

Nautical Numbers: Nathaniel Bowditch's Influence on Modern-Day Mathematics

Nathaniel Bowditch and the Power of Numbers: How a Nineteenth Century Man of Business, Science, and the Sea Changed American Life. By Tamara Plakins Thornton, University of North Carolina Press, Chapel Hill, NC, 2016, 416 pages, \$35.00.

In chapter 35 of *Moby Dick*, Herman Melville admonishes the ship owners of Nantucket, "Beware of enlisting in your vigilant fisheries any lad . . . who offers to ship with the Phaedon instead of Bowditch in his head."

The *Phaedon*, now usually called the *Phaedo* in English, is the most moving of Plato's dialogues; it is set on the last day of Socrates' life and ends with his execution. "Bowditch" refers to *The New American Practical Navigator* by Nathaniel Bowditch. And Nathaniel Bowditch (1773-1838), the subject of a new, fascinating, and scholarly biography by social historian Tamara Thornton, was a remarkable man.

Nathaniel Bowditch was born in 1773 to Mary Ingersoll and Habakkuk Bowditch in Salem, Massachusetts, the second largest port in New England and one of the largest cities in America. Because of the sea trade, it was rather cosmopolitan by the standards of time and place.

Bowditch's mathematical gifts were apparent from a young age, and he was soon widely known as a prodigy, able to quickly solve problems and puzzles that his elders found difficult. By extraordinary chance, a library of over 200 scientific and mathematical volumes came to Salem (as loot captured by a Patriot privateer). The young Bowditch worked through this library intensely, and taught himself Latin in order to read Newton's *Principia*.

Between 1795 and 1803, Bowditch made five sea voyages to destinations as remote as the Philippines and Réunion Island, first as the officer in charge of the cargo, and on his final voyage as master and part owner. Then he got married and began a career in business.

Bowditch had two great scientific accomplishments. The first was the one that got him into *Moby Dick*, his *New American Practical Navigator*, first published in 1802. The publication's key element was the presence of tables for the lunar method of computing longitude. At sea, latitude is easy to compute; it's the angle of the North Star above the horizon. Longitude, on the other hand, is very difficult; as the earth rotates, the position of the stars at a given local time and latitude remains the same at all longitudes. However, if you know the time at some fixed location—Greenwich, for example—you can compute the local time by astronomical observation. The difference between your time and Greenwich time in minutes is four times your longitude

in degrees. Thus, if you know Greenwich time within 4 minutes, you can determine your longitude to within 1 degree.

So how can you determine the time in Greenwich? The obvious solution is to carry a clock that reliably keeps Greenwich time. John Harrison's marine chronometer accomplished this in the mid-1700s. That would have been the end of the question, except that chronometers were extremely expensive; most ships could not afford one until the 1830s.

In the lunar method, the moon is the "clock." In a very crude first approximation, the position of the moon against the fixed stars is the same everywhere on Earth; however, one has to correct for the parallax and atmospheric refraction. Bowditch's tables precalculated all this, allowing a mariner to determine his longitude by measuring the angle between the moon and specified stars.

Contrary to popular belief, Bowditch did not invent the lunar method; he was not even the first to publish this kind of table. The standard of his day was John Hamilton Moore's *New Practical Navigator*, first published in 1772

and now in its twelfth edition. However, Bowditch corrected thousands of Moore's errors, and incorporated all kinds of additional useful information, including instruction in the basic mathematics needed to carry out the lunar method. Bowditch's book soon became the standard reference for navigation. The book is supposedly still carried aboard every commissioned U.S. Naval vessel, though presumably at this point for tradition rather than use.¹

Bowditch's second major mathematical contribution was a translation and annotation of the first four volumes of Pierre Laplace's five-volume *magnum opus*, *Mécanique Céleste*, the definitive analysis of the solar system in terms of Newtonian

gravity. Bowditch began his study of Laplace in 1803 and ultimately published his 3,000 page translation between 1828 and 1839, in four volumes at his own enormous expense. The work was a careful exposition of the theory for the beginning mathematical student, and incorporated an extensive discussion of the relation between Laplace's analysis and the later, more mathematically

sophisticated studies of problems by mathematicians such as Carl Friedrich Gauss and Heinrich Wilhelm Olbers.

Bowditch's translation earned him an international reputation. The likes of Sylvestre Lacroix, Adrien-Marie Legendre, and John Herschel showered him with plaudits, and Charles Babbage engaged

him in an extended correspondence to discuss his ideas for the Analytical Engine. Most cherished of all, Laplace's widow sent Bowditch a large marble bust of her former husband (see photo).

Bowditch was also a very successful man of affairs, and Thornton argues vigorously that his contributions in this sphere were ultimately more significant than his mathematical work. He imposed a strict mathematical order—then a radical innovation—on the doings of the life

insurance company that he headed: records were carefully kept and filed, business was carried out on preprinted forms, and bills were collected on time with penalties for late payment.

The finances of Harvard College at the time were scandalously badly managed. Bowditch was among the leading figures involved in placing the finances on sound footing. His reforms were proper and necessary, but his methods were somewhat ruthless; the well-respected incompetents Bowditch replaced were not allowed to back out gracefully and save face.

Thornton's account of Bowditch's role in the aforementioned business and financial activities is, I gather, the major original historical contribution of her biography. She has researched these deeply, and makes them as interesting as the details of business transactions from two centuries ago can be.

One of the most interesting aspects of Thornton's book is the account of Bowditch's slightly uneasy social position vis-à-vis the Boston Brahmins of his time. (Oliver Wendell Holmes Sr. didn't coin the phrase until three decades later, but the caste was very much in place at the time.) Bowditch was universally respected for his mathematical gifts, business ability, and absolute integrity. But he was not truly of the elite: his family, while related to the top families, was not quite one of them. He had not gone to college, his Latin was just adequate for reading science, and he knew no Greek. Moreover Bostonians regarded the people of Salem as crass philistines, interested only in making money, with no regard for the Higher Things. Harvard offered Bowditch a professorship, but he declined it, partly because it would have involved a substantial loss of income, but partly, Thornton speculates, because he may have felt inferior to his colleagues with classical educations.

The strangest part of Bowditch's life is the trajectory of his fame. I had never heard of him until I read Thornton's biography—I presume that the same is true of most readers of *SIAM News*—and I am entirely confident that it is true of most readers of *Moby Dick*. But in his own time, and in Melville's time, and for a century after Melville, Bowditch was extremely famous. Thornton writes, "Thomas Jefferson praised him as 'a meteor of the hemisphere' in which he lived. James Madison paid homage to his 'distinguished genius.' His countrymen compared him to Benjamin Franklin and even Isaac Newton, and his name became synonymous with genius, not unlike Einstein's is today."

Numerous biographical accounts of Bowditch were written over the years, and according to Thornton, the level of hero worship steadily increased even while accuracy diminished. Most remarkably, a children's biography, *Carry On, Mr. Bowditch*, by Jean Lee Latham and with charming woodcut illustrations, won the prestigious Newbery Medal in 1955.

In his own time and for many years afterward, the United States clearly and urgently needed a native-born mathematician hero, so Bowditch was venerated. Now that need is apparently no longer urgent, so he is largely forgotten. But Thornton's account of Bowditch's life still sheds a striking light on the science and activities of the early United States, and therefore is an important contribution to our historical understanding.

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BOOK REVIEW

By Ernest Davis



A portrait of Nathaniel Bowditch by Charles Osgood. This photo is featured on the book's jacket. In the top left, the marble bust of Pierre Laplace that his widow gifted to Bowditch is visible. © 2006 Peabody Essex Museum. Photo by Mark Sexton.

¹ This statement is not in Thornton's book; however it is repeated on many websites, including here: http://msi.nga.mil/MSISiteContent/StaticFiles/NAV_PUBS/UNTM/201541/Important_Info.pdf