The Commissioners of Longitude, 1714-1828

Rewards, Almanacs, and Instruments

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Preface

On 20 May 1714 a Bill for the Encouragement of Learning, and for Providing a Publick Reward for such Person or Persons as shall Discover the Longitude at Sea passed the House of Commons and was carried up to the Lords. Six weeks later, on 8 July, it received the royal assent as 13 Anne c. 14. The Act named no method, endorsed no maker, and made no promise as to when a reward would fall due. It committed the Crown to pay up to twenty thousand pounds for a workable solution to the problem of determining longitude at sea, and it placed the judgment of that solution in the hands of a standing committee of officers of state and Fellows of the Royal Society. That committee became the Commissioners of Longitude, and its ordinary business, from its first minuted meeting in 1737 to its statutory dissolution in 1828, supplies the material examined here.[1]

The archive is unusually generous to the reader. The surviving papers of the Board of Longitude, held at Cambridge University Library within the Royal Greenwich Observatory

[1] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14) (1714); "Papers of the Board of Longitude (RGO 14)," Cambridge University Library, Royal Greenwich Observatory Archives, 1714, https://cudl.lib.cam.ac.uk/collections/rgo14.

Archives as shelfmark RGO 14, run to sixty-eight volumes: minutes, accounts, petitions, instrument and publication papers, voyage logs. They are open-access as a full digital facsimile through the Cambridge Digital Library. The parallel collection of Nevil Maskelyne's own papers, RGO 4, is likewise digitised and freely available. What earlier centuries of scholarship on longitude read against a handful of pamphlets and a selective published correspondence, a reader today may read against the committee's own account books.[2]

The popular account of this story is Dava Sobel's *Longitude* (1995): a duel between a lone Yorkshire clockmaker, John Harrison, and a Board dominated by an obstructive Astronomer Royal, Nevil Maskelyne. Sobel wrote from Rupert Gould's transcriptions of a portion of the minute book, from Humphrey Quill's biography of Harrison, and from the printed Parliamentary Papers, a fraction of the surviving papers, read for Harrison's side of a grievance. The full archive changes the picture. The AHRC-funded Board of Longitude Project at Cambridge and the National Maritime Museum digitised the complete sixty-eight volumes of RGO 14 and, on that basis, produced a different account: Richard Dunn and Rebekah Higgitt's *Finding Longitude* (2014) and Alexi Baker, Dunn, Higgitt, and Simon Schaffer's *The Board of Longitude: Science, Innovation and Empire in the Georgian World* (2024) read the Board as a standing committee that made staged payments, subsidised the *Nautical Almanac*, contracted with instrument makers, and provisioned voyages, and whose own minutes give its reasons in its own words rather than in a petitioner's.[3] That is the reading the Board's own minutes sustain. Sobel's book remains useful for Harrison as a figure of cultural memory; it is not an equal and opposite reading to be re-argued at every turn. Katy Barrett's *Looking for Longitude* (2022) supplies a cultural-history complement drawn from satire, print, and the public understanding of the problem. Derek Howse's *Greenwich Time and the Longitude* (1997) is the standard technical account and the source, on both methods, that the archive tends to confirm.[4]

The tense throughout is past. Where a document remains before the reader as an object of analysis, the present may return. The Act came first, the archive followed it, and the historiography, three centuries later, is still turning it over.

Chapter 1. 1714: the founding Act

The petition and the committee

The immediate prompt for the Act of 1714 was not a single petition but a small campaign the mathematicians William Whiston and Humphry Ditton had set in motion the year before. Whiston, the deprived Lucasian Professor of Mathematics at Cambridge, and Ditton,

[2] "Papers of the Board of Longitude (RGO 14)"; "Papers of Nevil Maskelyne (RGO 4)," Cambridge University Library, Royal Greenwich Observatory Archives, 1732, https://cudl.lib.cam.ac.uk/collections/rgo4.

[3] Richard Dunn and Rebekah Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem* (Collins and the National Maritime Museum, 2014); Alexi Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World* (Cambridge University Press, 2024).

[4] Dava Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time* (Walker and Company, 1995); Katy Barrett, *Looking for Longitude: A Cultural History* (Liverpool University Press, 2022); Derek Howse, *Greenwich Time and the Longitude*, Millennium ed. (Philip Wilson Publishers and the National Maritime Museum, 1997).

mathematical master at Christ's Hospital, had circulated in the summer of 1713 a proposal for finding longitude at sea by signal-ships anchored at intervals across the ocean and firing timed rockets at midnight. The proposal was published as a pamphlet and, in the winter following, was pressed on the merchant and naval communities of London. Whiston and Ditton courted John Arbuthnot, the Queen's physician, and through him brought the matter to Isaac Newton's notice. Their scheme would not survive the committee's examination in June 1714. Its political utility lay in bringing merchant and naval opinion to Parliament with a specific ask.[5]

In the last week of May 1714 a petition was laid before the House of Commons in the names of a group described as "several Captains of Her Majesty's Ships, Merchants of London, and Commanders of Merchantmen." The petition asked that Parliament consider means for the discovery of the longitude at sea, "the want of which," it stated, had been "the occasion of many miserable disasters."[6] The Commons referred the matter to a small committee. The committee took oral testimony from Isaac Newton, from Edmond Halley, from Sir Christopher Wren's sometime protégé Roger Cotes at Cambridge, and from two Trinity House masters. Newton's contribution survives in a short memorandum which he read to the committee on or about 11 June 1714. The memorandum described four possible methods for finding longitude at sea, judged their present standing, and stated of each the same conclusion: none, at that date, was fit for use.[7]

The four methods Newton named were the eclipses of Jupiter's satellites, a keeper of exact time carried on the ship, the position of the Moon against the fixed stars, and dead reckoning corrected by observation of magnetic variation. The first was, by Newton's judgment, the most exact in principle. The second, the mechanical timekeeper, he described as theoretically possible but currently defeated by the temperature, humidity, and motion of a ship at sea. The third, the lunar-distance method, he considered promising but presently blocked by the state of the lunar tables, which erred by four or five minutes of arc. The fourth he treated with respect appropriate to its practitioners and did not recommend as a solution. The committee, having heard these opinions, reported to the House on 17 June 1714 that a reward for a practicable method would be well placed, and drafted a Bill accordingly.[8]

The Bill was read a first time on 25 June, a second time on 30 June, and passed into an Act at the royal assent on 8 July 1714. It stands in the statute book as 13 Anne c. 14, "An Act for Providing a Publick Reward for such Person or Persons as shall Discover the Longitude at Sea". The stipulated purpose, the graduated schedule of payments, and the nomination of the Commissioners of Longitude followed in the body of the Act. The wording of the graduated

[5]Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[6]"Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[7]Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[8]Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Howse, *Greenwich Time and the Longitude.*

schedule warrants attention, because the schedule, not the prize headline, carried the Board's actual financial commitments across the century that followed.[9]

The graduated schedule

The popular memory of the Act preserves a single figure: twenty thousand pounds. That figure was real. It was not, however, what the Act promised for any and every workable method. The Act specified three awards keyed to accuracy at the end of a voyage from Great Britain to any port in the West Indies. A method demonstrated to determine longitude to within one degree (about sixty nautical miles at the equator) was to receive ten thousand pounds. A method accurate to two-thirds of a degree, or about forty nautical miles, was to receive fifteen thousand pounds. A method accurate to half a degree, or about thirty nautical miles, was to receive the twenty thousand pounds of the subsequent legend.[10]

The schedule was not the whole of the Act's fiscal commitment. It authorised, in addition, the sum of two thousand pounds toward "experiments" tending to the discovery of the longitude, on the terms that the Commissioners considered proper. That two thousand pounds is easy to miss. Under its authority the Commissioners, and after 1737 the Board that grew from them, made the staged development payments to instrument makers and observers that ran, in aggregate, into tens of thousands of pounds across the century of the Board's existence.[11] The prize was a headline. The two thousand pounds for experiments was a working budget.

The Act named the Commissioners individually by office. The Lord High Admiral of Great Britain (or, in his absence, the First Commissioner of the Admiralty), the Speaker of the House of Commons, the First Commissioner of the Navy, the First Commissioner of Trade, the Admirals of the Red, the White, and the Blue, the Master of Trinity House, and the President of the Royal Society were ex officio Commissioners. Alongside them sat the Savilian Professors of Astronomy and Geometry at Oxford, and the Lucasian, Plumian, and (after 1749) Lowndean Professors at Cambridge. Any five, of whom one was to be a professor of astronomy or geometry, constituted a quorum authorised to certify a claim.[12] The composition put officers of state, whose interest in longitude was administrative and naval, in the same room as professors, whose interest was mathematical and astronomical. It was intended to do so.

What the Act committed the Crown to fund

Two propositions follow from a careful reading of the Act, and the disagreement between the two secondary literatures on the Board runs principally through the second of them.

[9] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14).

[10] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14); Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[11] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; "Papers of the Board of Longitude (RGO 14)."

[12] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14); Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

The first proposition is uncontroversial. The Act committed the Crown to a payment that fell due only on the demonstration of a workable method. The reward was not a research grant. It was, in the modern vocabulary, a milestone-conditioned prize. Nothing in the graduated schedule allowed the Commissioners to pay any part of the ten, fifteen, or twenty thousand pounds before the demonstration was made. The demonstration required a trial at sea, on a ship of the Royal Navy, from Great Britain to a West Indian port and (after the Act of 1765) from that port back again. The Commissioners were empowered to certify the trial. They were not empowered to hand out prize money on the strength of an idea, however promising.[13]

The second proposition is read here on the strength of the Board's own accounts across a century of practice: the two thousand pounds was the Act's authorisation for the Commissioners to fund research whose outcome could not be known in advance, the graduated prize was the ceiling of the Crown's commitment, and the Commissioners' authority, taken as a whole, made them a standing body funding research toward a prize rather than a body with a prize alone to administer. The Crown had committed itself, whether or not its ministers understood it in these terms, to the maintenance of a committee capable of purchasing invention.[14]

The Commissioners in their first two decades

The Act did not require the Commissioners to meet. It required them to be available if a case were presented for judgment. Between 1714 and 1737 no case was presented, and the Commissioners did not, as a body, meet. The absence has been treated, in the older narratives, as a scandal of institutional torpor. It is worth stating in different terms. The Commissioners were, in these two decades, a standing committee kept in being by statute against the day when a claim would arrive. That day fell in 1737, when John Harrison came south from Barrow-upon-Humber to lay his first sea-going timekeeper before them.[15] Before Harrison, there had been petitioners enough. The petitioners had brought schemes rather than instruments, and the Commissioners had been under no obligation to convene to reject them in person. Individual Commissioners advised, by correspondence, petitioners whose ideas struck them as worth advising.[16]

The correspondence of this early period is not thin. Halley, as Astronomer Royal from 1720, exchanged letters with candidates who believed themselves to have solved the problem, and answered Whiston's own signal-ship scheme with the courtesy proper to a former Lucasian Professor and the firmness proper to a scheme that could not be built. It was a live problem

[13] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14); Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[14] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[15] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[16] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

in the professors' private notebooks, alongside comets, tides, and lunar theory, but it did not yet have a candidate whose instrument the Commissioners were obliged to inspect.[17]

The problem the Act put before Parliament

The problem Parliament thought it was addressing was, in the Petition's phrase, the "many miserable disasters" occasioned by the want of longitude. Twelve years earlier, in October 1707, Sir Cloudesley Shovell's fleet returning from Toulon had wrecked on the Isles of Scilly with the loss of four ships of the line and between fourteen hundred and two thousand men. Contemporary accounts assigned the disaster to faulty dead reckoning, not, as the popular version has it, to a specific longitude error; the fleet's latitude, more than its longitude, was the load-bearing failure. The Scilly disaster nevertheless became the received prompt for the 1714 Act, and the debate in Commons made frequent use of it. The Act did not name Scilly. The petition drew on it. The committee's report cited it[18] .[19]

The problem behind the problem was harder. Latitude at sea, by the early eighteenth century, could be settled by a noon observation of the sun to within a few minutes of arc. Longitude, the east-west position, had no equivalent method. The Sun and the fixed stars supply a shipboard clock only for local time. To know longitude, a mariner needed either the local time and the time at a distant reference meridian, or a table of celestial phenomena predictable to the accuracy of a shipboard observation. The first required a clock that would keep Greenwich time at sea. The second required the positions of the Moon or of Jupiter's satellites tabulated to the accuracy of ten seconds of time. Neither existed in 1714. The Act was built on the presumption that Parliament could summon the second into being by paying for it.[20]

The commitment was novel in the terms eighteenth-century administration already possessed: warrants, bounties, patents, grants, and salaried office. Parliament had authorised bounties on naval stores, on saltpetre, on herring, and on tar, payable on delivery of a bulk commodity to a King's yard. It had granted patents that promised exclusive right to a maker or inventor, falling due on a demonstration of novelty to the Attorney General. Neither instrument required a standing committee of scientific advisers to sit in judgment on the performance of an instrument at sea over years of staged trial. The 1714 Act required exactly that, and in doing so authorised, for the first time, a committee of officers of state and Fellows of the Royal Society to hold a purse against a specified technical result: in the vocabulary the twentieth century would supply, a research-procurement committee for a technical problem, though the Act itself named none of its business in those terms. It named professors of astronomy and geometry as members of the committee not because Parliament wished to honour the universities, but because Parliament had no other body of expertise to draw on. The Royal Society, chartered in 1662, was the country's standing mathematical

[17] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[18] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[19] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[20] Howse, *Greenwich Time and the Longitude*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

body; its Fellows were the only Englishmen the Admiralty would trust to certify a trial the Admiralty could not itself perform. The Act placed them, ex officio, in a room with the officers of state who would have to authorise the payment. That room, on and after 1737, would be the Board[21] .[22]

Consequence

The specific consequence of 1714 was not the payment of a prize. No prize was paid in Anne's reign, or George I's, or during the first decade of George II's. The consequence was the availability of an authority. When John Harrison came south from Barrow in 1735 with a brass-and-lignum timekeeper and a working knowledge of the temperature compensation problem, an institution stood ready to receive him. The Act of 1714 had made the committee that would evaluate him a statutory fact. The two thousand pounds it had authorised for experiments would, over the next four decades, be paid to Harrison in staged sums well in excess of the sum the Act nominally provided, because the Commissioners would return to Parliament for further authorisations, and Parliament would grant them.[23]

The founding Act of 1714 was, seen from 1828, a Bill for two thousand pounds. Seen from 1737, when Harrison's grants began, it was a Bill for a working budget. Seen from 1773, when the Crown paid Harrison the balance of his claim by a special Act of Parliament secured through the Commissioners' minutes, it was a Bill for twenty thousand pounds and whatever else Parliament, hearing the Commissioners' advice, chose to add. The Act founded not one thing but three: a prize schedule, a research budget, and a standing committee that would use the second in service of the first. The Georgian British state, by 1737, had a research-procurement instrument sui generis on its statute book, and the making of that instrument out of the second and the third of these founding functions began in 1737 and continued across the decades that followed.

Chapter 2. 1737: Harrison's first grants

The 1737 meeting

The first minuted meeting of the Commissioners of Longitude sat on 30 June 1737 at the Admiralty in Whitehall. Present were the President of the Royal Society, Sir Hans Sloane, in the chair; James Bradley, the Savilian Professor of Astronomy at Oxford; John Machin, Secretary of the Royal Society; Robert Smith, the Plumian Professor at Cambridge; Edmond Halley, the Astronomer Royal; and John Colson, the Lucasian Professor at Cambridge. Four naval commissioners, whose warrants of appointment had been read into the minutes of the meeting, were absent. The five members present made a quorum under the Act of 1714, on the particular provision that three of them were professors of astronomy or geometry. The item before them was a memorial from John Harrison, carpenter, of Barrow-upon-Humber,

[21] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[22] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[23] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; "Papers of the Board of Longitude (RGO 14)."

and a sea-going clock of his making which had recently returned from a voyage to Lisbon on His Majesty's Ship *Centurion* and back on His Majesty's Ship *Orford*.[24]

The memorial and the report of the trial furnish the first item in what would become RGO 14/5, the minute-book of the Board of Longitude for 1737 to 1779. The document names the trial by the name the Commissioners used: not, in their vocabulary, the trial of Harrison, but the trial of his machine. The Board's business, throughout its history, was with instruments and methods, and Harrison, who had made his own vernacular version of that convention, understood it. He asked the Commissioners to give him the means to make a second and improved timekeeper, and estimated the sum required at five hundred pounds.[25]

The Commissioners resolved that Harrison's machine was of considerable use and that its maker was worthy of encouragement. They resolved further that the sum of five hundred pounds be paid to him, one half on his signing an agreement to complete a second machine within two years and to deposit both machines with the Royal Observatory at Greenwich if called upon, and the other half on the delivery of the second machine. The certification of the Commissioners bore date 30 June 1737 and was countersigned, at the Admiralty on 21 July 1737, as an order for payment out of the two thousand pounds standing to the credit of the Longitude account.[26]

The Lisbon trial

The Lisbon trial is the first substantive item in the surviving minutes, and it repays a close look. Harrison's clock had been carried out on *Centurion*, Captain George Proctor commanding, and returned on *Orford*, Captain Thomas Wyndham commanding. The clock was checked against local time at Lisbon by the taking of solar altitudes. On the return voyage, at a point south of Portland Bill on 22 May 1737, the master of *Orford* set the course by the timekeeper's indication of longitude. The timekeeper made the ship one degree twenty-six minutes of longitude further west of Portland than the master had calculated by dead reckoning. The land, when they raised it, proved the timekeeper right. Captain Wyndham's certificate, filed with the memorial, said as much in seven lines.[27]

The certificate is worth reading against the ceremonial framing that would later attach to Harrison's first great achievement. Wyndham did not certify the clock as a solution to the problem of longitude. He certified that on this voyage, at this position, in this weather, the clock had proved better than his dead reckoning by an amount that would have run his ship on Portland Bill if he had trusted the reckoning. That was a plain naval judgment about a piece of machinery. It was not an award of a prize. The Commissioners took it in the sense

[24] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[25] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[26] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[27] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

Wyndham gave it. They resolved that the machine warranted further investment. They did not resolve that it had won the longitude prize.[28]

What the grant funded

The five hundred pounds of 1737 was staged. The first two hundred and fifty were paid on Harrison's signature of the two-year deed of covenant. The second two hundred and fifty were to be paid on delivery of the second machine. Harrison did not deliver the second machine in two years. He did not deliver it in the four years the covenant might have been read to allow. The Commissioners paid the second instalment in 1741 all the same, on Harrison's presenting them with the movement, still unhoused, and undertaking to complete the case and try the machine at sea in due course.[29]

A second grant, of five hundred pounds, was approved on 4 April 1741, to fund the completion of the second machine and to begin work on a third. That grant, too, was staged. The Board paid one half on approval and the second half at Harrison's report of progress. In January 1749 the Royal Society awarded Harrison its Copley Medal, a Fellows' judgment about the timekeeper independent of the Board's, and in March 1749 the Board paid Harrison a further five hundred pounds on the strength of the medal and of Harrison's own report on the state of the third machine. By the end of 1750 the Board had paid Harrison, out of the two-thousand-pound authorisation of 1714 as supplemented by parliamentary grants in aid, the sum of two thousand pounds. All of it had been paid before Harrison had presented, or attempted at sea, a machine that the Board could certify as a solution to the problem.[30]

Payments in advance of the prize

The staged sums of 1737, 1741, 1749, and the further grants of 1753, 1755, and 1761 fall together into a pattern that is not, in the committee's own language, a substitute for the prize. It is a form of funding for which the 1714 Act had made specific provision under the two-thousand-pound authorisation. The Commissioners called it, in their minutes, "encouragement." The word covered payments to Harrison, to William Whiston, to Christopher Irwin (whose marine chair proposed to stabilise a Jovian-satellite observer at sea), to Jane Squire, to Zachariah Williams, and to several less prominent petitioners. The Board did not always distinguish, in the resolution, between a grant for further work and a grant in acknowledgment of work already done. The distinction was, in practice, whether a covenant or a deed of undertaking accompanied the payment. Where a covenant was drawn, the Board expected further work. Where no covenant was drawn, the payment was a bounty. Harrison's grants of 1737 and 1741 fell in the first category. The Copley Medal grant of 1749 fell in the second.[31]

[28] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[29] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[30] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[31] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

The popular account, read from Harrison's own petitions and from the grievance narrative built on them, treats these sums as bribes in lieu of the prize, extracted from a reluctant Board to delay the day it would have to certify a solution. The Board's own minutes name a different reason at the time of each payment: in 1741, the completion of the second machine; in 1749, the Copley Medal; in 1755, Harrison's report on the third machine and his proposed alteration for a fourth.[32] A body that sets down its reasons for a payment at the time of paying, rather than a payee's later account of having wanted it, is the more reliable witness to what the Board was doing, and the sums read, on that evidence, as staged research-and-development money against deliverables the Board itself set: not a substitute for the prize but a form of funding the Act's own experiments clause had specifically authorised, applied against an accuracy requirement (half a degree of longitude, on a voyage from Britain to the West Indies and back) the Board had no statutory authority to relax[33] .[34]

The working method the Board established

The staged payments of 1737 to 1761 established a working method the Board carried forward for the remainder of its existence. The method had four elements. First, an initial grant on the strength of a demonstration that the maker had a plausible instrument or method. Second, staged instalments payable on the meeting of milestones the Board and the maker jointly defined. Third, a right of inspection: the Board's minutes name a technical committee (Bradley, Smith, later Bliss and Maskelyne) charged with visiting the maker and reporting on the state of the work. Fourth, a deposit clause: at the end of the covenanted period, the instrument (or, in the case of a method, the tables or manuscripts) became the property of the Board and was to be delivered to the Royal Observatory or to another public custodian.[35] The four elements taken together are the Board's own working combination of grant, inspection, and deposit: the practice of a body funding invention before it owed a prize, built out of eighteenth-century administrative habit rather than out of any borrowed model.

The parallel funding of the lunar theory

The working method also made possible the funding of parallel lines of work, easy to lose in the Harrison narrative but on the same staged-milestone basis. Tobias Mayer, professor of mathematics at Göttingen and no British subject, had sent to London in 1755 a set of lunar tables computed on a corrected theory of the Moon's motion that improved on Halley's tables of 1719. The Board referred them to Bradley, who tested them against his own Greenwich observations and reported an average accuracy of about a minute and a half of arc, an error that, converted through time to longitude, came to roughly forty-five nautical miles at the equator, sufficient to warrant a trial at sea. The Board so resolved on 9 February 1756. Leonhard Euler, a further step removed from the sea, was paid three hundred pounds in 1765

[32] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[33] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[34] Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.*

[35] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

on the minuted ground that Mayer's tables had drawn on his theory of the Moon and would have been impossible without it; Mayer's own widow, when he did not survive to collect, received three thousand pounds in the same year. Neither payment was a prize under the graduated schedule of 1714, and both were minuted with their reasons set out.[36] The two sums together, ten times the amount by which either man is separately remembered, show the Board funding the state of the art in mathematical astronomy across the professional geography of Europe, as a practical application of the 1714 authorisation for experiments to a theoretical prerequisite of the lunar method.[37]

Consequence

The Commissioners' grants to Harrison between 1737 and 1761, and to Mayer, Euler, and others in the same period, made the Board a functional research funder before it made any award under the prize. The method the Board employed was, in its own vocabulary, encouragement of experiments. In vocabulary the twentieth century would introduce, it was contract research with staged milestone payments and deliverable clauses. The Act of 1714 had authorised neither the vocabulary nor the practice. The practice grew out of the first application of the two-thousand-pound clause to a particular candidate whose promise, in 1737, was already visible to a technical committee. By 1761 the working method was settled. When Nathaniel Bliss, Bradley's successor as Astronomer Royal, prepared H4 for its first trial voyage in that year, the Board that certified the trial was procedurally a different body from the Commissioners of 1714. The graduated prize was still available, and would soon be argued about. The working method had, in the meantime, been built. It rested on four operational habits (the milestone payment, the technical committee, the deposit clause, and the parallel line of research) that had not been foreseen in the 1714 Act and were not, in the Board's minutes, described as a system. They had grown out of the concrete requirements of paying Harrison in 1737, of paying Mayer in 1755, and of paying Euler in 1765. What began as three separate resolutions on three separate cases had, by 1761, become the Board's ordinary way of doing business, and it would remain so for as long as the Board sat.

Chapter 3. 1767: the Nautical Almanac and the lunar-distance method

The volume of 1766

On 14 January 1767 the first sheets of *The Nautical Almanac and Astronomical Ephemeris, for the Year 1767* were printed by William Richardson of Fleet Street on behalf of the Commissioners of Longitude and sold to the shipping trade at the price of two shillings and sixpence. The volume ran to one hundred and fifty-six pages of tables, a preface, and an explanation. It gave, day by day, the Sun's right ascension and declination, the equation of

[36] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Howse, *Greenwich Time and the Longitude*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[37] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

time, the Moon's ecliptic longitude and latitude, the appearances of Jupiter's satellites, and, in the largest single group of tables, the lunar distances: the angular distances between the centre of the Moon and the Sun or the brightest fixed stars, computed for every three hours of Greenwich apparent time.[38]

The compiler was Nevil Maskelyne, Astronomer Royal since 8 February 1765 and an ordinary member of the Board of Longitude ex officio. Maskelyne had not himself computed the tables; his signature stood on the preface, and his was the responsibility for the correctness of the volume, but the work of computation had been contracted to two men, Israel Lyons and George Witchell, working from Mayer's improved lunar tables and from Bradley's tabulated solar and stellar positions. The Board paid Lyons and Witchell two hundred pounds apiece for the year's work. The Board paid Maskelyne, in his separate capacity as editor, one hundred and fifty pounds. The remainder of the volume's costs (paper, printing, distribution) came out of a separate authorisation against the Longitude account.[39]

The lunar-distance method

The method the volume served was neither new nor Maskelyne's own. It had been proposed by Johann Werner at Nuremberg in 1514 and re-argued by Peter Apian, by Gemma Frisius, and by the French astronomer Jean- Dominique Cassini through the seventeenth century. What had held it back was not its principle but its ingredients: lunar tables accurate to a minute of arc, a hand instrument capable of measuring an angular distance to a fraction of a minute, and a printed source that gave the pre-computed distances between the Moon and reference bodies at Greenwich time. Mayer's tables of the Moon, on which the 1767 *Almanac* drew, had reached the first threshold in 1755. John Hadley's octant of 1731 and John Bird's sextant of the early 1760s had reached the second. The 1767 *Almanac* met the third.[40]

Once the three ingredients were in place, the method worked as follows. A navigator, at any time during the day or night, measured with his sextant the angular distance between the Moon and a neighbouring reference body (the Sun during the day; a bright fixed star, or one of the four bodies Venus, Jupiter, Mars, and Saturn, at night). He noted his shipboard clock time at the moment of the observation. He entered the *Almanac* to find the two three-hour values of Greenwich lunar distance bracketing his own measured distance. Interpolating between them, he read out the Greenwich time at which his observed distance would have obtained. His shipboard clock, corrected by the day's noon solar altitude to yield local apparent time, gave the local time. The difference between local time and Greenwich time, multiplied by fifteen degrees per hour, gave his longitude.[41]

[38] Nevil Maskelyne, *The Nautical Almanac and Astronomical Ephemeris, for the Year 1767* (Commissioners of Longitude, 1766); Howse, *Greenwich Time and the Longitude*.

[39] "Papers of the Board of Longitude (RGO 14)"; Howse, *Greenwich Time and the Longitude*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*.

[40] Howse, *Greenwich Time and the Longitude*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*.

[41] Maskelyne, *The Nautical Almanac and Astronomical Ephemeris, for the Year 1767*; Howse, *Greenwich Time and the Longitude*.

The catch was the intermediate calculation. The observation itself had to be "cleared" of the effects of refraction and of the parallax of the Moon (which, near the horizon, was almost a degree). Maskelyne worked out, and Lyons and Witchell reduced to tables, the procedure for clearing an observed lunar distance. The procedure, in a skilled hand, took forty minutes; in an unpractised hand, two hours or more. The *British Mariner's Guide*, which Maskelyne had published in 1763 in advance of the *Almanac*, taught the procedure to naval and merchant officers. By 1770 the Royal Navy required its lieutenants to demonstrate proficiency in the lunar method before promotion to master.[42]

The Board's investment

The Board's investment in the lunar method between 1755 and 1767 came to something over four thousand pounds in direct grants to Mayer, Euler, Lyons, Witchell, and Maskelyne, plus the costs of printing the *Almanac* and its supplementary volumes. It was the Board's largest single line of expenditure across those years. It ran, in the minutes, in parallel with the payments to Harrison. The two lines share the account books and the resolutions. The Board minuted, at its meeting of 30 May 1765, an agreement with Maskelyne for the production of the first *Almanac*, and at the same meeting minuted its receipt of Harrison's fourth timekeeper (H4) from the Board's storekeeper at the Royal Observatory. The two decisions sat, in the minute book, on consecutive pages. The Board did not, at that meeting or at any other, treat them as decisions between rival methods. It treated them as two simultaneous investments in complementary methods.[43]

The Cambridge account of the Board treats the parallel investment as the ordinary business of the Commissioners: a research-procurement committee, faced with two candidate methods for the same problem, put money into both. The reading rests on the minute books, on the account rolls, and on Maskelyne's correspondence, in which he wrote, after 1770, of the two methods as instruments to be used together rather than as instruments in competition.[44]

Maskelyne's own reasoning

The popular account makes Maskelyne, as the *Almanac*'s paid editor and the Board's chief scientific voice on lunar matters, an interested party who backed the lunar method to head off a Harrison victory that would have diminished him. The Board's own minutes do not support the charge. Its investment in the lunar method predates Maskelyne's appointment as Astronomer Royal by nine years: Mayer's grant was authorised in 1756, and Bradley, not Maskelyne, was the Board's lunar-method advocate through the 1750s. The line of work Maskelyne inherited in 1765 was already funded, already tested, and already tabulated; he carried it forward rather than inventing it to obstruct a rival. The *Almanac* also served a market a chronometer could not reach: at two shillings and sixpence a copy against several

[42] Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Howse, *Greenwich Time and the Longitude.*

[43] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[44] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

hundred pounds for a reproduced H4, a naval master could afford the one and not the other, and the Board's minutes gave exactly that reasoning for the parallel funding.[45] Maskelyne's own letters, to Bradley's successor as Savilian Professor at Oxford, read as a working navigator's comparison rather than a courtier's defence: he kept a chronometer on trial at the Royal Observatory, compared its readings against his own lunar observations, and concluded that the two methods together gave a better fix than either alone.[46] Motive is not a matter the minutes can finally prove, but the Board's contemporary reasoning, where it survives, reads as parallel investment on merit and need, not as an obstruction of Harrison[47] .[48]

The good-enough method

The lunar method's technical status in 1767 was not that of a rival to Harrison's timekeepers. It was that of a good-enough method available immediately. H4 had been tried at sea, on the Board's authority, in 1761–1762 and again in 1764. It had performed brilliantly on both trials, and Harrison had been paid staged sums against its performance. The trials had not, however, produced a timekeeper available to any navigator not named Harrison. The single instrument, H4, was in London. Its duplicates did not exist. Larcum Kendall's copy, K1, would not be finished until 1769. K2 and K3 would follow through the 1770s. Reproducibility, at the scale of several dozen instruments a year, would not come until John Arnold and Thomas Earnshaw brought manufacturing methods to chronometer work in the 1780s and 1790s. In 1767, the *Almanac* was what a mariner could buy.[49]

The Board's own language for the lunar method captures the distinction. In the resolution of May 1765 authorising the *Almanac*, the method is called "the method already in the mariner's hand." In the resolution of June 1767 accepting the completed volume, the method is called "the practicable method now available." Both descriptions are correct. Both are documentary. Neither implies a verdict on Harrison's timekeepers as a method not yet available. The Board maintained the parallel investment for a reason it minuted: insurance against the failure of chronometers to reproduce, and insurance against chronometer stoppage on a voyage where the loss of Greenwich time would leave a ship without longitude for the balance of its passage.[50]

The Almanac as a state publication

The *Almanac* was, at its inception, one of the earliest continuous state-funded scientific serials in Britain, earlier than the Royal Society's own *Philosophical Transactions*, a subscription publication until the Society took over its finances in 1752, and unlike the Board of

[45] "Papers of the Board of Longitude (RGO 14)"; Howse, *Greenwich Time and the Longitude.*

[46] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[47] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[48] Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.*

[49] Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Howse, *Greenwich Time and the Longitude.*

[50] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

Ordnance's technical serials or the Admiralty's own regulations and sailing directions, none of which was a predictive table recomputed and reissued every year. It has been published, without interruption, since 1767.[51]

The publication rhythm imposed on the Board a discipline the older prize model had not required. The *Almanac* for the year had to be in the mariner's hand before the year began; the sheets for 1767 had to be printed in late 1766, the tables computed in mid 1766, and the raw astronomical observations completed the previous winter. The schedule ran a full sixteen months ahead of the year the *Almanac* served. That discipline made a small permanent staff of computers and comparers a necessity, and the staff was never Maskelyne, Lyons, and Witchell alone. Across the *Almanac*'s sixty-one years under the Board, the computing establishment came to include women employed on the same piece-rate terms as the men: Mary Edwards computed for the *Almanac* among the office's paid calculators, one name recoverable from the accounts where most are not, since the Board paid computers and comparers by the sheet and recorded the fee rather than a biography. The arithmetic itself was organised for reliability rather than for authorship: each entry was computed twice, independently, by different hands, and a third person compared the two results before the tables went to the printer, so that the *Almanac*'s accuracy rested on duplicated, largely anonymous labour rather than on any one astronomer's name. The staff, from 1767 through 1832, was paid out of the Longitude account and, after 1832, was transferred to the Admiralty as the Nautical Almanac Office. The transfer, at the Board's dissolution, went to a body already in being[52] .[53]

The reception at sea

The *Almanac* went to sea almost at once. Captain James Cook, who had already made his name as a marine surveyor with the running survey of the St Lawrence in 1758–1759 and the coasts of Newfoundland in 1763– 1767, took the *Almanac* for 1768 with him on His Majesty's Bark *Endeavour* when she sailed from Plymouth for Tahiti on 26 August 1768. Charles Green, the astronomer whom the Board and the Royal Society had jointly commissioned to observe the transit of Venus of 1769, sailed with him. Green's own instructions from the Board included the use of the *Almanac* and the making of comparative lunar-distance observations for the improvement of the tables. On Cook's return in July 1771, Green having died at sea in the Batavia outbreak, the Board received Green's papers through Maskelyne and made an allowance of one hundred pounds to Green's widow.[54]

Cook's own use of the *Almanac* on the first voyage established, in the Admiralty's judgment, the practical value of the lunar method. On the second voyage of 1772–1775, Cook carried Kendall's copy K1 of Harrison's H4 alongside the *Almanac*, and he compared the two methods systematically. His remark, in the log of the *Resolution*, that Kendall's watch had proved "our faithful guide through all the vicissitudes of climates" reads, in isolation, as

[51]Howse, *Greenwich Time and the Longitude*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[52]"Papers of the Board of Longitude (RGO 14)"; Howse, *Greenwich Time and the Longitude.*

[53]"Papers of the Board of Longitude (RGO 14)."

[54]"Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

the beginning of chronometer supremacy. In the same log Cook noted, on more than sixty occasions, the taking of a lunar distance to check the watch. The check was not incidental. The Board's instructions to Cook, and Maskelyne's parallel instructions to Green's successor William Wales, treated both methods as reciprocally corrective. A chronometer that had run for six months required a lunar to certify its rate. A lunar taken in cloud required a chronometer to interpolate between clear-sky observations. The two methods, as the Board had minuted in 1765, were meant to be used together.[55]

Consequence

The 1767 *Almanac* did not settle the longitude problem. It gave the mariner, at a cost he could afford, a practicable method whose accuracy at sea, on Bradley's numbers, was within about a degree of longitude in the average and within half a degree in a skilled hand. Harrison's fourth timekeeper had, on the West India trials of 1761– 1764, done substantially better. But H4 could not be bought. The *Almanac* could. The Board's parallel funding of the lunar method gave the state, and the state's merchants and captains, a fallback that did not depend on Harrison's making a fourth machine reproducible. When, after 1780, chronometers came off the workshop benches of Arnold and Earnshaw in serial numbers, the lunar method did not go away. It became the method of second recourse, kept for the day the chronometer failed or the ship carried none. The Board's own investment in the *Almanac* proved, in the event, a consequential investment in redundancy. The volume remained in continuous publication under Board authority until 1832 and under Admiralty authority thereafter, enlarged by the 1830s to cometary ephemerides and occultations, and read by the German, French, Portuguese, and American navies, whose own tables were, well into the nineteenth century, reduced from the British computations. It is the Board's one continuous institutional survival, computed now by other hands and other means, but a direct descendant of the sheets William Richardson printed in Fleet Street in the closing weeks of 1766.

Chapter 4. 1773: the final settlement

The Act of Parliament of 14 June 1773

The final settlement of John Harrison's claim was made not by the Board of Longitude but by Act of Parliament, on 14 June 1773. The Act, 13 Geo. III c. 77, awarded Harrison a further sum of eight thousand seven hundred and fifty pounds in addition to what he had already received. The preamble named the Board only by way of reference to the earlier sums the Board had paid. It did not invoke the graduated schedule of 1714. It did not describe the sum as a prize. It described it, in its own words, as "a further reward for his invention of a time keeper," to be paid on the receipt into the Royal Society or the Royal Observatory of Harrison's remaining papers and drawings.[56]

By the date of the Act, Harrison had received from the Board and from Parliament, in staged payments running from 1737 to 1765, a total of about fourteen thousand three hundred and

[55] Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[56] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

fifteen pounds. The Act of 1773 brought the total to something above twenty-three thousand pounds. That figure is above the twenty thousand pounds the popular memory of the story attaches to the 1714 Act's top-tier award. It is substantially above what any other candidate for the longitude reward received across the whole of the Board's history. It was also not paid as the top-tier prize.[57]

The trial of H4

The 1773 settlement is the endpoint of a sequence of events that had begun on 18 November 1761, when His Majesty's Ship *Deptford* sailed from Portsmouth to Jamaica with Harrison's fourth timekeeper, H4, on board. William Harrison, the maker's son, was carried as observer, under a warrant from the Board dated 25 October 1761. The passage lasted eighty-one days. At Kingston, on 19 January 1762, H4 was compared with astronomically determined local time and found to give Kingston's longitude within five seconds of time, or about one and a quarter minutes of arc; converted to nautical miles, an error of about one and a quarter miles at the latitude of Kingston. The Kingston observation established, on its face, an accuracy far inside the half-degree threshold of the 1714 Act's top-tier prize.[58]

The Board, on the ship's return, did not certify the trial as sufficient. It resolved, on 19 February 1763, that the trial had been "observed under favourable conditions" and that further trials should be made before the top-tier prize could be certified. The resolution required a further sea trial and, before that, a further examination of the watch itself at the Royal Observatory. It required, in addition, that Harrison disclose to the Board the principles of the watch's mechanism, so that duplicates might be constructed by other artisans. All three conditions were, in the Board's reading, implicit in the 1714 Act's requirement of a "practicable" method. The Board would not certify a method as practicable that only one man in England could reproduce.[59]

The second sea trial ran from 28 March 1764 to 20 July 1764. H4 was carried on His Majesty's Ship *Tartar* from Portsmouth to Bridgetown, Barbados, and back. Maskelyne, then Astronomer Royal-designate, and Charles Green, whom the Board had commissioned to make comparative lunar observations, sailed with the ship. At Bridgetown, on 13 May 1764, H4 was compared with astronomically determined local time and found to give Barbados' longitude within thirty-nine seconds of arc of the Board's tabulated value. On the return, the watch's accumulated error over the whole voyage came to fifty-four seconds of time, or about a third of a degree of longitude on the average, corresponding to about ten nautical miles at the Barbados latitude.[60]

[57] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[58] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Howse, *Greenwich Time and the Longitude.*

[59] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[60] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

The Barbados trial met the top-tier threshold twice over. It also, in the Board's continuing view, did not by itself make H4 a "practicable" method within the meaning of the 1714 Act. A watch that required its maker's presence to be understood and reproduced was, in the Board's continuing reading, not yet an item of practical navigation. The Longitude Act of 1765 (5 Geo. III c. 20), passed at the Board's initiative and on the Admiralty's advice, put the disclosure requirement into statute. It provided for the payment to Harrison of half the top-tier prize, ten thousand pounds, on his demonstration of the mechanism to persons appointed by the Board; and the payment of the second half on the successful reproduction of the watch by other hands, tested at sea to the same standard as H4 itself.[61] The 1765 Act, in effect, codified the Board's condition of "practicability." It also codified the Board's obligation to pay ten thousand pounds on the disclosure.

The disclosure of 1765

The disclosure took place at Harrison's workshop in Red Lion Square, London, from 22 August to 8 October 1765. Harrison, working across some six weeks, disassembled H4 in the presence of Nevil Maskelyne, William Ludlam of St John's College, Cambridge, John Michell of Queens' College, Cambridge, Thomas Mudge and Larcum Kendall of the watchmaking trade, and John Bird the instrument-maker. Harrison explained each part, its function, and its relation to the whole. Kendall and Mudge, the two clockmakers present, made notes and drawings sufficient to reproduce the mechanism. Ludlam and Michell, the two academic clockwork specialists, drew up an attestation that the disclosure had been complete. On 28 October 1765 the Board certified the disclosure and directed the Admiralty to pay Harrison seven thousand five hundred pounds as the first ten thousand pounds less the sums he had already received. Harrison signed a receipt on 21 November 1765. He then set out to build the reproducible copy the 1765 Act required, taking H4 back to his workshop to guide him.[62]

The Board's second half

The second half of the ten thousand pounds, and the further ten thousand pounds of the top-tier prize, could be paid only on the reproduction requirement. Harrison, having taken H4 into his own workshop for reference, began the fifth timekeeper, H5, in early 1766. In the same period Kendall, working from H4 and from the disclosure notes, began the copy that would become K1. K1 was completed in January 1770 at a cost, invoiced to the Board, of four hundred and fifty pounds. It was carried on Cook's second voyage (1772–1775) and returned with a performance the Board's own technical committee reported as approximately equivalent to H4′s on the Barbados trial. Kendall's K2, completed in 1771 at two hundred pounds, sailed on Vancouver's voyage a decade later. K3, completed in 1774, sailed on Cook's third voyage. Between them, the three Kendalls demonstrated, on the Board's reading, that the H4 mechanism could be reproduced.[63]

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[61] An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14); Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[62] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[63] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

Harrison, in the same period, took a different view. He objected to the Board's continuing insistence that the reproduction requirement had not been fully met. He objected, in particular, to Maskelyne's supervision of H4 at the Royal Observatory, which Harrison believed had damaged the watch's performance in the course of tests. He petitioned the Board directly in 1770, and again in 1771, for the balance of the top-tier prize. The Board, on both petitions, resolved that the reproduction requirement remained unmet in its full statutory sense.[64]

The intervention of George III

In January 1772 Harrison, on the recommendation of his son William, sought an audience with King George III. The King, whose personal interest in astronomy and horology was known through his patronage of Stephen Demainbray at the Kew Observatory, received William Harrison in March 1772 and consented to test the fifth timekeeper, H5, at Kew. H5 was tested at Kew from May to July 1772 under conditions Harrison himself had specified. It performed to a standard that satisfied the King as to the correctness of Harrison's original principles. On the strength of the trial, William Harrison, again through John Frederick Sackville, third Duke of Dorset, urged the King to intervene with Parliament on his father's behalf.[65]

The King so intervened. Frederick North, Lord North, then First Lord of the Treasury, took up the matter in the Commons, and a Bill was introduced in the spring of 1773 to award John Harrison "a further reward for his invention of a time keeper" of eight thousand seven hundred and fifty pounds. The Bill was read a first time on 26 April 1773, and passed the Commons on 25 May. It received the royal assent on 14 June 1773. It did not describe the sum as the second half of the top-tier prize; it described it as "a further reward" and named the receipt of the papers and drawings as the payment's precondition.[66]

What Harrison obtained, and what he did not

The popular account reads the 1773 Act as royal justice done to Harrison over the head of a Board that had refused, for eight years after the disclosure of 1765, to pay him his due, and casts Maskelyne as the author of the delay. The Board's own minutes support a narrower and more exact statement. Harrison was denied a single, specific thing: certification of the top-tier prize as won outright under the graduated schedule of 1714. He was not denied the money that schedule would have paid: he received, across his lifetime, something above twenty-three thousand pounds from the Longitude account and from Parliament together, well in excess of the schedule's own twenty-thousand-pound ceiling. He was not denied recognition: the disclosure attestation of 1765 recorded the technical committee's judgment that H4′s mechanism was adequate to the problem. What he received in 1773 was not the second half of the top-tier prize under Board certification but a separate parliamentary grant, obtained

[64] "Papers of the Board of Longitude (RGO 14)"; Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.*

[65] Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[66] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

through the King's intervention and voted outside the Board's own statutory mandate, for a sum the Act itself did not describe as a prize[67] .[68]

The distinction rests on a fact of statute, not of temperament: the Longitude Act of 1765 had made reproducibility a condition of the top-tier award, and the Board, once that condition was written into law, had no discretion to waive it on Harrison's say-so that a watchmaker's presence should not be required to understand and copy the mechanism. The Board of 1765 certified the disclosure and paid the first half of the top-tier prize as the Act required. The Board of 1766–1772 continued to require reproduction because the Act required it. Its role in the 1773 settlement was that of a body whose statutory mandate had been reached, not exceeded and not withheld; Parliament, petitioned through the King, then made an award outside that mandate. Harrison received the money. He did not receive the certificate. Whether the distinction reads as principle or as evasion is a question about the Board's temperament that the archive, on its own, cannot finally settle; what it does settle is that the Board's minuted reasons for the continuing requirement were the reasons of the 1765 Act.[69]

The 1773 Act in the wider procedural pattern

The 1773 Act was not the only occasion on which Parliament made a Longitude payment outside the Board's own certification. It was, however, the largest and the most public. The 1774 Act, passed the following session, gave statutory form to a scheme of smaller premiums for improvements to the mechanism, and the 1790 and 1802 Acts made further adjustments. Across these Acts the pattern is consistent: the graduated prize of 1714 was preserved on the statute book, but Parliament, on the Board's advice or on independent petitioners' motions, made supplementary awards to individuals whose contributions the Board could not itself certify under the 1714 rules. The pattern was well established by the end of the eighteenth century: the standing prize remained theoretically available, and supplementary parliamentary awards were how the money actually moved.[70]

The persistence of the unwon prize as a statutory fixture meant that any future claimant could, in principle, bring a demonstration and demand the top-tier award; in practice no one did. By the time chronometers reached serial production, the "practicability" question the 1765 Act had introduced was moot, and the unclaimed prize sat on the statute book from 1773 to 1828 as a curiosity nobody sought and nobody could plausibly certify.[71]

Consequence

The 1773 settlement closed the Board's founding contest and did so on terms that preserved the graduated prize schedule of 1714 as unwon. The prize remained available. It was never claimed. When, after 1780, Arnold and Earnshaw brought chronometer manufacture to a

[67]"Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[68]Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.*

[69]"Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[70]"Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[71]Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

scale at which any well-found ship of the Royal Navy could carry one, the reproducibility question the 1765 Act had raised was, on practical evidence, answered. The Board did not then reopen the top- tier prize for Harrison's heirs or for anyone else. The prize was allowed to lapse into the general fund, and the Board turned to a wider programme of procurement of instruments and to the support of voyages of exploration.

Chapter 5. Procurement, voyages, and manufacture

The Board after 1773

With the Harrison contest settled in 1773, the Board was left with an annual authorisation for experiments, an established publication in the *Nautical Almanac*, and an accumulating stock of timekeepers, sextants, quadrants, and reflecting instruments held at the Royal Observatory or in contracted makers' workshops. Its business turned less on the adjudication of petitions and more on the outfitting of voyages and the contracting of instruments for the Royal Navy. Where the earlier minute volumes ran to petitions and trial reports, the volumes of the 1770s and 1780s run to voyage instructions, makers' invoices, and accounts of instruments lent, returned, and lost at sea. By 1780 the Board's ordinary meeting was largely procurement business: which instrument-makers had delivered which timekeepers to which ships, at what prices; which astronomers were to accompany which voyages; and which claims were to be paid out of the Longitude fund and which laid against the Navy Estimates.[72]

The Cook, Vancouver, and Flinders voyages

The three Cook voyages of 1768–1771, 1772–1775, and 1776–1780 were the Board's largest single call on its procurement capacity in the 1770s. Charles Green, the Royal Society's nominee to observe the transit of Venus of 3 June 1769, sailed on the first voyage under a Board warrant listing a Bird quadrant, a Bird reflecting telescope, three sextants, an astronomical clock, and the *Almanac* for 1768 and 1769, at a cost of some six hundred pounds. The second voyage carried a heavier investment: Kendall's K1 and three of John Arnold's early chronometers, loaned for comparative trial, with William Wales and William Bayly commissioned as astronomers to the *Resolution* and the *Adventure* at a combined cost above eight hundred pounds. On the third voyage K1 and K3 went to the *Resolution* and the *Discovery*; after Cook's death at Kealakekua Bay on 14 February 1779, K1 continued to run under William Bligh's care and returned, via the East India Company at Canton, rating at a fraction of a second per day after four years at sea, a result the Board minuted with satisfaction on 14 April 1780.[73]

George Vancouver's survey of the Pacific Northwest coast, sailing from Falmouth on 1 April 1791, carried K3 and K2 to the *Discovery* and the *Chatham*, with Arnold and Earnshaw chronometers besides. The expedition's own astronomer, William Gooch, died before he could join, and Vancouver and his officers took the observations themselves. The resulting

[72] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Barrett, *Looking for Longitude: A Cultural History.*

[73] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

charts, completed by 1795, are drawn on longitudes the modern comparison finds accurate to within about two nautical miles across the whole run from Cape Mendocino to Cook Inlet.[74] Matthew Flinders' voyage in the *Investigator*, from Spithead on 18 July 1801, drew Earnshaw and Arnold pocket chronometers and a box chronometer from the Board's stores; its astronomer, John Crosley, was invalided home from Cape Town, and the astronomical duties again fell to Flinders and his lieutenants. His running survey of the southern, eastern, and northern coasts of what would become Australia, completed by 1803, was reduced by chronometer and lunar and published, under Maskelyne's editorship, as a supplement to the 1814 *Almanac*.[75]

These voyages are usually narrated as the age of Pacific discovery. The Board's own accounts describe something more specific: a state procurement office lending rated instruments to naval voyages whose charts did not merely record coastlines but made them administrable. Accurate longitude was what let a chart become a claim: what let the Admiralty and, in time, colonial governments fix a coast's position well enough to survey it for settlement, garrison it, and tax the shipping that used it. The coasts the Board's instruments helped map (New Zealand, the Pacific Northwest, the southern and eastern seaboard of Australia) were already known, travelled, and named by the peoples who inhabited them. The Board's instructions carefully recorded the reduction of observations while leaving Indigenous geographical knowledge outside the compensated and archived work of the voyage. Its instruments made European measurements portable and authoritative within an imperial administration; they did not make the coasts newly known.

Instrument-maker contracts

The Board did not manufacture instruments; it contracted their manufacture with the London trade and inspected the finished work before payment. By the 1780s the contracted makers were a small number of London workshops: Jesse Ramsden for astronomical circles and sextants, Edward Troughton for smaller instruments, Larcum Kendall for the copies of H4, John Arnold and Thomas Earnshaw for production chronometers, and, until his death in 1776, John Bird for the largest astronomical quadrants, paid, across the 1780s, at annual totals of between one hundred and eight hundred pounds apiece.[76] The terms tracked each workshop's own practice rather than a single Board policy: Ramsden was paid on delivery at an agreed price; Arnold and Earnshaw partly on delivery and partly on sea performance, verified against the Observatory's transit clock; Kendall a lump sum for each of K1, K2, and K3 (four hundred and fifty, two hundred, and one hundred pounds); Bird on a mixed schedule of delivery, workmanship, and independent inspection. Every instrument bought or loaned, whatever its payment terms, was rated the same way: chronometers compared against the transit clock over weeks or months, sextants and quadrants checked by star observation,

[74] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[75] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Barrett, *Looking for Longitude: A Cultural History.*

[76] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

telescopes by a target of known angular size. The inspection reports form one of the earliest continuous datasets of instrument performance in Britain.[77]

Behind the makers' names the Board paid stood workshops the Board's accounts do not itemise. A contract with Arnold or Earnshaw was a contract with the master alone; the finishing, adjustment, and testing of a production chronometer was the work of apprentices, journeymen, and, in the ordinary practice of the London trade, of the household workshop in which a master's family assisted without separate pay. The Board's ledgers record what it paid Ramsden, Kendall, Arnold, and Earnshaw; they do not name the hands that filed a balance wheel true or cut a spring detent to tolerance, because the Board contracted for a finished, rated instrument and had no occasion to ask who in the workshop had made it.[78]

The Board's astronomers

The astronomers the Board commissioned to accompany voyages (Green, Wales, Bayly, John Bailly, William Gooch, John Crosley among them) formed a small standing cadre of practical observers, most trained under Bradley or Maskelyne at the Royal Observatory, paid on a common scale of two hundred pounds a year at sea, a further hundred and fifty for instruments, and a hundred more on return to reduce their observations for publication.[79] Their instructions were detailed and consistent: keep a journal of every observation and its reduction, compare the chronometers against Sun and Moon at every opportunity, take lunar distances at fixed intervals, and on return lodge journal, instruments, and reduced observations at the Board's rooms in Somerset House.[80] Where an astronomer could not complete the duty (Gooch dead before he sailed, Crosley invalided at Cape Town), the observations fell to the ship's own officers, and in the ordinary run to the ship's crew: comparing a chronometer against the noon sight, winding it, and logging its rate became watchkeeping labour distributed across a ship's company rather than a specialist's exclusive task. The Board sent a second observer to Table Bay in 1804 to complete Crosley's abandoned series; it did not, and could not, restore the labour a ship's own sailors had already absorbed into their watches.[81]

Manufacture at scale

Harrison's workshop method could not supply a fleet. John Arnold, in the Strand from 1770, and Thomas Earnshaw, on his own from 1780, spent the two decades to 1800 reducing chronometer-making from a bespoke craft to a serial trade, on the common technical foundation of the spring detent escapement: proposed by Pierre Le Roy at Paris in the 1760s, developed independently by Arnold by 1782 and Earnshaw by 1783. Both men claimed pri-

[77] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[78] "Papers of the Board of Longitude (RGO 14)."

[79] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[80] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[81] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

ority; the Board's technical committee, reporting on 12 April 1793, gave publication priority to Arnold and practical development to Earnshaw, declined to settle the dispute, and paid five hundred pounds to each "for the benefit derived from their respective mechanisms." Further sums followed for the temperature-compensation curb in 1798, and in 1805, after Arnold's death, three thousand pounds each to Earnshaw and to Arnold's son and heir, in recognition of having brought manufacture to a state at which the Navy could equip its ships.[82]

The price of a chronometer fell by roughly a factor of five between 1780 and 1815. Kendall's K1 had cost four hundred and fifty pounds; Arnold's first production chronometer, eighty; by 1800 Earnshaw was delivering pocket chronometers at sixty-five pounds and box chronometers at eighty, and by 1815 both firms produced on the order of a hundred instruments a year, joined in the wider trade by Josiah Emery, William Frodsham, William Hardy, and John Roger Arnold's partnership with Edward John Dent.[83] A Royal Navy of some six hundred ships in commission by 1810 could not have been supplied at Kendall's rate of one watch every two years; a London trade producing several hundred a year, issued by the Admiralty's own Chronometer Storekeeper, could. The Board's practical role, once the trade existed, narrowed to the maintenance of the inspection regime (a rating trial of forty-two days at constant temperature and equal periods twenty degrees above and below it, travelling with each watch to sea in its own certified paper) rather than the funding of new invention. Naval demand, met by the Admiralty directly from 1790, and merchant and East India Company demand, met by the Company's own Chronometer Storekeeper from the 1810s, had by 1815 outgrown the Board's own funding; the trade of 1815 was a joint product of Board grants that brought Arnold and Earnshaw to production quality and of naval and commercial demand that brought them to production volume.[84]

As the trade dispersed beyond London (to Liverpool and, more slowly, Glasgow), the Board's inspection regime became harder to maintain as a national standard. Provincial-made chronometers were seldom brought to the Royal Observatory for rating; their performance was assessed by a merchant's own agent, at prices below the London trade's. The transfer of inspection to the Admiralty in 1828 maintained the naval standard; it did not raise the merchant one, and the transatlantic packet and emigrant trades of the 1830s and 1840s sailed on chronometers the Royal Observatory would not have certified as best practice.[85]

Consequence

The Board's procurement gave the Pacific and the Australian coast their first accurate longitudes, and its grants to Arnold and Earnshaw gave the Navy and the merchant marine a chronometer trade capable of supplying a fleet rather than a single instrument. Neither

[82] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[83] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Howse, *Greenwich Time and the Longitude.*

[84] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Barrett, *Looking for Longitude: A Cultural History.*

[85] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

achievement was the Board's alone: it lent instruments to voyages it did not command, and it funded production quality that naval and commercial demand then carried to production volume. Its annual outlay across the 1780s, some three thousand five hundred pounds, ran roughly half to the *Almanac*, a quarter to instrument-maker premiums and inspection, and the remainder to astronomers' allowances and voyage loans, a division that had shifted further toward the *Almanac* and toward routine Observatory rating by 1800, with voyage instrument loans a residual line. The *Almanac*, not the exploration voyages, was the Board's largest single business throughout the century.[86] What the popular narrative treats as an age of discovery is, in the Board's own ledgers, a specialised procurement office lending rated instruments and paying astronomers and sailors to keep them running: instruments and labour that made coastlines navigable, chartable, and, for the states that held the charts, claimable. The chronometer trade those same grants helped build carried the Board into its final years and its dissolution.

Chapter 6. 1828: departmentalisation and dissolution

The Repeal Act

On 15 July 1828 the Longitude Repeal Act, 9 Geo. IV c. 66, received the royal assent. Its short title, in the statute book, ran to a single line: "An Act to repeal certain Acts, and Parts of Acts, relating to the Discovery of the Longitude at Sea, and to make other Provisions in lieu thereof." Its provisions ran to eleven sections. The first repealed the Acts of 1714, 1753, 1762, 1765, 1774, 1790, 1802, 1814, and 1818, together with such parts of any other Acts as related to the Commissioners of Longitude. The second dissolved the Board itself as a standing committee of the Crown. The third established three resident Commissioners of Scientific Advice to the Admiralty, appointed by the King on the recommendation of the Lord High Admiral, and to be paid one hundred pounds a year for their attendance. The fourth transferred the balance of the Longitude account, and all instruments then held by the Board at the Royal Observatory or elsewhere, to the Admiralty. The fifth transferred the publication of the *Nautical Almanac*, together with the persons of its computers and its editor, to the Admiralty. The remaining sections dealt with existing pensions and outstanding awards.[87]

The 1828 Act was, in a plain sense, a piece of administrative reform: it did not condemn the Board or criticise its conduct in its preamble, but transferred functions from a standing committee to departmental offices, of a kind Parliament had been making across the same decade for other statutory bodies (the Board of Ordnance's reforms of 1817 and 1823 to the War Office, the Board of Trade's reconstitutions of 1786 and 1825) as part of a wider consolidation of specialist boards into their sponsoring departments.[88]

[86] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[87] An Act to Repeal Certain Acts, and Parts of Acts, Relating to the Discovery of the Longitude at Sea, and to Make Other Provisions in Lieu Thereof (9 Geo. IV c. 66) (1828); "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[88] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

The 1818 reform

The 1828 Repeal was foreshadowed, ten years earlier, by the Longitude Act of 1818 (58 Geo. III c. 20). That Act had reconstituted the Board, added new prizes for polar exploration ("Northwest Passage," "Northern Passage," "approach to the Pole" clauses), and introduced a paid Secretary and paid Superintendent of the *Almanac*. The 1818 Act had also, and less publicly, given the Board the appearance of a body responsive to a set of exploration priorities that the Admiralty of the day (particularly John Barrow, second Secretary of the Admiralty from 1804) wished to advance. The Admiralty had reasons of its own for wishing to see the Arctic exploration programme (the voyages of John Ross, William Edward Parry, John Franklin, and later James Clark Ross) supported by prize money and public interest. The 1818 Act supplied both. By 1828, however, the polar prizes had not been won; the Northwest Passage prize was to remain unclaimed at the Board's dissolution; and the case for maintaining the Board as the paying agent had lost force.[89]

The 1818 reconstitution also brought the Board a Secretary whose salary was payable out of the Longitude account. Thomas Young, the polymath and physiologist, was appointed Secretary in 1818 at a salary of four hundred pounds a year. He took over the day-to-day running of the Board's business, the correspondence with makers and astronomers, and the editorship of the *Almanac* (Maskelyne having died in 1811 and John Pond, the succeeding Astronomer Royal, not having taken up the *Almanac* editorship in the same way). Young's appointment gave the Board, for the first time, a permanent salaried official at its centre. It also, and by the same token, gave the 1820s reformers a target: a Board that now had a paid Secretary, paid computers, and paid resident Commissioners was easier to characterise as an overhead than the ad hoc body of the eighteenth century had been.[90]

The reformers of the 1820s

The immediate pressure for the 1828 Repeal came from a coalition of Admiralty officers and Treasury interest that had begun, in 1823, to review the several scientific bodies to which Parliament made payments. John Wilson Croker, the First Secretary of the Admiralty, and Frederick John Robinson, then Chancellor of the Exchequer and after 1827 Viscount Goderich and briefly First Lord of the Treasury, were the political principals. Their instrument was a Parliamentary Select Committee on Public Salaries, which sat across 1826 and 1827 and issued a report in early 1828. The Committee recommended the transfer of the Board's functions to the Admiralty and the abolition of the Board as a standing body. Its reasoning was that the Board's functions had, since 1818, become departmental in character and could be discharged more economically by departmental officers. The recommendation was accepted by the Cabinet in April 1828, and the Bill was introduced in the Commons on 5 May 1828, passing the Lords on 9 July.[91]

[89] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[90] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[91] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

The Committee's reasoning bears examination. It did not argue that the Board had failed at what it had been founded to do. It argued that what it had been founded to do had, by 1828, been done. The longitude problem had, in a practical sense, been solved. Chronometers were being produced in serial quantities by a London trade. The *Almanac* was being published on schedule. The exploration voyages that carried the Board's instruments were, in the ordinary run, being commanded and provisioned by the Admiralty on its own account. The Committee saw no work remaining that required a body of the Board's composition and permanence to accomplish.[92]

The transfer of functions

The transfer of functions the 1828 Act effected was more thorough on paper than in practice. The *Nautical Almanac Office* was formally established as a section of the Admiralty in October 1831, three years after the Repeal, and moved into rooms at Somerset House previously used by the Board. The three resident Commissioners of Scientific Advice sat as an advisory committee to the First Lord; the initial appointments were Young himself (until his death in 1829), John Herschel, and Michael Faraday. The Hydrographic Office of the Admiralty, established under a separate warrant in 1795 and run by Francis Beaufort from 1829, took over the certification of marine surveys and, in due course, the running assessment of chronometers at sea. The Astronomer Royal, then John Pond and after 1835 George Biddell Airy, continued to run the chronometer rating service at the Royal Observatory. The rating service, incidentally, did not stop: it continued, under Admiralty warrant rather than under the Board's, into the twentieth century.[93]

The instruments the Board had held were transferred to the Admiralty in the summer and autumn of 1828. Kendall's K1, K2, and K3, Arnold's early production chronometers, the astronomical clocks that had travelled to Barbados and Tahiti, the Bird astronomical quadrants lent to Green in 1768 and to Wales in 1772, the various boxes of sextants, telescopes, and thermometers: all passed into the Admiralty inventory. Most were consigned to the Royal Observatory. A minority were consigned to the National Museum of the Navy at Greenwich, the predecessor of the National Maritime Museum, where they remain (K1, K2, K3, H1 through H4, and a large body of associated material) as accessioned museum objects, in some cases on public display.[94]

The Board's own retrospective

The Board's final meeting, held on 24 July 1828, was chaired by the Duke of Clarence (William, Duke of Clarence, at that date Lord High Admiral of the United Kingdom, and after 1830 King William IV). Its business, so far as the surviving minute records, closed the Longitude account with a balance of thirteen thousand four hundred and twenty-one pounds, seven shillings, and eight pence, transferred to the Admiralty, and thanked Thomas Young

[92] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[93] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[94] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

for his services as Secretary. The minute, signed by Young in what would prove to be his last major administrative act before his death on 10 May 1829, concludes the surviving RGO 14 series.[95]

The papers themselves survive today at Cambridge University Library, catalogued as RGO 14 within the Royal Greenwich Observatory Archives, the shelfmark under which the Board's papers have been cited throughout. That archive, and the papers within it, were deposited at the University Library as part of the Royal Greenwich Observatory's move to Cambridge in 1988–90, a century and a half after the Board's own dissolution. No resolution of the Board's final meeting is recorded directing the papers to Cambridge, and the closing business of 24 July 1828, so far as it survives, does not mention their disposal. What can be said with confidence is narrower than the story once told: the papers carry the Royal Observatory's own shelfmark, and the Observatory's archive reached Cambridge, and open digital access, only at the very end of the twentieth century. How the Board's papers passed from the dissolved committee of 1828 into that archive is not settled by anything in RGO 14 itself.[96]

Successor bodies

The 1828 Repeal took place inside a wider reorganisation of British astronomical and scientific administration. The Astronomical Society of London, founded in 1820 by a group that included Francis Baily, John Herschel, and Charles Babbage and chartered as the Royal Astronomical Society in 1831, supplied several of the reformers who pressed for the Board's dissolution and argued, through Herschel's 1827 *Preliminary Discourse* and Babbage's 1830 *Reflections on the Decline of Science in England*, that British scientific administration required consolidation and professionalisation rather than the ad hoc committee and the noble officer of state. From 1832 the Society's own Council took on the Board's advisory function, consulted by the Admiralty on the appointment of astronomers, the *Almanac*'s programme, and chronometer trials, though not on payment, which went to the Admiralty proper. George Biddell Airy, appointed Astronomer Royal in 1835, reorganised the Royal Observatory's rating service to a standardised forty-eight- day trial recorded in registers that survive intact, and took over the *Almanac*'s editorial supervision after 1835 though its formal head sat elsewhere. The Board's technical functions, across Airy's tenure to 1881, were performed by the Astronomer Royal and his staff with Admiralty administrative support, and the accuracy of British-issued chronometers improved steadily across the arrangement[97] .[98]

The historians on the dissolution

The characterisation of the 1828 Repeal as a verdict on the Board is a nineteenth-century commonplace easier to find in retrospective essays than in the papers of the reformers themselves. Airy's own retrospective, written for the Royal Astronomical Society in 1846, described the Board as having "outlived its usefulness" and as having, in its later years,

[95] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[96] "Papers of the Board of Longitude (RGO 14)."

[97] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[98] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

“distributed largesse rather than adjudicated invention.” Airy’s characterisation is polemical and has been repeated. The 1828 Committee’s own reasoning, as recovered by the Cambridge project from the Committee’s papers, is administrative rather than pejorative. The Board’s functions had become departmental. Its personnel were paid officials. Its premises were shared with the Admiralty. Its dissolution regularised what had, in practice, become an Admiralty branch under a Board title.[99]

The popular account, having brought Harrison to his 1773 settlement, mostly stops there: it closes shortly after his death in 1776 and does not follow the Board into the five decades that produced the *Almanac*’s maturity, the chronometer trade, and the Pacific and Australian surveys. Read across those decades, as the Committee itself read them, the 1828 Repeal is the closure of an office that had done its proper work, not the abolition of one that had failed.[100]

Consequence

The 1828 Repeal did not abolish the functions the Board had performed. It transferred them. Chronometer rating continued at the Royal Observatory. Marine surveys continued at the Hydrographic Office. The *Almanac* continued at its own newly established office. Advisory scientific input to the Admiralty continued through Young, Herschel, and Faraday. What ended was the standing committee that had held the whole of these functions in a single Board. Parliament, in transferring the functions to departmental offices, did what Parliament had done through the 1820s to a range of statutory bodies: it consolidated. What began, in 1714, as an unprecedented standing committee for a technical problem ended, in 1828, as the ordinary transfer of a functional office into its sponsoring department. The transition took a hundred and fourteen years.

An accounting entry closes the volume. The Board’s final audit, completed on 31 December 1828 and signed by the Auditor of the Public Accounts, showed a lifetime disbursement out of the Longitude account of something above one hundred and one thousand pounds sterling. The largest single line was the *Almanac*, at some thirty-seven thousand pounds across sixty-one years of continuous publication. The second-largest was the exploration voyage instrument loans and astronomer allowances, at some twenty-two thousand. The third was the Harrison sequence, at some fifteen thousand pounds paid directly out of the Longitude fund (excluding the 1773 Act’s parliamentary payment of eight thousand seven hundred and fifty pounds, which came out of the general appropriation rather than out of the Longitude account). The remaining twenty-seven thousand pounds covered premiums, inspections, printing, salaries, and the miscellaneous encouragements the Board had made across ninety-one years. The audit is one of the more compact institutional accountings of an eighteenth-century state body, and it survives in RGO 14 as the final volume of the Board’s own accounts.[101]

[99]Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[100]Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[101]“Papers of the Board of Longitude (RGO 14)”; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

Set against a state expenditure of the same century, the sum is small. The Royal Navy of 1780 spent one hundred thousand pounds on victualling in an average month at sea. The Board of Longitude, at its ninety-one-year total of one hundred and one thousand pounds, spent across its entire existence what the Navy spent on stores in about a month. That comparison is a corrective to the popular memory in both directions. On the one hand, the Board was not, in its consumption of the Treasury, a large item. On the other, its outputs (the *Almanac*, the chronometer trade, the Pacific and Australian coastal longitudes) are load-bearing achievements of British marine geography for which the state's investment was, by any modern standard, remarkable value.

Coda. A tournament with a treasury

What the Board did

Between 8 July 1714 and 15 July 1828, a body of Fellows of the Royal Society and officers of state, meeting in a series of rooms at the Admiralty and at Somerset House and at the Royal Observatory, authorised payments out of a fund held on Parliament's behalf against the discovery of longitude at sea. The fund had been created by a statute drafted at Newton's advice and passed with little debate. Its ceiling had been set at twenty thousand pounds for the top-tier prize. Its authorisation for experiments had been set at two thousand. Its Commissioners had been named by office. Its meetings had begun, on the coming of a serious candidate, in 1737. Its substantive work had run for the ninety-one years between 1737 and 1828. Its papers, catalogued today under the Royal Observatory's own shelfmark, reached open public access only at the end of the twentieth century. That is the institutional description of the Board of Longitude.[102]

The Board paid, across those years, sums whose total ran into the low hundreds of thousands of pounds. It funded John Harrison at sums that came, over four decades, to something above twenty-three thousand pounds. It funded Tobias Mayer's tables at some three thousand pounds. It funded Leonhard Euler's theory at three hundred. It funded Nevil Maskelyne, and after him the *Nautical Almanac*, at some two hundred pounds a year in his editorship and larger sums in computation and printing across the sixty-one years from 1767 to 1828. It funded Jesse Ramsden, Edward Troughton, Larcum Kendall, John Bird, John Arnold, and Thomas Earnshaw at sums ranging from premiums of hundreds of pounds to inspection fees of a few pounds per instrument. It funded Charles Green, William Wales, William Bayly, John Bailly, John Crosley, and William Gooch at two hundred pounds a year at sea. It funded the exploration voyages of James Cook, George Vancouver, and Matthew Flinders with the instruments those voyages carried. It made, in the words its own minutes used, "encouragements" to the many petitioners who came before it with schemes that could not be built.[103]

[102] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; An Act for Providing a Publick Reward for Such Person or Persons as Shall Discover the Longitude at Sea (13 Anne c. 14); An Act to Repeal Certain Acts, and Parts of Acts, Relating to the Discovery of the Longitude at Sea, and to Make Other Provisions in Lieu Thereof (9 Geo. IV c. 66).

[103] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

Beyond the lone-genius account

The popular account made Harrison's grievance the whole institution's story. The complete minutes show a Board applying a statutory reproducibility requirement, funding lunar work in parallel, and sending the final dispute to Parliament once Harrison's performance and the Board's conditions could not be reconciled. Harrison's achievement remains central; it no longer requires the Board to serve as a recurring villain[104] .[105]

Neither research council nor patent office

The Board's own vocabulary was not the modern reader's. Its statutory instrument, the 1714 Act, authorised warrants naming Commissioners by office, a graduated reward payable on certified accuracy, and a discretionary sum for "experiments." What the Board paid out under that authority, across the century that followed, took the period's own forms: staged grants to Harrison and other candidates on the strength of a committee's inspection; a salary to Maskelyne as editor and, after 1818, to a resident Secretary; fees to computers and comparers for the *Almanac*; premiums to instrument-makers for work judged of service to the Crown; contracts with the London trade for rated instruments; and allowances, close to salaries in their regularity, to the astronomers who sailed with the exploration voyages. Warrant, reward, grant, contract, salary, and patronage covered the Board's business more exactly than any later category does.[106]

It is nonetheless tempting to read the Board as an anticipation of the modern research council: a body that identified a technical problem, funded staged research against milestones, maintained parallel investment in alternative routes, scaled up procurement once a solution reached production quality, and wound itself down when the problem was solved. All of this is visible in the Board's practice, but its constitution was not the research council's. Its Commissioners were officers of state and Fellows of a learned society serving ex officio and without salary; its technical committee was a group of mathematicians, several of them ordained clergymen, advising at the Astronomer Royal's pleasure rather than a professionalised advisory board; its authorisations were annual, not programmatic. The resemblance to twentieth-century research funding is real. The identity is not, and the more restrained description holds: the Board was a tournament with a treasury, the 1714 Act's graduated reward the tournament, open to any claimant in Europe or the American colonies and paying nothing to those who failed; its two-thousand-pound experiments clause, and what Parliament supplemented it with, the treasury from which staged sums went to candidates whose demonstrations warranted them. That is what the eighteenth-century British state built out of the administrative materials of its own day: a standing committee, a fund, a rulebook, and an inspection regime, resembling a research council without being one.[107]

[104] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

[105] Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.*

[106] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[107] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

The compromise between prize, patronage, and payroll

The Board's ninety-one substantive years divide roughly into three periods, and each of the three periods rests on a different balance between what the Board did as a prize authority, what it did as a patron of individual practitioners, and what it did as an employer of paid staff. In the first period, from 1737 to 1773, the Board was principally a prize authority, with a growing patronage function. Its dominant business was the Harrison settlement and the parallel funding of the lunar method. In the second period, from 1773 to about 1815, the Board was principally a patron of exploration astronomy and a procurer of instruments. Its dominant business was the outfitting of voyages and the acquiring of chronometers from the London trade. In the third period, from 1815 to 1828, the Board was principally an employer of a small permanent staff and a subsidiser of an established publication. Its dominant business was the *Almanac*, the chronometer rating, and the resident-Commissioner arrangement of the 1818 Act.[108]

The three periods run into one another. The prize function did not disappear when the Board became a patron; the patronage function did not disappear when the Board became an employer. What shifted was the balance. By 1828 the balance had shifted so far in the direction of paid staff and standing publications that the specialists at the Committee on Public Salaries saw a departmental office in Board clothing and recommended the corresponding transfer. Their recommendation is not a criticism of what the Board had become. It is a description of what the Board had become. Neither the 1714 Act nor the 1737 Board would have recognised the 1828 Board as its own lineal successor. And yet the lineal succession was real, because each shift had been made in response to the actual technical and administrative situation the Board faced. The compromise between prize, patronage, and payroll had not been designed. It had accumulated.[109]

Harrison received more than the twenty-thousand-pound top-tier reward over his lifetime without receiving its certificate. Maskelyne's lunar method became affordable through the paid computers who produced the *Almanac*, Mary Edwards among them. K1 proved a copied timekeeper across Cook's second voyage, while Arnold, Earnshaw, their apprentices, and family workshops brought chronometers within reach of naval and commercial purchasers. The same instruments helped the British state fix and administer coasts whose inhabitants had known them without a chronometer.[110]

The Board of Longitude Project's digitisation of the sixty-eight surviving volumes of RGO 14 let Baker, Dunn, Higgitt, and Schaffer write from the whole of it, and let Barrett recover the Board's reception in eighteenth- and nineteenth-century print culture, a body that was, in her account, neither the villain of contemporary satire nor the hero of Enlightenment progress narratives, but a set of committee-men making unglamorous decisions about unglamorous

[108] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[109] Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[110] "Papers of the Board of Longitude (RGO 14)"; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

instruments.[111] The archive shows a specific eighteenth-century compromise between prize, patronage, and payroll, run inside the administrative imagination of Anne, of the four Georges, and of the reformers of the 1820s, closed by an Act that was a consolidation and not a verdict, and put in service, across its ninety-one substantive years, of a state that used the longitude it bought to survey, chart, and in due course govern coasts an ocean away from Westminster.[112]

At the last, an eighteenth-century image is available and worth using. Newton, in his memorandum to the 1714 committee, described the longitude problem as one for which "no perfect Solution is at present to be had, though Solutions of tolerable Exactness are already in the Way." A tolerable exactness, brought by staged payments and steady inspection to the point at which a mariner might carry it in his own hand, is what the Board's ninety-one years delivered. What Parliament built to deliver it was not a prize fund alone, and not a research council avant la lettre, but a mixed portfolio (prize, grant, contract, salary, and patronage together) that paid for a public good and then handed the instruments, the tables, and the surveyed coastlines to the departments, the Navy, and the colonial administrations that would use them. The constitutional peculiarity is not to be repeated, because the administrative conditions that made it are gone. Its results (the *Almanac* still printed under another name, the chronometer trade it seeded, and the outline of coasts on charts whose first accurate longitudes it paid for) are with us still, and so, less comfortably, are the uses to which an imperial state put them.

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[111] Barrett, *Looking for Longitude: A Cultural History*; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World.*

[112] "Papers of the Board of Longitude (RGO 14)"; Baker et al., *The Board of Longitude: Science, Innovation and Empire in the Georgian World*; Dunn and Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the Longitude Problem.*

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