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Law and Longitude

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The story of the eighteenth-century quest to “find the longitude” is an epic tale that blends science with law. The problem of determining longitude while at sea was so important that the British Parliament offered a large cash prize for a solution and created an administrative agency, the Board of Longitude, to determine the winner. The generally popular view is that the Board of Longitude cheated John Harrison, an inventor, out of the great longitude prize.

This Article examines the longitude story from a legal perspective. The Article considers how a court might rule on the dispute between Harrison and the Board of Longitude. The Article suggests that the popular account of the dispute is unfair to the Board. The Board gave a reasonable interpretation to the statute creating the longitude prize and was not improperly biased against Harrison’s method of solving the longitude problem. The Article concludes with some lessons the longitude story offers for modern intellectual property and administrative law.

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I. INTRODUCTION

The story of the eighteenth-century quest to "find the longitude" is an epic tale that blends science with law. On the one hand, the story is one of scientific achievement: it concerns the technical and engineering genius of John Harrison, who claimed to have solved the problem of determining longitude at sea, which had baffled Galileo, Newton, and innumerable others among generations of the world's greatest minds. On the other hand, the story belongs to intellectual property and administrative law. The longitude problem was so important that the British Parliament offered a large cash prize for a

solution and created an administrative agency to determine the winner. John Harrison worked for decades to claim this prize, and his struggles with the Board of Longitude implicate many administrative law issues. The longitude prize was also an early form of “patent prize,” and Harrison’s experience echoes the modern debate over such prizes.

The generally popular view is that the Board of Longitude cheated John Harrison out of the great longitude prize. Harrison, as the story goes, devoted his life to the longitude problem, worked on it with extraordinary ingenuity and tenacity for decades, and invented a device that passed the test set by Parliament as the condition for the prize. The Board, nevertheless, considered itself empowered to impose additional conditions, beyond those fixed by Parliament, and refused Harrison the prize when he could not meet these conditions.

The modern administrative lawyer, perusing this eighteenth-century story, sees many legal issues that are familiar from our own day. The Board of Longitude, some suggest, was improperly *biased* against Harrison’s proposals to tackle the longitude problem.¹ It is said that members of the Board had *conflicts of interest* that required recusal.² And most of all, the Board’s actions present classic problems of *administrative statutory construction*. Did the board wrongly withhold from Harrison the prize that he had fairly won by meeting the statutory requirements,³ or did the Board properly exercise discretion vested in it by statute to require Harrison to meet conditions of the Board’s own devising?

For the modern intellectual property lawyer, the longitude story immediately calls to mind the debate over patent prizes. For decades, scholars have suggested the possibility of substituting governmental prizes for privately enforceable patents.⁴ The longitude experience offers some lessons for these proposals.

Today, the longitude story is best known from Dava Sobel’s delightful 1995 book, *Longitude*.⁵ Sobel’s best-selling work provides history, science, and biography, and also describes the legal issues

1. See DAVA SOBEL, *LONGITUDE: THE TRUE STORY OF A LONE GENIUS WHO SOLVED THE GREATEST SCIENTIFIC PROBLEM OF HIS TIME* 9 (1995).

2. *Id.* at 118.

3. *Id.* at 121.

4. See, e.g., Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 122 (2003); Robert C. Guell & Marvin Fischbaum, *Toward Allocative Efficiency in the Prescription Drug Industry*, 73 MILBANK Q. 213 (1995); Michael Polanyi, *Patent Reform*, 11 REV. ECON. STUD. 61 (1944); Steven Shavell & Tanguy Van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & ECON. 525 (2001).

5. SOBEL, *supra* note 1.

raised by Harrison's battles with the Board of Longitude. Sobel's account of these issues is informative and engaging, but one-sided. Like most popular accounts of the longitude story, Sobel's book takes the view that the Board unjustly withheld the prize from Harrison. In her version of the tale, Sobel casts Harrison as the hero and a Board member as the villain.⁶ Arguments favoring the Board are neglected. The book is enchanting as history, but from a legal standpoint, reading it is like trying to decide a case by reading only the plaintiff's brief and ignoring the defendant's response. More balance is needed.

This Article attempts to supply the omission. Drawing on both primary sources and secondary accounts,⁷ the Article examines the longitude controversy from a legal perspective. It imagines Harrison's claims against the Board of Longitude translated into a judicial setting. Suppose Harrison sued for judicial review of the Board's refusal to award him the full prize. What would a court do? This Article considers the claims that Harrison might make, particularly his claim that the Board violated its governing statute, and concludes that the charges against the Board are unfair. The Board had reasonable grounds for its understanding of the governing statutes. While the matter is not crystal clear, the Board's interpretation would be one that any government lawyer would be happy to defend.⁸

6. See *id.* at 111.

7. For primary sources (the wonderfully long eighteenth-century titles of some of which have been shortened here), see ANONYMOUS, THE CASE OF MR. JOHN HARRISON (1767) [hereinafter CASE OF HARRISON]; ANONYMOUS, A NARRATIVE OF THE PROCEEDINGS RELATIVE TO THE DISCOVERY OF THE LONGITUDE AT SEA . . . (1765) [hereinafter NARRATIVE]; COMM'RS OF LONGITUDE, MINUTES OF THE PROCEEDINGS OF THE COMMISSIONERS APPOINTED BY ACT OF PARLIAMENT FOR THE DISCOVERY OF THE LONGITUDE AT SEA [hereinafter MINUTES]; GREAT BRITAIN, JOURNALS OF THE HOUSE OF COMMONS [hereinafter JOURNALS]; JOHN HARRISON, REMARKS ON A PAMPHLET LATELY PUBLISHED BY THE REV. MR. MASKELYNE . . . (1767) [hereinafter HARRISON, REMARKS]; NEVIL MASKELYNE, AN ANSWER TO A PAMPHLET ENTITLED "A NARRATIVE OF FACTS," LATELY PUBLISHED BY MR. THOMAS MUDGE, JUNIOR . . . (1792) [hereinafter MASKELYNE, ANSWER]; THOMAS MUDGE, JR., A NARRATIVE OF FACTS RELATING TO SOME TIMEKEEPERS CONSTRUCTED BY MR. THOMAS MUDGE . . . (1792) [hereinafter MUDGE, NARRATIVE]; THOMAS MUDGE, JR., A REPLY TO THE ANSWER OF THE REV. DR. MASKELYNE . . . (1792) [hereinafter MUDGE, REPLY]. For secondary accounts, see THE QUEST FOR LONGITUDE: THE PROCEEDINGS OF THE LONGITUDE SYMPOSIUM, HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS, NOVEMBER 4-6, 1993 (William J.H. Andrewes ed., 1996) (1993) [hereinafter ANDREWES], and the articles collected therein; DEREK HOWSE, GREENWICH TIME AND THE LONGITUDE (Philip Wilson Publishers Ltd. 1997) (1980) [hereinafter HOWSE, GREENWICH TIME]; DEREK HOWSE, NEVIL MASKELYNE: THE SEAMAN'S ASTRONOMER (1989) [hereinafter HOWSE, MASKELYNE]; HUMPHREY QUILL, JOHN HARRISON: THE MAN WHO FOUND LONGITUDE (1966); Eric G. Forbes, *Who Discovered Longitude at Sea?*, SKY & TELESCOPE, Jan. 1971, at 4.

8. I speak as one who defended many an administrative construction of a governing statute as an appellate lawyer in the Civil Division of the Department of Justice.

This Article's review of the longitude controversy is primarily designed to pass judgment on the historical questions involved. The ghosts of the Commissioners of Longitude should be allowed to rest more easily than they can with unanswered charges pending against them in the court of history. In addition, however, reconsideration of the longitude prize offers a lesson or two for modern intellectual property and administrative law. On the intellectual property side, the story illustrates some of the important obstacles that must affect any patent prize proposal. It shows the difficulty of implementing some scholarly proposals for statutory formulas that would supposedly permit a prize-awarding agency to distribute patent prizes without the need to exercise substantial discretion. On the administrative law side, the story teaches us that the problems of administrative law are eternal. Long before our nation was even a dream in the minds of its founders, legislatures had the same need that we have today for administrative agencies to supply expertise and administer programs on a day-to-day basis. The vexing question of the degree to which an agency may exercise discretion in interpreting its organic statute has vexed the world since agencies began. The interpretation of the Longitude Act also highlights the clash among interpretive methodologies that courts and agencies still face today, nearly 300 years later.

Part II of this Article recounts the story of the quest to find the longitude. Part III analyzes the story from a legal perspective. Part IV concludes with some lessons that the story offers for modern intellectual property and administrative law.

II. THE SETTING OF THE CASE

Before turning to the claims that John Harrison might have brought against the Board of Longitude, it is necessary to understand the problem Harrison was addressing, the prize he was seeking, and the statutory authority under which the Board was acting. Examining this history is also independently interesting. Harrison was attacking "the [g]reatest [s]cientific [p]roblem of [h]is [t]ime,"⁹ and his efforts led to a decades-long journey with innumerable twists, turns, and surprises.

9. SOBEL, *supra* note 1, at iii.

A. *The Longitude Problem*

For centuries, mariners confronted the problem of *finding the longitude*, that is, determining longitude while at sea. When navigating on the open seas, with nothing but water visible in every direction, it is, of course, vitally important to know one's position. The position is given by latitude and longitude: latitude specifies how far a ship lies north or south of the equator, and longitude specifies how far the ship lies east or west of the "prime meridian."¹⁰

Determining a ship's *latitude* was readily accomplished, even with eighteenth-century instruments. Using a sextant (or, in the earlier years of the century, tools such as a quadrant or backstaff),¹¹ a navigator would measure the angle between the horizon and a star—the sun during the day, or (in the northern hemisphere) Polaris, the North Star, at night. At night, the calculation of latitude is then for the most part trivial. Because the North Star always remains almost directly above the earth's axis, the observer's latitude is simply equal to the angle of Polaris above the horizon (with a couple of small corrections).¹² During the day, the matter is not quite so simple because the sun appears at different heights in the sky at different times of year, but, knowing the angle of the sun above the horizon at noon, a mariner could readily calculate the ship's latitude with the aid of information available in a published almanac.¹³

The ship's *longitude*, however, was another matter entirely. No natural, heavenly referent provides an easy way to determine longitude. This is because longitude, unlike latitude, is arbitrary. Latitude is measured on a scale ordained by nature: the equator is the natural zero point and the poles are naturally ninety degrees north and south. There is, however, no natural "prime meridian" of longitude. Any arc joining the poles could be designated as zero, and, indeed, over the centuries the prime meridian was deemed to be the line passing through Rome, Jerusalem, Paris, and many other places, before the modern choice of Greenwich, England.¹⁴ As a result, there is no natural referent for determining longitude.

10. *Id.* at 2-4; JOHN P. BUDLONG, SKY AND SEXTANT: PRACTICAL CELESTIAL NAVIGATION 5-8 (1978).

11. BUDLONG, *supra* note 10, at 12; QUILL, *supra* note 7, at 116; SOBEL, *supra* note 1, at 43. The sextant became available in 1730. BUDLONG, *supra* note 10, at 12.

12. BUDLONG, *supra* note 10, at 88; HOWSE, GREENWICH TIME, *supra* note 7, at 181.

13. BUDLONG, *supra* note 10, at 60-62; QUILL, *supra* note 7, at 3.

14. SOBEL, *supra* note 1, at 3-4.

For this reason, eighteenth-century navigators faced a deep problem in measuring their longitude. As the century began, the standard method was to use “dead reckoning,” which is the process of keeping track of a ship’s position from day to day based on its course and speed.¹⁵ A navigator who knew the position of a ship to start with, the direction the ship was traveling, the ship’s speed, and the amount of time traveled at that direction and speed, could plot a line of appropriate length and direction on a chart, from the starting point, to calculate the ship’s next position. In theory, using this method repeatedly would keep track of the ship’s position throughout a journey.

But in practice this method was unsatisfactory. All of the necessary data—speed, direction, and time—could be measured only approximately (speed, for example, was gauged by timing how quickly the ship receded from a log thrown overboard). The navigator’s judgment was therefore subject to error, and the error would accumulate from day to day. Navigators could find themselves on the open seas with only the vaguest notion of where they were.

The result was often difficult, sometimes disastrous. For safety, shipping tended to confine itself to narrow, well-trafficked routes. This made passage safer, but also made ships easier prey for pirates and hostile navies, which caused enormous losses.¹⁶ Ships traveling outside these routes might never find their destination. Sobel describes two tragic episodes: in 1707, the fleet of British Admiral Sir Cloudisley Shovell, returning from naval battles in Gibraltar, greatly misjudged its location and crashed into the Scilly Isles off the southwest tip of England, causing the loss of four ships and nearly 2000 lives.¹⁷ In 1741, Commodore George Anson of the *Centurion*, lost at sea for want of a means of measuring longitude, did not know whether to sail east or west to find an island with fresh water. He had to spend weeks traveling back and forth on a line of latitude, ultimately losing hundreds of his sailors to death by scurvy.¹⁸

Thus, finding the longitude was no mere abstract problem. Lives and fortunes turned on it. Private enterprise had produced no solution. It was time for governments to act.

15. *Id.* at 13-14; QUILL, *supra* note 7, at 1-2.

16. SOBEL, *supra* note 1, at 14-15.

17. *Id.* at 11-13; HOWSE, *GREENWICH TIME*, *supra* note 7, at 53.

18. SOBEL, *supra* note 1, at 17-20.

B. The Longitude Act and the Board of Longitude

Britain was not the first nation to offer a prize for finding the longitude. Spain's Philip II offered a reward for solving the longitude problem as early as 1567, and his son, Philip III, made the offer into a substantial pension in ducats in 1598.¹⁹ In the early seventeenth century, Holland offered 30,000 florins.²⁰ Innumerable inventors sought these prizes, including Galileo Galilei, but the funds were never fully awarded.²¹ The problem was so difficult that popular writers equated "[f]inding the longitude" with "squaring the circle," as an expression for seeking to do the impossible.²²

After the Shovell disaster of 1707, the British public became ever more concerned with the need for improved methods of navigation.²³ In May 1714, some "Captains, Merchants, and Commanders" presented a petition to Parliament, praying that the government encourage research into the longitude problem by offering a prize for the solution.²⁴ Parliament referred the petition to a committee, which received the advice of experts, including Sir Isaac Newton, then President of the "Royal Society," Britain's scientific academy.²⁵ Following the committee's report, Parliament swiftly adopted "An Act for providing a publick Reward for such Person or Persons as shall discover the Longitude at Sea," which became law on July 20, 1714.²⁶ The act adopted a course that looks familiar in the modern era: it created an administrative agency to address the problem. Like a modern agency organic act, the act specified how the agency was to be constituted, vested the agency with authority, and gave the agency its mission.

After reciting that "nothing is so much wanted and desired at Sea, as the Discovery of the Longitude," and that "such a Discovery would be of particular Advantage to the Trade of *Great Britain*," the Longitude Act appointed a group of twenty-three scientists, professors, naval officers, and other government officials (including several members of Parliament) to be "Commissioners for the Discovery of the Longitude at Sea, and for examining, trying, and judging of all

19. HOWSE, GREENWICH TIME, *supra* note 7, at 26.

20. *Id.*

21. *Id.*

22. *Id.* (internal quotation marks omitted).

23. *Id.* at 54.

24. 17 JOURNALS, *supra* note 7, at 641.

25. *Id.* at 641, 677; HOWSE, GREENWICH TIME, *supra* note 7, at 57.

26. 1714, 12 Ann., c. 15 (Eng.) [hereinafter Longitude Act 1714]; HOWSE, GREENWICH TIME, *supra* note 7, at 58. The act's full text is reprinted in the Appendix.

Proposals, Experiments, and Improvements relating to the same.”²⁷ The act empowered this body, which came to be known informally as the Board of Longitude,²⁸ “to hear and receive any Proposal . . . for discovering the said Longitude.”²⁹

The Board was authorized, not only to receive proposals, but to spend money on them. The act empowered any five or more of the commissioners, if they were satisfied that a proposal was worthy of trial, to authorize spending such sum, not exceeding £2000, as they thought necessary for testing the proposal by experiment³⁰—that is, to give what today we would call research grants. After experiment, the commissioners were to determine, by majority vote, the practicability of the proposal.³¹

Most important, the Board had power over the great longitude prize. The act specified that the first author or discoverer of a proper method for finding the longitude would be entitled to a reward of £10,000, if the method determined the longitude to within one degree (sixty nautical miles); £15,000, for a method accurate to within two-thirds of a degree; or £20,000 for a method accurate to within one-half of a degree.³² Half the award would be “due and paid” when a majority of the commissioners agreed that the method “extends to the Security of Ships within eighty Geographical Miles of the Shores,” and the other half when a ship, by the appointment of the commissioners, actually succeeded in sailing from Great Britain to the West Indies without losing its longitude beyond the specified limits.³³ Once a method had been “tried and found practicable and useful at Sea,” a majority of the commissioners were to certify it to the commissioners of the navy, who were to pay the prize.³⁴

Finally, the act also provided that the Board could make lesser awards for lesser achievements. If, upon trial, a proposal failed to win the longitude prize by meeting the standards laid down in the act, yet a majority of the commissioners were of the view that the method was “of considerable Use to the Publick,” then the author of the method

27. Longitude Act 1714, 12 Ann., c. 15, § 1; see HOWSE, MASKELYNE, *supra* note 7, at 11-12.

28. HOWSE, MASKELYNE, *supra* note 7, at 11. “Board of Longitude” was not a statutory term. See 1714, 12 Ann., c. 15 (Eng.).

29. Longitude Act 1714, 12 Ann., c. 15, § 1.

30. *Id.*

31. *Id.* § 2.

32. *Id.* § 3.

33. *Id.*

34. *Id.* § 4.

was to have “such less Reward therefore, as the said Commissioners, or the major Part of them, shall think reasonable,” again to be paid by the navy.³⁵

Parliament had applied a great spur to innovation. The full prize of £20,000 was a princely sum—the equivalent of perhaps \$5.5 million today.³⁶ It was an early form of “patent prize,” reminiscent of Senator John McCain’s recent proposal for a \$300 million public prize for an improved car battery.³⁷ But the prize was to be awarded only to the *first* to discover a method of finding the longitude.³⁸ The race to claim this prize was on.

C. *Finding the Longitude*

From the beginning of the race to claim the longitude prize—indeed, from the beginning of the search for the longitude—it was understood that finding the longitude is equivalent to keeping the *time*.³⁹ As the earth rotates, the sun appears to travel around the earth at fifteen degrees per hour, so that in twenty-four hours it travels 360 degrees. Therefore, a navigator who knew the local time on shipboard and the time at the prime meridian in Greenwich could calculate the ship’s longitude by simply taking the difference in hours and multiplying by fifteen degrees.⁴⁰

35. *Id.* § 5.

36. Comparing monetary values over such a long time period is difficult. On his helpful Web site, Measuring Worth, <http://www.measuringworth.com>, economics professor Lawrence Officer of the University of Illinois at Chicago provides a retail price index comparison going back to 1264. This method of comparison reports that £20,000 in 1714 would have the same purchasing power as £2.7 million in 2007. Allowing for exchange rates and further inflation since then, that would be \$5.5 million today.

The purchasing power comparison is probably the one most people have in mind when they ask what a given sum of money from the past would be worth today. Professor Officer also suggests four other comparative methods (going back only to 1830, though), such as measuring a sum of money as a percentage of average wages, or as a percentage of a nation’s total economy. These different methods produce widely different results: they report that £1 from 1830 is worth an amount ranging from £70 to £2690 in 2006 values. Assuming (naively) that the same ratios between methods would apply going back to 1714, the £20,000 prize, measured in terms of its impact on the total British economy, would be equivalent to a prize of about \$200 million today.

37. Michael D. Shear, *McCain Proposes \$300 Million Prize for Electric-Car Advance*, WASH. POST, June 24, 2008, at A4.

38. Longitude Act 1714, 12 Ann., c. 15, § 3 (Eng.).

39. HOWSE, GREENWICH TIME, *supra* note 7, at 181; *see* QUILL, *supra* note 7, at 4.

40. HOWSE, GREENWICH TIME, *supra* note 7, at 181-82. Actually, the references herein to searching for the “Greenwich Time” are anachronistic; the practice of using Greenwich as the prime meridian did not arise until publication of Britain’s *Nautical Almanac* beginning in 1767, and was not made universal until after an international conference held in 1884 recommended its standard adoption. *Id.* at 70-71, 137. In reality, navigators were

The question, therefore, was how a navigator could determine the necessary time data. An eighteenth-century navigator could determine a ship's *local* time by straightforward observation, because local noon occurs when the sun reaches the highest point in the sky.⁴¹ But how is the navigator (with no radio, telephone, or satellite signal) to know the time in Greenwich? There were, in the eighteenth century, two main suggestions.

1. The Chronometer Method

The seemingly obvious method would be to set a clock to Greenwich Time at the start of the ship's journey and to have that clock faithfully keep the Greenwich Time. The problem was that no such faithful clock existed. Time-keeping technology had yet to be developed that would work on shipboard. A pendulum could keep a clock's movement going properly if the clock was stationary, but would not work on board a pitching, rolling ship.⁴² Moreover, the changes in temperature typically encountered on a ship's journey wreaked havoc with a clock's metal parts, by causing them to expand or contract, and with its lubricating oil, by causing it to thicken or thin.⁴³ The result was that a clock that could keep time accurately at sea—dubbed a “chronometer”—did not exist.⁴⁴

Great accuracy was needed. At the equator, one degree of longitude equals sixty nautical miles.⁴⁵ With the sun moving fifteen degrees per hour, an hour of time is equivalent to 900 miles. Thus, every *minute* of inaccuracy in determining the time translates into fifteen *miles* of inaccuracy in determining longitude, or, to put it another way, every loss of *four seconds* in the chronometer would put a ship's position off by a nautical mile. To come within even the most generous limits of the Longitude Act, a chronometer would have to lose (or gain) no more than four minutes during the six-week voyage

seeking the local time and the time at any point of known longitude, which would serve the same purpose as the Greenwich Time. For simplicity, however, this Article refers to the search for the time at a point of known longitude as a search for the “Greenwich Time.”

41. BUDLONG, *supra* note 10, at 61.

42. SOBEL, *supra* note 1, at 5-6.

43. *Id.* at 6.

44. *See id.* at 56-57 (citing the first use of this term in 1714).

45. BUDLONG, *supra* note 10, at 6. Unlike lines of latitude, which are equally spaced everywhere on the earth, lines of longitude get closer to each other as one moves from the equator to the poles. A degree of latitude is always a fixed distance (sixty nautical miles), but a degree of longitude is a different distance at different latitudes. A nautical mile is 1/60 of a degree of longitude at the equator and is equal to about 1.15 ordinary land (or “statute”) miles.

from Britain to the West Indies; to win the full £20,000 prize, the timekeeper would have to be accurate to within two minutes. But when timepieces were first suggested as a solution to the longitude problem, even a good watch might gain or lose as much as fifteen minutes every day!⁴⁶ Little wonder, then, that the report of Parliament's committee that led up to the Longitude Act quoted Sir Isaac Newton as saying that keeping the longitude by a watch is one of "several Projects" that are "true in the Theory, but difficult to execute."⁴⁷

2. The Lunar Distance Method

The difficulties were, indeed, so great that the consensus of experts doubted the possibility of solving the longitude problem with a mechanical timekeeper. Instead, seekers of the longitude looked to the heavens. If a man-made watch could not keep time with sufficient accuracy, perhaps sailors could use the sky's natural timekeepers: the sun, moon, and stars. If an astronomical event could be viewed at sea, the time of that event at Greenwich could be determined from a published table, and a navigator could use this time to determine a ship's longitude. But difficulties lay in this direction also.

The idea of finding the longitude in the skies went back at least as far as Galileo. In claiming the longitude prizes that existed in his day (the late sixteenth and early seventeenth centuries), Galileo devised a method that relied on the moons of Jupiter. Using his newly invented telescope, Galileo found four moons of Jupiter, which frequently appear and disappear behind each other and behind Jupiter itself. Because Jupiter is so far away, the time of these eclipses would be the same for an observer anywhere on earth; thus, Galileo reasoned, all that was needed was a published table that would show the times of the eclipses several years in advance, and a device for viewing them.⁴⁸

Unfortunately, viewing the eclipses of Jupiter's moons with the necessary accuracy proved difficult enough on land; at sea, the problem was insuperable. Galileo invented a special headgear for a navigator to wear—it resembled a gas mask fitted with a telescope—but even on land, the beating of one's heart could disturb the delicate observations.⁴⁹ Galileo never received the longitude prize.

46. SOBEL, *supra* note 1, at 35-36.

47. 17 JOURNALS, *supra* note 7, at 677.

48. HOWSE, GREENWICH TIME, *supra* note 7, at 26-27; SOBEL, *supra* note 1, at 24-26; Albert Van Helden, *Longitude and the Satellites of Jupiter*, in ANDREWES, *supra* note 7, at 89-90.

49. SOBEL, *supra* note 1, at 26.

Still, astronomers hoped to solve the longitude problem by looking to a closer, more easily observed heavenly body—the moon. As early as 1514, the German astronomer Johannes Werner proposed that a navigator could determine the Greenwich Time by measuring the angle between the moon and various stars (including the sun, when the moon is visible in the daytime), consulting tables in a published almanac, and applying mathematical corrections.⁵⁰ This method, the “lunar distance” method, was the chief rival to the chronometer method in the race to win the longitude prize.

But like the chronometer method, the lunar distance method, although sound in theory, was not yet workable in practice. To use it, navigators would require an accurate chart of the stars, tables of the moon’s position (published several years in advance), and an instrument that could provide precise lunar observations.⁵¹ None of these existed at the start of the eighteenth century.⁵² The development of the sextant in 1730 provided the instrument, but astronomers had not yet mapped the skies, nor had they worked out the path of the moon sufficiently to be able to publish the tables.⁵³

Government was at work on the task. In 1675, King Charles II appointed John Flamsteed to be his “astronomical observator” (later the “Astronomer Royal”),⁵⁴ with the particular charge that he should forthwith “apply the most exact Care and Diligence to rectifying the Tables of the Motions of the Heavens, and the Places of the fixed Stars, so as to find out the so-much desired Longitude at Sea, for perfecting the art of Navigation.”⁵⁵ The Royal Greenwich Observatory was created to carry out the great project.⁵⁶ Flamsteed knew, however, that it would take years to make the observations,⁵⁷ and indeed, astronomers spent the next 150 years at the task,⁵⁸ which was complicated by repeated quarrels over ownership of the data.⁵⁹

50. *Id.* at 23; HOWSE, GREENWICH TIME, *supra* note 7, at 183.

51. HOWSE, GREENWICH TIME, *supra* note 7, at 183.

52. *Id.*

53. *Id.* at 183-84.

54. SOBEL, *supra* note 1, at 31.

55. *Id.* (internal quotation marks omitted); HOWSE, GREENWICH TIME, *supra* note 7, at 42.

56. HOWSE, GREENWICH TIME, *supra* note 7, at 42-45.

57. *Id.* at 39.

58. *Id.*

59. Flamsteed, who regarded his salary as inadequate, compensated by treating his observations as his private property. *Id.* at 49. James Bradley, the third Astronomer Royal, took the same position, and following his death in 1762, his daughter and the government disputed ownership of his observations for over a decade. HOWSE, MASKELYNE, *supra* note 7, at 55, 107, 121-22.

Thus, whether by chronometer or by lunar distance, the problem of finding the longitude was by no means solved. As the Board of Longitude came into existence in 1714, there were no credible proposals—although there were many incredible ones. In 1713, William Whiston and Humphrey Ditton, a pair of mathematicians, proposed that a fleet of ships be anchored across the ocean at 600-mile intervals and that each such ship fire off a cannon shell and flare every day at midnight. Navigators of other ships could then determine their position by timing the interval between seeing the flare and hearing the cannon.⁶⁰ The difficulty of anchoring ships in mid-ocean and the vast expense that would be required to man the ships made this proposal impractical.⁶¹ Even more incredible was the plan, proposed in 1687, to send a wounded dog aboard every ship, and to leave behind a discarded bandage from the dog's wound. Each day at noon, this bandage would be dipped in "powder of sympathy," a substance which had the miraculous power to heal at a distance, although at the cost of giving some pain to the patient. The dog's yelp when the bandage was dipped would give the ship's navigator the necessary time cue.⁶² Like most plans that rely on magic, however, the powder of sympathy method failed to work in practice.

D. Enter John Harrison

With navigation in this sorry state, a new proposal for finding the longitude came from an unlikely source: a carpenter and land surveyor, with little or no formal education and no training or apprenticeship in clock-making, from a remote, isolated, agricultural village called Barrow-on-Humber, by the name of John Harrison.⁶³ Despite coming from a place where even seeing a watch or clock would be rare,⁶⁴ Harrison had a genius for clock-making and thought he could build a clock that could keep proper time at sea. In 1730, Harrison traveled to London to put his plans before Edmond Halley. Halley (best known today for his study of "Halley's comet") was the second Astronomer Royal and therefore a member of the Board of

60. SOBEL, *supra* note 1, at 46-50.

61. *Id.* at 48-50; QUILL, *supra* note 7, at 5.

62. SOBEL, *supra* note 1, at 41-42; Owen Gingerich, *Cranks and Opportunists: "Nutty" Solutions to the Longitude Problem*, in ANDREWES, *supra* note 7, at 134-35. Gingerich suggests that this proposal was a satire on the concept of "powder of sympathy," not a serious suggestion. Gingerich, *supra*, at 135.

63. QUILL, *supra* note 7, at 11-15, 17, 208; SOBEL, *supra* note 1, at 113.

64. QUILL, *supra* note 7, at 17.

Longitude.⁶⁵ Halley referred Harrison to George Graham, an expert watchmaker and Fellow of the Royal Society, who encouraged Harrison and lent him money to finance his work.⁶⁶ Thus began Harrison's quest for the longitude prize—a quest that would last forty-three years.

After five years of work, Harrison returned to London with his first sea clock, known today as "H1."⁶⁷ Through the influence of Halley and Graham, H1 was investigated by the Royal Society, and five Fellows of the Society, including Halley, Graham, and James Bradley (later the third Astronomer Royal), signed a certificate praising the machine's accuracy and recommending that it receive "a thorough Tryal and Improvement."⁶⁸ The following year, the Admiralty arranged to have H1 tested by sending Harrison and H1 from Portsmouth, England, to Lisbon, Portugal, on the H.M.S. Centurion.⁶⁹

The trip proved a great success. Despite the unfortunate death of the ship's captain shortly after arrival in Lisbon (which resulted in no details of the outbound voyage being preserved),⁷⁰ H1 had an opportunity to shine on the return trip aboard the H.M.S. Orford. When the Orford sighted land upon its return to England, the ship's Master, navigating by dead reckoning, thought the land was the Start, a coastal point near Dartmouth, but Harrison, aided by H1, correctly stated that the land was actually the Lizard, a peninsula nearly sixty nautical miles west of the Start.⁷¹

The members of the Board of Longitude were so impressed that the Board did something it had never yet done in the twenty-three years of its existence: it held a meeting.⁷² At this first meeting, on June 30, 1737 (which was quite a high-powered affair—rather like a meeting today with the Speaker of the House of Representatives, the President's Science Advisor, and several cabinet Secretaries),⁷³ Harrison, apparently believing that his clock was not yet ready to meet

65. SOBEL, *supra* note 1, at 74-75.

66. *Id.* at 76-77; QUILL, *supra* note 7, at 42.

67. HOWSE, GREENWICH TIME, *supra* note 7, at 73.

68. QUILL, *supra* note 7, at 42.

69. *Id.* at 43-44.

70. *Id.* at 44.

71. *Id.* at 45-46; SOBEL, *supra* note 1, at 81.

72. QUILL, *supra* note 7, at 46; SOBEL, *supra* note 1, at 82.

73. Eight Commissioners of Longitude were present, including the Astronomer Royal, the President of the Royal Society, the Speaker of the House of Commons, the Admiral of the Fleet, the First Lord Commissioner of the Admiralty, the Commissioner of Lands and Plantations, and professors from Oxford and Cambridge. MINUTES, *supra* note 7, June 30, 1737.

the stringent standards of the Longitude Act, did not suggest that the Board send H1 on a trial to the West Indies.⁷⁴ Harrison instead asked that the Board exercise its power under the Longitude Act to grant him research funds, which he would use to build a second, improved timekeeper. The Board agreed to this request, and it awarded Harrison £500, on condition that both H1 and the new timekeeper would become public property.⁷⁵

There then followed a long period, which was ultimately to stretch for more than twenty years, during which Harrison worked to produce a timekeeper that could meet the standards of the Longitude Act. Harrison moved to London and completed his second clock, H2, in relatively short order—it took just two years—but, being still unsatisfied with its performance (and apparently concerned that it might be captured in the splendidly named “War of Jenkins’s Ear,” then being fought between Britain and Spain), Harrison never sent H2 to sea.⁷⁶ Instead, he sought funds from the Board for development of a third timekeeper, which the Board granted in 1741.

Harrison promised the Board that H3 would be completed two years later, in August 1743.⁷⁷ He missed the mark by a mere seventeen years. During the nineteen years that Harrison worked on H3, he appeared before the Board nine times, appealing for, and receiving, additional funding nearly every time,⁷⁸ until he had received public funding (apparently his only source of income) totaling £3000.⁷⁹ At these appearances, Harrison repeatedly suggested that H3 would be ready on specified dates, which he repeatedly missed. Finally, however, on July 18, 1760, Harrison reported to the Board that H3 was ready for a sea trial.⁸⁰

74. Apparently, despite its success on the Orford, Harrison did not think H1 could perform up to the requirements of the Longitude Act on a six-week voyage. Also, he seems to have labored under the misapprehension that he would be permitted only *one* official try for the longitude prize (even though there was no statutory language justifying this view), and he was not ready to risk everything on H1. QUILL, *supra* note 7, at 47-48.

75. The requirement to give H1 to the public was perhaps unfair, inasmuch as the Board had not contributed anything toward its construction, but Harrison accepted it as a condition of the Board’s subsidy. *Id.* at 48-49; SOBEL, *supra* note 1, at 84.

76. QUILL, *supra* note 7, at 59.

77. *Id.* at 63.

78. *Id.* at 68.

79. After most of the £2000 authorized by the original Longitude Act had been expended by payments to Harrison and others, Parliament enacted further statutes authorizing additional expenditures (and also replacing Commissioners of Longitude who had died). 1761, 2 Geo. 3, c. 18 (Eng.); 1753, 26 Geo. 2, c. 25 (Eng.).

80. QUILL, *supra* note 7, at 76.

Toward the end of this period, however, Harrison also, somewhat surprisingly, turned to watchmaking—surprisingly, because a clockmaker is usually not successful at making watches, nor vice-versa.⁸¹ Harrison originally intended to make a watch for use as an adjunct to his larger sea clock, but at the Board meeting of July 18, 1760, at which Harrison declared H3 ready for trial, he also reported that his watch, H4, then under construction, had turned out to be far more accurate than expected, and he predicted it would serve as a longitude timekeeper in its own right.⁸² On February 26, 1761, Harrison wrote to the Board to say that H4 was complete and that he desired both H3 and H4 to be tested at sea. A few months later, however, Harrison, apparently unsatisfied with the accuracy of H3, withdrew it from the proposal and sought a test of the watch, H4, only.⁸³

At long last, thirty-one years after beginning his quest, John Harrison had a marine chronometer ready for testing. But Harrison's hardest struggles to claim the longitude prize were just beginning.

E. Harrison's Struggles with the Board

With so much riding on the outcome, it was obviously important to arrange proper conditions for the test—and arranging those conditions was harder than one might imagine. The Longitude Act required that a ship sail from Britain to the West Indies “without losing [its] Longitude beyond the Limits” specified in the act.⁸⁴ But how was one to know whether a ship had done this?

It would seem simple enough to send a ship to the West Indies with Harrison's watch aboard and to check whether the longitude, as found by the watch, was sufficiently correct. But this assumes an accepted method of determining the “correct” longitude. In fact, the best method available for determining longitude on land was Galileo's Jovian satellite method, and there was dispute about how accurate it was.⁸⁵ The Royal Society suggested that the watch be sent to Jamaica and that the longitude as shown by the watch be compared to the longitude as determined on the spot by the satellite method.⁸⁶ Harrison, however, objected that the satellite method could be off by as

81. *Id.* at 79.

82. *Id.* at 77.

83. *Id.* at 90.

84. Longitude Act 1714, 12 Ann., c. 15, § 3 (Eng.).

85. SOBEL, *supra* note 1, at 27.

86. QUILL, *supra* note 7, at 88-89.

much as thirty miles or more.⁸⁷ Because accuracy to within thirty miles was a statutory requirement for the full £20,000 longitude prize, an error of thirty miles in the figure used as the “correct” longitude would necessarily invalidate the test.

The Board of Longitude, in giving Harrison his official instructions for the test voyage, omitted reference to the satellite method. The instructions required only that upon arrival in Jamaica, John Robison, an astronomer, determine the local time by astronomical means and record that time and the time shown by Harrison’s watch. Apparently, the plan was to compare the longitude as determined by the difference between these times to the previously accepted longitude of Jamaica.⁸⁸ In light of Harrison’s advancing age (he was then sixty-seven), it was decided that his son, William Harrison, would go to Jamaica with H4.

1. The Jamaica Trial

The Jamaica trial was beset by technical difficulties.⁸⁹ Most seriously, although Harrison claimed that H4 lost a mere 5.1 seconds during the eighty-one-day voyage (which, if true, would have been a stunning performance that would have more than met the statutory standards for the full longitude prize), his claim depended on allowance being made for the watch’s “rate of going.” Harrison claimed that, depending on how it was adjusted, H4 gained or lost some time—but a fixed time—each day. Harrison claimed that a navigator could still determine the Greenwich Time from H4 by making an allowance for this rate. Harrison claimed that a timekeeper that gains or loses a fixed amount of time each day is just as valuable for navigational purposes as one that keeps perfect time.⁹⁰

In theory, Harrison was perfectly correct. Even if, for example, a watch lost a whole minute every day, it could still be used to find the longitude as long as the daily loss was always *exactly* a minute. The

87. *Id.* at 89-90. One difficulty was that the satellite method called for the observer to exercise judgment in determining exactly when a satellite’s eclipse began. *Id.*

88. *Id.* at 93. This method required precautions against skulduggery. To prevent Harrison from simply setting the watch to the appropriate time at the last moment, the Board provided that the watch would be kept in a box fitted with four locks, the keys of which were to be held by different people, including Harrison.

89. In addition to the problem discussed in the text, there were difficulties finding a suitable place for the observations, with the result that nothing got done for six days, following which Harrison and Robison rushed to complete the observations in two days so as to be able to catch a homeward bound ship. *Id.* at 102-05.

90. *E.g.*, HARRISON, REMARKS, *supra* note 7, at 3, 13-15.

navigator would simply add a minute to the time shown on the face of the watch for each day since the watch was last set to the Greenwich Time. A similar allowance could be made for any fixed daily gain or loss, and the Board was not averse to making such an allowance.⁹¹

The fatal difficulty, however, was that Harrison had neglected to declare H4's rate of going *before* the voyage to Jamaica. This omission rendered a fair judgment of the trial impossible. If Harrison were allowed to declare the watch's rate of going *after* the trial, then he could make *any* trial seem a success, by dividing the watch's total error by the length of the trial and claiming the result as the watch's daily gain or loss.⁹² Therefore, if Harrison wanted the benefit of a "rate of going," he needed to declare it beforehand.

For this reason, the Jamaica trial was inconclusive.⁹³ At a meeting held August 17, 1762, the Board decided that another West Indies trial was required, with more precisely specified conditions.⁹⁴ Harrison agreed to this "if it would end all disputes."⁹⁵

The Board also, however, exercised its power under section V of the Longitude Act to declare Harrison's watch to be "of considerable Use to the Publick."⁹⁶ The Board determined that Harrison should receive an award of £2500 (£1500 immediately and the balance following the second West Indies trial), to count against whatever prize

91. The Board allowed such a rate on H4's second trial, discussed below. See NARRATIVE, *supra* note 7, at 19-21 (reproducing William Harrison's letter to the Board on this subject). Moreover, even this declaration revealed the slipperiness of the "rate" issue, because William Harrison stated that the watch's rate of going varied slightly with the temperature, from a gain of three seconds per day at forty-two degrees to a loss of one second per day at eighty-two degrees. *Id.* Thus, despite all of John Harrison's ingenuity, the watch was still somewhat temperature-sensitive, and the declaration could be seen as the Harrisons' attempt to leave themselves an "out" in case of failure.

92. If, for example, after eighty-one days of voyaging to Jamaica, H4 had turned out to be slow by 13.5 minutes (810 seconds), Harrison could simply claim, retrospectively, that the watch lost ten seconds per day, which would render its performance perfect.

93. Although the Board's surviving records do not clearly explain the basis of its rejection of the Jamaica trial, other evidence shows that the problem lay in the "rate of going" issue. A contemporary pamphlet published by a Harrison supporter explains that the claimed error of 5.1 seconds for the voyage relied on an allowance of losing 2.66 seconds per day. QUILL, *supra* note 7, at 112. Also, a pamphlet later published by the Astronomer Royal confirmed that the Jamaica trial was "rendered nugatory" because of the failure to ascertain H4's rate of going beforehand, and that the second trial resulted from the rate of going issue. MASKELYNE, ANSWER, *supra* note 7, at 87-88.

94. QUILL, *supra* note 7, at 114.

95. *Id.* (internal quotation marks omitted).

96. Longitude Act 1714, 12 Ann., c. 15, § 5 (Eng.).

Harrison ultimately received under the Act.⁹⁷ Harrison, not mollified, began to view the Board with suspicion and mistrust.⁹⁸

2. The Barbados Trial

Considerable activity preceded the second trial. Harrison appealed to Parliament for assistance, and Parliament, in 1763, responded with “An Act for the Encouragement of *John Harrison*,”⁹⁹ which provided that Harrison could receive a prize of £5000, without the necessity of a second sea trial, by providing “a full and clear Discovery [i.e., explanation] of the Principles” of his watch, “and of the true Manner and Method in which the same is and may be constructed,” to the satisfaction of a specified committee.¹⁰⁰ Harrison could also continue to pursue the prize offered by the original, 1714 Act.¹⁰¹ Moreover, the 1763 Act protected Harrison against any other person’s winning the longitude prize by means of a timekeeper for a period of four years.¹⁰²

Harrison promptly ran into interpretive difficulties regarding the 1763 Act—he spent months debating its meaning with the appointed committee.¹⁰³ The committee determined that to make a “full and clear Discovery” of the “true Manner and Method” by which his watch might be constructed, Harrison would not only have to supply drawings and descriptions, but also dismantle the watch piece by piece before the committee and supervise workmen in making two or more copies of it, which would have to be tested.¹⁰⁴ Harrison, fearful of the delay that this would entail (and of the difficulty of reassembling the watch for its second trial), refused.¹⁰⁵ He never received any money by virtue of the 1763 Act.¹⁰⁶

Instead, Harrison prepared for the second West Indies trial of H4. This time, the Board specified that the watch would travel to Barbados, where the local time would be determined by astronomical observation. Also, the longitude of the island would be determined on

97. QUILL, *supra* note 7, at 115.

98. *Id.* at 116.

99. 1763, 3 Geo. 3, c. 14 (Eng.).

100. *Id.* § 1.

101. *Id.* § 2. The £5000 available under the 1763 Act would be deducted from any prize he won under the original act. *Id.*

102. *Id.* § 3.

103. QUILL, *supra* note 7, at 121-25.

104. *Id.* at 122.

105. *Id.* at 123.

106. NARRATIVE, *supra* note 7, at 2.

the spot by the Jovian satellite method. The observations would be taken by persons specified by the Board, one of whom was the Reverend Nevil Maskelyne.¹⁰⁷

This last condition caused Harrison considerable consternation. Maskelyne was an astronomer—and not just any astronomer. For at least two years Maskelyne had been working on the lunar distance method for solving the longitude problem.¹⁰⁸

While Harrison was spending decades struggling to perfect the chronometer method, the lunar distance method was not standing still. In 1757, German astronomer Tobias Mayer sent the Board of Longitude a set of lunar tables that, he claimed, would enable mariners to find the longitude using the lunar distance method.¹⁰⁹ Maskelyne began testing these tables on sea voyages as early as 1761.¹¹⁰ The Board was sufficiently impressed with the results that in 1763, it authorized Maskelyne to produce *The British Mariner's Guide*, a handbook for use of the lunar distance method.¹¹¹ The Board also decided to test the lunar distance method (in addition to the chronometer method) during the Barbados trial.¹¹²

Parliament's 1763 Act, as noted above, gave Harrison four years' protection against another person's winning the longitude prize with a timekeeper, but did not protect him against being anticipated by the lunar distance method. Harrison was therefore deeply suspicious of Maskelyne.¹¹³ When H4 arrived in Barbados in May 1764, Harrison's son William (again traveling with the watch), accused Maskelyne of being a rival claimant for the prize and declared him to be "a most improper person" to make the observations that would determine H4's success in the test.¹¹⁴ Maskelyne was, of course, highly offended.¹¹⁵

But the Harrisons need not have worried about that. Despite the unpleasant fuss about the observations, and even though Harrison's

107. *Id.* at 3-6; QUILL, *supra* note 7, at 126-28.

108. *See* QUILL, *supra* note 7, at 126-27; HOWSE, MASKELYNE, *supra* note 7, at 28-29.

109. HOWSE, MASKELYNE, *supra* note 7, at 14. Mayer later prepared revised tables, which his widow submitted to the Board in 1762. *Id.* at 41.

110. *Id.* at 29-30.

111. QUILL, *supra* note 7, at 127.

112. HOWSE, MASKELYNE, *supra* note 7, at 47. A third method, the "marine chair" method, which attempted to make the Jovian satellite method practicable by providing a steady platform for observation, was also tested on the same voyage, but proved unsuccessful. *Id.* at 47-49.

113. QUILL, *supra* note 7, at 127-28.

114. *Id.* at 132.

115. *Id.*

suspensions regarding Maskelyne never dissipated,¹¹⁶ the Board subsequently agreed that H4's second test was a success. On the trip to Barbados, the watch kept the longitude to within less than 10 miles—an accuracy three times better than that demanded by the Longitude Act.¹¹⁷

But Harrison *still* did not get the prize.

3. The Prize Still Withheld

The Board considered Harrison's claim to the longitude prize on the basis of the Barbados voyage at its meeting of February 9, 1765. Attending the meeting as a Commissioner was the recently appointed fifth Astronomer Royal. Harrison must have been rather upset to see this appointment go to none other than his *bête noire*—Nevil Maskelyne.

The Board unanimously concluded that H4 had kept track of the longitude “considerably within” the narrowest limit set by the 1714 Act.¹¹⁸ The Board did not, however, conclude that Harrison had won the prize. The problem, the Board explained, lay in section IV of the Longitude Act. This section instructed the Board to certify a longitude method as having won the prize when the method had been “tried and found practicable and useful at Sea.”¹¹⁹ The Board noted that Harrison had not yet explained the principles by which the watch worked, nor had he explained how it could be duplicated and put into general use.¹²⁰ Therefore, the Board decided that it could not certify that the watch had been found “practicable and useful.”¹²¹

As will be explained in detail in Part III of this Article, this certification requirement was the ultimate crux of the disagreement between Harrison and the Board.¹²² Harrison believed that the successful Barbados trial entitled him to the full £20,000 prize. The Board believed that Harrison could not receive any part of the prize until it was able to certify his method as “practicable and useful” under section IV of the Longitude Act.

The Board decided, however, on a plan whereby Harrison could ultimately receive the prize and whereby he would even be able to

116. *Id.* at 133.

117. *Id.* at 137.

118. *Id.* at 139.

119. Longitude Act 1714, 12 Ann., c. 15, § 4 (Eng.).

120. QUILL, *supra* note 7, at 139.

121. *Id.*; see Longitude Act 1714, 12 Ann., c. 15, § 4.

122. See *infra* Part III.C.

receive half of the prize before the Board could make the section IV certification. The Board recommended that Parliament enact a new statute providing that Harrison should receive £10,000, half the full prize, when he explained the principles of H4 to them under oath. He would receive the other half when he sufficiently proved that his timekeepers were a “Method of common and general Utility in finding the Longitude at Sea.”¹²³

Harrison objected to the Board’s decision, claimed the full prize on the basis of the Barbados trial, and published pamphlets and articles publicly explaining his position.¹²⁴ However, the Board did not relent.

4. Further Board and Parliamentary Action

The Board and Harrison both turned to Parliament. The Board sought codification of its recommendation; Harrison sought recognition of his claim to the full prize. The Board won and Harrison lost. In May 1765, Parliament enacted “An Act for explaining and rendering more effectual” its previous Longitude Acts.¹²⁵

The 1765 Act essentially codified the Board’s recommendation. The act provided that Harrison would receive £10,000 (less the £2500 prize already received) when he explained the principles of his watch to the satisfaction of the Board and assigned the property rights in all four of his timekeepers to the Board for the use of the public.¹²⁶ Harrison would receive the other half of the money when “other . . . Time Keepers of the same Kind shall be made,” and when these other timekeepers, “upon Trial,” were determined by the Board to be capable of finding the longitude within half a degree.¹²⁷ The 1765 Act provided no particular method by which this “trial” was to take place.

Still further disputes arose over the interpretation of the 1765 Act. Harrison proposed to satisfy the disclosure requirement of the act by submitting drawings and explanations of H4, but the Board decided that in addition, Harrison would have to take the watch to pieces in front of a committee appointed by the Board.¹²⁸ When the Board explained this condition to Harrison at a meeting on June 13, 1765, Harrison left abruptly, declaring that he would never consent “*so long as he had a drop of English blood in his body*”—an outburst duly

123. QUILL, *supra* note 7, at 139-40.

124. QUILL, *supra* note 7, at 141.

125. 1765, 5 Geo. 3, c. 20 (Eng.).

126. *Id.* § 1.

127. *Id.*

128. QUILL, *supra* note 7, at 147-48.

recorded in the Board's minutes.¹²⁹ Some weeks later, Harrison submitted a letter of apology but still did not agree to disassemble the watch.¹³⁰ The Board's Chairman eventually told Harrison: "Sir, . . . you are the strangest and most obstinate creature that I have ever met with, and, would you do what we want you to do, and which is in your power, I will give you my word to give you the money, if you will but do it."¹³¹

Finally, Harrison agreed to the Board's conditions. Over a period of six days beginning on August 14, 1765, he dismantled H4 piece by piece before the Board's appointed representatives. To what must have been Harrison's considerable annoyance, Nevil Maskelyne also attended in his capacity as a Commissioner.¹³² On August 22, the committee members (and Maskelyne, too) finally certified that Harrison had satisfactorily explained the mechanism of the watch.¹³³

The only remaining condition for the first half of the prize was that Harrison assign his timekeepers to the Board. Harrison did so, but pleaded to be allowed to retain actual possession of H4, for use in production of the required duplicates. Much negotiation over this last hurdle ensued, but the Board demanded possession of H4, and Harrison yielded up the watch on October 28, 1765.¹³⁴ On the same day, after thirty-five years of effort, Harrison finally received *half* of the great longitude prize.¹³⁵

5. Royal Action and the Final Resolution

But what of the other half? According to the 1765 Act, Harrison could receive the other half only when "other . . . Time Keepers of the same Kind" were made.¹³⁶ The statute's use of the plural "time keepers" showed that at least *two* duplicates of H4 were required. These new watches would also have to be tested by a "trial" of a kind unspecified in the act.¹³⁷

Harrison and the Board debated these requirements over a considerable period. In April 1766, the Board rejected Harrison's

129. MINUTES, *supra* note 7, June 13, 1765.

130. QUILL, *supra* note 7, at 150.

131. *Id.* at 151 (internal quotation marks omitted).

132. HARRISON, REMARKS, *supra* note 7, at 6.

133. *Id.*

134. QUILL, *supra* note 7, at 156.

135. CASE OF HARRISON, *supra* note 7, at 3.

136. 1765, 5 Geo. 3, c. 20, § 1 (Eng.).

137. *Id.*

requests for public funds for production of the copies.¹³⁸ The Board instead hired another watchmaker, Larcum Kendall, to duplicate H4 for a fee of £450.¹³⁹ Moreover, the Board decided that Kendall, not Harrison, could have possession of H4 to use as a model for making copies—after, that is, H4 finished spending ten months at the Royal Observatory, being subjected to testing by the Astronomer Royal, Nevil Maskelyne.¹⁴⁰ The tension between Harrison and the Board cannot have been helped when in May 1766, Maskelyne, at the order of the Board, appeared at Harrison’s home to demand the surrender of H1, H2, and H3.¹⁴¹ Harrison yielded the clocks to Maskelyne with poor grace¹⁴² and later complained that one of them was dropped and “broke to Pieces *under his careful and ingenious management*, before it got out of my House.”¹⁴³

Even more damaging to Harrison’s prospects was the Board’s interpretation of the requirement of “trial” of his duplicate watches. At its meeting of May 2, 1767, the Board determined that once Harrison had produced two watches, the “trial” would not be a six-week West Indies voyage as provided by the original 1714 Longitude Act (which was still in force), but a *ten-month* long trial at the Royal Observatory, plus two months’ trial on shipboard.¹⁴⁴ Thus, Harrison, already seventy-four years old, would have to wait at least a year to see his watches tested—after he produced them. Moreover, and perhaps most damaging of all, the Board did not specify what would constitute a success in this trial.¹⁴⁵

Harrison managed to complete one duplicate watch, known as H5, by 1772, when he was seventy-nine. Partly because of his poor health and eyesight, this watch took four and a half years to complete. The chances of his being able to complete another duplicate seemed slim, and in any event, the Board had still not specified the requirements for a successful test.

Rather than submit H5 to Board testing, Harrison turned to a different authority—the King. Harrison’s son William obtained a personal interview with King George III. The King learned the details

138. QUILL, *supra* note 7, at 160.

139. *Id.* at 162.

140. *Id.* at 166-72, 177-78; HARRISON, REMARKS, *supra* note 7, at 23 & n.*.

141. QUILL, *supra* note 7, at 163.

142. *Id.* at 163-65. Harrison refused to give advice as to the best means of moving the clocks safely.

143. HARRISON, REMARKS, *supra* note 7, at 22.

144. QUILL, *supra* note 7, at 178.

145. *Id.* at 179, 198.

of the story and reportedly said, “These people have been cruelly treated,” and “By God, Harrison, I will see you righted!”¹⁴⁶

The King, who had an interest in scientific matters, personally tested H5 at his own observatory at Richmond. H5 proved extremely accurate, running only 4.5 seconds fast after a ten-week test. Harrison petitioned the Board for the remaining £10,000 of his prize on the basis of this test, but the Board refused. Even though the King had been personally involved, the test was unofficial. Under the Longitude Act, only the Board was authorized to conduct tests.¹⁴⁷

At this point, Harrison finally gave up dealing with the Board. Instead, in 1773, Harrison petitioned Parliament for redress. At first, Harrison prayed that Parliament “restore to him his legal rights” under the original, 1714 Longitude Act.¹⁴⁸ This petition met with resistance, presumably on the ground that Harrison had never satisfied the conditions of the 1765 Act, which “explained” the original act.¹⁴⁹ Harrison, therefore, withdrew this petition and submitted another one, in which he prayed simply for the benevolence of Parliament, that it might make him a suitable award for his lifetime of work, and in recognition of his age, infirmity, and consequent inability to meet the remaining conditions of the 1765 Act.¹⁵⁰

This second petition was successful. In July 1773, Parliament recognized Harrison’s “unremitting Industry,” his discovery of the principles of the longitude timekeeper, and the “great Benefit” that would arise therefrom to the trade and navigation of the Kingdom.¹⁵¹ Parliament awarded Harrison the sum of £8750.¹⁵² Although the money was a benevolence, and did not represent the actual prize money that Harrison had sought for so long, it was only £1250 less than the remaining amount of the prize.¹⁵³

Harrison never quite got over the denial of the final £1250.¹⁵⁴ Still, after forty-three years of Harrison’s efforts, Parliament’s award of

146. SOBEL, *supra* note 1, at 147 (internal quotation marks omitted).

147. QUILL, *supra* note 7, at 195.

148. 34 JOURNALS, *supra* note 7, at 244.

149. QUILL, *supra* note 7, at 201.

150. 34 JOURNALS, *supra* note 7, at 302.

151. 1773, 13 Geo. 3, c. 77, § 29 (Eng.).

152. *Id.*

153. Apparently, the £1250 deduction represented Parliament’s decision to enforce a proviso, attached to the early research grants awarded to Harrison by the Board, that the grants would be deducted from any prize later awarded. William J.H. Andrewes, *Even Newton Could Be Wrong: The Story of Harrison’s First Three Sea Clocks*, in ANDREWES, *supra* note 7, at 224 n.130; MINUTES, *supra* note 7, Jan. 16, 1741.

154. QUILL, *supra* note 7, at 204.

the £8750 finally put the matter at rest. The following year, 1774, Parliament repealed all the previous Longitude Acts and passed a new one offering a £10,000 longitude prize, with exacting conditions that mimicked those the Board imposed on Harrison.¹⁵⁵ There were many claimants, but this prize was never awarded.¹⁵⁶

John Harrison died on March 24, 1776.¹⁵⁷

III. *HARRISON V. BOARD OF LONGITUDE*

There is much more to the longitude story than the shortened account given here. Nearly all of the technical details—Harrison’s brilliance in inventing and/or employing ingenious devices to solve the problems of timekeeping at sea, including the gridiron pendulum,¹⁵⁸ the “grasshopper escapement,”¹⁵⁹ the remontoire,¹⁶⁰ and, perhaps most important, the bi-metallic strip¹⁶¹—have been omitted. Even the legal maneuvering, considerable though it must seem, is presented in shortened form, with an eye toward setting up the issues discussed in this Part.

The generally popular view is that the Board of Longitude unjustly withheld the longitude prize from John Harrison.¹⁶² Sobel’s

155. 1774, 14 Geo. 3, c. 66 (Eng.).

156. QUILL, *supra* note 7, at 207.

157. *Id.* at 239.

158. The gridiron pendulum was a pendulum constructed of a combination of steel and brass rods, which had different rates of expansion. Harrison combined them in such a way that the effective length of the pendulum would change little with changes in temperature. SOBEL, *supra* note 1, at 71; QUILL, *supra* note 7, at 25.

159. An escapement is a mechanism that alternately stops and releases the movement of a watch or clock, causing the characteristic ticking sound. Harrison’s “grasshopper escapement,” which had an action resembling the hind legs of a grasshopper, reduced friction and worked silently. SOBEL, *supra* note 1, at 71-72; QUILL, *supra* note 7, at 25.

160. A remontoire is a device that compensates for the different degrees of power that a spring-driven timekeeper will receive from its mainspring as the mainspring winds down. In a timekeeper that uses a remontoire, the mainspring does not directly power the escapement, but instead powers a secondary spring. This secondary spring is rewound every few seconds and so can deliver a constant force to the escapement. QUILL, *supra* note 7, at 59. The remontoire was not a Harrison invention, but his use of it in pendulum-driven clocks was innovative. *Id.* at 58, 231.

161. The bimetallic strip, perhaps Harrison’s most important innovation, was another device to compensate for changes in temperature. Harrison riveted together strips of brass and steel, which have different coefficients of expansion. In response to a rise in temperature, the brass would expand more than the steel, and the bimetallic strip would bend. Harrison caused one end of the strip to move along the balance spring of his timekeeper, altering its effective length and thus compensating for the temperature change. *Id.* at 65. The bimetallic strip was used for this purpose in many devices, such as thermostats, well into the twentieth century. *Id.* at 65, 219.

162. *Id.* at 140, 205.

book, the tremendous popularity of which eclipsed previous accounts of the longitude story,¹⁶³ gave further currency to this view. Sobel accuses the Board of bias,¹⁶⁴ conflict of interest,¹⁶⁵ and of wrongfully withholding the prize after Harrison had done all that the Longitude Act demanded.¹⁶⁶ Accusations such as these are part of the usual take on the longitude story. Thirty years before Sobel, Harrison biographer Humphrey Quill noted that “[i]t has been frequently stated and generally believed that the Board acted harshly and even unjustly to John Harrison by withholding any reward from him in spite of the wonderful and proved accuracy of H.4.”¹⁶⁷

However, to do justice to the Board as well as to Harrison, it is necessary to view the story through a lawyer’s eyes. Just as a lay jury may be moved by sympathy toward a severely injured plaintiff in a tort action against a wealthy, faceless corporation, so a lay writer may be moved by Harrison’s tremendous efforts and ingenuity and his decades of struggle against government bureaucracy.¹⁶⁸ However, rather than simply siding with the “lone genius” against the unsympathetic government agency, what is needed is a sober, impartial review of the statutory and other legal issues to which the longitude story gives rise.

This Part of the Article undertakes such a review. It imagines Harrison’s story translated into a judicial setting. Suppose Harrison, faced with the Board’s refusal to award him the longitude prize, had sought judicial review—as, indeed, he probably would have following the Barbados trial, had Parliament not intervened with the 1765 Act.¹⁶⁹ Harrison would put before the court the several issues that Sobel has outlined, particularly the claim that, under the Longitude Act, the Board had no option but to award Harrison the prize once his watch performed to the statutory specifications on a West Indies trial. This

163. *Longitude* spent sixteen weeks on the *New York Times* hardcover best-seller list and twenty-five weeks on the paperback list. See *Paperback Best Sellers*, N.Y. TIMES, July 13, 1997, at BR 28; *Best Sellers*, N.Y. TIMES, Apr. 28, 1996, at BR 34.

164. See SOBEL, *supra* note 1, at 9.

165. *Id.* at 118.

166. *Id.* at 121.

167. QUILL, *supra* note 7, at 140.

168. Sobel hints that her framing of the story may also have been influenced by literary considerations. See SOBEL, *supra* note 1, at 111 (“A story that hails a hero must also hiss at a villain . . .”).

169. Harrison stated that he “never would have desired nor ever will desire any better Satisfaction than a judicial Determination” of his right to the reward under the original Longitude Act, but he recognized that the 1765 Act gave the Board discretion to impose additional conditions beyond those specified in the 1714 Act. HARRISON, REMARKS, *supra* note 7, at 21.

Article considers these issues and determines what a court might make of them.

The Article considers these questions from several perspectives. First, because Harrison would have sued in an eighteenth-century British court, the Article considers how such a court would likely have ruled under the law applicable at the time. In addition, because modern American readers would also wish to know whether the Board's treatment of Harrison comports with our own notions of justice, the Article considers how the case might come out under modern principles of American administrative law. Finally, the Article considers whether the Board of Longitude itself reached the right decision, putting aside any deference the Board's decision might receive on judicial review.

Part III.A first investigates whether the Board had an illegal bias against Harrison and his chronometer method of finding the longitude. Part III.B then considers whether the commissioners, particularly Nevil Maskelyne, had an illegal conflict of interest. Finally, Part III.C takes up the most important question of all: the question of statutory construction. This Part examines whether the successful Barbados trial entitled Harrison to receive the longitude prize, or whether the Board was empowered to impose additional requirements.

A. *Bias*

Sobel charges the Board of Longitude with bias against Harrison's chronometer method of solving the longitude problem. The Board, Sobel observes, was "top-heavy with astronomers, mathematicians, and navigators" and "would not welcome a mechanical answer to what it saw as an astronomical question."¹⁷⁰ Sobel states that the commissioners "openly endorsed" the lunar distance method "as the logical outgrowth of their own life experience with sea and sky."¹⁷¹

The Board, according to Sobel, regarded the lunar distance method as "heroic," because its success resulted from decades of cumulative effort by an international team of astronomers and mathematicians.¹⁷² By contrast, Sobel suggests, Harrison's solution required only "a little ticking thing in a box."¹⁷³ The Board supposedly resented the chronometer method because its use required no mastery of mathematics or astronomy—all of the complex calculations

170. SOBEL, *supra* note 1, at 75-76.

171. *Id.* at 99.

172. *See id.*

173. *Id.*

required by the lunar distance method were “hardwired” into Harrison’s watch, which could, therefore, be used by any common seaman. As a result, the Board allegedly regarded the chronometer method as “unseemly,” “facile,” “flukish,” and “preposterous.”¹⁷⁴ Because of its bias, Sobel suggests, the Board “changed the contest rules whenever [it] saw fit, so as to favor the chances of astronomers over the likes of Harrison and his fellow ‘mechanics.’”¹⁷⁵ This is a serious charge.

The charge of agency bias is familiar in administrative law, and the applicable rules are familiar also. Under either contemporary or modern principles, Sobel’s charge that the Board of Longitude was improperly biased would likely fail on three counts: it disregards the permissible degree of reliance by agency administrators on their own expertise, it is not borne out by the facts, and it overlooks important policy reasons that underlay the Board’s actions.

1. The Law of Administrative Bias

The first and most important problem with the charge that the Board was improperly biased is that it disregards fundamental aspects of the way administrative agencies work. Sobel asserts that the Board of Longitude was top-heavy with astronomers, and that as a result, it was biased in favor of an astronomical solution to the longitude problem. Sobel’s implicit suggestion is that the Board members should either have been selected to avoid such potential bias, or should have been required to put aside such views as their life’s professional work had given them and to administer the Longitude Act without regard to these preconceptions.

That is not the rule, nor should it be. Administrative law recognizes that agency officials are typically chosen for their positions precisely because of their expertise in the relevant field and because of their views as to how the agency’s laws should be administered.¹⁷⁶ It would hardly make sense to appoint someone to be, say, the Secretary of Labor because he believed in strong enforcement of labor laws and then to complain when he put those views into practice. For an administrator’s mind to be “a complete *tabula rasa* . . . in the area of

174. *See id.*

175. *Id.* at 9.

176. *E.g.*, RICHARD J. PIERCE, JR., SIDNEY A. SHAPIRO & PAUL R. VERKUIL, ADMINISTRATIVE LAW AND PROCESS 478 (4th ed. 2004).

agency policy would be evidence of lack of qualification not lack of bias.”¹⁷⁷

These principles are recognized on both sides of the Atlantic. A British treatise observes that “[i]t is self-evident that ministerial or departmental policy cannot be regarded as disqualifying bias.”¹⁷⁸ American authors agree that administrators are required to be “open minded, but not empty headed.”¹⁷⁹ The critical distinction is between an administrator’s *factual* and *policy* preconceptions. It would be improper for an administrator to have completely prejudged the facts of a particular case, but for an administrator to come to her work with views on matters of agency policy, and to apply those views, is appropriate.¹⁸⁰ As long as the administrator keeps an open mind, she may participate in a matter and is not required to set aside her policy views while doing so.¹⁸¹ While it is difficult to find eighteenth-century British cases precisely on point, British law recognized “[a]n early date” that having, or even expressing, preconceived views did not constitute a disqualifying bias,¹⁸² and it seems likely that eighteenth-century British courts would have adopted the view now prevalent in both Britain and America.

Viewing the longitude story through the lens provided by these principles, one would observe that if the Board of Longitude was “top-heavy with astronomers, mathematicians, and navigators,”¹⁸³ it was because Parliament had made it so. In particular, Parliament decreed that the Astronomer Royal and the Savilian, Lucasian, and Plumian

177. *Mattes v. United States*, 721 F.2d 1125, 1132 (7th Cir. 1983) (quoting *Laird v. Tatum*, 409 U.S. 824, 835 (1972) (Rehnquist, J., mem.) (internal quotation marks omitted)).

178. SIR WILLIAM WADE & CHRISTOPHER FORSYTH, *ADMINISTRATIVE LAW* 488 (7th ed. 1994); see also GEOFFREY A. FLICK, *NATURAL JUSTICE: PRINCIPLES AND PRACTICAL APPLICATION* 123 (1979) (“[T]he requirement of administrative expertise can best be satisfied by the recruitment of those people most familiar with the field and those most likely to energetically frame and enforce agency policies.”).

179. ERNEST GELLHORN & RONALD M. LEVIN, *ADMINISTRATIVE LAW AND PROCESS IN A NUTSHELL* 287 (5th ed. 2006); see also 3 KENNETH CULP DAVIS, *ADMINISTRATIVE LAW TREATISE* 372 (2d ed. 1980) (“The law is entirely clear that an announced previous position about law or policy is not a disqualification . . .”).

180. PIERCE ET AL., *supra* note 176, at 478.

181. *R. v. Sec’y of State for the Env’t*, (1982) Q.B. 593, 643 (Eng.) (stating that the administrator’s mind must be kept “ajar”). The American standard is even more generously stated: it is sufficient that the administrator’s mind not be “irrevocably closed.” *FTC v. Cement Inst.*, 333 U.S. 683, 701 (1948).

182. Flick, *supra* note 178, at 126; see *R. v. The London City Council (Re The Empire Theatre)*, 71 L.T.R. 638, 639 (Q.B. Div. 1895); *R. v. Alcock (Ex parte Chilton)*, 37 L.T.R. 829, 831 (Q.B. Div. 1878) (“I know of no reason for saying that the expression of a man’s opinion on any subject should render him unfit to adjudicate upon it.”).

183. SOBEL, *supra* note 1, at 75-76.

professors of mathematics at Oxford and Cambridge should sit on the Board.¹⁸⁴ These scientists naturally had views on the best way to solve the longitude problem. The position of Astronomer Royal, it will be recalled, had been created with a particular charge of seeking the longitude in the heavens.¹⁸⁵ It would be absurd to appoint the Astronomer Royal as a commissioner of longitude, but expect him, when acting in that capacity, to disregard his life's work directed to the longitude problem. Thus, the charge that the Board was improperly biased would almost surely fail as a matter of law.

2. The Board's Attitude Toward the Chronometer Method

In addition, the charge seems notably out of keeping with the facts. So far from having their minds closed against the possibility of finding the longitude by chronometer, the Commissioners, in fact, displayed a favorable, open-minded attitude to the possibility that a mechanical solution might be found to what they were professionally predisposed to regard as an astronomical problem.

Although there is no doubt that the Board imposed stringent requirements on Harrison and never awarded him the full longitude prize, one must put these actions in the context of the full relationship between Harrison and the Board. The Board's favorable attitude is revealed by the Board's decades-long support for Harrison's efforts. Recall that the Board, after not holding a single meeting in the first twenty-three years of its existence, called its first meeting ever to receive Harrison and consider his plan. At that first meeting, the Board awarded Harrison a research grant of £500. Over the many subsequent years of Harrison's efforts, the Board continued to award him further research grants, notwithstanding Harrison's repeated failures to meet schedules that he himself proposed, until in the end the Board had provided public funding for Harrison's work in the amount of £4000, the equivalent of over \$1 million today.¹⁸⁶

The Board's favorable attitude toward Harrison also showed itself in the awards it did make to him. Following the Jamaica trial, the Board did not find Harrison eligible for the longitude prize, but it did award him £2500 under section V of the Longitude Act, which permitted it to make lesser awards to methods it found to be "of considerable use."¹⁸⁷ In addition, following the Barbados trial, the

184. Longitude Act 1714, 12 Ann., c. 15, § 1 (Eng.).

185. See *supra* note 55 and accompanying text.

186. QUILL, *supra* note 7, at 203-04; see *supra* note 36 and accompanying text.

187. QUILL, *supra* note 7, at 115.

Board did ultimately award Harrison £10,000 of the longitude prize—the largest amount it ever awarded to anybody—from which it deducted the £2500 just mentioned, but not the £4,000 in research money.¹⁸⁸

Moreover, the Board made this award possible by recommending that Parliament adopt a special statute that provided favorable terms applicable to Harrison alone. Under the Board's understanding of the Longitude Act (explained in more detail below),¹⁸⁹ Harrison was not eligible for *any* part of the official prize, because he could not show that his longitude method could be put into general use. It was the Board that moved Parliament to adopt the 1765 Act, which allowed Harrison to collect half the prize in return for simply *explaining* his method, without requiring him to show that it was of common and general utility, which the Board understood to be one of the original conditions for receiving any part of the prize.¹⁹⁰ These hardly seem like the actions of an agency that had a biased, closed mind regarding the chronometer method.¹⁹¹

Moreover, it is not as though the Board treated the lunar distance method (which it supposedly favored) with an open hand. At its meeting on February 9, 1765—the same meeting at which the Board evaluated the success of H4's Barbados trial—the Board received a message from Maskelyne regarding the lunar distance method, which

188. *Id.* But see *supra* note 153 and accompanying text.

189. See *infra* Part III.C.

190. 1765, 5 Geo. 3, c. 20, § 1 (Eng.); see *infra* Part III.C.

191. Other, lesser points that cut against the claim that the Board was biased against Harrison and his chronometer: (1) James Bradley, later to become the third Astronomer Royal and a member of the Board, was among those Fellows of the Royal Society who first reviewed H1 and recommended it for trial. QUILL, *supra* note 7, at 42. (2) Commissioners Maskelyne and Lord Morton (President of the Royal Society) were among those proposing, at John Harrison's request, that his son, William Harrison, be made a Fellow of the Royal Society. HOWSE, MASKELYNE, *supra* note 7, at 76-77; SOBEL, *supra* note 1, at 102. (3) In giving Harrison his instructions for the Barbados voyage, the Board concluded, "We heartily wish you Success in this Undertaking . . ." NARRATIVE, *supra* note 7, at 6.

On the other side, one may note the contemporary claim that a Board member had stated "that it was never the intention of the Board of Longitude, that Time-keepers should succeed." MUDGE, REPLY, *supra* note 7, at 21 n.*. This claim, however, comes to us third-hand, through a clockmaker seeking the prize, which does not appear to be the most reliable basis for forming a judgment.

It is also true that the Board should have made clear to Harrison earlier than it did that in its view, a successful West Indies voyage was not the sole criterion for winning the longitude prize. According to Harrison, the Board never told him this until after the Barbados trial. HARRISON, REMARKS, *supra* note 7, at 20. The Board should also have laid down criteria for success in the "trial" required by the 1765 Act. The Board's actions were not perfect. But the facts reviewed above undermine the claim of bias.

had been tested on the same voyage.¹⁹² Although Maskelyne—by then a member of the Board—claimed that the lunar distance method, using tables compiled by the late Tobias Mayer, had determined the longitude of Barbados to within half a degree (the amount stipulated as a condition for a £20,000 award under the 1714 Act), the Board recommended to Parliament that Mayer’s widow receive an award of only £5000—half of what it recommended for Harrison.¹⁹³ Thus, although Sobel accuses the Board of bias against the chronometer method and of being in favor of the lunar distance method, the facts show that, if anything, the Board treated the lunar distance method with *more* stringency than the chronometer method.¹⁹⁴ The Board’s actions, in short, are more suggestive of a general stringency and caution in determining that the longitude had truly been found and that the finder was entitled to the very substantial public prize than they are of a bias against the chronometer method.

3. Policy Reasons Supporting the Board’s Views

Finally, if the Board *was* biased against the chronometer method of finding the longitude and in favor of the lunar distance method, it is important to note that there were some policy reasons on the Board’s side. Although the chronometer method had certain advantages over the lunar distance method (particularly its ease of use and its ability to work under conditions of adverse weather and reduced visibility),¹⁹⁵ the lunar distance method had its own advantages over the chronometer method. Most notably, as Sir Isaac Newton pointed out as early as 1721, “when the Longitude at sea is once lost, it cannot be found again by any watch.”¹⁹⁶ That is, the chronometer method requires a timekeeper that operates properly throughout a ship’s voyage. Suppose the chronometer breaks down for even a single day. What then? Even if the chronometer were fixed the next day and again able to keep time faithfully, there would be no way to set it going from the correct

192. HOWSE, MASKELYNE, *supra* note 7, at 47, 49, 77.

193. Parliament in fact chose to award Mayer’s heirs only £3000, on condition that they assign the tables to the Board for the use of the public. 1765, 5 Geo. 3, c. 20, § 4 (Eng.).

194. Forbes, *supra* note 7, at 6.

195. The chronometer method required some ability to view the skies to determine the time of local noon, but would work under more weather conditions than the lunar distance method. Also, the lunar distance method could not work during the periods of each month when the moon is not visible, and it required complex calculations that could result in errors. Andrewes, *supra* note 153, at 225.

196. SOBEL, *supra* note 1, at 60 (internal quotation marks omitted).

Greenwich Time.¹⁹⁷ Once the longitude is lost through a failure to keep the time, the ability to keep perfect time subsequently will not get the longitude back. Similarly, if the chronometer performed badly on any days during the voyage, gaining or losing time, the resulting errors would accumulate from day to day—faithfully keeping the time on one day would not correct for errors on previous days.

By contrast, each measurement in the lunar distance method is independent. If one day's measurement were inaccurate because of a careless sextant reading, a mistake in the complex calculations that the method required, an error in the almanac tables for that day, or if no reading were obtainable at all because the skies were overcast, the next day's measurement would start afresh. Even if the ship lost its position entirely in a gale, the sky, the sextant, and the tables would find it again.¹⁹⁸

The lunar distance method also, at least in the time the Board was acting, seemed likely to be far easier and cheaper to put into practice than the chronometer method. Larcum Kendall, the first to copy Harrison's watch, took over two years to complete the task and, in 1770, expressed the view that "it would be many years (if ever) before a watch of the same kind with that of Mr. Harrison's could be afforded for £200."¹⁹⁹ That would be over \$40,000 today.²⁰⁰ By contrast, after the publication of Britain's *Nautical Almanac* starting in 1767, a navigator could find the longitude with a quadrant (£5) or sextant (£15), the almanac (6s.), a navigation guide (15s.), and a cheap watch (needing to be accurate only to within four minutes a day)—all told, an investment of less than a tenth the cost of a Harrison-style chronometer.²⁰¹

So even if the Board had evinced a preference for the lunar distance method, it would be too harsh to attribute that preference entirely to improper bias. Sound reasons of policy could equally support the Board's view.

197. A navigator might try to use dead reckoning to measure the ship's position during a temporary breakdown of the chronometer, and use the approximate longitude thus obtained to reset the chronometer when repaired. So a day's failure in the chronometer might not always lead to a complete loss of the ship's longitude. But it could still be a serious matter, especially when one recalls that each minute of inaccuracy in the chronometer translates into fifteen miles of inaccuracy in the ship's position.

198. See MASKELYNE, ANSWER, *supra* note 7, at 70 (noting that the lunar distance method is an "absolute method" of finding the longitude, whereas the chronometer method will only keep the longitude "from one known place to another").

199. QUILL, *supra* note 7, at 181 (internal quotation marks omitted).

200. See *supra* note 36 and accompanying text.

201. HOWSE, MASKELYNE, *supra* note 7, at 94.

B. Conflict of Interest

The charge of conflict of interest is obviously closely related to, and yet is distinct from, the charge of bias. The charge of bias, as detailed above, rests on the alleged professional and philosophical predisposition of the Commissioners to favor the lunar distance method over the chronometer method. The charge of conflict of interest goes further: it rests on the assertion that some of the Commissioners, particularly the Astronomer Royal, were personally and pecuniarily interested in the success of the lunar distance method. Most notably, Nevil Maskelyne, the fifth Astronomer Royal, was, as noted earlier, suspected by the Harrisons of being a rival claimant for the longitude prize. A later clockmaker charged him with being

particularly interested in the improvement of [the lunar distance tables], for the construction of which he receives from time to time considerable sums of money from the Board, and which he flatters himself he shall be able to bring to such a degree of correctness, as to entitle him to one of the specific rewards offered by the Act.²⁰²

These charges, if true, would represent a significant problem in the Board's proceedings. In both British and American law, personal financial interest, as opposed to the kind of philosophical interest discussed in the previous Part, disqualifies an adjudicator in legal proceedings.²⁰³ This same principle applies to administrative adjudicators.²⁰⁴

The evidence, however, gives good reason to doubt the charges of personal interest. Maskelyne denied having asked for or received any money in connection with the improvement of the lunar distance tables, except for sums that he received on account, to pay the salaries of those working on the *Nautical Almanac*.²⁰⁵ He also stated that he received no advantage from the sale of the almanac or other publications of the Board.²⁰⁶ The Board unanimously confirmed these statements.²⁰⁷ Harrison biographer Quill notes that Harrison and his supporters "accuse[d] Maskelyne of little less than fraudulent behaviour," but concludes "that there appears to be no foundation

202. MUDGE, NARRATIVE, *supra* note 7, at 4 n.*.

203. *Gibson v. Berryhill*, 411 U.S. 564, 579 (1973); *Dimes v. Grand Junction Canal*, (1852) 10 Eng. Rep. 301, 315 (H.L.).

204. *Gibson*, 411 U.S. at 579; *R. v. Cheltenham Comm'rs*, (1841) 113 Eng. Rep. 1211, 1214 (Q.B.).

205. MASKELYNE, ANSWER, *supra* note 7, at 54-55.

206. *Id.*

207. *Id.* at 56.

whatsoever for these jaundiced views” and that there is no “hint or suggestion that [Maskelyne], at any time, manoeuvred to obtain a longitude prize for himself.”²⁰⁸

Thus the conflict-of-interest charge appears to fail for lack of evidence. Much innuendo attended the Board’s deliberations over the years, but there is no hard evidence that any Board member was in fact a rival claimant for the prize or was otherwise personally financially interested in it. That leaves only the Board members’ philosophical predilections, which were dealt with earlier.

C. *Statutory Construction*

By far the most important dispute between Harrison and the Board was whether the Board properly interpreted the 1714 Longitude Act. The critical question was whether the statute required the Board to award the longitude prize to any claimant whose method performed successfully in a West Indies trial, or whether the Board could impose further conditions of its own devising.

Harrison believed that the successful West Indies trial entitled him to receive the reward. He believed that the Board was not empowered to impose further conditions.²⁰⁹ He claimed that this was the unanimous opinion of “several eminent Men of the Law” whom he consulted.²¹⁰ The popular modern view supports Harrison on this point.²¹¹

208. QUILL, *supra* note 7, at 127-28. Sobel also charges that James Bradley, the third Astronomer Royal, had a “personal investment in the lunar distance method [that] could be called a ‘conflict of interest,’ except that the term seems too weak to define what the Harrisons stood up against.” SOBEL, *supra* note 1, at 118. However, the only evidence she provides for this claim is a statement by William Harrison, asserting that Bradley told the Harrisons that, but for them, he and Mayer would have shared the longitude prize. *Id.* In light of the Harrisons’ suspicious nature, this statement seems a doubtful basis for concluding that Bradley had a fatal conflict of interest. William Andrewes, chair of the Longitude Symposium conducted at Harvard in 1993, regarded Bradley as one of Harrison’s “most influential supporters.” Andrewes, *supra* note 153, at 221.

209. NARRATIVE, *supra* note 7, at 17-18.

210. CASE OF HARRISON, *supra* note 7, at 2.

211. Sobel charges that once H4 performed to the statutory specifications on a West Indies trial, Harrison was entitled to the full, £20,000 longitude prize. SOBEL, *supra* note 1, at 121. The Board, in Sobel’s view, erred in enforcing what it regarded as the *spirit* of the 1714 Act while ignoring the letter of the law. *Id.* at 144.

Quill, although not as hard on the Board as Sobel, concludes that “there seems to be little doubt that John Harrison should have received the full £20,000 in 1764 when H.4 returned from Barbados.” QUILL, *supra* note 7, at 205. Quill’s conclusion is somewhat curious, inasmuch as he also states that the original Longitude Act was “so vague that it was almost impossible to obtain any clear-cut direction from it.” *Id.* at 140.

The Board, however, seems to have believed that a successful West Indies trial was just one criterion for receiving the prize and that the ultimate question was whether, in the Board's judgment, a claimant had *solved the longitude problem*. Harrison's method, the Board believed, could not solve the problem until Harrison—or at least someone—demonstrated that it was possible to reproduce Harrison's timekeeper and put it into *general* use.

In imposing this requirement, the Board was implementing a sensible policy and promoting the purposes of the Longitude Act. Harrison's method suffered from a significant flaw—it required Harrison's watch, which could not be readily duplicated and which only one person could possess at one time. Surely the goal of the Longitude Act was to improve navigation for shipping generally, not to permit *one* ship to find its longitude. What good was a method of finding the longitude if it required possessing a device, of which there was only one in the whole world? It made sense to demand more before awarding the great prize.

The question, however, is whether the Longitude Act permitted this policy. Promoting the discovery of a longitude method that could be put into general use was presumably Parliament's goal, but, as veterans of modern statutory interpretation debates know only too well, it often happens that a legislature, in seeking to promote some goal, enacts a rule that furthers the goal only imperfectly.²¹² If Parliament, in the 1714 Act, determined that a single, successful West Indies trial was the sole criterion of a method's effectiveness, then the Board erred in demanding more, even if demanding more would have furthered Parliament's ultimate goal. On the other hand, if Parliament vested the Board with flexible authority to determine what constituted "finding the longitude," then the Board acted properly.

The question demands a careful review of the Longitude Act. Such a review reveals strong arguments on both sides. As shown below, Harrison had support in the text of section III of the Longitude Act, which provided that half of the longitude prize would be "due and paid" upon a successful West Indies voyage. The Board, however, had support in the text of section IV, which required a prize-winning

Anthony Randall regards the Board's construction of the act as "questionable," Anthony Randall, *The Timekeeper that Won the Longitude Prize*, in ANDREWES, *supra* note 7, at 247, and William Andrewes states that the prize "was, by all reasonable interpretation of the 1714 Act, clearly [Harrison's] due." Andrewes, *supra* note 153, at 225 n.133.

212. *E.g.*, Frank H. Easterbrook, *Statutes' Domains*, 50 U. CHI. L. REV. 533, 546-47 (1983); John F. Manning, *Textualism and the Equity of the Statute*, 101 COLUM. L. REV. 1, 7 (2001).

method to be “practicable and useful,” and in the policy consideration, reflective of the likely intent of Parliament, that the longitude prize should be awarded to someone who truly solved the longitude problem with a method that could be put into general use.

1. The 1765 Act

Before examining the Longitude Act, it is important to specify which act really counts. As Harrison himself recognized, under the *new* Longitude Act passed in 1765,²¹³ a successful West Indies trial did not, by itself, suffice to win the prize.²¹⁴ The 1765 Act provided that Harrison would receive half of the £20,000 prize when he explained the principles of his watch and assigned his timekeepers to the Board, but it also provided that he would receive the other half only when “other Time Keepers of the same Kind shall be made, and shall, upon Trial, be found to be of a sufficient Correctness to determine the said Longitude within half a Degree of a Great Circle.”²¹⁵

Thus, Parliament, by its 1765 Act, demonstrated its own determination that a successful West Indies trial should not be the sole criterion of winning the longitude prize.²¹⁶ Moreover, inasmuch as the 1765 Act billed itself as “[a]n Act for *explaining* and rendering more effectual” the original 1714 Act,²¹⁷ it might seem that Parliament itself settled the question of the proper interpretation of the original act, and, by doing so, showed that the Board’s interpretation of that act was correct.

But let us be as charitable as possible to Harrison. His legal claim was that he was entitled to the prize under the original, 1714 Act.²¹⁸ Therefore, let us put the 1765 Act aside. After the Barbados trial in 1764, and before passage of the 1765 Act, the 1714 Act governed. Under that statute, did the successful trial entitle Harrison to the prize, or could the Board properly demand that Harrison demonstrate that his method could be generally practiced? That is the ultimate question.

213. 1765, 5 Geo. 3, c. 20, § 1 (Eng.).

214. Harrison fervently believed that before passage of the 1765 Act, he had “as full and perfect a *Right* to the Reward of 20,000*l.* as any Free-holder in *Britain* has to his Estate,” but even he recognized that the 1765 Act placed him “*too certainly* under the Discretion of the Commissioners.” HARRISON, REMARKS, *supra* note 7, at 20-21.

215. 1765, 5 Geo. 3, c. 20, § 1 (Eng.).

216. The 1765 Act’s preamble recited the facts of H4’s successful West Indies trial, so Parliament was aware that Harrison had met that criterion of the 1714 Act. *Id.*

217. *Id.* (emphasis added).

218. HARRISON, REMARKS, *supra* note 7, at 20.

Also in the spirit of putting the case as favorably to Harrison as possible, let us put aside certain threshold issues that might have arisen upon judicial review. Had he sued in an eighteenth-century British court, Harrison would have been subject to the labyrinthine system of then-existing remedies, under which judicial review would have been technically limited to inquiring into the Board's jurisdiction to act.²¹⁹ Although Harrison might well have lost on the ground that any error by the Board was nonjurisdictional and so not remediable, let us assume that a court would have awarded relief if it determined that the Board erred. Similarly, in considering how Harrison might have fared in a suit for judicial review in an American court today, let us disregard such difficulties as might arise under doctrines of sovereign immunity. The focus will instead be on the correctness of the Board's understanding of the 1714 Longitude Act.

2. The 1714 Act

The dispute over the meaning of the Longitude Act presents the familiar problem of whether an administrative agency is obeying the commands of its organic statute. Careful consideration of the relevant statutory language would be an essential step under either the modern or the eighteenth-century regime.

a. The Critical Statutory Provisions

Two sections of the 1714 Act critically bear on the dispute. First, on Harrison's side, is section III of the Act. This section, after establishing the amounts of the rewards for "finding the said

219. In the eighteenth century, Harrison might have attempted to obtain judicial review of the Board's decision by seeking a writ of certiorari to quash the Board's decision and/or a writ of mandamus to order the Board to award him the longitude prize. PAUL CRAIG, *ADMINISTRATIVE LAW* 827-40 (6th ed. 2008). However, because the Longitude Act did not provide for a judicial appeal, even if a court believed that the Board had acted erroneously, it could have awarded relief only if the Board erred on a jurisdictional (also called a "collateral") question; an error by the Board acting within its jurisdiction was not remediable. *Id.* at 437-41; WADE & FORSYTH, *supra* note 178, at 284-85; Terry v. Huntington, (1668) 145 Eng. Rep. 557, 559. The issue of what constituted a "jurisdictional" question, however, did not correspond to what one might infer today from that term; rather, this point was determined under doctrines that gave rise to "no predictability as to how a case would be categorised." CRAIG, *supra*, at 441. The matter was further complicated by a court's power to correct certain errors (even nonjurisdictional errors) that "appeared on the face of the record." *Id.* at 462-63. Because of the great difficulty of determining whether the Board's errors would have been considered "jurisdictional," this discussion simply assumes that a court would have awarded relief if it believed that the Board had erred.

longitude” (including the grand prize of £20,000 for finding the longitude to within half a degree), provided:

III. . . . [O]ne Moiety or Half-Part of such Reward or Sum shall be due and paid when the said Commissioners, or the major Part of them, do agree that any such Method extends to the Security of Ships within eighty Geographical Miles of the Shores, which are Places of the greatest Danger, and the other Moiety or Half-Part, when a Ship by the Appointment of the said Commissioners, or the major Part of them, shall thereby actually sail over the Ocean, from *Great Britain* to any such Port in the *West-Indies*, as those Commissioners, or the major Part of them, shall choose or nominate for the Experiment, without losing their Longitude beyond the Limits before mentioned.²²⁰

This section supports Harrison. The provision that half the longitude prize would be “due and paid” following a successful West Indies trial is particularly significant.²²¹ The words “shall be due and paid when” suggest that what follows is the sole criterion for receiving the prize.²²²

On the other side, however, the Board relied upon section IV. This section told the Board when and how to certify the winner of the prize:

IV . . . [A]s soon as such Method for the Discovery of the said Longitude shall have been *tried and found practicable and useful at Sea*, within any of the Degrees aforesaid, . . . the said Commissioners, or the major Part of them, shall certify the same accordingly, under their Hands and Seals, to the Commissioners of the Navy.²²³

Section IV went on to provide that the commissioners would specify the amount to be paid and the person or persons to be paid, and that the treasurer of the navy would then pay the prize, “according to the true Intent and Meaning of this Act.”²²⁴

220. Longitude Act 1714, 12 Ann., c. 15, § 3 (Eng.).

221. *Id.* The words “due and paid” appear only in connection with the *other* half of the prize, but the structure of the sentence applies the words to both halves.

222. Of course, success in a West Indies trial, even if by itself sufficient, entitled a claimant to only *half* the prize. *Id.* Because Harrison received half the prize under the 1765 Act, it might seem that he had nothing to complain about, and a contemporary court might have so ruled. From a modern perspective, this simple resolution is not satisfactory, because it was not the Board’s own explanation for its determination not to award Harrison the full prize. Oddly, neither Harrison nor the Board seem to have mentioned this point. Under modern principles, it would be inappropriate for a reviewing court to uphold the Board’s action based on a theory other than the Board’s own. *SEC v. Chenery Corp.*, 318 U.S. 80, 87-88 (1943).

223. Longitude Act 1714, 12 Ann., c. 15, § 4 (emphasis added).

224. *Id.*

These phrases, and particularly the words “practicable and useful,” lie at the heart of the dispute. The board understood section IV to impose an *additional requirement*—a requirement that, quite apart from anything mentioned in section III, the prize was to be awarded only when a majority of the Board were satisfied that a claimant’s method was “practicable and useful.” The commissioners felt that they could not certify a method as “practicable and useful” if it could not be put into *general* use, and Harrison’s method could not be put into general use so long as it required a unique device, the construction of which Harrison had never even explained.²²⁵

Thus, the question is sharply framed. Did section III of the Longitude Act mandate an award based solely on a successful West Indies trial? Or did section IV *also* require that the Board be satisfied that a method was “practicable and useful”?

b. Harrison’s Best Arguments

The best argument for Harrison is one that he does not appear to have made. Indeed, his supporters, both contemporary and modern, do not appear to have made it either.²²⁶ Harrison and his supporters focus on the words “practicable and useful” in section IV of the Longitude Act. However, as is shown below,²²⁷ a better argument would rely on the words “due and paid” in section III.

225. On this issue (in contrast to the issues that arose following the Jamaica trial, see *supra* note 93 and accompanying text), the Board’s reasoning is fully preserved. At its meeting of February 9, 1765, the Board resolved that because Harrison had not yet explained the principles of his watch, nor the method by which other such watches could be made, Harrison’s invention could not “be adjudged practicable and useful in Terms of the [Longitude] Act, and agreeable to the true Intent and Meaning thereof.” MINUTES, *supra* note 7, Feb. 9, 1765. Thus, it is clear that the Board’s refusal to award Harrison the prize turned on its understanding of section IV of the Longitude Act.

226. I hesitate to say this, because I cannot claim to have seen every argument regarding the Longitude Act, particularly those published in pamphlet form in the eighteenth century. In addition, I find it hard to imagine that no one else has thought of the argument presented below, see *infra* text accompanying notes 246-248, in the nearly 300 years since the Longitude Act was passed. Still, Harrison does not mention the argument in his “Remarks” pamphlet, see HARRISON, REMARKS, *supra* note 7, nor does he appear to have mentioned it in his petitions to Parliament, either in 1765 or 1773, see 30 JOURNALS, *supra* note 7, at 180-81; 34 JOURNALS, *supra* note 7, at 244, nor does it appear in the “Case of Harrison” pamphlet. I also have not seen the argument in other discussions of the longitude controversy.

227. See *infra* text accompanying notes 246-248.

i. Arguments that Harrison's Method was "Practicable and Useful"

Harrison and his supporters tried to show that, even assuming that the Board was right that the words "practicable and useful" in section IV imposed an independent requirement (beyond the requirements of section III), Harrison met this requirement. There are two ways to argue this point.

First, one might argue that the phrase "practicable and useful" in section IV does not impose any requirement that a claimant's method be capable of being put into *general* use. One would argue that the dictionary definition of "practicable" is simply "able to be done or put into practice successfully," and so this term merely required that a method be capable of being practiced at all.²²⁸ It did not require the method to be expeditious or cost-effective—that is, *practical*, as opposed to *practicable*.²²⁹ The term "useful," one would say, merely required that the method have some utility. As the contemporary pamphlet "The Case of Mr. John Harrison" put it, "[t]hat [Harrison's invention] is *practicable and useful* is proved, for he has made the Watches which have kept the Longitude."²³⁰ Quill agrees: the Barbados trial showed that Harrison's method was "practicable," because the method was successfully put into practice, and "useful," in that it successfully kept the longitude.²³¹

However, although this argument presents a possible understanding of the phrase "practicable and useful," it is not the only possible understanding. The phrase could also connote, as the Board suggested, that a method must be capable of being put into general use. This interpretation is possible because, before one can determine whether a method is practicable, one must first determine what it is a method *for*. Parliament enacted a reward for "finding the longitude," but it did not define this phrase.²³² If one understands the task as being to enable mariners generally to find their longitude, then a method that

228. OXFORD ENGLISH DICTIONARY 1218 (1961).

229. Usage dictionaries note that *practicable* is sometimes used in place of *practical* (which would more comfortably bear the meaning given to section IV by the Board), but recommend distinguishing the terms by confining *practicable* to the meaning given above. MERRIAM-WEBSTER'S DICTIONARY OF ENGLISH USAGE 755 (1994); H.W. FOWLER, A DICTIONARY OF MODERN ENGLISH USAGE 469 (2d ed. 1965).

230. CASE OF HARRISON, *supra* note 7, at 4.

231. QUILL, *supra* note 7, at 205; *see also* SOBEL, *supra* note 1, at 144 ("[T]he original Longitude Act never stipulated that the 'Practicable and Useful' method must be copied by its inventor or anyone else.").

232. Longitude Act 1714, 12 Ann., c. 15, § 3 (Eng.).

requires a unique device is not a “practicable” solution, in any sense of the word “practicable,” and is also not “useful.” Moreover, in any event, the term “practicable” is also sometimes used to connote the concept of practicality.²³³

With regard to the term “useful,” one must also bear in mind the distinction between the appropriate scope of the utility requirement in a patent system and in a prize system. In modern patent law, the requirement that an invention be “useful”²³⁴ is easily satisfied—an invention need only serve some useful goal; it need not even be better than what previously existed.²³⁵ This generous understanding, however, arises because a patentee merely obtains exclusive rights to market the invention, and it is no loss to the public if the patentee gains exclusive rights to something that is no good anyway—the market will sufficiently punish such a patentee.²³⁶ By contrast, where the public is paying a substantial cash prize for an invention, it is appropriate to give the requirement that the invention be “practicable and useful” a stronger sense, which takes meaning from the scope of the problem to be solved.

For these reasons, construing the phrase “practicable and useful” to require that the invention be capable of being put into general use is a meaning that the words will bear. By themselves, the words “practicable and useful” are ambiguous. (The *best* interpretation will be considered below, after the arguments for both sides are presented.²³⁷)

One might also argue that even assuming that the words “practicable and useful” implied a requirement that a method could be put into general use, Harrison’s method satisfied this requirement. Harrison himself, in a pamphlet published in 1767, argued that he had provided information sufficient to enable others to make watches “of

233. MERRIAM-WEBSTER’S DICTIONARY OF ENGLISH USAGE, *supra* note 229, at 755. The *Oxford English Dictionary*’s illustrations of the word “practicable” include the 1807 quotation, “By the Wild Cattle is to be understood Animals which no barrier practicable to be made by us at present can confine.” As any one animal could surely be confined by a barrier if there were no considerations of cost or effort involved, the word “practicable” here must mean that the animals could not be confined by a barrier capable of being put into general use with reasonable effort and cost. *Cf.* Jonathan Betts, *Arnold and Earnshaw: The Practicable Solution*, in ANDREWES, *supra* note 7, at 312 (noting that Harrison’s design “was still not practicable because it was such a complicated, and therefore expensive, thing to make”).

234. 35 U.S.C. § 101 (2006).

235. *Lowell v. Lewis*, 15 F. Cas. 1018, 1019 (C.C.D. Mass. 1817) (No. 8568).

236. *Id.*

237. *See infra* Part III.C.2.d.

equal goodness” with his own, at a price that would be within “reach of purchase.”²³⁸

This argument, however, admits that the question is one of fact—whether others really could make watches of the Harrison design at a reasonable price. The facts on this question support the Board. The great difficulties Harrison experienced in preparing his timekeepers—difficulties that extended over decades—gave the Board reason to be cautious in deciding whether they could be duplicated at a reasonable cost. The Board’s decision to put the matter to the test, by requiring that other such watches actually be made, seems eminently reasonable.²³⁹ In the end, Harrison never succeeded in producing even two duplicates of his watch, and his failure supports the Board’s view that mass production of his watch was not practicable.

Moreover, in thinking about how this issue might fare upon judicial review, we must recall some administrative law basics. In a proceeding for judicial review, the Board would receive deference on questions of fact. The modern American standard is that a court should uphold an agency’s factual findings provided they are supported by “substantial evidence,”²⁴⁰ which requires only “such relevant evidence as a reasonable mind might accept as adequate to support a conclusion.”²⁴¹ In Harrison’s Britain, although a court on judicial review could theoretically substitute its judgment on questions of “jurisdictional” fact,²⁴² in practice courts were reluctant to interfere with a tribunal’s decision on questions of disputed fact as long as the evidence could have justified the tribunal’s conclusion.²⁴³ Given that the evidence favors the Board’s factual finding that Harrison’s watch could not practicably be put into general use, it certainly provides a reasonable basis for that conclusion. So an argument that Harrison’s watch could in fact have been put into general use would likely fail in court.

238. HARRISON, REMARKS, *supra* note 7, at 24-28.

239. Harrison claimed that “no Estimate of the future Expence can . . . be grounded upon any Authority better than that of Opinion,” and his opinion was that the price of his watch could be brought down to as little as £70. HARRISON, REMARKS, *supra* note 7, at 26-27. The Board was not, however, required to accept Harrison’s opinion on this point.

240. 5 U.S.C. § 706(2)(e) (2006).

241. *Universal Camera Corp. v. NLRB*, 340 U.S. 474, 477 (1951) (internal quotation marks omitted).

242. *See* sources cited *supra* note 219.

243. WADE & FORSYTH, *supra* note 178, at 297; *see* *Brown v. Cocking*, (1868) 3 Q.B. 672. If the factual finding were regarded as nonjurisdictional, it would certainly have been reviewed deferentially, if at all. WADE & FORSYTH, *supra* note 178, at 312.

ii. “Practicable and Useful” as a Cross-Reference, Not a Requirement

There is, however, a stronger textual argument on Harrison’s side. Harrison’s best argument would be that section IV did not impose any additional requirement at all and that the prize was to be awarded based solely on the requirements of section III. The Board, Harrison would argue, lacked discretionary authority to impose additional requirements.²⁴⁴ The argument would rely on the “due and paid” language of section III.

As noted earlier, section III’s statement that the award would be “due and paid” upon a successful West Indies voyage suggests that there would be no other contingency between such a voyage and the award.²⁴⁵ Harrison might have argued that, in light of this language, section IV’s requirement must be understood as a *cross-reference* to the tests set forth in section III. That is, a method’s having been tested on a successful West Indies voyage, in accordance with section III, would be the very *definition* of the method’s having been “tried and found practicable and useful at Sea,” as required by section IV.²⁴⁶ Section IV would not empower the Board to add additional tests.

Only such a reading, one would argue, makes sense of all the statutory language. Consider the language carefully: Section III states that the two halves of the longitude prize would be “*due and paid*” upon specified events—one half when a majority of the Commissioners agree that a longitude method is effective within eighty miles of shore, and the other upon a successful West Indies trial.²⁴⁷ Section IV states that the Commissioners would certify a longitude method for payment “*as soon as*” it has been “tried and

244. Harrison did make this argument, but he did not really put his best case forward. He asked, “If [under section IV] . . . the Commissioners had a general discretionary Power [to impose requirements of their own devising], where was the Reason or Use of specifying *any Trial at all* in the original Act?” HARRISON, REMARKS, *supra* note 7, at 20 n.*. That is, he suggested that Parliament’s specification of a test in section III would serve no purpose if it did not implicitly preclude the Board from devising additional tests.

That objection, however, can be answered. Parliament might have desired the test of section III to set a minimum standard, without necessarily having it be the only requirement for the prize. Even if construed as setting only a minimum standard, section III would serve a legitimate purpose. It would ensure that the Board would not award the prize to a method it found convincing in theory, without putting the method to a practical test. It would guard against the Board’s being too lenient, while still permitting the Board to be more stringent. Thus, it is not correct to suggest that section III would serve *no* purpose if it did not preclude the Board from imposing additional requirements.

245. See *supra* notes 221-222 and accompanying text.

246. Longitude Act 1714, 12 Ann., c. 15, §§ 3-4 (Eng.).

247. *Id.* § 3 (emphasis added).

found practicable and useful at Sea.”²⁴⁸ Each of the expressions “due and paid” and “as soon as” connotes *immediacy*. The implication, one would argue, is that section IV’s requirement that a method be “tried and found practicable and useful at Sea” must be equivalent to the requirements specified in section III.

Otherwise, the “due and paid” and “as soon as” requirements could not both be met. If section IV’s requirement of being “tried and found practicable and useful at Sea” were a *more* stringent requirement than the requirements of section III (as the Board believed), then the prize money could not be “due and paid” at the times specified in section III—in particular, the money could not be “due and paid” upon a successful West Indies voyage if there were still some other requirement to be satisfied before the money could really be paid. On the other hand, if section IV’s requirement were *less* stringent than the requirements of section III, then the commissioners could not certify a method for payment “as soon as” section IV’s requirement was met—they would have to wait until the method met the (hypothetically more stringent) requirements of section III. Only if section IV’s requirement is the *same* as the requirements of section III can the “due and paid” and “as soon as” requirements both be met.

This textual argument supports Harrison’s claim to the prize money. It is an elaboration of the main point supporting Harrison, which is the “due and paid” language of section III. By considering the implications of this point for the “practicable and useful” requirement of section IV, this argument appears to give coherent meaning to all of the provisions of the Longitude Act, in a way that implies that Harrison should have received his reward.

c. The Board’s Best Arguments

However, the debate is not over. The Board’s answers to Harrison’s arguments would consist of textual arguments to counter Harrison’s, plus intentionalist and policy considerations.

First, the Board would, of course, observe that section IV of the Act instructs it to certify a method for payment only when the method has been “tried and found practicable and useful at Sea.”²⁴⁹ Whatever section III might say, the Board could not certify a method if it did not meet this requirement. While this phrase could be a mere cross-reference to the requirements of section III, that is not immediately

248. *Id.* § 4 (emphasis added).

249. *Id.*

evident. If that was what Parliament had meant, it could easily have said so. The Longitude Act is filled with cross-references—section IV, for example, refers to “*such* Method for the Discovery of the *said* Longitude,” to “the *said* Commissioners,” and to discovery of the longitude “within any of the Degrees *aforsaid*.”²⁵⁰ Parliament could have expressly referred to section III’s requirements in section IV, but it did not.²⁵¹ Parliament’s use of the different phrase, “tried and found practicable and useful at Sea,” is consistent with, and indeed suggestive of, the view that the phrase is not a cross-reference, but a new and independent requirement.

Moreover, the Harrison-favoring argument given in Part III.C.2.b.ii is not perfect. Viewing section IV as a cross-reference to the requirements of section III creates some difficulty with the words “as soon as” in section IV, because section III contains *two* requirements. Under section III, a method could win half the longitude prize without winning the other half. If a method won half the prize by satisfying the Board that it worked within eighty miles of shore, it would be certified for payment, which would require that it had been “tried and found practicable and useful at [S]ea” within the

250. *Id.* (emphasis added).

251. Section IV does say, “tried and found practicable and useful at Sea, within any of the Degrees aforsaid.” *Id.* But the cross-reference here is to the *degrees of accuracy* mentioned in section III rather than to the *tests* mentioned in section III. This cross-reference could be made whether or not the phrase “tried and found practicable and useful at Sea” is a cross-reference to the tests of section III.

The 1774 Act helps to show this. As noted above, see *supra* text accompanying note 155, the 1774 Act repealed all previous longitude acts and set forth strict new conditions for a prize, which included (for timekeeper methods) a twelve-month test at the Greenwich observatory and two voyages round Great Britain. The prize was again keyed to particular degrees of accuracy: specified sums of money were available for determining the longitude to within a degree, two-thirds of a degree, or half a degree. 1774, 14 Geo. 3, c. 66, § 2 (Eng.). The 1774 Act included this condition:

When and so soon as the said Commissioners, or two-thirds of them, at the least, shall, after such Experiments and Voyages have been made and performed as aforsaid, have declared and determined that such Method *is generally practicable and useful, and sufficiently exact to determine the Longitude at Sea within the Degrees or Limits aforsaid*

Id. (emphasis added). Clearly, in this formulation, the requirement that the Commissioners be satisfied that a method is generally practicable and useful is a separate requirement, and they must also be satisfied that the method will determine the longitude to within the specified degrees of accuracy. Thus, a cross-reference to degrees of accuracy may be independent of other requirements; it does not imply that what comes immediately before is a cross-reference to a previously specified test. The crucial phrase from the 1714 Act, requiring that the method be “tried and found practicable and useful at Sea, within any of the Degrees aforsaid,” could simply be a short way to express the requirements expressed in the italicized phrase from the 1774 Act.

meaning of section IV. If the method then won the other half of the prize with a successful West Indies trial some years later, it would need to be certified again, and it would be somewhat awkward to say that this second certificate issued “as soon as” the method had been tried and found practicable and useful at sea, because that would have happened years before.²⁵²

Thus the “as soon as” requirement of section IV must be interpreted sensibly. It must be implicitly tempered by the “due and paid” requirements of section III. However, once that is recognized, it should be equally possible to say that the “due and paid” requirement of section III is implicitly tempered by the “practicable and useful” requirement of section IV. In other words, it is implicit in the act that the money is to be paid only when *both* sections III and IV are satisfied. If this point is accepted, then there is no paradox in reading sections III and IV to impose different requirements that might be satisfied at different times.

Also, in answering Harrison’s assertion that Parliament could not have intended to give the Board a general discretionary power to specify tests for winning the prize,²⁵³ the Board could point out that the Longitude Act provided that half of the prize would be won only when a majority of the commissioners “do *agree* that [a longitude] Method extends to the Security of Ships within eighty Geographical Miles of the Shores.”²⁵⁴ This section of the Act specified no test whatsoever, and thus vested the Board with complete discretion to determine whether a claimant had won this portion of the prize. While this part of the statute was not directly relevant to claims based on a successful West Indies voyage, this statutory text shows that Parliament was comfortable vesting the Board with full discretion to determine the conditions for winning at least half of the prize. Thus, it is certainly possible to imagine that Parliament would vest the Board with discretion to specify conditions for winning the other half.

In addition, beyond presenting textual analysis of its own, the Board would observe that, in the process of statutory interpretation, text is not everything. Consideration of the intent and purpose of the Longitude Act favors the Board’s interpretation. Surely the intent was

252. The second certificate would issue as soon as the method had been tried and found practicable and useful at sea *a second time*, but the method would still have been tried and found practicable and useful at sea years before the second certificate issued.

253. See *supra* note 244 and accompanying text.

254. Longitude Act 1714, 12 Ann. c. 15, § 3 (Eng.) (emphasis added). See *supra* note 222 for a discussion of why this part of the statute does not resolve the entire controversy.

to promote the discovery of a longitude method that could be put into general use. As noted earlier, this is evident from the very nature of the longitude problem. A method that could be used only on one ship at a time would be worth little. The essence of the problem was to promote safer and more expeditious shipping generally.

This intent is, moreover, textually suggested in the Act itself. The Longitude Act's preamble states that the discovery of the longitude is wanted "for the Safety and Quickness of Voyages, the Preservation of Ships, and the Lives of Men."²⁵⁵ These purposes would be little served by a method that works on only one ship at a time. The preamble also suggests the desire to move beyond methods that are "true in Theory, though very difficult in Practice"—and a method requiring a unique device would fall in that category. Finally, the preamble states that discovery of a longitude method "would be of particular Advantage to the Trade of *Great Britain*," and, again, not much advantage could accrue to a method that would work on only one ship.²⁵⁶ These textual, statutory indications confirm that Parliament was seeking to promote the discovery of a longitude method that could be made to work on ships generally.

This view of the Longitude Act also receives some support from the Act's legislative history.²⁵⁷ The report of the committee appointed by the House of Commons to consider the longitude problem recommended that Parliament should grant a reward to whoever discovered "a more certain and *practicable* Method of ascertaining the Longitude, than any yet in Practice."²⁵⁸ The House unanimously adopted this recommendation.²⁵⁹ This history confirms that the word "practicable" did not make its way into section IV casually. Practicability was a prime concern of Parliament from the beginning, which supports the Board's view that section IV's requirement that a

255. Longitude Act 1714, 12 Ann. C. 15, § 1.

256. *Id.*

257. Unfortunately (or fortunately, for those who do not like the use of legislative history in statutory interpretation), the legislative history of the act is not well preserved. A fire burned down the British Parliament building in 1834, and the only surviving House of Commons records prior to that date are those contained in the House's Journals. The journals show that the Longitude Act was introduced in the House on June 16, 1714, and considered in the Committee of the Whole, which made several amendments, on June 30. 17 JOURNALS, *supra* note 7, at 686, 711. However, the *Journals* do not say what the original text was, nor what amendments were made, and do not preserve any of the debate in the Committee of the Whole. *Id.*

258. *Id.* at 678 (emphasis added).

259. *Id.*

longitude method be “practicable and useful” was no mere cross-reference, but, rather, an independent requirement for the prize.²⁶⁰

Of course, Harrison would have responses to these intentionalist arguments. He might argue that awarding the prize based solely on a single, successful West Indies voyage would sufficiently further the ultimate goal of finding a method that could be put into general use, because, once a method had proved its success on a West Indies voyage, market forces would ensure that the method would be refined to the point of general practicability. However, if that were Parliament’s view, Parliament might well have omitted the “practicable and useful” language of section IV. That language suggests a Parliamentary requirement applying to the method that wins the prize, not to some method that would materialize later.

In sum, while Harrison had a strong textual basis for demanding that the prize money be “due and paid,” the Board had support in the text of section IV of the Longitude Act and also had legislative intent on its side.

d. The Ultimate Outcome

The Longitude Act remains fascinating nearly three hundred years after its passage because it presents a classic battle among interpretive methodologies. In statutory interpretation today, an endless series of cases and scholarly articles explore the problems posed by statutes in which text pulls primarily in one direction, intent and policy in the other.²⁶¹ The Longitude Act shows us that, centuries ago, people had to struggle with the same interpretive difficulties that we face today.

Harrison has a strong textual argument. The words “due and paid” in section III do suggest that the prize was to be awarded upon a successful West Indies voyage. However, as shown above, the text is not clear-cut. The Board has textual support on its side too. To win the prize, a method had to be “practicable and useful.” Harrison perhaps has the better of the text, but even on the text alone, the case is close. Moreover, textual analysis is not the only consideration in

260. This legislative history does not refute the possibility that Parliament, although desiring the prize to go only to a practicable method, determined that a West Indies trial would be the test of practicability. So the legislative history provides only mild support for the Board’s view. But it does confirm, as is already evident from the act itself, that the practicability of a method was a critical consideration for the prize.

261. *E.g.*, *Zuni Pub. Sch. Dist. No. 89 v. Dep’t of Educ.*, 550 U.S. 81 (2007); *Limtiaco v. Camacho*, 549 U.S. 483 (2007); William N. Eskridge, Jr., *The New Textualism*, 37 UCLA L. REV. 621, 621 (1990).

statutory interpretation. Purposive and intentionalist considerations favor the Board's interpretation, and even textualists permit consideration of statutory purpose in the resolution of textual ambiguity.²⁶²

One can see why Quill concludes that the Longitude Act "was so vague that it was almost impossible to obtain any clear-cut direction from it."²⁶³ Or, as Parliament stated in its 1765 Act, "*Doubts may arise whether, by the Words of the [1714] Act . . . the said Commissioners can direct the Payment of the said Reward of twenty thousand Pounds to the said John Harrison.*"²⁶⁴ The Longitude Act is ambiguous.

How should the ambiguity best be resolved? Considering the matter first from a British perspective (either as a question of the Board's initial decision or of how that decision might fare upon judicial review in a contemporary British court), a vital consideration is that eighteenth-century British principles permitted the use of intentionalism in statutory interpretation. Sobel criticizes the Board for, in her view, enforcing the *spirit* of the Longitude Act while disregarding the letter of the law.²⁶⁵ Considering the spirit of a statute was, however, in keeping with the interpretive practices of the day.

In the much-noted sixteenth-century case of *Eyston v. Studd*, the court of King's Bench "took it that the . . . intent of statutes is *more* to be regarded and pursued than the precise letter of them."²⁶⁶ Plowden, the reporter of the case, felicitously compared the law to a nut, which has a shell and a kernel: the letter of the law, he explained, is only its shell, while the sense of the law is its true kernel.²⁶⁷ Plowden taught, therefore, that statutes must always be understood according to the intent of the legislature, and he noted many cases in which courts had deviated from statutory text in light of legislative intent.²⁶⁸

262. John F. Manning, *What Divides Textualists from Purposivists?*, 106 COLUM. L. REV. 70, 84 (2006); John F. Manning, *The Absurdity Doctrine*, 116 HARV. L. REV. 2387, 2408 (2003).

263. QUILL, *supra* note 7, at 140. As noted earlier, Quill also concludes that "there seems to be little doubt" that the Board should have awarded Harrison the full £20,000 after the Barbados trial. *Id.* at 205. There is obviously some tension between these conclusions.

264. 1765, 5 Geo. 3, c. 20 (Eng.) (emphasis added).

265. SOBEL, *supra* note 1, at 144.

266. *Eyston v. Studd*, (1574) 75 Eng. Rep. 688, 694 (emphasis added).

267. *Id.* at 695.

268. As Plowden remarked in his report of *Stradling v. Morgan*, (1560) 75 Eng. Rep. 305, 315:

[T]he sages of the law heretofore have construed statutes quite contrary to the letter in some appearance, and those statutes which comprehend all things in the letter, they have expounded to extend but to some things, and those which generally prohibit all people from doing such an act, they have interpreted to permit some

Plowden wrote more than a century before passage of the Longitude Act, and interpretive principles in Britain changed over time, with textualism gradually overtaking intentionalism as the dominant interpretive method.²⁶⁹ In the eighteenth century, however, Plowden's rule was still hornbook law.²⁷⁰ Thus, in deciding to resolve the ambiguities in the Longitude Act in favor of a construction that would best fulfill the intent of the act, the Board acted in accordance with accepted, contemporary interpretive practices.²⁷¹

Moreover, the Longitude Act required that the prize be paid "according to the *true Intent and Meaning* of this Act."²⁷² This phrase (overlooked in most discussions of the longitude controversy) was cited by the Board in its decision to deny Harrison the prize.²⁷³ The phrase, found in many statutes and judicial opinions of the period, is somewhat enigmatic. Although it appears to be a direct statutory instruction to apply the intentionalist method of statutory

people to do it, and those which include every person in the letter they have adjudged to reach to some persons only, which expositions have always been founded upon the intent of the Legislature.

269. By 1913, for example, Lord Atkinson could state: "If the language of a statute be plain, admitting of only one meaning, the Legislature must be taken to have meant and intended what it has plainly expressed, and whatever it has in clear terms enacted must be enforced though it should lead to absurd or mischievous results." *Vacher & Sons Ltd. v. London Soc'y of Compositors* [1913] A.C. 107, 121 (P.C. 1912). This language is still quoted in British decisions today. See, e.g., *Greenweb Ltd. v. Wandsworth London Borough Council*, [2008] EWCA (Civ) 910, [30] (U.K.).

270. E.g., 4 MATTHEW BACON, A NEW ABRIDGEMENT OF THE LAW 647-48 (2d ed. 1759) ("Such a Construction ought to be put upon a Statute, as may best answer that Intent which the Makers of it had in View. . . . Every Thing, which is within the Intent of the Makers of a Statute, is, although it be not within the Letter, as strongly within the Act as that which is within the Intent and the Letter also. . . . On the other Hand, a thing, which is within the Letter of an Act of Parliament, is not within the Act, if it is not within the Intention of the Makers of such Act."); see also *Hawkins v. Gathercole*, (1855) 43 Eng. Rep. 1129, 1135-36 (Ch.) ("[I]n construing Acts of Parliament, the words which are used are not alone to be regarded. Regard must also be had to the intent and meaning of the Legislature.").

271. Of course, eighteenth-century interpretive practices were not entirely uniform; as is true today, there were differing views on the relative virtues of textualism and intentionalism. See, e.g., *Colehan v. Cooke*, (1742) 125 Eng. Rep. 1231 ("When the words of an Act are doubtful and uncertain, it is proper to inquire what was the intent of the Legislature: but it is very dangerous for Judges to launch out too far in searching into the intent of the Legislature, when they have expressed themselves in plain and clear words."). But intentionalist interpretation was generally an accepted practice of the day. See WILLIAM D. POPKIN, *STATUTES IN COURT: THE HISTORY AND THEORY OF STATUTORY INTERPRETATION* 19-29 (1999) (refuting the suggestion that Blackstone's *COMMENTARIES* endorsed textualism); William N. Eskridge, Jr., *All About Words: Early Understandings of the "Judicial Power" in Statutory Interpretation, 1776-1806*, 101 COLUM. L. REV. 990, 998-1009 (2001) (examining English practice).

272. 1714, 12 Ann., c. 15, § 4 (Eng.) (emphasis added).

273. See *supra* note 225 and accompanying text.

interpretation, in many cases, the context in which the phrase is used suggests that, to contemporary writers, “the true intent and meaning” of a statute or other instrument meant only something like “the correct construction.”²⁷⁴ At least some cases, however, suggest that this phrase instructed courts to look beyond “strict construction” to the underlying intent of the makers of the instrument.²⁷⁵ The inclusion of this phrase in the Longitude Act therefore provides some further support for the Board’s construction of the act.

In addition, even the staunchest textualist would have to hesitate to conclude that the act required the Board to award the longitude prize on the basis of a single, successful West Indies voyage, no matter what. Such a reading could lead to absurd results. Imagine, for example, that an inventor created a complex device, costing £1000 to build, that could successfully keep the longitude to within half a degree on a single voyage from Britain to the West Indies, but that, in the course of the six-week voyage, the device would be *consumed*, so that it could work on *one* trip only.²⁷⁶ Such a device could meet the test of section III of the Longitude Act, and if it would win its inventor the prize of £20,000, it would justify the expense of £1000 in its construction. But as a solution to the longitude problem, the device would be utterly impracticable. No one could afford to spend £1000 *per voyage* to keep the longitude, and surely Parliament could never have intended that the great, public prize be wasted on such a perfectly useless device.

And yet the difficulty posed by this hypothetical device is only a sharpening of the difficulty posed by Harrison’s actual invention, which, although it could work on more than one *voyage*, was effectively available only for one *ship*. If the Board would have been justified in withholding the prize for the hypothetical device, it must be because the statute required that a prize-worthy invention have some generalizable utility. That is the essential insight behind the Board’s understanding of the phrase “practicable and useful” in section IV of the Longitude Act.

In sum, the best understanding of the Longitude Act, when all interpretive considerations are taken into account, supports the Board. Where statutory text is ambiguous, it is appropriate to consider intent and purpose in resolving the ambiguity. It is appropriate to give the

274. See H. Jefferson Powell, *The Original Understanding of Original Intent*, 98 HARV. L. REV. 885, 894-96 (1985). Of course, under this reading, the phrase is redundant, because a court should always apply the correct construction of a statute.

275. *E.g.*, *The Magdalen Coll. Case*, (1615) 77 Eng. Rep. 1235, 1239-40.

276. I am indebted to my colleague Roger Trangsrud for suggesting this hypothetical.

statute an interpretation that will not permit an absurd result that would frustrate the statute's purpose.

The Board's interpretation had textual support and was necessary to fulfill the intent and purpose behind the Longitude Act. Harrison met the specific test set forth in section III of the Act, but his claim to the prize rested on a method that could not, at the time of the claim, fulfill the statute's evident purpose of generally permitting mariners to find their longitude. The Board was therefore justified in reading the phrase "practicable and useful" in section IV to bar Harrison from winning the prize. While it is impossible, in light of the act's ambiguities, to be wholly certain as to how a court would have ruled, the Board acted in accordance with accepted interpretive principles, and it seems likely that the Board would have received approval from a contemporary British court.

The above considerations would all also be relevant in modern, American practice. In a modern American court, however, another point would be even more important: *Chevron* deference.²⁷⁷ In American law, where an administrative statute is ambiguous, the ambiguity is to be resolved by the administering agency, subject to review only for reasonableness.²⁷⁸ Under this principle, courts give considerable deference to administrative interpretations. Unless a court were persuaded that the Act *clearly* instructed the Board to pay the prize upon a successful West Indies trial, the Board's interpretation, supported by some of the Act's text and by intentionalist considerations, would be upheld as reasonable.

Under these modern standards, it seems even more likely that the Board would prevail. A modern court would likely conclude that the words "practicable and useful" are just the kind of vague, open-ended language that a legislature uses as an implicit delegation of authority to an administering agency.²⁷⁹ Given the ambiguities in the Longitude Act, the Board would have enough to show that its interpretation is a *permissible* understanding of the act, which is all that *Chevron* requires.

The longitude controversy is reminiscent of cases in which modern administrative agencies permitted policy and intentionalist considerations to influence their readings of statutory text. For example, in the well-known case of *Babbitt v. Sweet Home Chapter of*

277. *Chevron U.S.A., Inc. v. Natural Res. Def. Council, Inc.*, 467 U.S. 837 (1984).

278. *Id.* at 843-44.

279. *See id.* at 844.

Communities for a Great Oregon,²⁸⁰ the United States Supreme Court approved the Secretary of the Interior's determination that to "take" an endangered species includes modifying the species' habitat in a way that results in death or injury to members of the species. Although such action is not within the natural meaning of the word "take," the Court approved the interpretation as reasonable in light of the "broad purpose" of the Endangered Species Act.²⁸¹

The Board of Longitude's interpretation of the Longitude Act similarly promoted the broad purpose of that act. The Board's interpretation seems no more of a strain on the Act's text than our Secretary's interpretation of the Endangered Species Act or other modern agency interpretations that have received judicial approval under *Chevron*.²⁸² Given deferential *Chevron* review, the Board's interpretation would likely be upheld.

In any event, whether the case is considered from a contemporary British or a modern American perspective, and whichever outcome the reader thinks best, what is ultimately clear is this: the popular, modern judgment on the Board is too harsh. The popular judgment is that the Board simply ignored Parliament's instructions and violated Harrison's clear right to the longitude prize.²⁸³ That is certainly not true. The Board did what administrative agencies are supposed to do. It gave sensible meaning to its governing statute in light of new conditions. One possible reason for the difficulty with the Longitude Act is that

280. 515 U.S. 687 (1995).

281. *Id.* at 698-99.

282. In addition to *Sweet Home*, the Board's action seems particularly reminiscent of the agency interpretation recently approved in *Zuni Public School District No. 89 v. Department of Education*, 550 U.S. 81 (2007). The case is too complex for full discussion here, but the agency was required to interpret a statutory instruction to give special treatment to school districts "above the 95th percentile" in per-pupil expenditures in any given state. *Id.* at 81. Although this technical, mathematical instruction most naturally suggested special treatment for five percent of *school districts*, the agency decided to weight school districts by student population, so that the agency gave special treatment to whatever number of school districts accounted for five percent of the state's *student population*. The Supreme Court approved this considerable massaging of the statutory text as "a reasonable method that carries out Congress' likely intent." *Id.* at 82.

Of course, this decision pattern is not uniform. Some cases require agencies to adhere firmly to statutory text even where the result seems contrary to likely intent and even logically incoherent. *E.g.*, *Barnhart v. Sigmon Coal Co.*, 534 U.S. 438, 462 (2002). Even in such cases, however, there are often at least some votes for deferring to an agency construction that is influenced by policy and intentionalist considerations. *E.g.*, *id.* at 462-63 (Stevens, J., dissenting).

283. *See supra* note 211 and accompanying text (noting modern writers who assert that there was "little doubt" that Harrison should have received the prize or that it was "clearly" his due).

the original act “had been drawn up . . . at a period when it was unthinkable that a mechanical timekeeper could solve the longitude problem.”²⁸⁴ Also, Parliament might not have foreseen the possibility that a method might succeed in a West Indies trial, and yet give rise to serious questions as to whether it could be put into general use. But that is the situation the Board faced.

In dealing with this situation, the Board did not ignore the text of the Longitude Act. It read that text carefully, and it found language suited to the problem at hand—the requirement of section IV that a winning method be “practicable and useful.” The Board gave a sensible content to this provision that permitted it to further the statutory purpose.

The Commissioners of Longitude should be absolved of the charge that they cheated Harrison out of his clear and rightful due. They faced a difficult factual situation and an ambiguous statute. They chose an interpretation of the statute that rested on statutory text, that furthered sensible policy, and that implemented the likely legislative intent.

IV. LESSONS OF THE GREAT LONGITUDE CONTROVERSY

The primary goal of this Article is to pass judgment on an historical controversy. One cannot, however, look back on the history of the longitude controversy without considering the lessons it provides for the modern era. Harrison’s struggles with the Board provide some useful perspectives on administrative law. They also highlight some important issues arising in patent prize proposals.

A. *The Longitude Controversy and Administrative Law*

When scholars discuss the “rise of the administrative state,” they are usually discussing twentieth-century, and typically post-New Deal, developments.²⁸⁵ The longitude controversy usefully reminds us that administrative agencies are no new-fangled phenomenon. They are

284. QUILL, *supra* note 7, at 140.

285. The phrase “rise of the administrative state” can be found over 500 times in the scholarly literature. For examples linking this phrase to the modern, and particularly post-New Deal, period, see, for example, Rachel E. Barkow, *Separation of Powers and the Criminal Law*, 58 STAN. L. REV. 989, 1020 (2006); Gary Lawson, *The Rise and Rise of the Administrative State*, 107 HARV. L. REV. 1231, 1231-33 (1994); and Richard A. Nagareda, *Class Actions in the Administrative State: Kalven and Rosenfield Revisited*, 75 U. CHI. L. REV. 603, 628 n.93 (2008). See also Jerry L. Mashaw, *Recovering American Administrative Law: Federalist Foundations, 1787-1801*, 115 YALE L.J. 1256, 1258 (2006) (providing an analysis of administrative law prior to the twentieth century).

older than our nation, and the problems of modern administrative law have roots that go back through the centuries. The longitude controversy shows that many of the themes of modern administrative law are eternal.

The longitude controversy provides a useful illustration of the important theme of flexibility versus micromanagement in the design of agency organic statutes. A legislature must constantly choose how much discretion to delegate to the executive. The United States Congress sometimes chooses to require administrative agencies to follow precisely specified rules in the service of particular goals. Such legislative micromanagement may cause harm to other, equally important goals.

The “Delaney Clause,” which prohibits the approval of any food additive found by appropriate tests to induce cancer in humans or animals, provides a well-known example.²⁸⁶ It serves the goal of reducing exposure to carcinogens, but at the cost of increasing exposure to other health risks.²⁸⁷ The statutory specificity prevents the agency from exercising its discretion to reach the best public policy outcomes.

Parliament’s specification of a test for the longitude prize, if it were interpreted to serve as *the* test for the longitude prize, provides a similar example. As discussed above, it seems likely that the purpose of the Longitude Act was to promote the discovery of a method that would truly solve the longitude problem, which would occur only when the method could be put into general use. Harrison’s watch was what would today be called a “proof of concept” invention. It demonstrated that the longitude problem *could be* solved by a timekeeper. That was a very significant contribution, to be sure, and Harrison deserves much credit for spurring the efforts of later clockmakers who enabled chronometers to be produced more expeditiously and cheaply.²⁸⁸ Nonetheless, it goes too far to say that H4 *did* solve the longitude problem. The Board, in passing judgment, had to consider all facets of the complex situation it faced, including the knowledge that awarding the full prize to Harrison would eliminate the public encouragement for a method that would truly solve the problem. If the Longitude Act were understood as requiring the Board to award the prize to any method that succeeded in a West Indies trial, it would

286. 21 U.S.C. § 348(c)(3)(A) (2006).

287. Cass R. Sunstein, *Interpreting Statutes in the Regulatory State*, 103 HARV. L. REV. 405, 423 (1989).

288. See SOBEL, *supra* note 1, at 155-64; Betts, *supra* note 233, at 312.

be a classic example of an overly specific statute by which a legislature micromanaged an administrative agency to the public's detriment.

The longitude controversy also reminds us of the important role of administrative agencies in adapting the law to changed and possibly unforeseen circumstances. As noted earlier, the difficulty in interpreting the Longitude Act lies partly in the altered circumstances that arose in the fifty-year interval between the act's passage and the time the Board was called upon to evaluate Harrison's claim to the prize. Originally, even assuming that Parliament conceived of the West Indies trial and the "practicable and useful" requirement as independent tests, people might have assumed that the tests would naturally be satisfied simultaneously. Such an assumption would make sense for methods that, once established, could easily be put into widespread practice—such as, most notably, the lunar distance method. That the chronometer method achieved surprising success, but by a device that could not easily be reproduced, created the kind of unforeseen circumstance that agencies constantly face. The Board, like modern agencies, had to adapt its organic act to the new circumstances.

The surprising circumstances that gave rise to the longitude controversy also remind us of issues that constantly arise in administrative statutory interpretation. Modern administrative agencies, and indeed, modern statutory interpreters generally, constantly struggle with the often conflicting influences of textualism, intentionalism, and other interpretive methods. As Cass Sunstein has observed, "Textualism becomes even more problematic when time has affected the assumptions under which the statute was originally written. Changed circumstances may produce ambiguity or interpretive doubt in the text where neither existed before."²⁸⁹ The longitude controversy shows that this struggle among interpretive methods is nothing new—nearly three hundred years ago, the Board had to reconcile conflicting impulses from statutory text, statutory purpose, and likely legislative intent, particularly in light of unforeseen circumstances.

The case also highlights many of the reasons underlying the modern principle that, in such a situation, courts should give interpretive leeway to the administrative agency. The Board had fifty years of experience and expertise in dealing with the Longitude Act and surely understood best how any particular construction would

289. Sunstein, *supra* note 287, at 422-23.

affect the fulfillment of its purposes. The broad powers Parliament gave to the Board, the expertise of the commissioners, and the political representativeness of the Board (which was unencumbered by American principles of separation of powers) also underscore the appropriateness, in this case, of the *Chevron* assumption that legislative ambiguity implies delegation of interpretive authority to resolve the ambiguity.

In sum, the longitude controversy presents a rich microcosm of administrative law issues. In this one agency, created nearly 300 years ago, we see the same issues and concerns that regularly face administrative agencies today: claims of bias and conflict of interest, the need for flexibility to adapt organic law to changing circumstances, and, perhaps most of all, the difficulties administrative agencies face in struggling to be faithful to the requirements of their organic statutes while also serving those statutes' purposes.

B. The Longitude Controversy and Intellectual Property

From another vantage point, the longitude controversy belongs to intellectual property law. Parliament faced the problem of encouraging private development of a solution to a scientific problem of great importance. The problem was particularly important to Britain, where navigation played a vital role in the foundation of national wealth and power.

Today, we rely on the patent system to foster such needed invention. The modern reader may wonder why Harrison, if he was experiencing such difficulty receiving the longitude prize, did not apply for a patent on his invention and exploit its value in the marketplace. One reason may be that British patent law was still underdeveloped. The Statute of Monopolies,²⁹⁰ enacted in 1624, confirmed the power of the Crown to grant patents for any "new manufacture,"²⁹¹ but the grant of patents remained a royal prerogative, not a right.²⁹² There were no fixed criteria for the issuance of a patent, nor fixed terms for patents that did issue.²⁹³ During the decades when Harrison worked on his timekeepers, British patent law underwent a gradual transformation toward more standardized criteria and terms for

290. 1624, 21 James I, c. 3 (Eng.).

291. *Id.* § 5.

292. Attorney General *ex rel.* Hecker v. Rumford Chem. Works, 32 F. 608, 618 (C.C.R.I. 1876); Oren Bracha, *The Commodification of Patents 1600-1836: How Patents Became Rights and Why We Should Care*, 38 LOY. L.A. L. REV. 177, 185-86 (2004).

293. Bracha, *supra* note 292, at 185-86.

patents,²⁹⁴ but well into the nineteenth century, British treatise writers explained that patents were a matter of grace and favor, not a matter of right,²⁹⁵ and at the end of the eighteenth century, judges and lawyers were still complaining that no accurate descriptions of the law of patents were available.²⁹⁶

Thus, Parliament's decision to offer what we would today call a patent prize, and Harrison's choice to rely on the parliamentary prize rather than to run the hazards of the patent system, are understandable. But the difficult experience that ensued offers some useful perspective on modern patent prize proposals.

As my colleague Michael Abramowicz has observed, a critical element of patent prize proposals is the specification of how the prize-awarding agency should decide to grant awards. Other scholars, Abramowicz observes, imagine that the task of giving awards could be reduced to a formula or algorithm that would leave little discretion to the award-granting agency.²⁹⁷ Abramowicz rightly points out, however, that "there are so many considerations relevant to dispensing prizes" that no statutory specification is ever likely to capture the considerations into an administrable formula.²⁹⁸ The longitude controversy supports this observation. Even in the relatively simple case wherein the legislature sought to promote a solution to a single, specific problem, and in which a single, discrete product embodied the sought-after innovation,²⁹⁹ Parliament could not usefully specify the test that would determine whether the invention had won the prize in a way that could eliminate the need for administrative discretion. As Harrison's experience showed, it was possible to pass the specific test stated in the statute without genuinely solving the longitude problem.

The longitude controversy is, of course, merely a single case, but it highlights important difficulties that any patent prize system must encounter. Legislative specification that eliminates bureaucratic flexibility can, as discussed in the previous section, be a hazardous undertaking, and this seems particularly likely in the patent area, where

294. *Id.* at 201-11.

295. *Id.* at 209.

296. Adam Mossoff, *Rethinking the Development of Patents: An Intellectual History, 1550-1800*, 52 HASTINGS L.J. 1255, 1276 (2001).

297. Abramowicz, *supra* note 4, at 122.

298. *Id.*

299. Many modern devices such as computers or cell phones may embody hundreds, or even thousands, of separate patents.

the very essence of the task is to promote unforeseen innovation.³⁰⁰ It seems unlikely that a statutory formula could capture all of the considerations and complexities in a way that would ever eliminate the role of sound judgment in a patent prize system.

The longitude controversy also highlights the difficulty of spurring truly useful innovation through a prize system. Although a prize can provide an incentive for innovation where the market incentive is insufficient, innovation directed toward winning a prize may, as the longitude matter shows, be quite different from innovation directed toward bringing a successful product to market. If Harrison had sought to develop a chronometer for actual sale, he would have been compelled to consider the issues of cost and reproducibility from the beginning. His work, directed instead toward satisfying what he thought were the requirements for the prize, neglected these considerations. Even today, any innovative work directed toward specified requirements for a prize rather than toward actual market needs could encounter similar problems.

V. CONCLUSION

There can be an irresistible fascination to early cases. Society has grown far more complex over the centuries, but many of our basic legal principles have not changed. Part of the charm of early cases such as *Raffles v. Wichelhaus*³⁰¹ or *Sherwood v. Walker*³⁰² in contract law or *Vaughan v. Menlove*³⁰³ in tort is that they tie our modern life back to the simpler society of prior centuries.

The longitude controversy does the same thing in administrative law and intellectual property. It shows that, as long as administrative agencies have existed, people have been fighting them. Agencies have always struggled to apply their statutory instructions to changing circumstances, and their efforts have long led to claims of bias and illegality. On the intellectual property side, the controversy illustrates the longstanding nature of the difficulties of devising a system of appropriate incentives for innovations that promote the progress of the useful arts.

300. *Cf. Diamond v. Chakrabarty*, 447 U.S. 303, 316 (1980) (“Congress employed broad general language in drafting § 101 precisely because such inventions are often unforeseeable.”).

301. (1864) 159 Eng. Rep. 375.

302. 33 N.W. 919 (Mich. 1887).

303. (1837) 132 Eng. Rep. 490.

A close study of the longitude controversy answers the unjustified charges made against the Board of Longitude. The Board faced a difficult task and an ambiguous statute. It arranged appropriate compensation for Harrison while adhering to a reasonable interpretation of the Longitude Act that furthered the act's goal of finding the longitude. The Commissioners of Longitude did their duty.

APPENDIX

1714, 12 Ann., c. 15 (Eng.)

An Act for Providing a Publick Reward for Such Person or Persons
as Shall Discover the Longitude at Sea.

WHEREAS it is well known by all that are acquainted with the Art of Navigation, That nothing is so much wanted and desired at Sea, as the Discovery of the Longitude, for the Safety and Quickness of Voyages, the Preservation of Ships, and the Lives of Men: and Whereas in the Judgement of able Mathematicians and Navigators, several Methods have already been discovered, true in Theory though very difficult in Practice, some of which (there is Reason to expect) may be capable of Improvement, some already discovered may be proposed to the Publick, and others may be invented hereafter: And whereas such a Discovery would be of particular Advantage to the Trade of Great Britain, and very much for the Honour of this Kingdom; but besides the great Difficulty of the Thing itself, partly for the Want of some Publick Reward to be settled as an Encouragement for so useful and beneficial a Work, and partly for want of Money for Trials and Experiments necessary thereunto, no such Inventions or Proposals, hitherto made, have been brought to Perfection; Be it therefore enacted by the Queen's most Excellent Majesty, by and with the Advice and Consent of the Lords Spiritual and Temporal, and commons, in Parliament assembled, and by the Authority of the same, That the Lord High Admiral of *GREAT BRITAIN*, or the first Commissioner of the Admiralty, the Speaker of the Honourable House of Commons, the first Commissioner of the Navy, the first Commissioner of Trade, the Admirals of the Red, White, and Blue Squadrons, the Master of the Trinity-House, the President of the Royal Society, the Royal Astronomer of Greenwich, the Savilian, Lucasian, and Plumiam Professors of the Mathematicks in Oxford and Cambridge, all for the Time being, the Right Honourable Thomas Earl of Pembroke and Montgomery, Philip Lord bishop of Hereford, George Lord Bishop of Bristol, Thomas Lord Trevor, the Honourable Sir Thomas Hammer Baronet, Speaker of the Honourable House of Commons, the Honourable Francis Robarts, Esq.; James Stanhope, Esq.; William Clayton, Esq.; and William Lowndes, Esq.; be constituted, and they are hereby constituted Commissioners for the Discovery of the Longitude at Sea, and for examining, trying, and judging of all Proposals, Experiments, and Improvements relating to the same; and that the said

Commissioners, or any five or more of them, have full Power to hear and receive any Proposal or Proposals that shall be made to them for discovering the said Longitude; and in Case the said Commissioners, or any five or more of them, shall be so far satisfied of the Probability of any such Discovery, as to think it proper to make Experiment thereof, they shall certify the same under their Hands and Seals, to the Commissioners of the Navy for the Time being, together with the Persons Names, who are the Authors of such Proposals; and upon producing such Certificate, the said Commissioners are hereby authorized and required to make out a Bill or Bills for any such Sum or Sums of Money, not exceeding two thousand Pounds, as the said Commissioners for the Discovery of the said Longitude, or any five or more of them, shall think necessary for making the Experiments, payable by the Treasurer of the Navy; which Sum or Sums the Treasurer of the Navy is hereby required to pay immediately to such Person or Persons as shall be appointed by the Commissioners for the Discovery of the said Longitude, to make those Experiments, out of any Money that shall be in his Hands, unapplied for the Use of the Navy.

II. And be it further enacted by the Authority aforesaid, That after Experiments made of any Proposal or Proposals for the Discovery of the said Longitude, the Commissioners appointed by this Act, or the major Part of them, shall declare and determine how far the same is found practicable, and to what Degree of Exactness.

III. And for a due and sufficient Encouragement to any such Person or Persons as shall discover a proper Method for finding the said Longitude, Be it enacted by the Authority aforesaid, That the first Author or Authors, Discoverer or Discoverers of any such Method, his or their Executors, Administrators, or Assigns, shall be entitled to, and have such Reward as herein after is mentioned; that is to say, to a Reward, or Sum of ten thousand Pounds, if it determines the said Longitude to one Degree of a great Circle, or sixty Geographical Miles; to fifteen thousand Pounds, if it determines the same to two Thirds of that Distance; and to twenty thousand Pounds, if it determines the same to one Half of the same Distance; and that one Moiety or Half-Part of such Reward or Sum shall be due and paid when the said Commissioners, or the major part of them, do agree that any such Method extends to the Security of Ships within eighty Geographical Miles of the Shores, which are places of the greatest Danger, and the other Moiety or half-Part, when a Ship by the Appointment of the said Commissioners, or the major Part of them,

shall thereby actually sail over the Ocean, from Great Britain to any such Port in the West-Indies, as those Commissioners, or the major Part of them, shall choose or nominate for the Experiment, without losing their Longitude beyond the limits before mentioned.

IV. And be it further enacted by the Authority aforesaid, That as soon as such Method for the Discovery of the said Longitude shall have been tried and found practicable and useful at Sea, within any of the Degrees aforesaid, That the said Commissioners, or the major Part of them, shall certify the same accordingly, under their Hands and Seals, to the Commissioners of the Navy for the Time being, together with the Person or Persons Names, who are Authors of such Proposal; and upon such Certificate the said Commissioners are hereby authorized and required to make out a Bill or Bills for the respective Sum or Sums of Money, to which the Author or Authors of such Proposal, their Executors, Administrators, or Assigns, shall be entitled by Virtue of this Act; which Sum or Sums the Treasurer of the Navy is hereby required to pay to the said Author or Authors, their Executors, Administrators, or Assigns, out of any Money that shall be in his Hands unapplied to the Use of the Navy, according to the true Intent and Meaning of this Act.

V. And it is hereby further enacted by the Authority aforesaid, That if any such Proposal shall not, on Trial, be found of so great Use, as aforementioned, yet if the same, on Trial, in the Judgement of the said Commissioners, or the major Part of them, be found of considerable Use to the Publick, that then in such case, the said Author or Authors, their Executors, Administrators, or Assigns, shall have and receive such less Reward therefore, as the said Commissioners, or the major Part of them, shall think reasonable, to be paid by the Treasurer of the Navy, on such Certificate, as aforesaid.