# ASTRONOMICAL MINDS

## THE TRUE LONGITUDE STORY

THE ROYAL AFRICAN COMPANY & THE SLAVE TRADE
GREENWICH OBSERVATORY & THE LONGITUDE DISPUTE
EDMOND HALLEY & ISAAC NEWTON'S SECRET INVENTION
THE PARAMORE MUTINY & THE 1707 SHOVELL DISASTER
THE LONGITUDE PRIZE DECEPTION &
THE CHRISTOPHER WREN BLACKMAIL CIPHER

TED GERRARD

At a specially convened meeting of the Royal Society on the 26th August 1699 Isaac Newton demonstrated an instrument he had manufactured in secret at the Royal Mint and loaned to Edmond Halley. The minutes of that historical meeting record that 'Mr Newton shewed a new instrument contrived by him ... with which ... Mr Hally had found the Longitude better than the Seamen by other means.' At the same meeting Halley '.... shew'd that the Coast of Brazile was ill placed in the Common Mapps.' Comments which surely must be the most underplayed navigational statements of all time.

Sir Isaac Newton never mentioned his only invention again and Captain Edmond Halley, RN., never published any details of how he determined either latitude or longitude on any of his voyages of discovery aboard Paramore. He did however publish a warning to mariners over the incorrect location of the Scilly Isles - a warning his commander-in-chief Admiral Sir Cloudesly Shovell foolishly ignored.

The author explains for the first time how Halley used Newton's secret invention to determine longitude on the high seas 70 years before John Harrison 'won' the great longitude prize and why Halley's feat has never been acknowledged.

£13.95 U.K.

ISBN 978-0-9556439-0-3

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Published by Samos Books
Broadford Skye IV49 9AQ
www.samosbooks.org

The audience, according to Flamsteed's précis, went as follows:- *'his Majesty would give a great and altogether necessary encouragement to our navigation and commerce (the strength and wealth of our nation) if he would cause an Observatory to be built, furnished with proper instruments, and persons skilful in mathematics, especially astronomy, to be employed in it, to take new observations of the heavens, both of the fixed stars and the planets, in order to correct their places and motions, the moon's especially; that so no help might be wanting to our sailors for correcting their sea charts, or finding the places of their ships at sea. Hereupon his Majesty was pleased to order an Observatory to be built in Greenwich Park: Mr Flamsteed was appointed to the work'* [10] (appendix 1).

Note the clear emphasis on maritime navigation and lunar observations from the very outset. Hooke and Wren, despite their heavy work load had somehow conjured up planning permission and finance for an observatory; the nation's longitude quest was up and running thanks to a Frenchman.

Acting on Wren's advice the king gave orders for an observatory to be built to Wren's design well away from the polluted atmosphere of London in leafy Greenwich Royal Park. In order to save time and money the site of an existing building on the highest point in the park, the remains of Duke Humphrey's Tower, was selected, which incidentally would provide stunning views across the Thames to the north. An overworked Hooke undertook to act as Wren's site manager and supervise the construction which commenced in July 1675.

As if Hooke did not have enough on his plate, he was also at this time entangled in a dispute with Louis XIV's pendulum clock specialist Huygens. In January 1675, one of the Secretaries of the RS, Henry Oldenburg had read out a letter from Huygens to an assembly of fellows. Their Dutch corresponding member was advising them that he had invented a new watch but withheld the details by concealing them in a Latin transposition cipher. The English 60 letter version would have read...

**aaaaaabccccdeeeeeeeeffhhhhiiiiilllmnnnoooooprrrrsssttttttvx**

A computer programmed with the likely text matter could probably unravel this in a few seconds, but in the 17th century it was unbreakable. Mind you, a clever person could hedge his bets should further research warrant it, by producing a solution having an alternative meaning (chapter 24). Even the mere transposing of words might be sufficient.

A month later a second communication provided the key which, translated from the original Latin revealed the details, such as they were. *'The axis of the movable circle is attached to the centre of an iron spiral.'* Even if no

## CHAPTER 12

Whether or not the *Guynie* incident was a setback for the Royal African Company's new policy of owning vessels, the *Falconberg* purchase was a money-spinner. This armed frigate bought as a replacement for the *Guynie* and named after a major RAC stockholder Thomas Belasyse, Viscount Falconberg, was destined to become the single most successful slaver of all time, despite the steady demise of her owners.

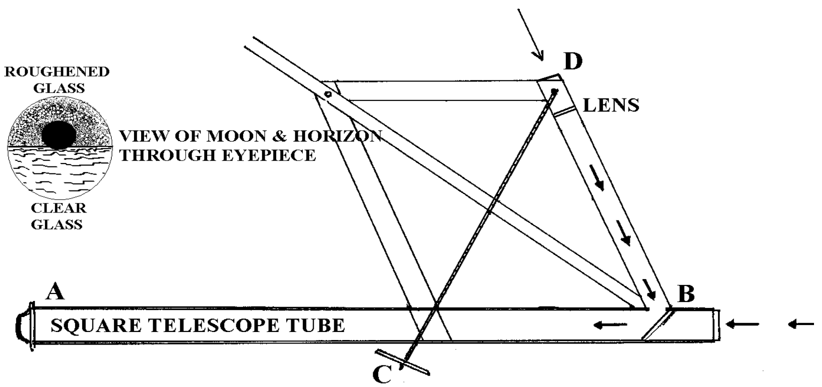
The maiden voyage of this 320-ton vessel, which left the London docks in October 1691, was not particularly noteworthy. Her total journey time for the triangular Atlantic voyage was slow, the number of slaves delivered to Barbados went unrecorded and her return 'third leg' cargo consisted of a mere 19 tons of sugar. It was almost certainly at this point that her captain was replaced.

*Falconberg* left England outward-bound on her second triangular Atlantic passage on 29th May 1694. She probably passed within sight of the *Guynie* wreck site as her crew pressed on all sail in order to clear the confines of the English Channel speedily, prudently not venturing too close to the French coast. Her cargo would have included iron ingots, many bales of cloth and crates of trading goods. Her unenviable destination on that first leg was the slave market at Ardra on the West African Gold Coast; local RAC employees posted to this hellhole had a life expectancy on arrival of only five years!

*Falconberg* did not take aboard her new cargo of slaves until the hurricane season was over and so completed the middle passage across to Barbados late in the year. There she unloaded no less than 592 live Negro slaves! This from a ship of about 30 metres in length and not much bigger than a modern luxury yacht. *Falconberg* now carrying 148 tons of sugar worth nearly £300,000 (£60 million), an unspecified amount of private imports and her normal wartime crew of about 60, was back in England by June 1695 having completed the entire three-way trans-Atlantic voyage in a little over a year.

Considering the delays caused by the hurricane season and the need clean out the holds and careen the hull in the West Indies, the captain of this particular ship was either a risk-taker or an exceptionally fine seaman. Because of these unavoidable delays, merchants usually expected their ships to take up to two years for the round trip, as indeed had been the case on *Falconberg's* maiden voyage.

Although slaver captains were rapidly acquiring the expertise to enable heavenly object, Halley had realised that he could then see both the image of the heavenly object (reflected off) and the actual horizon (seen through) the same piece of glass quite clearly. Halley had transformed Hooke's simple metal mirror idea into what could become a very useful tool. Anyone looking out through the window of a lamp-lit room towards a garden can see both the garden and the super-imposed lamp's reflection, but in the field of angle-measuring instruments this was an entirely new concept. There was no need to manufacture and polish a speculum as Hooke had done or as Newton had been forced to do for the concave lens in his reflector telescope. However, the instrument Halley described in his paper was still only at best a rough wooden test rig (figure 5) and although he planned to have a brass version made, nothing more was ever heard of this invention. In reality the flimsy instruments of Hooke and Halley would have been little more accurate (and far more difficult to use and even more easily subject to misalignment) than the back-staff, with or without lens, in general use at the time. So although the novel idea of using a single piece of glass to view two images simultaneously was never going to work well with his own angle-measuring device, Halley may well have been responsible for stimulating further research on similar lines (chapters 15 and 29).




<u>*Figure 5. Halley's mirrored angle-measuring device.*</u>
*The horizon was to be viewed directly through the telescope tube and through the lower section of the angled piece of glass at point B. The heavenly object's image would be projected down onto the upper back-roughened section of this same piece of glass through a gap cut into the square telescope tube and on into the eyepiece at A. The Moon or Sun would have been behind the viewer. The device was an advance on Hooke's design (figure 2) because a piece of half-roughened glass replaced the metal mirror which was positioned to allow the horizon to be viewed* through *the clear lower section. When the two images just appeared to touch at the join between the rough and clear glass, the angle was read off a scale on the threaded adjuster screw C-D. The view through the eyepiece would be inverted.*

and had they been permitted to maintain that north-westerly course the entire crew could well have died of thirst. The nearest land in that direction was over 1,000 miles away.

Harrison was probably aware of this and would have brought the ship's heading back on track after Fernando de Noronha had been missed to Halley's embarrassment.

The angry captain took command, reset the course and the following afternoon a speck in the vast southern Atlantic Ocean, the island of Fernando de Noronha hove into sight. But a despondent Halley had realised that the entire expedition had been jeopardised. How often had the pair disobeyed his sailing directions in the past? Were not his explicit instructions from the Admiralty to plot the positions of all lands encountered? How could he achieve this when subordinates chose to alter course to avoid such lands and maybe put their shipmates' lives in danger into the bargain? Yet almost unbelievably Halley still did not realise Harrison was the author of *Idea Longitudinis.*

Unfortunately when Halley, wisely taking Harrison and some of the crew with him, landed on the desolate scrub-covered Fernando de Noronha they could find no water and Halley failed to obtain a longitudinal fix using Jupiter although he never explained in his journal why. Cloud cover, strong winds which shook his long telescope or his unwillingness to remain ashore overnight (Jupiter was not rising until after midnight) in the peculiar circumstances prevailing; all could have been explanations.

So instead of being able to confirm that historical first lunar 'fix' of 24th February he was forced to rely on it. He fixed the longitude of the island as 31°40'W. (23°40'W of DR + the 8°). Halley then fixed the latitude as being 03°57'S by taking a tricky noon Sun observation, the Sun being at an altitude of 86° or almost directly overhead. This incidentally confirms that Newton's instrument was capable of measuring angles as wide as 90°. The true position of Fernando de Noronha is 03°52'S, 32°23'W; Halley was 5 miles in error latitudinally and at most 43 miles in error longitudinally.

Four days of sailing SW took them to the coast of Brazil and there on the very night of his arrival on 7th March, Halley finally obtained the confirmatory longitudinal lunar appulse fix (the moon passing close to a star), he had been so patiently waiting for. *'On the night we fell in with the Coast viz Februr 25th* [7th March] *I observ'd the Moon to apply to the Bulls Eye and that the starr was in a right line with the Moons horns when it was 10 deg 26 min high in the West, or at 10h 11' 44"* [pm estimated local time] *from both which observations I conclude that the Longitude of* transports. The intention was to capture the vital Spanish port of Cadiz with 14,000 troops and create mayhem all along the Spanish Atlantic coastline. If Cadiz proved impregnable they were to attack Vigo, Corunna or even Gibraltar.

Shovell was to remain in the western approaches to the English Channel to protect Rooke's back should the French Atlantic fleet chose to sail from Brest. Hamstrung by lack of ships and the men to man them, Shovell could do little all summer but organise raids on odd enemy vessels and complain to the Admiralty about his genuine manning problems. Nevertheless, his squadron did somehow manage to capture a number of unfortunates, including one with a prize value approaching £60,000 (£12 million).

Rooke spent most of the summer of 1702 in his cot suffering from gout, trying to capture Cadiz with forces more at odds with each other than their enemy. Meanwhile, information had reached the Admiralty that a Spanish Plate fleet which had left the West Indies bound for Cadiz and now had a French escort, had altered course and was now heading for either Corunna or Vigo. Rooke decided Cadiz was a tougher nut to crack than had been supposed and sailed for Vigo 350 miles to the north.

Shovell, galvanised into action by the news, now found the manning strength to sail south, hoping to intercept the Plate fleet before it reached a Spanish port. The Spanish and French neatly sailed between the two English fleets without being sighted by scouting frigates from either, docked in Vigo and began unloading the treasure and carting it into the hinterland in frantic haste.

Rook's fleet arrived before all the treasure had been unloaded, destroyed many of the Spanish ships and captured between £1,000,000 and £1,750,000 (£200 to £350 million) in silver bullion, together with a small quantity of gold. The Admiralty issued strict orders for the protection of this treasure and of any seaworthy captured vessels, and Shovell was made responsible for bringing all the loot back to England post haste, which he did after removing the armaments (including 60 bronze cannons) from any un-seaworthy enemy vessels before setting them on fire.

Still being technically in charge of the coins and bullion, Shovell personally supervised its safe delivery to the Mint at the Tower in London, handing it over to the Master, Isaac Newton. Much of the silver was distributed as prize money, but the Mint finished up with some £13,000 worth of silver pieces of eight and several hundred pounds weight of the gold.

Newton, aware of the victory at Vigo, had already altered the dies for the proposed first issue of Queen Anne silver and gold coinage to include the word "VIGO" on the obverse side under the queen's bust. A nice touch and a thumb to the nose at the French and Spanish. The day following the making use of abbreviations but by using two of the 'u's' as 'v's'. A common enough substitution in Latin but one that he had avoided in his earlier construction.

This double-meaning type of cipher that contained a safety net in the event of a flaw being discovered in the ongoing research prior to formal announcement was uncommon. The normal response in such unfortunate circumstances was simply to decline to offer a decipher and hope everyone would forget all about it. Which leads directly to the use of a different type of cipher that, as with both Galileo's examples, could 'cheat' if required.

As mentioned briefly in chapter 8, Newton had early in his career used the pseudonym *'One Holy God',* underlining his Arian belief to others without revealing his name to his fellow heretics. In fact the pseudonym he had used was not *'One Holy God'* but the Latin equivalent; *'Jeova Sanctus Unus'* which was in fact also an enciphered Latinised version of his name *'Isaacus Neuutonus'*, a far from anonymous statement to anyone capable of unscrambling it properly and very dangerous to his career prospects at that time. But Newton had covered his back in so far as the decipher actually read *'Jsaacvs Neuutonus'* which would enable Newton to claim was nothing more than a terrible coincidence if confronted by an enemy; his cipher could very effectively cheat with a little Latin assistance. Also mentioned briefly in chapter 8, Newton may well have incorporated a 'signed' confirmation of his Arian principles within a cipher sent to Leibniz ... i319n… , but again he had covered his back by including it in a long string of letters and numbers.

A classic example of the misuse of Latin in manipulating ciphers to fit facts was one that was well known to everyone in late 17th century England. This one is technically a chronogram; the use of Roman numeral letters within a phrase to reveal a significant date. The *'Lord have mercy upon us'* prayer revealed the date of the great plague. 'LorD haVe MerCy Vpon Vs'.... 50+500+5+1000+100+5+5=1665. This was then updated following the Fire of London in 1666 by changing the spelling of MerCy to MerCIe. In either example again making use of the 'v' substitution.

This last illustration leads on directly to the Shovell monument in Westminster Abbey. Where better for Newton to illustrate his fascination with numerology and his knowledge of ciphers than on Shovell's monument? The obese fool had ignored data obtained by his wonderful invention and consequently drowned 2,000 innocent seamen, and then managed to get himself buried in Westminster Abbey of all places. He had died in his 57th year on the 22nd October (o.s.) 1707, a numerical total of

The three enciphered descriptions were contained within the following three strings of letters:-

**OZVCVAYINIXDNCVOCWEDCNMALNABECIRTEWNGRAMHHCCAW**
**ZEIYEINOIEBIVTXESCIOCPSDEDMNANHSEEPRPIWHDRAEHHXCIF**
**EZKAVEBIMOXRFCSLCEEDHWMGNNIVEOMREWWERRCSHEPCIP**

According to one account these were later deciphered by a Francis Williams of Chigwell in Essex but the first formally published solution appears to have come from Bancroft H. Brown of Dartmouth College, New Hampshire in 1927 [2]. By reversing the letters in each line and omitting every third letter the cipher then reads:-

WACH MAGNETIC BALANCE WOVND IN VACVO
FIX HEAD HIPPES HANDS POISE TVBE ON EYE
PIPE SCREWE MOVING WHEELS FROM BEAKE

The omitted letters spelling CHR WREN MDCCXIV Z (or CHR WREN MDCCXIIII Z in the 2nd string).

Brown's vague interpretation of these three sentences merged the second and third ciphers, suggesting the cipher referred to two instruments not three.

In 2002 Lisa Jardine published a virtually identical interpretation [3] :-

WACH MAGNETIC BALANCE WOVND IN VACVO
FIX HEAD HIPPES HANDS POISE TUBE ON EYE
PIPE SCREWE MOVING WHEELS FROM BEAKE

However Jardine managed a much better explanation than Brown, neatly describing three instruments in modern English. 'WACH MAGNETIC BALANCE WOVND IN VACVO' related to the direct method of carrying standard time by marine chronometer and harked back to 1662 at the RS when *'Dr Wren proposed to try a watch in Mr Boyle's (vacuum pump) engine.'*

The 'FIX HEAD HIPPES HANDS POISE TUBE ON EYE' described, not a juggler's routine but a method for taking accurate angle measurements at sea with a special type of telescope, again relating to research started in 1662. The final 'PIPE SCREWE MOVING WHEELS FROM BEAKE' suggested a device for measuring the speed of a ship through the water via a pipe set in the prow (the beake) [4].

Neither the Brown nor Jardine solutions were precise deciphers, the 'V' at in much the same way that Hadley and Godfrey would later describe and sketch instruments prior to manufacture. But in this case, the diagram was by now either lost or had been pocketed by Jones; sketches by Newton were rare items.

The full text [1] of Newton's note as published in the *Philosophical Transactions of the Royal Society, Vol.42, no. 465 pp 155-6, 1742* but with paragraph numbers added is set out in appendix 10.

The first paragraph read '*In the annexed Scheme, PQRS denotes a Plate of Brass, accurately divided in the Limb DQ, into 1/2 Degrees, 1/2 Minutes, and 1/12 Minutes, by a Diagonal Scale; and the 1/2 Degrees, and 1/2 Minutes, and the 1/12 Minutes, counted for Degrees, Minutes, and 1/6 Minutes'* ; the rest of the letter was equally technical.

This opening paragraph confirms Newton intended to make his instrument from metal, intended to make use of a diagonal scale that could measure angles to an accuracy of better than one minute of arc and most importantly intended to use double reflection because of the statement that the half degree divisions would be doubled (by reflection) and count as full degrees.

The RS must surely have commissioned an expert familiar with twin-mirrored angle-measuring devices such as John or George Hadley to advise on a new interpretive diagram to accompany the publication. Certainly only such persons could have made sense of Newton's note. For example, how could anyone but an expert guess Newton was referring to a thin wedge of cheese shape when he wrote *'PQRS denotes a Plate of Brass'* or make any sense out of the diagonal scale division descriptions?

Unfortunately, although an expert obviously did advise the artist, by accident or design he made a confusingly poor job of it. Even worse, the drawing was then given to an engraver (figure 12) and the engraving was passed off as a copy of Newton's original (lost) *'annexed scheme'*.

The artist's wash drawing failed to match Newton's descriptive note on four major points (illustrated and discussed in appendix 10), the most obvious being that the assumed 45° arc was divided into 45 degree sections; no allowance was made for the double reflection halving the space occupied by each degree division. This glaring mistake was corrected on the engraving but surely not by the engraver?

Despite the correction, the engraver then managed to create two new mistakes and the only area left partially uncorrupted was Newton's innovative twin-mirror double reflection invention. Indeed the illustration was so misleading that Newton's newly-discovered note now conveniently posed little risk to vice-president John Hadley's reputation, a reputation