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LOOKING FOR LONGITUDE

How English clockmaker John Harrison changed the history of maritime travel with the world's first marine chronometer

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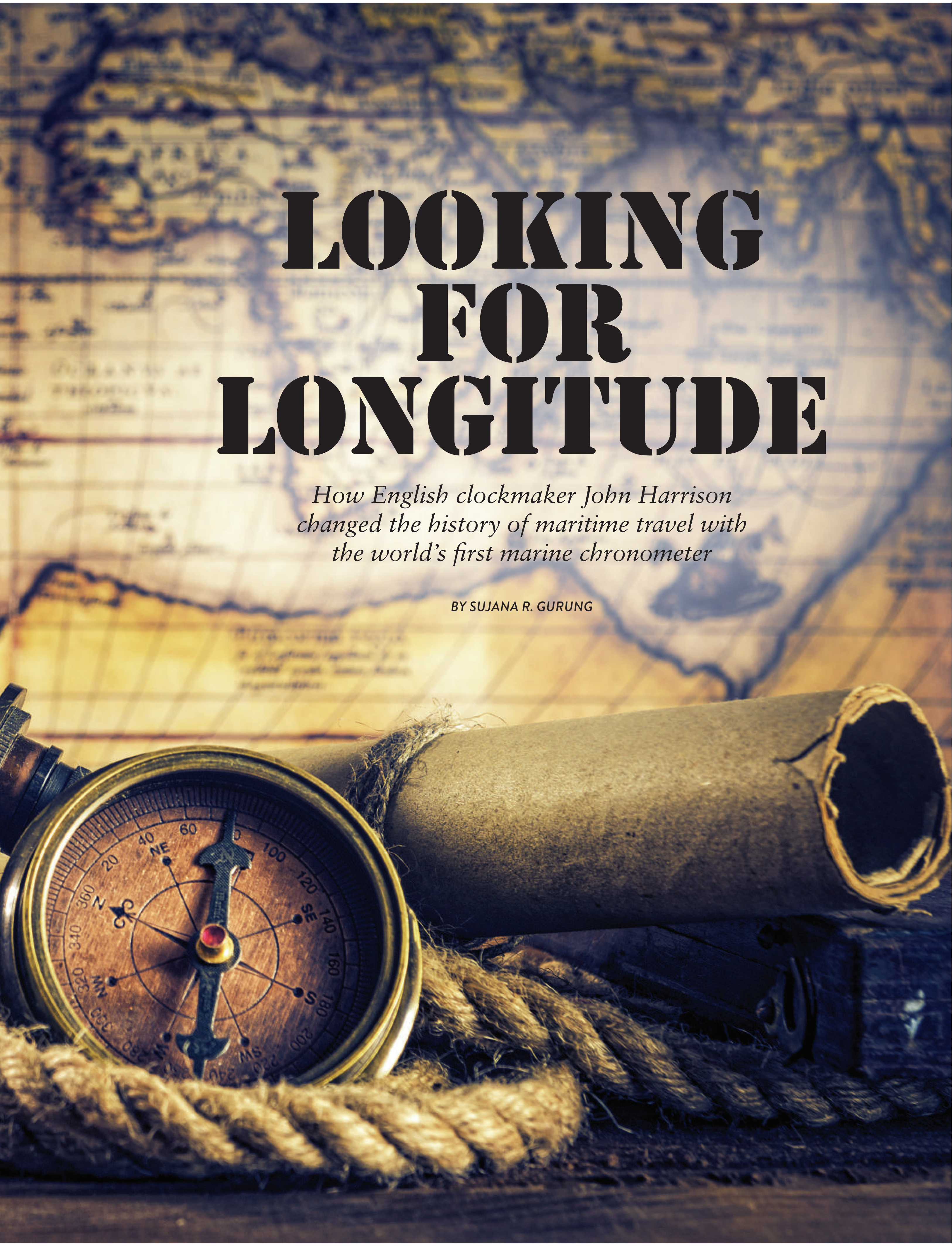

In the old days, people measured the position of the moon using a navigational instrument like a sextant

During the 1700s, the world saw a massive increase in transoceanic travel, courtesy the immense technological advancements taking place across the globe. With this, there was also a need for an accurate and reliable way of navigation at sea, especially one based on longitude. Measuring the east-west position of a ship could determine its precise location. This helped avoid naval disasters like the Scilly tragedy of 1707, which killed nearly 2,000 sailors.

So, in 1714, the British government set up the Longitude Act, which offered £20,000 to anyone who could pinpoint the location of a ship by knowing its longitude. There were several winners, and they were rewarded for their determination and dedication in not just finding a solution to the longitude problem but, in the process, improving the instruments or publishing atlases and star charts.

Like Leonhard Euler, a notable Swiss mathematician and Tobias Mayer, a German astronomer, who were awarded £300 and £3,000, respectively, for their contribution to the development of accurate longitude tables and the lunar distance method. Larcum Kendall, a British watchmaker, was awarded £800 for his copy and subsequent refinements of English clockmaker John Harrison's sea-watch. While the Board of Longitude (a British government body formed to administer the Longitude Act) did not award the full money to one person at a time, John Harrison, the most prolific among them, was awarded £23,065 over many years.

When it came to the longitude problem, there were basically two schools of thought. One was based on the principle of time difference between the reference points (current and local time), which was earlier estimated from the position of the sun and later by carrying a mechanical clock. This, however, did not work because of the miscalculations and ambiguity involved in computing the time difference between the reference points. Additionally, any attempt to determine the local time with an accurate pendulum clock (which existed in the 18th century) failed due to the motion of the ship and changes in temperature and humidity while at sea.

Astronomical observations were the next best bet. With Charles II and the creation of the Royal Observatory in 1675, many observations were carried out. One of them was to prepare an accurate catalogue of the positions of the stars. This catalogue was then used to calculate the Greenwich Time (or any other point) in reference to the moon's motion relative to the stars. However, the challenge remained in predicting the moon's complex motions and

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English clockmaker John Harrison

FOR HIS FIRST SEA CLOCK H1, HARRISON OPTED TO USE TWO DOUBLE-ENDED PENDULUMS OR BALANCES TO ENSURE ACCURACY WHILE AT SEA

H4, the first marine chronometer developed by John Harrison and Lardum Kendall's exact replica of the H4

perfecting the instruments required to make accurate observations.

John Harrison, an English carpenter and clockmaker, came to the rescue. Bringing to life the age-old proverb of "necessity being the mother of invention", Harrison took on the challenge and began work on his device—the first marine chronometer to calculate longitude at sea. What worked for Harrison (and proved fatal for the others) was his perception of the problem. While others attempted astronomical solutions, he believed that accurate timekeeping was the key to the longitude problem.

If one knew the accurate time of his local place and referenced it with a distant place (with a known longitude), then one could easily use the difference in time to calculate the current longitude position. How? With 24 hours in a day, one hour of time difference corresponds to 15° of longitude (360°/24 hours = 15°/hour). Hence, every four minutes of difference in time is translated into one degree difference in longitude. With a little bit of calculation, once could easily figure out the current location in longitude.

Keeping this theory in mind, Harrison went on to design and create his three sea clocks; H1, H2 and H3. For H1 (the one that took five long years to make), Harrison opted to use two double-ended pendulums or balances to ensure accuracy while at sea. However, the machine's accuracy was heavily affected by the motion and temperature changes while at sea. Despite its failure, the Board of Longitude still saw some promise and decided to fund his work.

The resolute Yorkshire clockmaker went on to design and develop two more clocks, H2 and H3, which were improvements on his first design. The former being a more compact and rugged version of the original marine chronometer. But due to the ongoing war between England and Spain, H2 could not be tested. During this time, Harrison realised an important design flaw in his sea clocks. He had disregarded the direct affect of the "yawing" action of a ship to the bar balances.

Taking this into account, Harrison set on to correct his mistake and started working on circular balance springs for his third sea clock—the H3. After 17 years of working on the clock, he still could not get his clock to perform the way he wanted. His limited understanding of the physics behind the springs that control the balance wheels affected the accuracy of his clock.

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Deeply disappointed, he started to look for new ways and methods to improve his clocks. The year 1755 saw a sudden change in Harrison's tactic. He realised that instead of a humongous sea clock, he could comfortably achieve accuracy on sea with a simple pocket watch. For the next few years, Harrison combined his understanding of watchmaking with the mechanisms of watches built by Thomas Mudge (an English horologist who invented the lever escapement) to develop his masterpiece - an oversized pocket watch called the H4.

Engraved with his signature, marked Number 1 and dated AD 1759, the H4 went on to prove itself on not one but two long missions to the Caribbean. Thus was born mankind's solution to the longitude problem. A reliable timekeeper that assured the safety of sailors and also paved the way for future chronometers that would further humanity's foray into the sea. Additionally, while his previous sea clocks were never perfected to his satisfaction, his innovative work definitely marked a giant leap in revolutionising maritime travel.

So, about 300 years ago, the Longitude Prize birthed a self-taught genius who changed the world. This time around, it aims to solve the longstanding issue of antimicrobial resistance (AMR). With a £10m prize fund, and with an £8m payout, the Longitude Prize has not changed much since 1714; it is still about mankind's challenges. ○