your Compassse, and get some of these bookes,
but practice is the best.

Master Wright's errours of Navigation³

¹"Almacantar;" an obsolete Spanish term, of Arabic derivation, for parallels of altitude. When two stars are in the same almacantar, they have the same altitude.

²In The Seaman's Secrets, 1599 edition. B4 verso - John Davis described an instrument, a "Horizontal Tide Table whereby he may shift the sun or moon".

³Edward Wright (1558-1615) Certaine Errors of Navigation Revealed. 2nd edition. 1610. See illustration.

Master Tapp's Sea-mans' 'Kalender'⁴

The Art of Navigation⁵

The Sea Regiment⁶

The Sea-man's secret⁷

Waggoner⁸

Master Gunter's works⁹

The Sea-man's glass for the Scale¹⁰

⁴ John Tapp (1596-1615) The Seaman's Kalendar 1602. By 1631 10 editions had appeared.

⁵ Martin Cortes, Arte de Navegar (1551) translated by Richard Eden, The Arte of Navigation (1561) reprinted 1572, 1579, 1589. Enlarged by John Tapp 1596; reprinted 1609, 1615, 1630.

⁶ William Bourne, A Regiment for the Sea, 1574, 1576, 1577, 1580. Reedited by James Hood in 1592 with at least six more editions through 1631.

⁷ John Davis (1552-1605), The Seaman's Secrets (1594); reprinted 1599 etc.

⁸ Lucas Janszoon Waghenaeer, Spiegel der Zeevaart, 1584, 1585. Translated into English by Anthony Ashley (1588) under the title "The Mariners Mirror."

⁹ Edmund Gunter, (1581-1626) Description and use of Sector. The Cross staff, and other Instruments, 1623, second imprint 1624.

¹⁰ John Apsley, Speculum Nauticum, a looking glass for Sea-men (1624).

APPENDIX 3

Letter of Luis Texeira of 20th February 1592
to Ortelius

"Worshipful master Ortelius, you wrote to me a few days ago that the thing to be sent to you should go through Senor Francisco Revalsco, and when I saw him and spoke to him he told me that he was going to Mina and was on his way, [and that] everything I had to send could be taken by Senor Theronimo Comaas as if it were by himself. This gentleman who is the bearer brings you two pieces of the description of China and Japan, the ones that have just arrived, truly drawn as they show. Now when you make these I want to make for you the land of Brazil, and its captaincies one by one, which is the greatest thing that exists, and all this I have seen and truly drawn, and there are nine or ten pieces, besides many others that I shall send to you, as the bearer will tell you, and I promise to make your book very copious, and now I finish. Have the goodness to inform me of any way I can serve you, because I shall serve you as is my wish. And please let me know a trusty man through whom I may send messages and as I have nothing more to say, may our Lord give you all that you wish. Written the 20th February 1592. Your true servant that kisses your hands. Luis Texeira"

[On the back] "To master Ortelius, His Majesty's geographer in Antwerp"

BIBLIOGRAPHY

Manuscript Sources

Christ Church College Library, Oxford,

- MS. Sea Atlas by Martin Llewellyn of London(senior). Presented by his sons William and Martin to Christ Church College in 1634. Its title page is headed thus;"In this Book is Contayned a part of the Mayne Lande of the Sea Coste of Africa and of Asia, begininge from Cape Bonsperanca, in 34d. 12m. of South Latitude in the Kingedome of China and the Islands from C. Bonsperanca, 120d. of Longitude to the East, towards Perue in America." (Dated by A.Campbell, 1598, see below.)

Durham University, Gulbenkian Museum.

- Taishokan (An_onymous) , Gulbenkian M S. 1962-144

Bristol City Record Office,

- The Great Orphan Book and Book of Wills No. 1., D. 4421(1)

British Library, (British Museum),

- Sloane MS. 3959 "Mr. John Davies His Observations voyaging from Acheen to Tecoe and Priaman". (?August 1605)
 - Additional MS 31317 "Universalis et integra totius orbis hidrographia ad verissimam Luzitanorum traditionem descripta Fernando Vâ. 1575."
 - Additional MS. 5413 Unsigned and undated, but normally known as the "Harleian Map", after its previous owner. Probably made in 1544 by either Pierre Deseliers or Jean Rotz.
 - Additional M S. 5415. Atlas of 9 charts and 3 folios on Cosmography by Diogo Homem. 1558
 - Additional M S. 16932. Roteiro desde o Cabo de Boã Esperança ate o das corrientes, by Manuel Mesquita Perestrelo. 1576
 - Additional M S. 19889. "The Jewell of Artes," by George Waymouth Dedicated to King James the First. (1604). Seven Books.
 - Additional M S. 22116. Part of annonymous chart, (probably by Vaz Dourado), showing the eastern Indian Ocean.
 - Additional M S. 27303. Chart of the Atlantic by Sebastio Lopes, 1558.
 - Additional MS. 19300 Extracts from the Journal of Captain John Saris describing his voyage to the Red Sea, Java the Moluccas and Japan, 1611-1612. (The begining is in Alexander Dalrymple's hand.)
- India Office Records,
- Court Minutes of the East India Company: Court Books 1, 2, & 3. B/1/1, B/1/2, B/1/5.
 - Original correspondence from India with collateral documents originating at any place between England and Japan from 1603-1708. Volumes E/3/1, E/3/2, E/3/3, E/3/4.

Lambeth Palace Library,

- M S. 463 . Portolano in the style of Battista Agnese. c.1555 (Bears the signature of Robert Hare, 1564. The compass mounted into the rear binding, together with English compass bearings written in contemporaneously, serves to illustrate the practical value of such small scale yet highly decorative collections of charts.)
- Carew Manuscripts. Codex Lambethani 250, 601, 604, 607, 611, 614, 619,.
- M S. 91 "A Briefe Abstract, Exposition, & Demonstration of all Termes, Parts & Things belonging to a Ship, and the Practice of Navigation", A copy presented to His Grace the Archbishop of Canterbury (George Abbot), c.1623, by Captain Mainwaring.

Sydney Jones Library, Liverpool University,

- Portulan Atlas (in the style of Diogo Homem) showing European waters, North Africa, and the Black Sea. Liverpool University MS. 4.3
- Portolano of the Mediterranean (in the style of Joan Oliva) Liverpool University MS 4.17

National Maritime Museum, Greenwich.

- MS. 38-9929-c/P21. Isolario by Bartholommeo dalli Sonetti. (These are copies of the first printed sea charts, the work of Tridensis of Venice, called Anima Mia, 1485, two copies of which are in the NMM Library).
- N 9208c Chart of the World on a whole vellum skin. (Attributed to Girolamo Verrazano, c.1529).
- N 35-CC Sup. Chart of the Atlantic, Mediterranean and the Black Sea. (Attributed to Pedro Reinel c. 1535).
- L/CB(CC1p.6) Manuscript chart for seas between Aberdeen, the Baltic and Gibraltar, included at the rear of G. Brouscon's tide tables. (On folio 7 there is written "That this appear'd to S P to have been K Hen 8th's own Book.") Chart signed K.B.
- N 32-9210C/ Portolano of the Mediterranean and Black Sea. 1546 It says "Vesconte de maillo composuit hanc cartam in janua [Genoa] anno domini 1546 die x decembris.
- MS. 9926C/P25 Atlas of 13 charts from the Black Sea to The British Isles. (Attributed to Joan Martines c.1525, formerly c.1550.)
- MS 36-8924C/P14 World Atlas of 24 charts, unsigned and undated but can be attributed to a Portuguese cartographer c.1550-60.
- MS39-9922C/P24 Atlas of 29 charts entitled "SeeKarten von Baptista Agnese AnnoMdliv .d IV May" (this was a product of Battista Agnese's, being made in Venice for a German customer as the titles and place names outside the charts' borders are in German, while chart 8 is inscribed thus "Baptista agnese fecit venetijs anno 1554 die 4 may").
- MS 33-9921c/P12 Atlas of 29 charts, with a small compass set into the back cover, with partly completed arms of Baron Rolf von Humann of Schloss Hainhofen on Fol.1 and on fol.8 the inscription "Baptista agnese fecit Venetis anno nostri domini 1555 die 24 marciij".
- MS 58-078/P36 Atlas of 9 charts by Angelo de Conte Freducci, with on the second chart the inscription "x IHS x M x Angelo de conte x freducci x Anconitanox lea facte in Ancona x nel x Mx d.l.v."
- N /36CC Sup P 99 Portolano on Whole vellum skin covering the Mediterranean, the Black Sea, Scotland and Weest Africa to Cape Branco. c.1555
- MS 35-9936c/P2 World Map on vellum by Nicolas Desliens inscribed "A DIEPPE PAR NICOLAS DESLIENS 1567"
- MS 33-9925C/P6 Atlas of 10 charts by Joan Martines, in which the first chart is inscribed "Joan Martines En messina Any 1572.
- N51-4 Chart showing the East coast of England, Scotland, Norway and the head of the Gulf of Finland on a whole vellum skin, inscribed "Made by W.B. William Borough c.1580

National Maritime Museum , Con't

- MS 39-9943C/P29 Chart of the Strait of Dover , based on chart 3 of Waghenaeer's Spieghel Der Zeevaert, 1584. This manuscript copy is attributed to Luis Teixeira.c.1587.
- MS.32-9923C/P17 Isolario ,including charts of the Mediterra -
nean ,and written descriptions in Italian of Cuba Sumatra,
Iceland and England,with further notes on navigation covering
37 pages in Italian and 2 further pages on lodestones in
English.1590 .
- MS 39-9931C/P22 Atlas of 6 charts by Joan Oliva,with device
crucifix over hand and anchor on fol.7 beneath which is written
F(ecit)C(artam) Ioan Olivo in Missina. Año 1592,
- N.47-197 Chart of the English Channel and the Bay of Biscay
showing many soundings. By Thomas Hood 1596
- N 32-CC1/P40 Three fragments from a World Chart by
Harmem and Marten Jansz showing the southern Hemisphere
including Australia c. 1606 (see Illustration for the
inscription)

Danish Maritime Museum, Kronberg Palace , Elsinore,

MS. Portolano by an anonymous Italian maker c.1560.

Pepysian Library, Magdalene College, Cambridge,

- MS.1825 Conjectura Nautica seu Disquisitio et de Origine
Navigationis
- MS.1296 An Ancient Discourse and Description of Milford Haven.
Map Dated 24th December 1596.
- MS. 2806 Expeditio Hispanorum in Angliam , 1588.
- MS. 2700 A Catalogue and Alphabet To My Books Of Geography &
Hydrography.
- MS. 2185 . Papers of Mr Halley and Mr Graves Touching upon
the yet imperfect knowledge in navigation , with notes
subsequent thereto containing;
Letter of February 17th 1696, Mr Halley to Mr Pepys
touching upon the yet imperfect measure of knowledge in
our ordinary navigators ;
Mr Graves indictment to the Nobility and Gentry of England
to the Study and Practice of Navigation;
Mr. Graves touching the principal Articles of Navigation,
the Methods and Instruments & use of each, and the defects and
errors incident thereto;
Mr. Graves upon the longitude;
Mr. Graves Monumental Inscription in Honour of Mr Wright, &
to the lasting reproach of the City of London:
- MS.1 Chart at the back of Guillaume Brouscon's Tide Tables
and Almanack. On the fly leaf of this little folded chart
there is a signature "F.Drak".

Pepysian Library, Magdalene College Cambridge

- MS.2184. Mr. Flamsteed, An Act of the begining and Progress and present state of our improvements and Deficiencies in ye Doctrine and Practice of Navigation. 21st. April 1697.

-MS.2269 Libro de Cargos (Contains Armada stores for 1587.)

Public Record Office

- High Court of Admiralty. Oyer and Terminer Records HCA/1.
- Examination of Pirates HCA/13
- Libels etc. HCA/24.

Printed Primary Sources - up to 1800A.D..

ABBOT, GEORGE, (Archbishop of Canterbury), A Brief Description of the Whole World. T. Judson for J.Brown, London, 1599.

ACOSTA, JOSE DE. The Naturall and Morall Historie of the East and West Indies, translated into English by E.G. (Edward Grimestone), London, 1604: Sims for Edward Blount and William Apsley.

ANGLERIUS, PETER MARTYR. De Orbe Novo Decades, A. Gulelmi, Acala, 1516.

(Bristol Reference Library E/P/B 196 . Spine says "Justinii" Winship's bibliography of Cabot suggests this is the earliest printed reference to Cabot voyages.)

ANONYMOUS. Bankoku Sōzu. Nagasaki, 1645. BM. Maps 920/485.

ARTHUS, COTHARDUS. Indiae Orientalis,....., Ioannem Theodorum et Ioannem Israellem de Bry, Frankfurt 5 Parts, 1607-1629
(Note that each of the first thirty books has its own title page, but all will be found in Durham Chapter Library F.II.35)

BARLOW, WILLIAM. The Navigator's Supply, Containing many thinges of principall importance belonging to Navigation, with the description and use of diverse Instrumentes formed chiefly for that purpose, but serving also for sundry other of Cosmography in Generall. The Particular Instruments are specified on the next page. G. Bishop, R.Newberry, R.Barker. London. 1597.

BARROW, JOHN. Navigatio Britannica - Or a Complete System of Navigation In all its Branches, both with regard to Theory and Practice. W. and J.Mount. and T.Page, London, 1750.

BILLINGSLEY, HENRY. The Elements of Geometrie of the most ancient Philosopher Euclid of Megan, Faithfully now first translated into Englishe toung by H. Billingsley, Citizen of London. Whereunto are annexed certaine Scholies, Annotations and Inventions, of the best mathematicians, both of time past, and in our age. With a very fruitfull Preface by M.I. Dee, specifying the Chief Mathematical sciences, what they are and whereunto commodius, where also are disclosed certaine new Secrets Mathematicall and Mechanicall until these our daies, greatly missed. John Day. London, 1570.

BLEAU, W.J. The Light of Navigation. Wherein are declared and lively pourtrayed, all the Coasts and Havens, of the West, North and East Seas. Collected partly out of the books of the principall Authors which have written of Navigation, (as Lucas Waghenaeer and divers others) partly also out of marine other expert seafaring Mens writings and verball declarations:

corrected from manie faults, and enlarged with manie newe Descriptions and Cardes. Divided into two books. Hereunto are added (beside an Institution in the Art of Navigation) newe Tables of the Declination of the Sonne, according to Tycho Brahes Observations, applied to the Meridian of Amsterdam. Together with newe Tables and Instructions to teach men the right use of the North-starre, and other firme starres, profitable for all Seafaring men. William Johnson, Amsterdam, 1612.

- BLUNDEVILLE, THOMAS. M. Blundeville His exercises, Containing sixe Treatises, the titles whereof are set down in the next printed page; which Treatise are verie necessarie to be read and learned of all yoong Gentlemen that have not been exercised in such disciplines, and yet are desirous to have knowledge as well in Cosmographie, Astronomie and Geographie, as also in the Art of Navigation, in which Arte it is impossible to profite withoute the helpe of these, or such like instructions. To the furtherance of which Arte of Navigation, the said M. Blundeville speciallie wrote the said Treatises and of more good will doth dedicate the same to all young Gentlemen of this realme. John Windet, London, 1594. (Later editions contain eight treatises and were published in 1597, 1606, 1613, 1638.)
- The Making Description and Use, of Two Most Ingenious And Instruments for Sea-men, to find out thereby the latitude of any place upon Sea or Land, in the darkest night that is without the helpe of Sunne, Moone, or Starre. First inuented by my good friend, Master Doctor Gilbert, a most excellent Philosopher, and one of the ordinarie Physicians to her Maiestie; Adam Islip, London, 1602:
- BOROUGH, WILLIAM. A Discours of the Variation of the Cumpass, or Magneticall Needle. Wherein is Mathematicall shewed the manner of observation, effects, and application thereof, made by W.B. (William Borough) and this is to be annexed to the Newe Attractive of R.N. 1581. See ROBERT NORMAN, The Newe Attractive....
- CASTANHEDA, FERNAM LOPES DE. Historia dell indie oriental scoperte & Conquistate da Portoghese in Italiana Tradotti dal signor a Ulloa. 4 Tomi. G. Ziletti. Venice, 1577-8.
- COIGNET, MICHIEL. Instrucion nouvelle des points plus excellents & necessaires, touchant l'art de naviger. Contenant plusieurs reigles, pratiques, enseignements, & instrumens tresidones à tous Pilotes, maistres de navire & autres qui iournellement hantent la mer. Ensemble, Un moyen facil, certain & tresseur pour naviger Est & Oest, lequel iusques à present a este incognu a tous Pilotes. Nouvellement practiqué & composé en langue Thioise par Michiel Coignet, natif d'Anvers, Depuis reveu & augmenté par le mesme Autheur, en divers endroits. Henry Hendrix. Anvers, 1581.
- COLLINS, CAPT. GREENVILLE Great Britain's Coasting Pilot, Being a new and Exact survey of the Sea Coast of England and Scotland, From the River of Thames to the Westward and North-Ward with the Islands of Scilly And from thence to Carlisle likewise the Islands of Orkney and Shetland, Describing all the Harbours, Rivers, Bays, Roads, Rocks, Sands, Buoys, Beacons, Sea-Marks, Depths of Water, Latitude, Bearings and Distances from place to place. The Setting of and Flowing of the Tides; with directions for the knowing of any place and how to harbour a ship in the same with Safety with Directions for Coming into the Channel between England and France. J. Mount T. Page and W. Mount, London, 1779
- CORTES, MARTIN see Richard Eden . Art of Navigation.

- Breve compendio de la sphaera y de la arte de navegar con nuevos instrumentos y reglas exemplificado con muy subtiles demonstraciones: compuesto por Martin Cortes natural de burjalaroz en el reyno de Aragon y de presente vezino de la ciudad de Cadiz dirigido al inuictissimo monarcha Carlo Quinto Rey de las Hespanas e Senor Nuestro. Anton Alvarez. Seville, 1551.
- CUNNINGHAM, WILLIAM. The Cosmographicall Glasse, conteyning the pleasant Principles of Cosmographie, Geography, Hydrographie, or Navigation. John Day. London, 1559.
- EDEN, RICHARD, The Arte of Navigation conteyning a compendious description of the sphere, with the making of certain instruments and rules for Navigations: And exemplified by many Demonstrations. Written in Spanyshe tongue by Martin Curtis And directed to the Emperor Charles the fyfte. Translated out of the Spanyshe tongue by Richard Eden. Richard Jugge. London, 1561. Note this was reprinted with very minor changes in 1572 and 1577. One copy of the 1584 edition given by Andrew Rothwell " to
- The History of Travayle in the West and East Indies and other countreys lying by either way, towards the fruitfull and ryche Molluccas As Moscouia, Persia (text damaged) Syria, Aegypt, Ethiopia, Guinea, China in Cathago and Cipangu. With a discourse of the North West Passage Gathered into Englysshe by Richard Eden, Newly set out in orde and augmented by Richard Willes. Imprinted at London by Richard Jugge, 1577.
- EDEN, RICHARD (with revisions and additions by TAPP, JOHN). The Arte of Navigation, Contayning a brief description of the Spheare, with the Partes and Circles of the Same: as also the making and use of Certaine Instrumentes, Very necessarie for all sortes of Sea-men to understand. First written in Spanish by Martin Curtis, and translated into English by Richard Eden, and lastly corrected and augmented, with a Regiment or Table of declination, and divers other necessary tables, and rules of common Navigation, Calculated (this yeare 1596 being leap yeare) by J.T., Edward Allde. London, 1596. See also CORTES, MARTIN.
- EDEN, RICHARD (revisions by TAPP, JOHN). The Arte of Navigation First written in Spanish tongue by that excellent Marriner and Mathematician of these times, Martin Curtis. From thence Translated into English by Richard Eden: And now newly Corrected and enlarged with many necessary Tables, Rules and Instructions, for the more easie attaining to the knowledge of Navigation. By John Tapp. B.A.&T.Fawcett. London, 1630.
- FIGUEIREDO, MANUEL DE. Hidrographia, exame de pilotos, no qual se contem a, regas que todo piloto deve guardas em suas navegacoes, assi no sol, variacao d agulha, como no cartear, com alguns regras da navegacao, de teste, Oeste...em os roteiros de Portugal pero o Brasil, Rio de Plata...etc. Pedro Crasbeeck, Lisbon, 1609.
- FIGUEIREDO, MANUEL DE. Roteiro e Navegacao das Indias Occidentais ilhas, Antilhas do Mar Oceano Occidental, com suas derrotas, Sondas, fundos e conhecimentos. Novamente ordenado segundo os Pilotos, por Manoel de Figueirido, que serve de Cosmographo Mor, por mandado de sua Magestade nestes Reynos e senhorios de Portugal. Dirigido a Dom Carlos de Borga, Conde do Ficalho, do Concelho do Estado de sua Magestade. Pedro Crasbeeck. Lisbon 1609.
- FRISIUS, GEMMA. De Principiis Astronomiae et Cosmographiae Deo usu Globi ad eodem editi. Item de orbis divisione, et insulis rebus et insulis rebus nuper inuentis. Ioan Grapheus, Antwerp, 1543.

- FRÓIS, Fr. LUIS. Brevis Japonicae insulae, descripti, ac rerum
quarundum in ea mirabilium, a Patribus Societas Jesu nuper
gestarum, succinna narratio. Item insigne a(u)liddan matvrium
quod in Africa quidam pro christiana religione catholica inducta
constantia subiit. Birkmanica, Cologne, 1582.
- CEDDES, MICHAEL. A short history of the Church in Malabar from the
time of its first being discovered by the Portuguese in the
year 1501 until the celebration of the following synod in the
year 1599. S. Smith and B. Walford, London, 1713 (1st ed. 1694)
- GRYNELUS, SIMON. Nouus Orbis Regionum de Insularum veteribus
incognitarum. Henagium, Basle, 1537.
- GUICCIARDINI, FRANCESCO. La Historia d' Italia di M. Francesco
Guicciardini Gentil'huomo Fiorentino. Divisa in Venti Libri
Riscontrata con tutti gli altri storici, & Autori, che dell
istesse cose habbiano scritto, per Tomaso Porcacchi da Castiglione
arretino, Con Guidicio fatto dal medesimo, per discoprir tutte le
bellezze di questa Historia; & vna Raccolta di tutte le
Sententie sparse per l'opera. Et con due Taule; vna de gli
Autore citati in margine, & l'altra delle cose notabili.
Aggiuntoui la Vita dell' Autore scritta da M. Remigio Fiorentino.
 Pietro Maria Bertano. Venice, 1616.
- HAKLUYT, RICHARD. The Principall Navigations, Voiges and
discoveries of the English Nation, made by Sea or over Land,
to the most remote and farthest distant Quarters of the Earth
at any time within the compasse of these 1500 yeares: Devided
into thre Severall parts, according to the positions of the
Regions whereunto they were directed. The first, conteining
the personall travels of the English unto Iudea, Syria, Arabia,
the river Euphrates, Babylon, Balsara, the Persian Gulfe,
Ormuz, Chaul, Goa, India, and many Islands adioyning to the
South parts of Asia: together with the like unto Egypt, the
chiefest ports and places of Africa within and without the
Streight of Gibraltar, and about the famous Promontorie of
Buona Esperanza. The second, comprehending the worthy
discoveries of the English towards the North and Northeast by
Sea, as of Lapland, Scrickfinia, Corelia, the Baie of S. Nicholas,
the Isles of Colgoieve, Vaigats, and Nova Zembla toward the
great river Ob, with the mightie Empire of Russia, the
Caspian Sea, Georgia, Armenia, Media, Persia, Boghar in Bactria,
& divers kingdoms in Tartaria. The third and last, including
the English valiant attempts in searching almost all the
corners of the vaste new world of America, from 73. degrees
of Northerly latitude Southward, to Meta Incognita,
Newfoundland, the maine of Virginia, the point of Florida, the
Baie of Mexico, all the inland of Nova Hispania, the coast of
Terra firma, Brasill, the river of Plate, to the Streight of
Magellan: and from it to the South Sea to Chili, Peru, Xalisco,
the Gulfe of California, Nova Albion upon the backside of
Canada, further then ever any Christian hitherto hath pierced.
Whereunto is added the last most renowned English Navigation,
round about the whole Globe of the Earth. George Bishop &
 Ralph Newberie. London, 1589 and 1600. See also Hakluyt
 Society Edition, 1903-1905. Maclehose & Sons, Glasgow.
- HARRIS, JOHN. Navigantium Itinerantium Bibliotheca, or a compleat
Collection of Voyages and Travels consisting of above Four
Hundred of the Most Authentick Writers beginning with Hakluyt,
Purchas and in English, Ramusio in Italian, Thevenot in French,
De Bry and Grynæii, Novus Orbis in Latin, the Dutch East
India Company in Dutch, and continued with others of note
that have published Histories, Voyages, Travels or Discoveries,
are in English, Latin, French, Italian, Spanish, Portuguese,
German or Dutch origines, relating to any part of Asia, Africa,
America, Europe or the Islands thereof to the present time.
With the heads of severall of our most considerable
commanders, and great number of excellent maps of all parts
of the world and cuts of Most Curious Thinges in all the
voyages, Also an Appendix of the Remarkable Accidents at-Sea,
and severall of considerable engagements, the Charters, Acts

- relating to the Union of the Two Companies throughout the world. All Originall Papers printed at large as the Pope's Bull to dispose of the West Indies to the King of Spaine, Letters Patent for establishing Companies of Merchants, as the Russia, East India Companies, etc., Letters from Great Men to another, showing their Titles, Style, etc. by John Harris A.M., F.R.S.. John Bennet, John Nicholson and David Midwinter. London, 1705. 2 Vols.
- HAWKINS, RICHARD. The Observations of Sir Richard Hawkins in his voyage into the South Sea Anno Domini 1593. John Jaggard, London, 1622.
- HONDIUS, IODOCUS. Vera Totius Expeditionis Nauticae Descriptio D. Franc. Draci...Addita est etiam viva delineatio navigatione^s Thomae Caundish...Iodocus Hondius, Amsterdam, c.1595. (Map)
- LINSCHOTEN, JOHN HUIGHEN VAN. His Discours of Voyages into ye East and West Indies Devided into Foure Bookes. John Wolfe, London, 1598. (This work was translated by William Phillip.)
- MACROBIUS, Somnium Scipionis ex Ciceronis Libro de Republica Sexto Excerptum. Jocodius Baduis, Paris, 1524.
- MEDINA, PEDRO DE, Arte de Navégar en se contémien todas las reglas Declaraciones Secretos. y Avisos, que a la buena navegacio son necessarios, y se deve saber, hecha por el maestro Pedro de España, y de las dos Sicillias sa e con privilegio imperial. Francisco de Cordova. Valladolid, 1545.
- See LAMB, URSULA. A Navigator's Universe. The Libro de Cosmographia of 1538 by Pedro de Medina.
 - Regimiento de navegacio contiene las casas que los pilotos Era de saber para bien navegar: y avisos que hau de tener para pelegros que navando les pueden suceder... Por el Maestro Pedro de Medina, Simon Carpintero. Seville 1543. Also later editions in 1552, 1562, 1563.
- MILLAR, GEORGE HENRY. The New and Universal System of Geography being a Complete History and Description of the Whole World. Alex Hogg. London, 1783.
- NORMAN, ROBERT. The Newe Attractive, containyng a short discourse of the Magnet or Lodestone, and amongst his other vertues, of a new discovered secret and subtil propertie, concernyng the Declinyng of the Needle, touched therewith under the plaine of the horizon. Now first founde out by Robert Norman Hydrographer. Hereunto are annexed certaine necessarie rules for the art of Navigation, by one R.N.. Printed by John Kyngston for Richard Ballard, London, 1581.
- See also BOROUGH, WILLIAM
- NICOLAS DE NICOLAI. L'Art de Naviguer de Maistre de Pierre de Medine Espaignol: contenant toutes les reigles, secrets et enseignements necessaires, a la bonne navigation. Traduit de Castillan en François, avec augmentation et illustration de plusieurs figures et annotations, par Nicolas de Nicolai, du Dauphiné, Geographe du tres Chrétien Roy Henri II de ce Nom: Et dédié à sa tres Auguste Maieste. A Lyon chez Guillaume Rouille Avec Privilege pour dix ans 1554.
- PINTO, FERNÃO MENDES. Peregrinacãm de Fernam Mendez Pinto. Em que da Conta de Muytas e muyto estranhas cousas que vio & ouuio no reyno da China, no da Tartaria, no do Sornau que vulgarmente se chama Siao no do Calaminhan, no de Pegu, no de Martauas, & em outros muytos reynos & senhorios das partes Orientais, de que nestas nossas do Occidente ha muyto pouca ou nenhua noticia. Et tambem da conta de muytos casos particulares que acontecerão assi a elle como a outras muytas pessoas. E no sim della trata brevemente de algumas cousas & da morte do santo Padre mestre Francisco Xavier unica luz & resplandor daquellas partes do Oriente & Reytor nellas

- universal da Companhia de Iesus. Pedro Crasbeeck, Lisbon 1614.
- PLAUTIUS, GASPAR(pseud. HONORIUS PHILIPONUS). Nova typis transacta navigatio. Novi orbis Indiae Occidentalis et nunc primus a variis scriptoribus in unum collecta, authore H.P. Observatio de Magneta Nautico. Vaticinium de Messina, 1621.
- PTOLEMY. (ed. PIRKHEIMER). Geographicae enarrationis libri octo B.Pirkheymerho interprete annotationes de Regio Monte in errores comissos Angelo in translatione sua. Griengerius, Basle, 1525.
- Geographia universalis, vetus et nova enarrationis Libros VIII quorum primus nova translatione Pirkheimeri et accessione commentarioli illustrior...redditus est. H.Petram. Basle, 1545.
- PURCHAS, SAMUEL. Hakluytus Posthumus or Purchas His Pilgrimes, conteyning a History of the World or sea voyages and land travells, by Englishmen and others, Wherein God's Wonders and Nature and Providence, The Actes, Artes, Varieties, and Vanities of Men, with a world of the world's Rarities, and by a world of Eye witness Authors related to the World. Some left written by Mr.Hakluyt at his death. All examined abbreviated, Illustrated with Notes, Enlarged with Discourses. Adorned with Maps. In four parts, Each containing five Books by Samuel Purchas B.D., Henry Fetherstone. London, 1625 5Vols.
- RECORDE, ROBERT. The Castle of Knowledge, containing the explication of the sphere both celestial and materiall and divers thinges incident thereto. Reyner Woolfe. London 1557.
- REUWICH, E. Reise ins Heilige Land. Bernhard von Breydenbach. Mainz, 1486.
- ROBERTSON, JOHN. The Elements of Navigation. Containing the theory and practice, with the necessary tables. To which is added a treatise on Marine Fortification...Third edition, with additions, and compendiums for finding the Latitude at Sea. 2Vols. Mount & Page, London, 1772.
- Fourth edition with additions, revised by W.Wales. A dissertation on the rise and progress of the modern art of navigation by T.Wilson. 2Vols. London, 1780.
 - The Elements of Navigation, containing the theory and practice, with the necessary tables. To which is added a treatise on marine fortification. Corrected with annotations by William Wales and with treatise by James Wilson. 5th. ed. London, 1784.
- STRABO. Strabo Graece & Latine cum Notis Isaaci Casuaboni. Paris, 1620.
- THEVET, ANDRÉ. La Cosmographie universelle d'André Thevet cosmographe du roy. Illustree de diverses figures des choses plus remarquables revés par l'auteur et incognues de noz anciens & moderns. 2Vols. P.L.Hullier, Paris, 1575.
- TUNSTALL, CUTHBERT. De Arte Suppetandi Libri Quattuor. Pynson, London, 1522.
- VIVERO, RODRIGO de. Relazion que hace Don Rodrigo de Vivero Velasco... See JULIETTE MONBEIG Japon et du bon gouvernement de l'Espagne et des Indes. Traduit et presente par Juliette Montheig S.E.V.P.E.N. Paris, 1972.
- WAGHENAEER, LUCAS JANSON, (tr) ANTHONY ASHLEY. The Mariners Mirrour wherein may playnley be seen the courses, heights, distances, depths, soundings, floudes and ebs, rising of rocks sands and and shoalds, with the marks for thentrings of the Harboroughs Havens and Ports of the greatest part of Europe: their several trafficks and commodities together with Rules and intrumetes of Navigation. First made and set fourth in divers exact seacharts, by that famous Navigator Luke Wagenar of Enchuisen, And now fitted with necessarie additions for the use of Englishmen by Anthony Ashley. Herein also may be understood the exploits lately achieved by the right

Honourable the L. Admiral of England with her Mat^{ies} Navie
 some services don by that worthy Knight Sr. Fra. Drake,
 (No place of publication given ? London, 1588)

- Spiegel der Zeevaert, vande navigatie der Westersche Zee, Inhoudende alle de Custe vā Vranckrijck Spaighen en t' principaelste deel van Engelandt, indiuersche Zee Caerte begrepe met den gebruijcke van dien, nu met grooter naersticheijt bij ee vergadert in gherpractizeert. Door Lucas Jansz Waghenaer Pilotot ofte Stuijrinan Residerende inde vermaerde Zeestadt Enchuisen. Cum privilegio ad decennium Reg. 1583 Mat^{ies} et Cancellarie Brabantie. Christoffel Plantin, Leyden, 1585 (See R.A. Skelton for a facsimile edition of Teerste Deel Vande Spiegel der Zee vaert which contained 23 charts, and Het Tweede Deel van de Spiegel der Zeevaert vande der Westersche Zee, published in 1585 containing another 21 charts. The 1585 edition is a reprint of both parts. Latin texts entitled Speculum Nauticum appeared in 1586 with 45 charts and 1591 with 47 charts, and a Dutch text with 46 charts in 1588.)
- Thresoor de Zeevaert, F. Raphelengius, Amsterdam, 1592. (Later editions 1596, 1598, 1602, 1608, and a French edition in 1601.)

WRIGHT, EDWARD. Certaine Errors In Navigation, Detected and corrected By Edw. Wright With Many additions that were in the former edition as appeareth in the next pages. Felix Knight, London, 1610. (2nd. edition.)

Facsimiles, Reprints, and Printed Versions of Manuscripts.

- ANNONYMOUS, The Lawes and Standing Orders of the East India Company, 1621, Gregg International Reprint, Aldershot, 1968.
- ALBUQUERQUE, LUIS MENDONCA DE, Os Guias Nauticos de Munique e Evora (Introduction by Armando Cortesao) Agrupamento de Estudos de Cartografia Antiga, Junta de Investações do Ultramar, 4, Lisbon, 1965.
- O Livro de Marinharia de Andre Pires, (Introduction by Armando Cortesao), Agrupamento de Estudos de Cartografia Antiga, 1, Junta de Investações do Ultramar, Lisbon, 1963.
- O Livro de Marinharia de Manuel Alvares, (Introduction by Armando Cortesao), Junta de Investacoes, Lisbon, 1969.
- ANDERSON, R.C. Letters of the 15th and 16th Centuries. Southampton Records Society, No 95.
- ANDRADA, ANTONIO ALBERTO BANHA DE, Mundo Novos do Mundo. Panorama da diffusa, pela Eurapa de noticias dos Descobrimentos Geograficos Portugueses. 2 Vols, Junta de Investacoes do Ultramar. Lisbon, 1972.
- ASHLEY, ANTHONY, See Waghenaer.
- BLAZQUEZ, D. ANTONIO, Isolario General de Todas las del mundo por Alonso de Santa Cruz, Cosmografia Mayor de Carlos 1 de España publicado por vez primera con un prólogo de D. Antonio Blazquez. Bibliotecario perpetuo de la Real Sociedad Geografia, Real Sociedad Geografica, Caracas, 1920, (2 Vols.)
- BOURNE, WILLIAM, A Regiment of the Sea, and other writings on Navigation by William Bourne of Gravesend, a gunner. C.1532-82 Edited by E.G.R. TAYLOR, Hakluyt Society 2nd Series CXXI. Cambridge, 1964.
- CHAUCER, GEOFFREY, See W.W. Skeat, Chaucer Complete Works,
- CORTESAO, ARMANDO, Cartografia e Cartógrafos Portugueses dos Séculos XVeXVI: Contribuicao Para cum estudio completo. Seara Nova, Lisbon, 1935, (2 Vols.)
- CROFT, PAULINE, The Spanish Company, London Record Society, 1973.
- HOWSE, DEREK and SANDERSON, MICHAEL, The Sea Chart. An Historical Survey based on the collections in the National Maritime Museum David and Charles, Newton Abbot, 1973.
- JOHNSON, WILLIAM, See Bleau, W.J. The Light Of Navigation, 1612. (Note reprinted with introduction by R.A. Skelton by N.V. Orbis Terrarum Orbis, Amsterdam, 1964.)

- JONES, YOLANDE and WALLIS, HELEN and NELSON, HOWARD. Chinese and Japanese Maps. Catalogue of an exhibition held at the British Museum, 1st February to 3rd December, 1974. British Library, 1974.
- KOH-UN, IKEDA. Genna Kokaisho (Navigation Treatise of The Genna Era) Edition by Saigusa Hiroto, Nihon Kagaku Koten Zunsho (History of Science and Technology) Asahi Shinbunsha, Tokyo, 1946, Volume 12, p1-134. (Available through University of London, School of Oriental Studies, D.B.40272466.)
- LAMB, URSULA. A Navigator's Universe. The Libro de Cosmographia of 1538 by Pedro de Medina. Translated with an introduction by Ursula Lamb. Chicago University Press, 1972.
- LODESWIJKSZ, G.A.M.L. Nieuwe Caerte op Java geteeckert. Cornelius Claesz, Amsterdam, 1598. (Slide)
- LOPES DE ALMEIDA, MANUEL, COSTA BROCHADO, IDALINO FERREIRA DA, DIAS DINIS, ANTÓNIO JOAQUIM, O.F.M. Monumenta Henricina, 14 vols. Comissão Executiva das Commercções de Quinto Centenário Infante D. Henrique. Coimbra, 1960 onwards
- MAINWARING, SIR HENRY, The Life and Works of Sir Henry Mainwaring, Navy Records Society, Vols 1 & 2. Navy Records Society Vols 54 & 56 (Edited by G.E. Mainwaring & W.G. Perrin.)
- MAJOR R.H. Early Voyages to Terra Australis. Hakluyt Society, 1859.
- MARSDEN, REGINALD G. Select Pleas in the Court of Admiralty, Volume I The Court of Admiralty of the West (A.D. 1390-1404 and the High Court of Admiralty (A.D. 1527-1545)), Edited for the Selden Society by Reginald G. Marsden. Volume II The High Court of Admiralty (1547-1602). Edited for the Selden Society by Reginald G. Marsden, Selden Society Volumes VI for 1892 and Volume XI for 1897.
- MENDOZA, JUAN GONZALEZ DE. The Historie of the Great and Mightie Kingdom of China, and the situation thereof, Together with the great riches, huge cities, politicke government and rare invention of the same, White, London, 1588. Edited Sir G. Staunton, Hakluyt Society Edition, 2 Vols. 1854.
- MERTEN LE MAYRE. The Dutch Schoole Master Wherein is shewed the true and perfect way to learne the Dutch tongue to the fartherance of all those which would gladly learne it. George Elder, for Simon Waterson. London 1606. (Facsimile by the Scholar Press, Ilkley, 1972.)
- MUN, THOMAS. A Discourse of Trade from England into the East Indies Answering to diverse objections which are usually made against the same by Thomas Mun. Printed Thomas Okes for John Pynson. (Facsimile edition by Gregg International Publishers, Aldershot, 1968.
- NAVARETTE, D. EUSTACIO FERNANDEZ DE, Memoria sobre la tentativas hechas y Premios efreidos en espana al que resolviere problema de la longitud an la mar. Coleccion de Documentos Ineditos, Volume 21, Madrid, 1852.
- NICOLAI, NICOLAS DE, L' Art De Nauigver de Maistre Pierre de . Medine, Espaignol: contenant toutes les reigles, secrets, & enseignements necessaires, a la bonne navigation. Traduit de Castillan en Francoys, avec augmentation & illustration de plusieurs figures & annotations, par Nicolas de Nicolai du Dauphine, Geographe du tres- Chretien Roy Henri II de ce Nom: Et dedie a tres- Auguste Maitie. Guillaume Roville, Lyon, 1554, Reprinted by De Boer Maritieme Handboeken, Bossum (the Netherlands), in a limited edition. Undated.
- NORDENSKIÖLD, N.A.E. Facsimile Atlas to the Early History of Cartography. Translated from the Swedish Original by Johan Ekelof and Clements.R. Markham. 1st Edition Stockholm 1889 and reprinted by Kraus Reprint Corp. New York, 1961.
- PARRY, J.H. (Editor) The European Reconnaissance. Selected Documents. The Documentary History of Western Civilisation, Macmillan London 1968.

- PURNELL, C.J. The Log Book of William Adams, 1614-1619. Transactions of the Japan Society. Vol. XIII part II, London, 1915.
- RALPH, ELIZABETH, The Great White Book of Bristol, Bristol Record Society, Vol. XXXII, Bristol, 1979.
- RUNDALL, THOMAS. Memorials of the Empire of Japan. Hakluyt Society, Series I, No4, 1850.
- SKELTON, R.A. Spiegel der Zeevaert, (for full title, see Waghenaeer) Reprinted by N.V. theatrum Orbis Terrarum, Amsterdam, 1964)
- SMITH, JOHN. A Sea Grammar with the Plaine Exposition of Smith's Accidence for young sea-men, enlarged. Written by Captaine John Smith sometimes Gouverneur of Virginia, and Admirall of New-England. First edition John Haviland, London, 1627; also 1654. Edited by Kermit Goell, Michael Joseph, London, 1970.
- STEVENS, H. The Dawn of British Trade to the East Indies as recorded in the Court Minutes of the East India Company, 1599-1603. Containing an account of the formation of the Company, The first adventure and Waymouth's voyage in search of the North West Passage. Now first Printed from the original manuscripts. Henry Stevens and Son, London, 1886
- TAYLOR, E.G.R. A Regiment For The Sea, and other writings on navigation by William Bourne of Gavesend, a gunner (c. 1535-82) Edited by E.G.R. Taylor. Hakluyt Society 2nd series CXXI. Cambridge, 1963
- VANES, J. (editor) Documents illustrating the Overseas Trade of Bristol in the Sixteenth Century. Bristol Record Society Publications, Bristol, Vol XXXI, Bristol, 1979.
- WATERS, D.W. Rutters of the Sea, the sailing directions of Pierre Garcie A study of the first English printed sailing directions with facsimile reproductions. Yale University Press, New Haven, 1967.
- WILLIAMSON, J.A. The Cabot voyages and Bristol discovery under Henry VII. With the Cartography of the voyages by R.A. Skelton. Edited by J.A. Williamson. Hakluyt Society 2nd Series CXX Cambridge, 1962.
- The observations of Sir Richard Hawkins, Argonaut Press, London, 1933.

Translation of Primary Sources and Manuscripts.

- For many of the early translations contained in sources printed before 1700 see-
- ALLISON, A.F. English Translations from the Spanish and Portuguese to the year 1700. An Annotated Catalogue of the Extant Printed Versions (excluding Dramatic Adaptations) Dawson of Pall Mall, London, 1974.
- BOXER, C.R. The Tragic History of the Sea, 1589-1622, Narratives of the shipwrecks of the Portuguese East Indiamen São Thomé (1589), Santo Alberto (1593), São João Baptista (1622) and the journeys of the survivors in South East Africa, Hakluyt Society 2nd Series, Cambridge, 1959.
- Further selections from the Tragic History of the Sea 1559-1565. Narratives of the shipwrecks of the Portuguese East Indiamen Aguia and Garça (1559), São Paulo (1561) and the misadventures of the Brazil-ship Santo Antonio (1565). Translated and Edited from the Original Portuguese by C.R. Boxer. Hakluyt Society 2nd Series cxxxi, Cambridge, 1968

Translations of Primary Sources and Manuscripts

- BOXER, CHARLES R. South China in the Sixteenth Century. Hakluyt Society, Series II, Vol. CVI. 1953.
- CABRAL, PEDRO ALVARES. The Voyage of Pedro Alvares Cabral to Brazil and India. Hakluyt Society, Series II, Vol. LXXI.
- CAMÔENS, LUIS VAN DE. Translated by William C. Atkinson. The Luslads. Penguin Books, 1952 and 1973.
- CORTESAO, ARMANDO and TEIXEIRA DA MOTA, AVELINO. Portugalia Monumenta Cartographica. 5 vols and index. Comissão Executiva das Commercções de quinto Centenario do Infante D. Henrique. Lisbon, 1960.
- FEI HSIN. Hsing-ch'a Sheng-lan (The Overall Survey of the Star Raft). L'Acedemie des Sciences. S.Petersburg, 1915.
- KELLY, Fr CELSIUS. La Australia del Espiritu Santo and the Franciscan Missionary Plan. Hakluyt Society, Series II, Vol. CXXVI. Cambridge, 1966 (second vol. CXXVII)
- IBN KHALDUN. An Introduction to History 'The Muquaddimah'. Translated from the Arabic by Franz Rosenthal. Abridged and edited by J. Dawood. Routledge, Kegan Paul, London. 1969
- MA HUAN. Ying Yai Sheng Lan. Overall Survey of the Oceans. 1433. Edited and translated by J.V.Mills. Hakluyt Society, Extra Series, No 42. 1971.
- MALLET, M. E. Florentine Galleys of the Fifteenth Century. Oxford University Press, 1967.
- MONTBEIG, JULIETTE. Japan et du bon gouvernement de l'Espagne et des Indes. Traduit et presente par Juliette Montbeig. S.E.V.P.E.N. Paris, 1972.
- MORGA, ANTONIO DE. Sucesos de Las Filipinas. Translated and edited by J.S.Cummins. Hakluyt Society, Series II, Vol. 140. 1972.
- MUNILLA O.F.M. FRAY MARTÍN DE. Journal for March 22nd, 1606. (See Kelly, Vol. 1.)
- ROCKHILL, W.W., and HIRTH, F.. Chau Ju Kua - His work on the Chinese and Arab Trade in the Twelfth and Thirteenth Centuries entitled 'Chu - fan - chi'. L'Acedemie des Sciences. S.Petersburg, 1911.
- SCHURMANN, H.F.. Economic Structure of the Yuan Dynasty. A Translation of Chapters 93 and 94 of the Yuan Shih. Harvard University Press. Cambridge - Mass, 1956.
- STEFANSSON VILHJAMUR. Great Adventurers and Explorations from the Earliest Times to the Present as told by the Explorers themselves. R.Hale, London, 1947.
- TIBBETTS G.R. Arab Navigation in the Indian Ocean before the Coming of the Portuguese. Oriental Translations Fund Vol. XLII. Royal Asiatic Society. Luzac, London, 1971.
- VAMBURY, A. The Travels and Adventures of the Turkish Admiral Sidi Ali Reis in India, Afghanistan, Central Asia and Persia during the years 1553 - 1556. Translation by A.Vambury of Sidi Ali Reis, Mirat ul Memalik. Luzac, London, 1899.

Secondary Sources including Periodicals.

- ABRAHAMS, I.A. The Legacy of Israel. Ed. Bevan and Singer Oxford University Press, London, 1927.
- AHMED, S.MAQBUL. Islamic Cartography with Special Reference to the World Map of Muhammad b. Musa al Khumarizimi based on Ptolemy. Sixth International Conference on the History of Cartography. N.M.M. Greenwich, 1975.
- ANDERSON, R.G.W. The Mariners Astrolabe. An Exhibition at the Royal Scottish Museum 19th. August to 22nd. September 1972. Royal Scottish Museum, 1972.
- ANNIS, P.G.W. (Ed) Ingrid and Other Studies. National Maritime Museum Monograph No. 36, 1978.
- ANTHIAUME. ABBE ALBERT. Cartes marines, constructions navales, voyages de decouverte chez les Normands 1550-1650 par L'abbe A. Albert. Preface de l'Amiral Bucharde. 2Vols. E. Dumont, Paris, 1916.
- ARCHAEOLOGIA CANTIANA 1972, G.NESBETT-WOOD Vol.LXXXII pp.208-209.
- ARIMA, SEIHO. The Western Influence on Chinese Military Science, Shipbuilding, and Navigation. Monumenta Nipponica Vol.19. 1964 pp.118-45.
- BALDWIN, D.J.P. The Form in which Aristotle's Politics reached Western Christendom and the latter's reaction to it up to the time of St.Thomas Aquinas. Durham University. BA. Dissertation, 1977.
- BALDWIN, R.C.D. 'The Interchange of European and Asian Navigational information in the Far East before 1620'. Paper presented to the 3rd. International Reunion for the History of Nautical Science and Hydrography. N.M.M. Greenwich, 1979.
- The Iberian Influence on English Navigation, 1540-1570. Durham University B.A. Dissertation, 1975.
 - The Sixteenth Century Books in S.Chad's College Library. An Insight into Tudor Tastes. S.Chad's College Magazine No.34 1976 pp.21-26.
- BARROW, JOHN. A Chronological History of Voyages into the Arctic Regions (1818). Undertaken chiefly for the purpose of discovering a North East, North West, or Polar Passage. Introduction by Christopher Lloyd. David & Charles, Newton Abbot, 1971.
- BASHAM, A.L. The Wonder that was India. Sidgwick and Jackson, London, 1958.
- BEAGLEHOLE, J.C. The Life of Captain Cook. A & C.Black, London, 1974.
- BEAZLEY, R. John and Sebastian Cabot (Builders of Greater Britain). Fisher Unwin, London, 1898.
- BENSAUDE, JOAQUIM and MARJAY, FREDRICO. Dom Henrique, the Navigator. Comissão Executiva das Comerações do quínti centenário do Morte do Infante D.Henrique. Lisbon, 1960.
- BICKLEY, FRANCIS B. (Ed) The Little Red Book of Bristol. Council of the City of Bristol, Henry Southeran, Bristol 1900
- BOVILL, E.W. The Golden Trade of the Moors. Oxford University Press, London, 1950
- BOXER, C.R. The Christian Century in Japan 1549-1650. University of California Press, Berkeley, 1974.
- The Dutch Seaborne Empire 1600-1800. Pelican, London, 1973.
 - Four Centuries of Portuguese Expansion 1415-1825. University of California Press, 1969.
 - The Great Ship from Amacon. Annals of the Old Japan Trade 1535-1640. Centro de estudos historicos ultramarinos, Lisbon, 1959.
 - The Manila Galleon 1565-1815. History Today 1958. p539-547

- BOXER, C.R. cont. Review of 'A Marinharia dos Descobrimentos' by Fontoura da costa. Lisbon 1934. Mariners Mirror, 1935.
- Portuguese Roterios 1500-1700. Mariners Mirror, 1934 pp.171-186
 - The Portuguese Seaborne Empire 1415-1825. Hutchinsons, London, 1977 reprint.
 - Some Second Thoughts on The Tragic History of the Sea, 1550-1650, Hakluyt Society Annual Report for 1978, London, 1979, pp.1-9
 - Jan Compagnie in Japan, 1600-1850. An Essay on the Cultural, Artistic and Scientific influences exercised by Hollanders in Japan from the 17th to the 19th Centuries, O.U.P., London, 1968.
- BRADFORD, ERNLE. The Great Siege of Malta, 1565, Penguin, London, 1968
- BRITISH MUSEUM. Sir Francis Drake. An Exhibition held to Commemorate Francis Drake's voyage around the world 1577-80. British Museum Publications Ltd, 1977.
- BROCHADO, COSTA. 'La Découverte de l'Atlantique' article in Henry Le Navigateur. Commissao Executiva das Commeracoes do quinto centenário do morte D.Henrique. Coimbra, 1960.
- BURWASH, DOROTHY. English Merchant Shipping 1460-1540. David and Charles Reprint, Newton Abbot, 1969.
- ↑ JOSE MARÍA de la PENA y CÁMARA. Archivo General de Indias de Sevilla guia del visitante. Direccion General de Archivos y Bibliotecas, Seville, 1958
- CAMPBELL, TONY. Martin Llewellyn Atlas of the East, 1598. Sixth International Conference on the History of Cartography, N.M.M. Greenwich, 1975.
- CARRINGTON GOODRICH, L. and CHAOYING FANG. Dictionary of Ming Biography, 1368-1644. Columbia University Press, 2 Vols. 1976.
- CARTER, C.H. The Secret Diplomacy of the Habsburgs 1598-1625. Columbia University Press, 1964.
- CHAUNU, HUGETTE et PIERRE. Seville et l'Atlantique 1504-1650, par Hugette et Pierre Chaunu. Preface de Lucien Febvre. 8 Vols., S.E.V.P.E.N., Paris, 1955-1958.
- CHENEY, C.R. Handbook of Dates for Students of English History. Royal Historical Society Guides and Handbooks No.4., Royal Historical Society, London, 1978.
- CIPOLLA, CARLO. Guns, Sails and Empires, Minerva Press, New York, 1965.
- COLLIS, MAURICE. Marco Polo, Faber, London, 1950.
- The Grand Peregrination being the life and adventures of Fernao Mendes Pinto. Faber, London, 1949.
- CONGREVE. A brief notice of some contrivances practiced by the native mariners of the Coromandel coast in navigating, sailing and repairing their vessels. Madras Journal of Literature and Science XVI, January, June 1850.
- CONNELL-SMITH, E. English Merchants Trading to the New World in the Early Sixteenth Century. Bulletin of the Institute of Historical Research 1950. pp.53-66.
- CONNOR, JEANETTE T. Jean Ribaut. Florida State Historical Society, Miami, 1927.
- COOK, WARREN L. The Flood Tide of Empire. Spain and the Pacific North West 1543-1819. Yale University Press, 1973.
- COOPER, MICHAEL. Richard Cocks, English Merchant in Japan. History Today 1973. pp.247-255.
- CORTESAO, ARMANDO. Early Portuguese Navigation. Journal of Navigation Vol. 28 No. 1, 1975. pp.91-2.
- Note on the Castiglioni planisphere. Imago Mundi XI, 1954. pp.53-56.
 - The Suma Oriental of Tome Pires, an account of the East from the Red Sea to Japan written in Malacca and India in 1512-1515, and the Book of Francisco Rodrigues, rutter of a voyage in the Red Sea, nautical rules, almanack and maps, written and drawn in the East before 1515. Translated from a Portuguese M S. in the Bibliothèque de la Chambres des Deputies, Paris. 2 Vols. Hakluyt Society. 2nd. Series CXXXIX and XC. Cambridge, 1944.

- 565
- CORTESAO, JAIME. The Pre-Columbian Discovery of America. Geographical Journal, LXXXIX, 1937. pp.29-42.
- COULTON, G.C. Medieval Panorama. Cambridge University Press 1945.
- CRONE, G.R. The Alleged pre-Columbian Discovery of America. Geographical Journal, LXXXIX, 1937. pp.455-460.
- The Discovery of the East. Hamish Hamilton, London, 1972.
- CUMMING W.R., SKELTON R.A., QUINN D.B. The Discovery of North America. Paul Elek, London, 1971.
- DAHLGEN, E.W. Les Débûts de la Cartographie du Japon. Archives d'études orientales, Uppsala, 1911.
- DANISH MARITIME MUSEUM. Schistorisk Billedbog. Helsingør, 1967.
- DAVIES, A. The Egerton MS 2803 map and the Padrón Real of Spain in 1510. Imago Mundi XI. pp.47-52.
- DAVIS, RALPH. The Rise of the English Shipping Industry in the Seventeenth and Eighteenth Centuries. N.M.M. Modern Maritime Classics Reprint, 3, Greenwich, 1979.
- DESTOMBES, MARCEL. Notes de cartographie Chinoise une carte Chinoise de 1594 a la biblioteque nationale. La Navigation, Vol.93. part I, 1976.
- Quelques rares cartes nautiques néerlandaises du XVIIe siècle. Proceedings of the Sixth International Conference on the History of Cartography. N.M.M. Greenwich, 1975.
- DIFFIE, B.W. and WINNIUS, G.D. Foundations of the Portuguese Empire, 1415-1580. University of Minnesota/Oxford University Press, 1977.
- DIVINE, DAVID. The Opening of the World. Collins, London, 1973.
- DUYVENDAK, J.J.L. China's Discovery of Africa. A.Probsthain, London, 1947.
- EDWARDES, MICHAEL. Ralph Fitch, Elizabethan in the Indies. Faber, London, 1972.
- ELLIOTT, J.H. Crisis in Europe 1550-1660. Routledge Kegan Paul, London, 1970. (Ed. ASTON, T.).
- Imperial Spain 1469-1716. Pelican, 1970.
 - The Old World and the New, 1492-1650. Cambridge University Press, London, 1972.
- FEBVRE, LUCIEN. The Coming of the Book. The Impact of Printing on Western Europe 1450-1800. Foundations of History Library, New York, 1976.
- FOSTER, Sir WILLIAM. England's Quest of Eastern Trade. A&C.Black, London, 1933. Reprinted 1966.
- FROUDE, J.A. English Seamen in the Sixteenth Century. Lectures delivered at Oxford Easter Terms 1893-4. Longmans, London, 1909.
- GARRETT, C. The Marian Exiles. Cambridge University Press, 1938.
- GILBERT, JOHN. Eastern Islands, Southern Seas. Aldus Jupiter, London, 1973.
- GRAY, E.F. Facts and Factors in Economic History. Harvard University Press, 1932. See USHER, A.P.
- GRIMBLE, A. Return to the Islands. John Murray, London, 1957.
- Pattern of Islands. John Murray, London, 1963.
- GROSSET-GRANGE, H. An Arabian Sea Chart of the Middle Ages. Journal of Navigation, Vol.28, No.4, 1975. pp.434-448.
- GUISEPPI, M.S. Guide to the Contents of Public Record Office. Vol.I, HMSO. 1963.
- HALE, J.R. Renaissance Exploration (Text of seven Radio Broadcasts summer 1968). B.B.C. 1968.
- HARBORD, Rev. J.B. Glossary of Navigation, W.Blackwood, Edinburgh, 1863.
- HARING, C.H. The Spanish Empire in America. Oxford University Press, London, 1947.
- Trade and Navigation between Spain and the Indies in the time of the Habsburgs. Peter Smith. Gloucester, Mass., 1964.
- HAWKINS, RICHARD. The Observations of Sir Richard Hawkins-1622. (Ed. J.A.WILLIAMSON) Argonaut Press, London, 1933.

- HELLINGA, W.G. Copy and Print in the Netherlands. An Atlas of Historical Bibliography. North Holland Publishing Company, Amsterdam, 1962.
- HENNINGER, S.K. The Cosmographical Glasse. Renaissance Diagrams of the Universe. Huntington Library, San Marino, 1977.
- HESS, ANDREW C. The Forgotten Frontier. A History of the Sixteenth Century Ibero-African Frontier. University of Chicago Press, 1978.
- HEYERDAHL, T. American Indians in the Pacific. Allen Unwin, London, 1952.
- HIGNETT H.M. An Outline History of Marine Pilotage in Britain. Journal of the Royal Institute of Navigation, Vol.31., No.3, September 1978. pp.453-464.
- HILL, C.P. The History of Bristol Grammar School. Pitman, London, 1951.
- HORRIDGE, G.A. The Design of the Planked Boats of the Moluccas. N.M.M. Monograph No.38, 1978.
- HOURLANI, GEORGE PALDO. Arab Seafaring in the Indian Ocean in Ancient and Medieval Times. Princeton Oriental Studies, Princeton, 1951.
- HOWSE, DEREK. The Earliest Printed Charts 1485-1569. N.M.M. Monograph No.36, 1978. Ingrid and Other Studies,
- HOWSE, DEREK, and SANDERSON, MICHAEL, The Sea Chart, An Historical Survey based on the Collections in the National Maritime Museum. David and Charles, Newton Abbot, 1973.
- HOWSE, DEREK. and BILLINGS, PAT. Handlist of Manuscript Sea Charts and Pilot Books executed before 1700. Reprinted for an inventory of the Navigation and Astronomy Collection in the National Maritime Museum, Greenwich. N.M.M., 1973.
- HUART, CLEMENT. A History of Arab Literature. Khayats, Beirut, 1966.
- HUGHES, E.R. The Invasion of China by the Western World. A&C. Black, London, 1937.
- HUMBOLDT, Baron ALEXANDER de. Voyages du Bonpland: Voyages en regions equinoxiales du nouveau continent et du progres de la premiere partie. (Examen critique de l'histoire de la geographie du Nouveau Continent et des progres de l'astronomie nautique au quinzieme et sixieme siecles.). 1st. ed. Paris 1836. Facsimile Terrarum Orbis Terrarum, Amsterdam, 1971.
- HUTSON, A.B.A. The Navigator's Art. Mills and Poon Ltd., London, 1974.
- HYDE, W.W. Ancient Greek Mariners. Oxford University Press, 1949.
- IRVING, WASHINGTON. The Life of Christopher Columbus. Henry Bohn, London, 1850 ed..
- IZON, JOHN. Sir Thomas Stucley c1525-1578, Traitor Extraordinary. Andrew Melrose, London, 1956.
- JACK-HINTON, C. The Search for the Islands of Solomon 1517-1838. Clarendon Press, Oxford, 1969.
- JOHNSON, F.R. Astronomical Thought in Renaissance England. A Study in English Scientific Writings from 1560-1645. John Hopkins Press, Baltimore, 1937. p.121.
- JONES, R.V. Navigation and War. (Duke of Edinburgh Lecture on 23rd. October 1974 to the Royal Institute of Navigation, Kensington Grove, London). Journal of Navigation Vol.28, No.1, 1975. pp.1-24.
- INGLETON, G.C. The First Navigation of Torres Strait. Some Comments. Journal of Navigation Vol.31, No.2 May 1978. p231-243
- KEUNING, J. De Tweede schipvaart der Nederlanders Naar Oost Indië onder Jacob Cornelisz van Neck en Wybrant Warwicq, 1598-1600. Kaarten. Linschoten Vereeniging, SGravenhage, 1941.
- KEMP, PETER. The Oxford Companion to Ships and the Sea. Oxford University Press, 1976.

- KIRTLAND-WRIGHT, JOHN. The Geographical Lore of the time of the Crusades. A Study in the History of Medieval Science and Tradition in Western Europe. Dover Books, New York, 1965.
- KUEI-SHENG, CHANG. The Maritime Scene in China at the Dawn of the Great European Discoveries. Journal of American Oriental History. Vol.94 1974. pp.347-357.
- LACH, DONALD F. Asia in the Making of Europe. Book 1 2Vols. Book 2 3Vols. University of Chicago Press, 1965-1977.
- LATHAM, R.E. Revised Medieval Latin Word List. Oxford University Press, London, 1973.
- LESSA, W.A. Ulithi: A Micronesian design for living. Holt Richard & Wilson, New York, 1966.
- LEWIS, DAVID. The Voyaging Stars. Secrets of the Present Island Navigators. Collins, Sydney 1978.
- We, the Navigators. Australian National Press, 1972.
- LLOYD, CHRISTOPHER. Article in Decorative Arts of the Mariner. Jupiter Books, London, 1974.
- LONDON MUSEUM. The Dutch in London. Catalogue of an Exhibition held at the London Museum 1971. London Museum, 1971.
- LYNAM, EDWARD. English Maps and Map Makers of the Sixteenth Century. Geographical Journal Vol.116. 1950. pp.7-28.
- LYNCH, JOHN. Spain under the Habsburgs. Vol.1. Blackwell, Oxford, 1964.
- MACINTYRE, DONALD. The Privateers. Paul Elek, London, 1975.
- McKEW - PARR, CHARLES. So Noble a Captain. The Life of Ferdinand Magellan. London, 1955.
- McLEAN, ANTONIA. Humanism and the Rise of Science in Tudor England. Heineman, London 1972. p.124.
- MADDISON, F. Early Astronomical & Mathematical instruments- a brief survey of sources and modern studies. History of Science Vol.2 1963. pp.17-50.
- MAGHALAES, GODINHO. L'Economie de L'empire Portugais. Aux XV et XVIIe siecles. S.E.V.P.E.N. Paris, 1969.
- MAJOR, R.H. On the Discovery of Australia by the Portuguese in 1601, Supplement to Early Voyages to Australia, Hak. Soc. 1859
- MALINOWSKI, B. Argonauts of the Western Pacific. Kegan Paul, London, 1922.
- MALTBY, W. The Black Legend in England. The Development of anti-Spanish Sentiment 1588-1660. Harper Torchbooks, 1970.
- MARTIN, C. Full Fathom Five. Wrecks of the Spanish Armada. Chatto and Windus, London, 1975.
- MASAYOSHI, SUGI MOTO. See SWAIN, DAVID L..
- MASON, A.E.W. The Life of Francis Drake. Hodder & Stoughton, London, 1941.
- MASON, STUART URSULA. & MILLER, CHARLES G. There and Back: Fortaleza, in Ingrid and Other Studies Presented to David W. Waters F.S.A., F.R.Hist.S., F.R.I.N. Deputy Director of the National Maritime Museum. pp.103-108. Maritime Monographs and Reports No.36. National Maritime Museum, 1978.
- MATTHEWS, NOEL. & WAINWRIGHT, M.DOREEN. A Guide to the Manuscripts and Documents in the British Isles relating to Africa. Ed. J.D.Pearson, Oxford University Press, 1971.
- A Guide to the Manuscripts and Documents in the British Isles relating to the Far East. Ed. J.D.Pearson, Oxford University Press, 1977.
- MATO, LUIS de. Les Portugais a l'universite de Paris entre 1500 et 1550. Coimbra, 1950.
- MAQBUL AHMED, S. Islamic Cartography. Paper presented to the 6th. International Conference on the History of Cartography. Greenwich, September 1975.
- MEAD, H.P. Trinity House. S. Low, Marston, London, 1947
- MILLS, J.V. Chinese Coastal Maps. Imago Mundi XI 1954. pp.151-168

- MOIR, A.L.(Prebendary). The World Map in Hereford Cathedral circa 1300 and Pictures in the Hereford Mappa Mundi by Malcolm Letts F.S.A.. Friends of Hereford Cathedral Publications Committee, 1977.
- MOIR, D.R. The Birth and History of the Trinity House of Newcastle upon Tyne. Mackenzie Vincent, Glasgow, 1958.
- MOORE, PATRICK. Watchers of the Stars. Michael Joseph, London 1974
- MOORE, S.F.C. The Seizure of Brill by the Sea Beggars. History Today 1972.
- MORISON, SAMUEL E. Admiral of the Ocean Sea. A Life of Christopher Columbus. Little and Brown, Boston, 1942.
- Portuguese Voyages to America in the Fifteenth Century. Harvard University Press, Cambridge Mass., 1940.
- MOZAI, TORAO. Two Centuries of Nautical Instruments in Japan. Journal of Navigation Vol.30, No.2, May 1977. pp.306-10.
- MUNGELO, DAVID E. Some Recent Studies in the Confluence of Chinese and Western Intellectual History. Journal of the History of Ideas Vol.XL, No.4, December 1979. pp.649-661.
- McKEE, A. The Lost Caravel, Journal of Nautical Archaeology, 8, 4, 1979
- NAKAMURA, H. Les Cartes du Japon qui servaient de modele aux cartographes europeens au debut des relations de l'occident avec Japan. Monumenta Nipponica Vol.II 1939. pp.100-123.
- NAMBIAR, O.K. The Kungali's Admirals of Calicut, Asia Publishing House, Bombay, (2nd edition) 1963
- NEEDHAM, JOSEPH. China, Europe and the Seas Between. Abstract of Material Presented at the International Maritime History Commission at Beirut 1966, in Societes et Compagnies de Commerce en Orient et dans l'ocean Indien. S.E.V.P.E.N. Paris, 1970.
- Chinese Astronomy and the Jesuit Mission. China Society, London, 1958.
 - Clerks and Craftsmen in China and the West. Cambridge University Press, London, 1970.
 - Science and Civilisation in China. 5 Vols. Cambridge University Press, London, 1958-1973.
- NELSON, HOWARD. Maps from old Cathay. Geographical Magazine 1975 pp.700-710.
- NORTON, F.J. Printing in Spain, 1501-1520. Cambridge University Press, London, 1966.
- NOWELL, C.E. Prince Henry the Navigator and brother Dom Pedro. Hispanic American Review. XXVIII 1948. pp.62-67.
- OKAMOTO, YOSHITOMO. The Namban Art of Japan. Heibonsha Survey of Japanese Art. Weatherhill, New York, 1972.
- PADFIELD, P. Tide of Empires. Decisive Naval Campaigns in the Rise of the West. Vol.I 1481-1654. Routledge Kegan Paul, London, 1979.
- PARKS, G.B. and SKELTON, R.A., Gian Battista Ramusio, Navigazioni et Viaggi, Venice, 1563-1606, Theatrum Urbis Terrarum, Amsterdam, 1970, (3 volumes)
- PARRY, J.H. The Age of Reconnaissance. Discovery, Exploration and Settlement, 1450-1650. Cardinal, London 1973 edition.
- The Discovery of the Sea. Weidenfield and Nicolson, London, 1975. Also The Dial Press, New York 1974.
 - Europe and a Wider World, 1415-1715. Hutchinson, London, 1969.
 - (Ed) The European Reconnaissance. Selected Documents. Macmillan, London, 1968.
 - The Spanish Seaborne Empire. Pelican, London, 1973.

- PELLIOT, P. Les Grands voyages maritimes chinois au debut du XVIeme siecle. T'oung Pao. Vol.XXX. 1933. p.229.
- Review of Chau Ju Kua.(Ed.W.W.Rockhill and F.Hirth). T'oung Pao. Vol.IX 1912. pp.446-81.
- PENROSE, BOIES. Travel and Discovery in the Renaissance, 1420-1620 Harvard University Press, Cambridge Mass., 1960.
- PHILLIPS, M.G. The Seaports of India and Ceylon described by Chinese Voyagers of the Fifteenth Century, together with an account of Chinese Navigation. Journal of the Royal Asiatic Society, North China Branch, New Series No.20 1885.pp.207-226 and No.21 1886. p.30 et seq..
- PLAUTIUS, GASPAR.(PHILIPONUS HONORIUS pseud.) Nova Typis Transacta Navigatio in Novi Orbis Indiae Occidentalis et Nunc primum et variis Scriptoribus in unum collecta. 1621. authore H.P. (Vatticinium de Messia)
- PLUMLEY, N.M. The Royal Mathematical School, Christ's Hospital. History Today. 1965. pp.581-7.
- POLLARD, A.W. & REDGRAVE, G.R. A short Title Catalogue of Books printed in England and Ireland, and of English Books printed Abroad. The Bibliographical Society, London, 1926.
- POWICKE, Sir F.Maurice & Foyde E.B. Handbook of British Chronology Royal Historical Society Guides and Handbooks No.2. Royal Historical Society, London, 1961.
- QUINN, D.B. & CUMMING W.P. & SKELTON, R.A. The Discovery of North America. Elek, London, 1971.
- QUINN, D.B. Hakluyt Handbook. Hak.Soc.2nd Series, 144, 145 London 1974
- RAVENHILL, WILLIAM. As to its Position in respect to the Heavens. Sixth International Conference on the History of Cartography. N.M.M., Greenwich, 1975.
- ITCHIE, Rear Admiral G.S. The Admiralty Chart. British Naval Hydrography in the Nineteenth Century. Hollis and Carter, London, 1967.
- Five Hundred Years of Graphical and Symbolised Representation on marine charts. 6th. International Conference on the History of Cartography, N.M.M., Greenwich, 1975.
- ROCHE, T.W.E. The Golden Hind. Arthur Barker, London 1973.
- RODITI, EDOUARD. Magellan of the Pacific. Faber, London, 1972.
- ROWSE, A.L. The Elizabethan Age, The Expansion of Elizabethan England, Macmillan's, London, 1955
- SAINSBURY, NOEL. Calendar of State Papers. Colonial Series, East Indies, China and Japan, 1513-1616. Longman, Green, Longman & Roberts, London 1862. (Note: The India Office Library has changed most of the manuscript reference numbers since this volume was produced. Modern reference numbers are given in the text of this study.).
- SANDERSON, M. Catalogue of the Library of the National Maritime Museum. Vol.III. Atlases and Cartography, 2parts, H.M.S.O. 1971.
- Catalogue of the Library, Vol V, Naval History Part I From Early times to 1815, H.M.S.O., 1976
- SANG WOON JEON. Science and Technology in Korea: Traditional Instruments and Techniques. M.I.T. Press, 1974.
- SANCHES, B.A. ALONSO. Fuentes de la Historia Española ensayo de bibliografía sistemática de las monografías impresas que ilustran la historia política nacional de España, excluidas sus relaciones con américa. Junta para ampliación de estudios e investigaciones científicas centro de Estudios Historicos. Madrid, 1919.
- SCHILDER, G.G. The Organisation and Development of the Dutch East India Company's Hydrographic Office in the 17th. Century. Sixth International Conference on the History of Cartography, Greenwich, 1975.

- SEIHO ARIMA. See ARIMA.
- SIMKIN, C. The Traditional Trade of Asia. Oxford University Press, Oxford, 1968.
- SIVIN, NATHAN. Science and Culture in China. M.I.T. Press. Cambridge Mass., 1974.
- SKEAT, W.W.(Ed). Chaucer, Complete Works. Oxford University Press. London, 1967.
- SKELTON, R.A. & CUMMING W.P. & QUINN, D.B. The Discovery of America. Paul Elek, London, 1971.
- SKELTON, R.A. Explorers Maps. Spring Books, London and Hong Kong, 1970.
- SMITH, GEORGE (founder). Dictionary of National Biography. 63 Vols + Index, Smith, Elder and Co., London, 1885-1903
- SOTHEY & Co. The Celebrated Library of Boies Penrose Esq. F.S.A. F.R.G.S. Removed from Barbados Hill, Devon, Pennsylvania. Travel and Exploration, Navigation and Trade. 7 June & 9 Nov. Sales 1971. 2Vols. London, 1971.
- STENUIT, ROBERT. Treasures of the Armada. Cardinal, London, 1974.
- STEVENS, H. The Dawn of British Trade to the East Indies... See facsimile editions etc..
- SWAIN, DAVID L. and MASAYOSHI, SUGIMOTO. Science and Culture in Traditional Japan AD.600-1854. Massachusetts Institute of Technology Press, 1979.
- SWECKER, ZOE. The Early Iberian Accounts of the Far East 1550-1600. A Dissertation submitted to the Faculty of Social Sciences in Candidacy for the Degree of Doctor of Philosophy. Department of History, University of Chicago, 1960.
- TAYLOR, E.G.R. & RICHEY, G.R. The Geometrical Seaman. A Book of Early Nautical Instruments. Hollis & Carter for the Institute of Navigation, London, 1967.
- TAYLOR, E.G.R. The Haven Finding Art - A History of Navigation from Odysseus to Captain Cook, 2nd.ed. Hollis & Carter, London, 1971.
- Mathematical Practitioners of Tudor and Stuart England. Hollis & Carter, London, 1970.
 - Late Stuart and Early Tudor Geography 1583-1650. A sequel to Tudor Geography, 1485-1583. Methuan, London, 1930
 - Tudor Geography, 1485-1583. Methuen, London, 1934
 - Ideas of the shape and Habitability of the Earth Prior to the Great Age of Discovery, History, June, 1937, p54-58.
- TAYLOR, GORDON. The Sea Chaplains. Oxford Illustrated Press, Oxford, 1978.
- TEIXEIRA DA MOTA. Cartographie Nautique dans l'océan Indien avant le XVIIe siècle. 6 Colloque International d'Histoire Internationale de l'océan Indien. Held at Lourenço Marques 1964. S.E.V.P.E.N. Paris, 1964.
- Some Notes on the Organisation of Hydrographical Services in Portugal until the beginning of the 19th. century. 6 International Conference on the History of Cartography, N.M.M., Greenwich, 1975.
- THEAL, GEORGE McCALL. Records of South Eastern Africa, collected in various libraries and archive departments in Europe by George McCall Theal. Printed for the Government of Cape Colony 1900. Vol VI
- THE TIMES. Tuesday 9th. September 1975. Elizabethan Sea Atlas Rediscovered. p.1.
- Monday 17th. January 1976. Samuel E. Morison. p.16..
- TILLYARD, E.M.W. The Elizabethan World Picture. Peregrine Books, London, 1968.
- TOOLEY, R.V. Maps and Map Makers. Batsford, London 6th. edition, 1978.

- TYLER, ROYALL. Calendar of Letters, Dispatches and State Papers relating to negotiations between England and Spain preserved in the archives at Vienna, Simancas, Besançon, and Brussels. Vol.XI. Edward and Mary 1553 H.M.S.O. 1916, Vol.XII. Mary 1554 H.M.S.O. 1949, Vol.XIII. Mary 1554-1558. Kraus Reprint, 1972..
- USHER, A.P. Spanish Ships and Shipping in the Sixteenth and Seventeenth Centuries, from E.F.Gray Facts and Factors in Economic History. Harvard University Press, 1932.
- VLEKKE, B.H.M. Nusantara. Harvard University Press, 1925.
- WAGNER, H.R. The Manuscript Atlases of Battista Agnese. Papers of the Bibliographical Society of America XXV 1931.
- WALLIS, HELEN. Dieppe Maps. Third International Re-union for the History of Nautical Science and Hydrography. Greenwich, 1979
- WATERS, DAVID W. The Art of Navigation in England in Elizabethan and Early Stuart Times. 1st. ed. Hollis & Carter 1958.
Revised 2nd. ed. Trustees of the National Maritime Museum 1978
- The Elizabethan Navy and the Armada of Spain. N.M.M. Monograph No.17, 1974..
 - The Iberian Bases of the English Art of Navigation in the 16th. century. Junta de Investigações do Ultramar, Lisbon, Coimbra, 1970.
 - The Navigation and Instruments of the Batavia, Dutch East Indiamen, 1629. Sième Colloque d'histoire maritime. Beirut, 1970.
 - Science and the Techniques of Navigation in the Renaissance. Maritime Monographs and Reports. No.19. N.M.M., 1974.
- WILLAN, T.S. The Early History of the Russia Company 1553-1603. Manchester University Press, Manchester 1968 (reprint).
- WINDAS (Lieut. Cmdr)Kungali, the Great Hereditary Admiral of Calicut, U.S.N.I.P. VolCXVI, December 1970, p70-71.
- WILLIAMSON, J.A. The Age of Drake. A.&C. Black, London, 1938.
- The Ocean in English History, Oxford University Press, 1941.
- WOLTERS, O.W. Early Indonesian Commerce. A Study of the Origins of Srivijaya, Cornell University Press, Ithica, 1967.
- WORCESTER, G.R.G. Junks and Sampans of the Yangtze. 2nd. edition, Naval Institute Press, Annapolis, 1971.
- WROTH, L.C. An Elizabethan Merchant and Man of Letters. Huntington Library Quarterly. No.4, August 1954, pp.299-314.
- The Early Cartography of the Pacific, Papers of the Bibliographical Society of America, Vol 32, No2 1944, p207-227.

