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Longitude

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Dava Sobel

This study occupies a unique position in current naval literature, not least for its methodology. Glete has amassed sufficient quantitative data on the strengths and qualities of almost all the navies of this period to provide not only comparative tables of fleet strengths, vessel sizes, armaments, and manning levels throughout the study's text (which itself occupies some five hundred pages) but also to supply over two hundred pages of appendices, packed with further statistical analyses of most of the major fleets throughout the 350 years covered in this work. Some earlier limited statistical surveys, confined to the principal fleets of the seventeenth century, were assembled in the 1920s and 1930s in Europe, but nothing on this scale has ever been attempted. Glete's raw statistical data by itself is invaluable. It provides historians and analysts with an incomparable tool for future studies of Western naval development during the critical period of Europe's expansion toward global hegemony.

Glete, however, does not confine himself to basic comparisons but employs them to explore more significant issues of the role of military forces, in particular of navies, in the process of state-building. He puts forward the concept of a second military revolution: the emergence of self-perpetuating and expanding military bureaucracies whose existence both contributed substantially to solidifying the development of the European nation-state and served as the vehicle for expanding state monopolization of violence. Using his statistical data, he explores the long-term interactions between national policies, naval expansion, technological advances, and bureaucratic inertia. In particular, Glete demonstrates the overwhelming importance for the durability of navies of the aggregation of domestic interests behind policy, concluding that its impact generally outweighs that of external threats.

From 1500, warships were constructed and naval organizations were created to enforce state monopolization of violence at sea, which was essential to the process of state-building because it provided the power to control organizations, factions, or groups. Aggregation of interests behind this process was essential for its consistency and durability. Glete also notes that as naval organizations became institutionalized they tended to acquire hierarchical and authoritarian bureaucratic characteristics, gradually changing from instigators of radical technological innovation to conservative importers, a process broken only by the advent of industrialization.

Glete presents his analysis within a chronological framework derived almost entirely from secondary sources. His discussion of naval strategy and tactics is consequently unadventurous and, occasionally, erroneous. This, however, does not detract from the significance of his conclusions or from the importance of this extraordinary work.

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Sobel, Dava. *Longitude.* New York: Walker, 1995. 184pp. $19

In 1714, when the annual pay of a senior post captain was but £300, the British parliament offered £20,000 for a practical solution to the longitude problem.

Finding their longitude had bedeviled mariners since the time of the Phoenicians. In 1707 Admiral Shovell lost two thousand men and his own life to shipwreck when he miscalculated his longitude on a fog-shrouded night off the Scilly Isles. Partly in response, Parliament established the Board of Longitude, with the best naval, astronomical, and scientific minds available, to encourage and evaluate methods for finding longitude at sea.

Parliament's £20,000 prize was not an idle offer. In the eighteenth century the nation that solved the problem would obtain a significant commercial and military maritime advantage. Ships could sail more directly to their destinations, vice blindly following lines of latitude, and fewer ships would have unplanned encounters with the beach.

Astronomers favored the method of lunar distances to find longitude. It was a cumbersome technique involving observation of angular distances between heavenly bodies, followed by four hours of intense logarithms. Few mariners could do it with reliable accuracy. At the same time, it was well understood that longitude could be determined by measuring precisely the time difference between local noon and noon at a reference position—Greenwich, England, for example. To do this, a timepiece on board ship had to keep the time at Greenwich. Though this is a simple solution, it was considered impracticable because even the best timepieces could not keep sufficiently accurate time during long voyages. To win the longitude prize, a timepiece would have to gain or lose no more than three seconds per day on a voyage to the Caribbean. No timepiece of the day could come close; even Isaac Newton considered so accurate a clock to be beyond possibility.

Onto this stage stepped John Harrison, a self-taught clockmaker of high intelligence and persistence, and the focus of Dava Sobel's elegant book. Sobel, a former science reporter for the *New York Times*, offers clean and lucid explanations of the astronomical and horological matters while portraying Harrison's brilliance, the importance of the longitude problem, and the intrigues of the Board of Longitude.

In 1735 Harrison built the H-1, his first "sea clock," which weighed seventy-five pounds and stood four feet high, wide, and deep. It was used on a short sea trial to Lisbon, and the captain was mightily impressed. However, Harrison was determined to build a better clock, and in 1741 he presented the H-2 to the Royal Society. Harrison was an extraordinary, self-driven perfectionist, and he began a twenty-year project to build an even better clock, the H-3. They all, however, failed to satisfy him. Each of his clocks was a marvel of design and imaginative technique to offset the effects of temperature and motion. Each clock attracted the attention of the scientific and horological communities. Nonetheless, they did not satisfy Harrison.

After the H-3, Harrison made an important technical change in his approach. He abandoned the pendulum-based clock and turned his attention to the escapement-regulated watch. Such watches had been constructed by others, most notably John Jefferys, who made one for Harrison in 1755. Jefferys's watch captivated Harrison, who set out to perfect it for oceanic navigation. He developed near-frictionless bearings using diamonds and rubies, and a winding mechanism that allowed the watch to be wound without interrupting its timekeeping. In 1759 Harrison presented his H-4 watch to the Board of Longitude. In 1761 trials were conducted on voyages to the West Indies with resounding success. The H-4 lost only five seconds in eighty-one days at sea.

Harrison's design was adopted by other watchmakers, who reduced both size and manufacturing costs. The "chronometer" came into general use, and by 1815 there were five thousand in the Royal Navy.

Unfortunately, Harrison's brilliance was not matched by that of the members of the Board of Longitude. Sobel's descriptions of the machinations of the Board, the determination of the astronomers to find longitude in the heavens rather than in a mechanical box, and the changing specifications for the £20,000 prize will sound all too familiar to today's observer of the naval research and development scene.

While the Board dealt out to Harrison a few thousand pounds in progress payments, they never gave him the full amount. His son William took up the campaign to have his father honorably rewarded and in 1772 met with King George III. After hearing William's story and seeing the H-4 and its simpler successor, the H-5, King George observed that "these people have been cruelly treated." To William, he said, "By God, Harrison, I will see you righted."

After tests showed the H-5 to be accurate to one-third of a second per day, Parliament awarded John Harrison the difference between what the Board had given him and the full prize. The Board of Longitude never recanted.

Today we take for granted the accurate and easy measurement of time and position. Such measurements are at the core of modern military operations. The technical marvels of LORAN and the Global Positioning System depend on precise time, and they owe their debt to John Harrison, who, in Dava Sobel's words, was the "lone genius who solved the greatest scientific problem of his time."

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