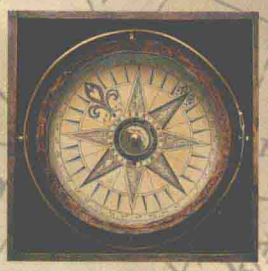

SHIPS, CLOCKS, AND STARS

The Quest for Longitude

RICHARD DUNN AND REBEKAH HIGGITT

SHIPS, CLOCKS, AND STARS

PRODUCED IN ASSOCIATION WITH THE *Ships, Clocks & Stars: The Quest for Longitude* EXHIBITION

AT THE NATIONAL MARITIME MUSEUM, PROUDLY SPONSORED BY UNITED TECHNOLOGIES CORPORATION.

United Technologies

Richard Dunn & Rebekah Higgitt

HARPER DESIGN
An Imprint of HarperCollinsPublishers

ROYAL MUSEUMS GREENWICH

Published under the title *Finding Longitude*
in the United Kingdom in 2014.

Ships, Clocks, and Stars

Authors Richard Dunn and Rebekah Higgitt

In association with
Royal Museums Greenwich, the group name for the National Maritime Museum,
Royal Observatory Greenwich, Queen's House and Cutty Sark
Greenwich
London SE10 9NF
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Published in 2014 by:
Harper Design
An Imprint of HarperCollins*Publishers*
195 Broadway
New York, NY 10007
Tel: (212) 207-7000
Fax: (212) 207-7654
harperdesign@harpercollins.com
www.harpercollins.com

Distributed throughout the world by:
HarperCollins*Publishers*
195 Broadway
New York, NY 10007

Front cover images:
The Great and Newly Enlarged Sea Atlas, by Johannes van Keulen
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ISBN 978-0-06-235356-6

Library of Congress Control Number: 2014940259

Printed in China

First Printing, 2014

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Director's Foreword

Longitude is central to the stories of navigation and discovery told by the National Maritime Museum since it opened in 1937. It gained even greater importance to us in the 1950s, when we assumed responsibility for the Royal Observatory, itself founded expressly to help solve the 'longitude problem'. It is most appropriate and a great pleasure, therefore, to be able to commemorate the tercentenary of the first Longitude Act of 1714 with an ambitious exhibition and this new book, both of which tell what is an extraordinary story for twenty-first century audiences.

The famous Harrison timekeepers are, naturally, central to it and have been a draw for visitors since coming to the Museum in time for its opening in 1937. In thinking about them in this tercentenary year, it has been fascinating to look afresh at the often fraught events that first brought them to Greenwich nearly 250 years ago, and at their broader context as part of the longitude story as a whole.

I would like to thank the authors for their efforts in researching and writing this book. Their work has been possible thanks to a major research project on the history of the Board of Longitude, run in collaboration with the Department of History and Philosophy of Science at the University of Cambridge and funded by the Arts and Humanities Research Council, to whom we are most grateful. I should also like to thank United Technologies, which has supported the exhibition so generously. Together, the book and exhibition present an extraordinary story of innovation, creativity and competition that changed how we understand our world.

Dr Kevin Fewster am frsa
Royal Museums Greenwich

Sponsor Statement

Innovation is timeless. Yesterday's ideas form the foundation for today's inventions, which power tomorrow's solutions. At United Technologies, we are proud of our long history of pioneering innovation to make modern life possible. We understand the relentless drive of those who sought to solve the longitude problem. It's the same drive that pushes us to solve today's global challenges. In this spirit of innovation, we are delighted to sponsor the exhibition *Ships, Clocks & Stars: The Quest for Longitude*. We hope you are inspired by this great story.

Louis R. Chênevert
Chairman & Ceo,
United Technologies Corporation

Foreword

The Longitude Act of 1714 was an extraordinary event, an unprecedented moment when natural philosophers put a scientific problem on the political and national agenda. Their success was evident in the speed with which Parliament took up the call to action, and in the large rewards that the Act offered – sums that could be life-changing for the winners. More important, the potential rewards would incentivize energetic and ingenious efforts to meet the challenge, and the measurement of longitude was indeed the number-one technical challenge for a maritime nation.

The Act was also notable in creating a diverse group of experts, the Commissioners of Longitude, who brought together Britain's naval, political, academic and scientific interests. The Commissioners constituted what was in effect the first 'research council', aimed at rewarding invention and innovation. And although it is best known for the long-delayed recognition of Harrison's achievements, the Commission remained in existence for more than a century, rewarding other ingenious inventions and explorations.

The ex-officio members of the Commission included the Astronomer Royal, the President of the Royal Society, and a Cambridge professor. As the fifteenth Astronomer Royal, as well as a former holder of the other offices, I have special historic links with the Commission ('Astronomer Royal' is now, however, just an honorary title, without any formal link with Greenwich). I am therefore delighted that the 300th anniversary of the Longitude Act should be marked by a splendid exhibition at the National Maritime Museum. This fine book accompanies the exhibition. It tells the story of the search for practical ways of determining longitude while on a ship at sea, a quest that many considered to be as hopeless as the search for perpetual motion or eternal life. Yet the problem was effectively solved in the eighteenth century, largely by British artisans and philosophers.

This book takes a broad view of the subject, tracing the history from the attempts of the sixteenth and seventeenth centuries, some of which seemed genuinely promising, to the mid-nineteenth century, by which time new techniques for measuring longitude at sea had been embedded in naval routines. These advances helped create a better understanding of the world through improved charting, in which British surveyors and ships were a major force.

The story is also about problem-solving – the process of identifying a problem, exploring different options to overcome it, and then bringing workable solutions to a state where they can be used by all. Clock- and watchmakers including John Harrison, John Arnold and Thomas Earnshaw, and astronomers including Edmond Halley and Nevil Maskelyne, all feature prominently. But it is also a story that shows that the most difficult technical problems are not solved instantaneously: they usually require huge efforts over a long time to become a part of everyday life, often necessitating what we would now call 'public/private partnership' whereby the state offers support to inventors and entrepreneurs. Thanks to the priority given to the longitude challenge, London became a crucial centre for the development and discussion of ideas, instruments and techniques that would underpin major changes in seafaring, which was Britain's lifeblood.

MARTIN REES, ASTRONOMER ROYAL

A World Divided

it is well known by all that are acquainted with the Art of Navigation, That nothing is so much wanted and desired at Sea, as the Discovery of the Longitude, for the Safety and Quickness of Voyages, the Preservation of ships, and the Lives of Men.

'An Act for providing a Publick Reward for such Person or Persons as shall discover the Longitude at Sea' (1714)

In 1494, Spain and Portugal partitioned the world. Under the Treaty of Tordesillas, signed that year, a line 370 leagues west of the Cape Verde and Azores islands split the globe from pole to pole. Lands discovered to the west of the line would belong to Spain, those to the east to Portugal. East–west position – longitude – had become territorial. Yet the treaty did not explain which of the islands was to be used to determine the line's position, or how to translate leagues (roughly three miles) into degrees and so decide whether new discoveries lay to east or west. Portugal also assigned more leagues to a degree of longitude than did Spain, placing more territory under its domain. Moreover, the Treaty had effect only in the Atlantic hemisphere and things became even more difficult when both nations reached the East Indies. Within a few years, matters came to a head there over possession of the Moluccas, the 'Spice Islands'. The struggle for the control of the lucrative spice trade was intense, and the conflict between Spain and Portugal was only resolved in 1529 by the Treaty of Saragossa, which specified an equivalent dividing line in the East. Global positioning was, even then, a serious political matter.

This book is an account of how the determination of longitude at sea became feasible, and of how global positions could be agreed and the world known with greater clarity. On the one hand, it is a tale of seafaring, time and astronomy; on the other, it concerns commerce, competition and conflict, exploration and empire. The 'longitude problem', as it has become known, was a technical challenge that taxed the minds of many of the great thinkers of the Renaissance and Enlightenment. Galileo Galilei, Christiaan Huygens and Isaac Newton all grappled with it as a puzzle that seemed insoluble. Finding the longitude became a ridiculous quest only to be undertaken by the deluded, until the simultaneous development in the late eighteenth century of two practicable, complementary means of fixing a ship's position changed everything. These methods gradually came into use, both for routine navigation and for creating better charts of the

world's oceans and coastlines, mapping the Earth in ways that had been inconceivable in 1494.

The quest for longitude is an international story, and this account touches on important work in the Netherlands, France and other countries from the late fifteenth century onwards. However, the main focus is on events in Britain from the early eighteenth century to the middle of the nineteenth. It was in Britain that the rewards offered under the Longitude Act of 1714, and the creation of an administrative structure to support promising ideas, led to the testing and development of the two methods that would eventually come into standard use at sea.

Why it should have been in Britain that the problem was solved is one of the issues this book addresses. The answer has much to do with the relationships operating between government, commerce and science at the time. Longitude solutions were encouraged by the British state through the 1714 Act, as had happened elsewhere; but, crucially, the new incentives addressed a British audience of skilled, commercially driven artisans working in a context of public discussion of new ideas. The Act therefore played to the strengths of Britain's metropolitan culture of craft skill and open intellectual debate.

Longitude mattered greatly at sea, but much of the story of how it was found and then deployed took place in cities on land, among academics and artisans. Crucially, the Commissioners of Longitude named in the 1714 Act eventually took on the role of encouraging promising work over many years, and of fostering the means by which the new techniques could be used on all ships, not just Britain's alone. It was not simply a matter of paying a reward; good ideas needed to be turned into reliable tools. Once they had been, Britain's existing maritime dominance allowed its navy to lead efforts to deploy the new methods for finding longitude in order to chart the world with certainty. As a result, a new line, now passing through the Royal Observatory at Greenwich, would come to divide the globe and define every ship's longitude.

(following page) – A map of the world, by Paolo Forlani, published by Fernando Bertelli, 1565

VNIVERSALE DESCRITTIONE DI TVT

OCEANO SETENTRIONALE
TERRA DE LABORADOR
SEGVENAY REG.
CANADA PRO.
BACALEAOS
CIRCVLO ARTICO
TERRA INCOGNITA
NVEVA FRANZA
LARCADIA
GOLFO DI TONZA
LE SETE CITA
TROPERA PRO.
OCEANO OCCIDENTALE
CANARIE
TROPICO DE CANCRO
CVBA
MALVCHE
MAR DELA CHINA
MAR DEL SVR
EQVINOTIALE
QVITO
PERV
BRASIL PRO.
ATACAMA
CHILACA
CHILI
PLATA
OCEANO MERIDIONALE
STRETO DE MAGALANES
TERRA DEL FVEGO
CIRCOLO ANTARTICO
TERRA INCOGNITA
MERIDIONALE DISCOPERTO DA NOVO
TERRA INCOGNITA

LA TERRA CONOSCIVTA FIN QVI

CHAPTER 1

THE PROBLEM

Nowe some there be that be very inquisitive to have a way to get the longitude, but that is to tedious.

William Bourne, *A Regiment for the Sea (1574)*[1]

Seafarers have always needed to know where they are to avoid danger and ensure a successful voyage. First and foremost, this was about safety, although they appreciated that more precise navigation could increase speed and efficiency. To most, this meant pinpointing the ship's latitude and longitude on a reliable chart. Latitude was fairly straightforward to measure from a ship. Longitude was the problem and good charts could only be produced when both could be measured.

As European vessels made longer and longer voyages from the fifteenth century onwards, navigation, including the determination of longitude, began to matter more. Long-distance trade, in particular, drove the desire for speed and reliability, and with it navigational certainty, to make voyages safer and more profitable. As international trading networks developed, and with them the need for stronger navies, navigational knowledge and training became more important to those with commercial and political power. Yet, despite this growing interest, the problem of determining longitude at sea would challenge seafarers, artisans and men of science for centuries before being solved, in principle at least, in the mid-eighteenth century. In the meantime, and, indeed, for long afterwards, seafarers relied on knowledge and techniques that had been developed over generations. Many voyages were successful, some ended in disaster.








... some difference arose between them about Latitude and Longitude; Mr. Kempthorne alledging that there was no such word as Longitude; after that, further angry words arose

Evidence at the trial of John Glendon, convicted of the manslaughter of Rupert Kempthorne at the Ship Tavern in Temple Bar, London in October 1692[2]