TIMES OF THE TRADE:
MARINE CHRONOMETER USE
IN NINETEENTH-CENTURY AMERICA

by

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ACKNOWLEDGMENTS

In some ways, this thesis has been 28 years in the making—ironic for a project on timekeeping. Researching the sea is also an attractive topic, but few are willing to take it on. I am grateful to the entire network of people who gave so generously of their time and collections to help me explore the links between timekeeping and maritime life.

First and foremost, my deepest gratitude goes to Arwen Mohun for her thoughtful questions and gentle guidance throughout this process. Her encouraging storytelling and perceptive advice on focusing the narrative made writing and refining a joy. Thank you.

My sincere thanks go to the staff and faculty at the Winterthur Museum and the University of Delaware. Catharine Dann Roeber, Tom Guiler, and Emily Guthrie provided me with endless encouragement and thoughtful comments for this and every other project in the past two years. Their enthusiasm for objects and exploring their stories have been inspiring. I am indebted to others in the support network here including Greg Landrey, Wendy Bellion, J. Ritchie Garrison, Chase Markee, and Laura Olds Schmidt. Completing this program takes a village, and without your help and support, I could not have done it.

This project took me all over New England and the mid-Atlantic, and I am beholden to many generous people throughout these regions. Thank you to Elisabeth Meier, Kelly Page, and Amory Houghton for giving so freely of their time and knowledge at Maine Maritime Museum. I am grateful to Lan Morgan, Don McPhee,
and George Schwartz at the Peabody Essex Museum for helping me mine the library
and object collections in my search for what makes these things tick. My sincere
thanks go to Nancy Seager, Maribeth Bielinski, and Paul O’Pecko at Mystic Seaport
Museum for their willingness to have me dive into the depths of the marine
chronometer collection. Finally, thank you to Mark Procknik and Sarah Rose at the
New Bedford Whaling Museum for helping me understand the American whaling
community’s reliance on chronometers. I am grateful to countless others for their
assistance in finding these timekeepers and accessing their secrets.

Last but certainly not least, thank you to my family and friends. I am indebted
to the Class of 2019 for all the love, punny reality checks, and encouragement to
pursue even the topics you all knew I should have left alone. This experience was
made all the richer thanks to your friendship. Thank you to Robert C. Cheney, the
Director of the Willard House and Clock Museum, for making sure I knew how to
dismantle a chronometer properly before I even began this voyage. To my mom, dad,
and brother, Mary Lou, Kevin, and Tom, I cannot thank you enough for your patience
and questions when I could not talk about anything other than clocks. Finally, all my
love to Ian Grant, for your never-failing encouragement, for reading every draft and
listening to every presentation, and for all the wonderful meals.
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ABSTRACT

The nineteenth-century adoption of marine chronometers by American naval and merchant vessels made travel on the open ocean safer and faster. However, marine chronometers required extensive check-ups and daily or weekly winding during use at sea. To maintain their accuracy, these intricate clocks relied on highly skilled mariners who counted on these objects both as timekeepers and global positioning systems. In other words, nineteenth-century marine chronometers were needy. Mariners could not care for these instruments alone. They needed skilled craftspeople on land to complete regular cleanings and occasional repairs.

This thesis argues that marine chronometers cannot be fully understood without examining the networks created through their acquisition, use, and care on land and at sea. To expose these networks, this project relies on nineteenth-century objects and documents in northeastern United States collections. Interrogating marine chronometer construction, design, and repairs uncovers these instruments’ stories of use and preservation. Letters, logbooks, and ships’ accounts reveal how mariners perceived these devices as tools and treasures. Analysis of documentary and object sources reveals the international networks of these instruments’ use, ownership, and care in the nineteenth century.
INTRODUCTION

Figure 1  William French Marine Chronometer, London, No. 4982. 1850-1860. This instrument and its case are a fairly standard size for the period. Case 6 ½ x 6 ½ x 6 ¾ inches. M800, courtesy Peabody Essex Museum.
When the *Rousseau* sailed into New Bedford for the final time in 1893, she had carried mercantile and whaling crews for almost a century. The *Rousseau* was more than a vessel: she was part of the New Bedford community, a source of pride and a symbol of the city’s identity. Hundreds of New Bedfordians, sailors and landlubbers alike, came out to celebrate the ship and mourn her loss. Her boards were fuel for bonfires on the beach for days, and her mysteries inspired creative essays from nostalgic community members.¹ Even her marine chronometer, the object at the center of her success in navigating across perilous seas, was salvaged (Figure 1). An 1893 photograph of the *Rousseau* still hangs at Girard College in a frame made of the ship itself (Figure 2).² These material memories, both visual and tactile, are a frequent refrain in maritime material culture. Romanticized visions of life at sea compelled people to retain material evidence of it, and the *Rousseau*’s legendary status legitimized saving countless bits and pieces connected to the old ship. From hull fragments to marine chronometers, this ship’s story and her artifacts exemplify the power of ties between land-bound and seafaring communities throughout the United States. Its marine chronometer, with its standard mid-nineteenth century design and unsubstantiated ties to the *Rousseau*, proves the strength of connections between land and sea through the tools of the mariner’s trade.

¹ One such essay read, “if only the ship could tell the story of its voyages—the long passages over tropic seas, the fierce simoons, the strange life in the ports of the antipodes, its precious freighlage of costly silks and fragrant spices!” Almon Gunnison, *Memories Stirred by a Blazing Fire of Driftwood Taken from the Old Rousseau* (New Bedford: H.S. Hutchinson & Co., 1895), 6.

² Girard College is the independent preparatory school in Philadelphia financed by Stephen Girard, the merchant who commissioned the *Rousseau* in 1801.
Figure 2  The ship *Rousseau* coming into the port of New Bedford for the final
time in 1893. The plaque reads, “Ship Rousseau Condemned Whaler
Broken up New Bedford 1893 Built for Stephen Girard by Nicholas
Vandusen Shackemaxon St. Philad’la launched 1801.” Photograph framed
with components of the *Rousseau*’s hull, 22 ½ x 25 ½ inches, framed.
Courtesy Girard College History Collections, Philadelphia, PA.

Taken on their own, marine chronometers are nothing more than fancy clocks
(Figure 3). However, unlike most clocks, they must remain reliable on a pitching
vessel on the open ocean. Marine chronometers have intricate mechanisms, similar to
Figure 3  “What Makes a Chronometer so Precise?” graphic which explains the key features of a marine chronometer. Image from Time and Navigation, an exhibition at the Smithsonian National Air and Space Museum. Courtesy Smithsonian National Air and Space Museum (NASM9A11805).

those in pocket watches, to compensate for changes in the environment. They are also mounted on gimbals inside a hardwood case which allow the instrument to remain
level despite the motion of a ship at sea. Closer in size to a shelf clock, yet compact and resistant to external factors like movement and temperature, they inhabit the space between clocks and watches and provide reliable timekeeping even in the harshest conditions.

Before the marine chronometer, mariners had a variety of tools they could use to approximate their location on the open ocean. Devices like quadrants, sextants, and octants enabled sailors to measure the altitude of a star from the horizon line. These observations were then incorporated into calculations for the ship’s latitude, or North-South, position. The results of these mathematics were plotted on charts to track the ship’s movement in relation to celestial bodies and the North or South Pole. However, none of these tools gave mariners their longitudinal, or East-West, position. Logs and lines gave sailors the ship’s approximate speed, and the use of a compass provided the ship’s general direction. Called “dead reckoning,” this method allowed

3 John Harrison, British clockmaker, was the first to understand how watch designs could help with timekeeping and navigation at sea. For more on this subject, see Richard Dunn and Rebekah Higgitt, *Ships, Clocks, and Stars* (New York: Harper Design, 2014).


6 “Logs” were blocks of wood tied at designated intervals along a rope, or “line.” The speed at which the logs disappeared beneath the ocean as the user released the line gave “knots,” or the approximate speed of the vessel.
sailors to approximate the ship’s longitude for centuries. Unfortunately, it was an inexact process that often did the opposite, leading ships farther from their destination. John Harrison, a British eighteenth-century clockmaker, is credited with proving that timekeeping could solve this longitudinal problem. By taking readings of the time at a specific reference point on land, mariners could calculate their distance from that location and better understand the ship’s East-West position (Figure 4). Marine chronometers provided accurate timekeeping for this practice. By comparing the local time—found through celestial observation—with the reference point’s time as shown on the chronometer, mariners could understand their ships’ locations on the open ocean in all directions. Marine chronometers were crucial to mariners’ wayfinding capabilities because of their accuracy, but they were only effective when used with this host of other astronomical instruments.

The nineteenth-century adoption of marine chronometers by American naval and merchant vessels made travel on the open ocean safer and faster. However, marine chronometers required extensive check-ups and daily or weekly winding during use at sea. To maintain their accuracy, these intricate clocks relied on highly skilled mariners who counted on these objects both as timekeepers and global positioning systems. In other words, nineteenth-century marine chronometers were needy. Mariners could not care for these instruments alone. They needed skilled craftspeople on land to complete regular cleanings and occasional repairs. This thesis argues that marine chronometers

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cannot be fully understood without examining the networks created through their acquisition, use, and care on land and at sea, an approach that extant scholarship has yet to explore.

Figure 4  “Using a Marine Chronometer” graphic which demonstrates how a marine chronometer was an integral tool in finding one’s location on the open ocean. Image from Time and Navigation, an exhibition at the National Air and Space Museum. Courtesy Smithsonian National Air and Space Museum (NASM9A11818).
Nineteenth-century marine chronometers reveal important stories that share themes of invention, ownership, and collecting over time. For this reason, there has been a large body of scholarship dedicated to them. Much of this literature is created by and for two groups: clock collectors and maritime historians. Clock and watch experts discuss marine chronometers for their technical and mechanical qualities, grouping them with other timekeepers to demonstrate the skill of the maker and the breadth of objects produced by a particular shop. Conversely, maritime historians frame chronometers as one element in an extensive network of marine equipment. This scholarship focuses on more analog instruments, such as compasses, sextants, and octants. It mentions marine chronometers to underscore the variety of tools required for life at sea. These scholars tackle well-studied and specific topics such as

9 There are a number of published examples where marine chronometers demonstrate the broader output of a particular maker or workshop. William Cranch Bond, Boston clockmaker who will be discussed further in the first chapter, is one such individual; see Edward S. Holden, *Memorials of William Cranch Bond, Director of the Harvard College Observatory, 1840-1859, and of His Son, George Phillips Bond, Director of the Harvard College Observatory, 1859-1965* (San Francisco and New York: C.A. Murdock & Co, Lemcke & Buechne, 1897) and Donald Saff’s forthcoming publication on the Bond & Son workshop. For a British example, see George White, *The Clockmakers of London: An Account of the Worshipful Company of Clockmakers, Its Library and Its Collection*, 2nd ed. (London: Worshipful Company of Clockmakers, 2018). Marvin E. Whitney also writes of marine chronometers within their commercial contexts of nineteenth-century America to explore the realm of makers and retailers on land in *The Ship’s Chronometer* (Cincinnati: American Watchmakers Institute Press, 1985).

the political history surrounding the moment of invention, the historic implications of improvements to a basic form, and the trade of marine chronometers within the context of the nautical instrument market.11

Museum professionals who exhibit marine chronometers put them in the context of both kinds of literature, but tend to lean towards the political history of these objects. The 2014 traveling exhibition of Greenwich Royal Observatory’s eighteenth-century nautical timekeepers, Ships, Clocks & Stars: The Quest for Longitude, explored how these fascinating objects transitioned from obscure invention, to necessary tool, to antique decoration, and how they were finally forgotten in the shadow of satellite technology and global positioning systems.12 While the stories in this exhibition complement the majority of extant scholarship, they focused on the politically-constructed world around these instruments and incorporated technical explanations to support complex history. Despite these forays into timekeeping and navigation, there remains ample space for the marine chronometer itself to be at the center of the story.

Utilizing a host of objects and documents in northeastern United States collections, this thesis explores the networks that developed around marine

11 Dunn and Higgitt explore John Harrison’s story in detail, from his beginnings as a clockmaker to his inventive mind and finally his political battles with the Board of Longitude and the Astronomers Royal in Ships, Clocks, and Stars. For the story of how Harrison’s instruments were first rediscovered and cleaned in the twentieth century, see Jonathan Betts, Time Restored: The Harrison Timekeepers and R.T. Gould, the Man Who Knew (Almost) Everything (Oxford and New York: Oxford University Press and the National Maritime Museum, 2006).

12 Exhibition mounted at Mystic Seaport Museum in collaboration with the Royal Museums Greenwich and the Greenwich Royal Observatory. Ships, Clocks & Stars: The Quest for Longitude (Mystic, CT: 19 September 2015-28 March 2016).
chronometers in the nineteenth century. The first chapter examines the earliest evidence of marine chronometers in a United States context. From a clockmaker’s tinkering during the War of 1812 to the Navy’s establishment of the Depot of Charts and Instruments in 1831, marine chronometers provided a clear link between sea and sky. This connection enabled American sailors to incorporate these instruments into their daily navigational practices. These early stories also reveal where chronometers likely lived on board ship and how their location ordered daily life. From this first moment of acceptance, marine chronometers suddenly and silently became a required tool on American vessels. Written records kept by civilian mariners and shipyards after 1850 provide the foundation for the second chapter, revealing how these instruments were regarded and incorporated into daily life at sea. The puzzling lack of documentary evidence for marine chronometer use demonstrates these instruments’ significance through their absence. However, surviving records indicate the lengths that mariners would go to preserve these tools. These sources reveal that marine chronometers became the most important tool on American vessels by the late nineteenth century.

Without the work of talented and knowledgeable maintainers, marine chronometers would never have become so accessible. The final chapter explores this land-based side of chronometers through maintenance records on the instruments themselves. Marine chronometers were useless at sea unless they were regularly maintained by skilled craftspeople on land. These instruments were part of a larger navigational system that included reading charts, taking sights, and calculating one’s position based on this series of data points. They were precise timekeepers that required constant care to maintain their accuracy. There was a large potential for
human error, which revealed the true nature of navigation—an immense and mercurial math problem. Marine chronometers were an integral part of solving this problem, but would never have done so without the international networks of users and maintainers.

Although primarily perceived as tools, marine chronometers were also important symbols of American maritime life. Where sailor valentines, compasses, and diaries were saved to mark the wonders of life at sea, marine chronometers appeared in a category of devices preserved only for their utility. In truth, marine chronometers were equally evocative as these other relics. They joined sea and land through their trade, utilization, and maintenance. The chronometer in Figure 1, purportedly used on the Rousseau, was saved for this very reason. A visitor to New Bedford bought it in the late 1890s. He then gifted the instrument to the East India Marine Society in 1907.\(^\text{13}\) The donor’s testimony provides the only link between chronometer and vessel; since early twentieth-century sources disagree on the year that the Rousseau was dismantled, the instrument’s connection to the ship is tenuous at best.\(^\text{14}\) While some of the Rousseau’s logbooks indicate the use of a marine

\(^\text{13}\) The East India Marine Society is now part of the Peabody Essex Museum in Salem, Massachusetts.

\(^\text{14}\) The donor told the Museum that he was in New Bedford in 1898, the same year that the Rousseau was dismantled; however, other early twentieth-century sources document 1891 and 1893. Still more compelling late nineteenth-century sources also state the 1893 date, leading to the conclusion that the Rousseau was most likely broken up in 1893. William Armstrong Fairburn and Ethel M. Ritchie, *Merchant Sail* (Center Lovell, ME: Fairburn Marine Educational Foundation, 1957). See also Rachel Conley, “Artifact of the Month - Medicine Chest,” *Mariner’s Museum* (blog), January 4, 2016, [https://www.marinersmuseum.org/blog/2016/01/artifact-month-medicine-chest/](https://www.marinersmuseum.org/blog/2016/01/artifact-month-medicine-chest/). Finally, see Gunnison, *Memories Stirred by a Blazing Fire of Driftwood Taken from the Old Rousseau.*
chronometer, no documentation provides specific information about the exact instrument on board. The fact that this chronometer was accepted by the Society, and has remained part of the Peabody Essex Museum’s collection to this day, demonstrates these instruments’ continued symbolic importance to seafaring communities throughout New England. Marine chronometers, even as rote timekeepers, lie at the heart of New England’s love for the sea. They remind us of another life, of a ship like the Rousseau, or of the people who went to sea and never returned. They evoke the beauty and power of the ocean in their functional consistency and visual grace. They provide more accurate means to explore the natural world. However, they can only function with the help of other tools to map the sky. They are one of the few object types that unify land, sky, sea—worlds which are so often separated.

15 One Rousseau logbook has several notations like, “‘Lat by obs 43’11 South Long by chro 53’40 West.” Logbook of the Ship Rousseau, Edward J.R. Selby, Master, 17 October 1853-5 July 1857, ODHS #284, Reel 258, New Bedford Whaling Museum.
Chapter 1

NAVIGATING THE NEW NATION

1812: President James Madison declared war on Great Britain. His action was provoked by many British attacks on United States ships as well as British encouragement of Native Americans skirmishes with western-moving settlers. Madison’s decision coincided with Boston clockmaker William Cranch Bond’s choice to build a new kind of clock (Figure 5). This was not just any clock, but a marine chronometer. Bond is credited with making the earliest known American version of this important maritime navigational tool. The British had nearly perfected a spring-driven design for such an instrument, using a new formula for resilient yet flexible steel that allowed a spring to power a mechanism consistently for extended periods. However, wartime embargoes and British inventors’ secrecy prevented Bond’s access to these designs. Instead, he turned to French newspapers, where two clockmakers practically flaunted their designs at each other, including enough detail for Bond to form his own model. Against the backdrop of faltering United States maritime power, Bond created a timekeeper that changed the fate of United States Naval dominance and travel—a device which continued its work at sea in 1818 with the enthusiastic Captain Curtis on a voyage to India. Thanks to this journey, Bond realized his first chronometer was too delicate and complicated to function consistently over a long time. However, it set the stage for widespread American adoption of these instruments.

16 These two French clockmakers, Berthoud and Le Roy, were attempting to garner a commission from the King of France for the French Royal Navy. Dunn and Higgitt, Ships, Clocks, and Stars, 181.
Fast forward to 1831: In January, the United States Navy purchased a marine chronometer made by Parkinson & Frodsham of London for $420.00. By this time, trade with Great Britain had been renewed, and Parkinson & Frodsham were known as one of the best chronometer firms in the world. Their instrument was immediately assigned to a vessel, where captain and crew presumably used it to aid in their safe and efficient navigation. Marine chronometers and their designs had become more accessible to American mariners, and the Navy decided to try this newly-available tool. In December of the same year, the Board of Navy Commissioners authorized the Depot of Charts and Instruments. In these short eleven months, the Navy realized the significance of marine chronometers to their military might and sailors’ well-being. By the end of the decade, the United States Navy had more marine chronometers for their vessels and stations than the British Navy. Shockingly, given Bond’s early innovations and the climate of technological innovation beginning to take hold in antebellum America, over half of the United States Navy’s instruments were of British manufacture. The United States economy was growing, and British makers took advantage of this exploding market.

These two moments in the first half of the nineteenth century enabled the widespread use of marine chronometers by American mariners. However, these instruments were useless without a thorough understanding of astronomy. Whether


Naval or civilian, daring individuals used their navigational knowledge and tools to situate themselves between sea and sky. To use a marine chronometer in finding longitude, one needed to understand how to take sights and read astronomical charts and almanacs; otherwise, the information provided by this timekeeper was useless. To find land, sailors first needed to integrate sea and sky.

The work of Bond, Curtis, and the Officers in Charge of the Depot converged to create the first American marine chronometer market. However, this market could only exist if users and maintainers worked together. Collaboration between makers and users in the first half of the nineteenth century brought the chronometer market into existence and perpetuated its role in maritime America.
Wartime Beginnings

Figure 5  
William Cranch Bond built his first marine chronometer between 1812 and 1815. He fashioned the instrument out of brass, glass, and other materials he already had for making clocks in his Boston shop. The moment of this instrument’s creation, and Bond’s access to French schematics, provide the context for understanding how this chronometer came to exist. In this first quarter of the century, many American mariners likely did not know what a marine chronometer was or how to use it. Bond introduced this tool to the Boston maritime community in a wartime context—a time when the United States Navy struggled to command international respect. This environment attracted more attention to the instrument, probably contributing to Captain Thomas B. Curtis’s willingness to try it on his ship in 1818.

How Bond and Curtis became acquainted is unknown, but their collaboration foreshadowed the partnerships between mariners and chronometer makers throughout the rest of the century. Communication between makers and users was paramount to these instruments’ reliability. Users depended on marine chronometers to provide accurate timekeeping no matter the weather, while makers counted on the users to assess the instruments’ functionality. Curtis’ feedback on using such a tricky

19 The dial gives the date “1812,” and according to notes in the files at the National Museum of American History “1812-1815” is engraved beneath the top plate. Additional description of the instrument reads, “A ship’s chronometer made by him at the age of twenty-three years is now in our possession, and bears the date 1812…He was ambitious that it should be of home manufacture, and for that reason substituted a weight for the maintaining power, in room of the mainspring commonly used. The latter he could not make, and would not procure from Europe.” Edward S. Holden, Memorials of William Cranch Bond, Director of the Harvard College Observatory, 1840-1859, and of His Son, George Phillips Bond, Director of the Harvard College Observatory, 1859-1965 (San Francisco and New York: C.A. Murdock & Co, Lemcke & Buechne, 1897), 11-12.
instrument was crucial to Bond’s ability to understand its efficacy and improve its design, setting the stage for the wider adoption of marine chronometers on American ships. Through human collaboration and the concept of timekeeping, Bond’s first marine chronometer became emblematic of early American navigation.

This instrument’s construction and inscription reveal why the first known American marine chronometer was made in 1812. Engraved by hand underneath the top plate is the date, “1812-1815,” indicating that Bond built the instrument during the War of 1812. While this date range appeared on the chronometer at an unknown time and by an anonymous hand, either Bond or one of his successors felt it necessary to be physically present on the instrument. In reality, this inclusion highlights the political moment of this chronometer’s creation. It reveals why Bond chose a French weight-powered, rather than British spring-driven, movement design due to wartime embargos on British goods. It also highlights the secrecy and animosity of marine chronometer development in England; even if Bond had been able to acquire the necessary materials, British designs would have remained out of his reach. By using supplies already in stock, Bond side-stepped the embargos to build this chronometer. His creative design and use of materials made this chronometer a unique contribution to nineteenth-century maritime America. This richer understanding of the instrument’s creation also elucidates the ways that mariners would have used it on the open ocean.

Any instructions Bond gave to Captain Curtis for using this chronometer are long gone, but the instrument’s design informed where it probably lived on board ship and how it could be used. According to Curtis’s letters, the device was his personal responsibility during the voyage. This information indicates that it lived below decks with other valuable tools. On most mercantile vessels of this era, the captain’s quarters
were in the stern—the most stable part of the ship.20 By keeping this instrument in a steadier location, the chronometer was better protected from the unpredictable motions of a ship on the open ocean. This stability was crucial to a weight-powered timekeeper’s reliability: while the weight was confined laterally by brass posts, its vertical motion was at the mercy of the ship’s movements. Consistent application of gravity was crucial to the success of a weight-driven timekeeper. In choppy seas, the weight could be suspended for an extra moment and ruin its ability to keep continual pressure on the movement. As Curtis mentioned in his letters to Bond, gravity prevented dependable use throughout the voyage. However, continued winding and care of the instrument could ameliorate the unpredictable influence of gravity and allow Curtis to rely on its consistency when traversing calm seas. Even during this first trial with a marine chronometer, Curtis understood the potential for human error and adapted his care of the instrument to minimize it.

While Curtis personally assessed this chronometer in letters to Bond, he relied on a network of tools and individuals to gather information before analyzing and recording it. He already possessed the mathematical skills necessary to incorporate this new tool into his navigational practices. The trust he shared with his crew also would have been typical for most nineteenth-century ocean voyages. Observations for determining latitude and local time took place on deck, likely by a crewmember, while calculations were probably made below decks near the chronometer’s storage location. Readings of local time above deck and reference time from the chronometer needed to be taken at the same instant: a process which required several experienced mariners.

Otherwise, inaccurate longitudinal calculations could lead the ship into danger. The integration of work above and below decks likely continued throughout the century on a variety of mercantile and Navy vessels, though detailed instructions seldom appear in written chronometer instruction manuals.21

When Captain Curtis left Boston on November 15, 1818, he likely had great mercantile aspirations for the voyage.22 However, he was also clearly invested in experimenting with Bond’s chronometer. As Bond remained in Boston during this voyage, the letters that Curtis wrote to Bond comprise the only insights into this instrument’s vital importance to captain and crew. Curtis chose a difficult route, going around the Cape of Good Hope, but he insisted on using the chronometer as frequently as possible despite rough seas:

From this getting near Cape Good Hope the TK carried from 30 to 50’ from lunars, the seas were chiefly boisterous and rough the SE trade blowing very hard and after doubling that Cape which I did in mid winter when the weather is always tempestuous and seas run very high it resumed its rate of 4”.23

21 While later editions of Bowditch’s New American Practical Navigator include sections on using a marine chronometer, they lack detail in where one would use this kind of instrument or how to care for it more extensively than daily winding.

22 Curtis begins his first letter to Bond by establishing that he left Boston on November 15, 1818. He also apologizes for how long it took him to write. Thomas B. Curtis to William Cranch Bond, 25 December 1818, William Bond & Son Records Letterbook 1816-1865, Collection of Historic Scientific Instruments 1, Box 8, Harvard University.

23 “TK” refers to timekeeper, or the marine chronometer. Celestial observations for using a marine chronometer could use the sun, moon, or stars with relatively equal outcome; Curtis seems to have preferred using lunars, possibly because nautical almanacs tend to have the most detailed information about lunar data. The information in these almanacs provided the necessary equations and standard information to effectively calculate longitude. Midwinter here likely refers to the Southern
Curtis intimated that this was a familiar course in the way that he described the journey. He also exuded confidence in his ability to navigate a dangerous stretch of ocean and determination to continue maintaining and using the chronometer despite these complexities. While the point of the letters was to assess the chronometer, Curtis’s tone and detail about the instrument’s reliability increased in enthusiasm and detail throughout the voyage. He wrote excitedly, filling numerous pages with detailed information about the chronometer. The amount of time that Curtis spent evaluating this instrument indicates that by the time he had crossed the Atlantic, his mercantile goals had become secondary to testing this instrument as thoroughly as possible.

The affectionate and respectful way Curtis wrote about this marine chronometer reveals the importance of his experience to Bond’s assessment of the instrument and the high level of trust required to complete the trial. Bond believed that Curtis could care for the chronometer appropriately and use it accurately, tasks which Curtis completed successfully despite his unfamiliarity with the device at the beginning of the voyage:

…I believe that of the TK will afford you as much pleasure. I have kept a journal of the going of the chron’ some extracts of which are annexed for your examination. Should you work them over, you will please remember that I am not experienced in the use of the instrument, and attribute any errors you may discover to this cause.24

Hemisphere’s winter considering that Curtis wrote this letter in August, but Curtis does not specify either way. Thomas B. Curtis to William Cranch Bond, 21 August 1819, William Bond & Son Records Letterbook 1816-1865, Collection of Historic Scientific Instruments 1, Box 8, Harvard University.

24 Thomas B. Curtis to William Cranch Bond, 21 August 1819, William Bond & Son Records Letterbook 1816-1865, Collection of Historic Scientific Instruments 1, Box 8, Harvard University.
While Bond was unable to interact with this chronometer at sea firsthand, Curtis afforded him a clear picture of how it contributed to Curtis’s understanding of navigation and benefitted the voyage. Curtis’s letters demonstrate that mariners already possessed the requisite skills to use a marine chronometer thanks to familiarity with other navigational tools. Marine chronometers’ connection to these other instruments made them accessible to American sailors later in the century.

The tone and detail in Curtis’s letters throughout the voyage reveal his personal attachment to the instrument, but his fondness was expressed most clearly when it broke. Bond built primarily weight-driven clocks, which used a cord or catgut to raise and lower the weight. By using this same material in his first chronometer, the cord immediately became a potential weak spot. In the damp environment of a ship’s cabins, it broke only nine months after leaving Boston:

And a few hours after in the operation of winding it, the cord broke, of course nothing could be done but to bewail the accident which deprived me of the use of the instrument [and] of the pleasure of returning it to your hands uninjured, and the satisfaction of again verifying its rate &c. However so many opportunities have occurred to do this both by land and lunars that I feel warranted in assuring you that it fully equaled my expectations as nothing but extreme heavy seas affected its rate, and I think such improvements particularly in the form of the case and manner of suspending it, will suggest themselves to you, as to prevent even that defect.25

Curtis could only describe how the instrument broke—in winding, not use—and lament that he could no longer use it on his voyage. Neither he nor his crew possessed the skills or tools to repair it. Even if they could mend the cord, they had no way to

synchronize it to Boston’s local time. This letter reveals that the instrument became more than an experiment: Curtis relied on the chronometer to help him navigate across the globe. His final words about the instrument provided crucial information that Bond could then use to repair and improve his design.

Curtis’s clear description of how and when the instrument failed demonstrates the importance of communication between maker/maintainer (Bond) and user (Curtis). Without Curtis’s assessment of the chronometer, Bond would have had no understanding of the device’s utility and necessity throughout the voyage. While the design was flawed, the concept was sound. If Bond made other marine chronometers like this one, there was a good chance that mariners would be interested in them; Bond never would have known this without Curtis’s feedback. Furthermore, Curtis’s clear description provided Bond with a starting point to refine the next chronometer he designed. Equally significantly, without Bond’s instruction on how to operate the instrument, Curtis could never have used it so consistently or assessed it so thoroughly. Although Bond and Curtis probably spoke in person before and after the voyage, these letters reveal the power of written communication between user and maker. Later nineteenth-century records show that this collaboration between Bond and Curtis became the standard procedure for communication between maintainers and users throughout the rest of the century.

Thirteen years later, the United States Navy picked up where Bond and Curtis ended, establishing the Depot of Charts and Instruments in 1831. During this interval, marine chronometers rarely appear in documentary records. While a few American mariners probably used these instruments between 1818 and 1831, no evidence of their use remains. Marine chronometers seemingly disappeared from the United States
for over a decade, reappearing in a Naval context in droves. However, there must have been a connection of some kind in order for the Depot to exist: while it was built to house all kinds of nautical instruments and charts, the marine chronometers within its walls took precedence.\(^26\) As Bond worked closely with the Navy throughout the 1830s, perhaps he quietly encouraged the government’s interest in these instruments. The two partnerships—Bond and Curtis, and the Navy Commissioners and their Officers at the Depot—together made possible the existence of a marine chronometer market, expanding the system of charts, almanacs, and other instruments for American navigation.

**Sea and Sky: The United States Navy and First American Marine Chronometer Market**

Between January and December of 1831, the United States Navy purchased their first marine chronometer, established the Depot of Charts and Instruments, and appointed Passed Midshipman Louis M. Goldsborough as the first Officer in Charge of the Depot.\(^27\) These events, and the subsequent attention that the entire Navy

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\(^{26}\) Marine chronometers appear in correspondence between the Navy Commissioners and the Officers in Charge of the Depot more frequently than any other subject or object. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.

\(^{27}\) It was thanks to Goldsborough that the Depot even came to be established. He wrote to the Commissioners in November 1830 on the potential benefits of a centralized location for instrument storage and maintenance, and less than a year later the Depot was born. Steven J. Dick, “Louis M. Goldsborough’s Proposal to Establish a Depot of Charts and Instruments in the U.S. Navy: Text and Comments,” *Rittenhouse: Journal of the American Scientific Instrument Enterprise* 4, no. 3 (May 1990), 79.
lavished upon their chronometers, reveal these instruments to be essential nautical equipment in the nineteenth century. Goldsborough took his job very seriously, considering every potential marine chronometer acquisition for the Navy and meticulously tending to each instrument upon its arrival. He frequently communicated with the Board of Navy Commissioners, sparing no details in the description of his duties or in his recommendations for chronometer procurement or care. In doing so, he developed the first protocol for marine chronometer procurement in the United States. The Commissioners, for their part, authorized or rejected every chronometer purchase, assignment, and examination throughout the nineteenth century; however, it was Goldsborough who convinced them of the Depot’s crucial role in the Navy’s growth and power. In this first decade of the Depot’s existence, the Navy’s speed in purchasing enough chronometers to supply their ships and the protocols they implemented to maintain and assess these instruments created the first market for these instruments in the United States.

The Navy’s first purchase of an English chronometer made a statement with widespread repercussions in 1831. Trade routes were now well-established with England following the War of 1812, and both civilians and the United States government recognized the benefits of buying ready-made goods from England. Marine chronometers, whether sold as individual components or pre-assembled, were an essential part of this trade. Thanks to the strength of the watchmaking industry in Lancashire, English chronometer parts were of good quality and reasonable price. However, assembling these components into a reliable instrument was skilled work that few American firms could accomplish. Bond went on to become a successful chronometer maker, but at this time he was one of a very few American makers.
experimenting with making marine chronometers. English firms, however, had standardized a reliable design that they could sell to a global market. While expensive, these English-made chronometers were reliable. The Navy economized resources by purchasing English instruments that they could trust to work accurately for a long time despite their total cost, a choice that may have encouraged American makers to finish on their own instrument designs faster.

By fostering relationships with a select group of makers, the Navy ensured the quality of their purchases through economic and technological competition. Parkinson & Frodsham had been world-renowned for marine chronometers since early in the century, and the Navy owned and used a number of their devices after 1831.\textsuperscript{28} Even in the Depot’s first year, Goldsborough acknowledged the superior quality of marine chronometers not merely made in England, but by Parkinson & Frodsham specifically:

\textit{…Of economy and the procuring of the best instruments—alone such, it is presumed, as are desirable—an importation on the part of the government, directly from the manufactory of a maker, would be the best means to adopt…Messrs Parkinson & Frodsham…and Mr. French, also of London, stand, it is believed, as the best chronometer makers of England.}\textsuperscript{29}

\textsuperscript{28} The Commissioners refer to Parkinson & Frodsham at least fourteen times in the table of contents for letters sent to the Depot between 1834 and 1839. “Board of Naval Commissioners: Letters Sent to Naval Officers, 28 April 1815-29 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-308 I-18 Vol. 2 of 2., National Archives.

\textsuperscript{29} Louis M. Goldsborough to President of the Board of Commissioners, 18 July 1831. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.
Goldsborough’s rationale for choosing two firms was simple: financial solvency and instrument quality. It was also probably compelling to the Commissioners, always concerned with spending the Navy’s money wisely. While they always welcomed Goldsborough’s expert advice, they did not always heed it. Rather than rely on one or two firms, the Commissioners ordered instruments from Parkinson & Frodsham as well as an assortment of other English and American firms.\textsuperscript{30} In so doing, the Navy supported a growing market for marine chronometers and encouraged competition for better components and technology in these instruments. Naval support for these firms in the Atlantic World established high standards for the instruments they obtained and assigned to their vessels. Goldsborough played an essential role in forming these policies and setting such high standards.

American clock and nautical instrument firms remained crucial actors in marine chronometer trade with England. Many of the Navy’s English chronometers arrived at the Depot through American agents.\textsuperscript{31} American chronometer firms often provided assessments of marine chronometers before the Navy officially purchased any English- or American-made instruments. By this time, American makers could access English chronometer designs and provide their own instruments in addition to retailing English ones. Civilian and Naval partnerships and proximity of American


\textsuperscript{31} Two firms that appear frequently in Navy chronometer procurement records are Bond & Son of Boston and Bliss & Creighton of New York. Bond & Son was the firm name chosen by William Cranch Bond as his sons entered the business with him in Boston. Whitney, \textit{The Ship’s Chronometer}, 353.
firms to the Depot also provided the Navy with pioneering intelligence in scientific innovation. In turn, these firms could rely on the Navy as a consistent client, a source of economic stability which equipped them to provide services in all areas of the chronometer trade.

Both sides of the chronometer industry—purchase and disposal—were equally important in fostering an American market for these instruments:

...and in relation to those chronometers unsuitable for the service, I shall proceed to dispose of them by placing them, for sale, on commission, at an estimated value, in the hands of Mr Demitt of New York, and Mr Lukins of Philadelphia—both vendors of such instruments...32

Goldsborough collaborated with chronometer retailers in at least two cities to discard instruments the Navy no longer needed. As the largest consumer of marine chronometers in the United States, the Navy had to find places where old instruments could be sold for the right price. By selling them within the United States, the Navy perpetuated the relationship between instrument retailers and users while simultaneously making them available to the broader American public.

The Navy precipitated these instruments’ presence in the United States, presumably using them until they were no longer fit for service. However, these were expensive devices: spending $420 in 1831 was a substantial investment, a sum unlikely available to many civilian mariners. While Goldsborough neglected to

32 Louis M. Goldsborough to Commodore John Rodgers, President of the Board of Naval Commissioners, 18 July 1831. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.
mention the price assigned to these chronometers for resale, it was likely lower than the initial purchase price. The Navy released chronometers into a civilian context throughout the nineteenth century, making them both more accessible and more affordable than previously. The Navy needed a way to dispose of unwanted instruments, and using domestic retailers to sell them encouraged personal chronometer ownership throughout the United States. Thanks to the work of Goldsborough and his immediate successors, the Navy acquired, used, and disposed of hundreds of marine chronometers throughout the 1830s.

**Daily Attention: Marine Chronometer Care at the Depot**

The Navy realized early in the century that marine chronometers were an important tool for cementing United States maritime power. The Commissioners were committed to technological refinement and the full utilization of all their tools. They demonstrated this dedication through the time, money, and human power they devoted to the Depot. Chronometers were exceptionally important: a fact that the Commissioners addressed by assigning considerable resources to keeping these instruments in working order. First and foremost among these resources was the position of Officer in Charge. The duties of this Officer were vast and complex, but every task contributed to the proper care of marine chronometers (Figure 6). As a result, the Depot housed all the necessary utensils to help the Officer in Charge store, test, and transport marine chronometers. These tools included transit circles to accurately track celestial bodies and a special climate- and humidity-controlled room for the marine chronometers themselves. While not always immediately adjoined, the proximity of transit circle and chronometer room meant that Officers in Charge could consistently provide reliable marine chronometers for Naval missions all over the
world. The Navy’s protocols for marine chronometer maintenance and assessment formalized American chronometer care practices for the remainder of the century.

Figure 6  Artist rendering of the 8.5-inch transit circle at the old United States Naval Observatory, mounted in 1868, and the Chronometer Room, drawn February 19, 1870. Tci5b, United States Naval Observatory. Image in the public domain, permitted for fair use.

Correspondence between the Board of Navy Commissioners and the Officer in Charge reveals that marine chronometers dictated the rhythm of life at the Depot. From day one, the Officers in Charge communicated the importance of their work with chronometers to Naval success and the complexity of their many tasks. Passed Midshipman Goldsborough, the first Officer in Charge of the Depot, listed his responsibilities in detail for the Commissioners:
The chronometers require daily attention, not only to wind them up at a specific time but to ascertain their precise rate of going—the latter operation requiring, as is well known to yourself, continued celestial observations both by day & by night. The transportation of the Chronometers...can be entrusted to none but the most careful hands, particularly after they have been carefully & accurately rated. In attending to this branch of duty my occasional absence from Washington is indispensable & when absent there is no one left to attend to the winding up & continue the rating of the chronometers...and the duty of making observations...is unavoidably suspended during my absence. In case of my sickness, there is no one to attend to either branch of the duties...33

Goldsborough began as the only employee at the Depot. This letter emphasized not only the length of his to-do list but the skill required to work there. From taking regular transit observations and recording them correctly, to ensuring that the chronometer room maintained its constant temperature and humidity, to calculating each instrument’s accuracy, work at the Depot never ceased. Goldsborough’s frantic tone and detailed description make sense after realizing that many Naval officers did not possess the skills necessary to complete these tasks. As such, Goldsborough ends the letter by requesting one qualified assistant. Even the essential process of taking transit observations was a two-person job.34 While no contemporaneous letters from

33 Louis M. Goldsborough to the President of the Board of Commissioners, 10 June 1831. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.

34 “When to these considerations, we add the fact well known to you sir, that to make observations with any convenience two persons are requisite—that keeping records of such observations & making the numerous calculations thence arising, & in preparing the charts for issue, much labor is indispensable…” Louis M. Goldsborough to the President of the Board of Commissioners, 10 June 1831. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of
Goldsborough mentioned an assistant by name, the progress he recorded in caring for the instruments indicates that he convinced the Commissioners that he needed help to complete these never-ending tasks. Thanks to Goldsborough’s clear and constant communication with the Commissioners, the Navy made significant adjustments to staffing and resources at the Depot. These adjustments reveal the Commissioners’ understanding of marine chronometer importance to the Navy’s success.

Goldsborough and his successors relied on American marine chronometer makers to help them maintain and assess the Navy’s marine chronometers. The transit observations that Goldsborough mentioned in his letter were only useful to a chronometer’s assessment after extensive calculations. Goldsborough could only make these calculations with additional research and equations, work that was too onerous with all of his other duties. While the Navy collaborated with many American firms, they favored one in particular for astronomical charts and observations. By the end of the 1830s, William Cranch Bond’s firm of Bond & Son supplied the Navy with all necessary tables to fully assess their marine chronometers:

The Commissioners send herewith a letter, with tables of astronomical observations, from Mr Bond dated 1st inst of which you may if you desire it, make copies…

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The firm’s accomplishments in the fields of scientific instruments and astronomy inspired the Navy’s trust and motivated the Commissioners to build their relationship beyond buying chronometers. The Navy could trust Bond’s astronomical tables when assessing chronometers at the Depot, and it relieved the Officer in Charge of time-consuming tasks.

The Commissioners not only dictated procurement, care, and disposal of marine chronometers; they controlled the flow of information from firms like Bond & Son to the Depot. The Commissioners’ letters to the Officer in Charge reveal an added step in communication between maker and user that occasionally appears in civilian contexts later in the century. Here it demonstrates the Commissioners’ interest in the tools the Navy owned and that their officers used. Throughout the decade, the Commissioners remained directly involved in marine chronometer care at the Depot, even requiring the Officer in Charge to submit monthly reports on the number and type of instruments in his care. The entire Navy, from Commissioners to Depot Officers to users, understood the importance of marine chronometer maintenance.

By 1840, marine chronometer proliferation had advanced another step in American navigation thanks to the United States Navy. These instruments were fully integrated into a system of technologies alongside compasses, sextants, charts, the sun,

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36 The “Monthly return of instruments” begins January 31, 1837, and continues at least through the end of this volume. Monthly tables submitted to the Naval Commissioners are interleaved with letters sent to the Naval Commissioners and enumerate an extensive list of chronometer purchases, assessments, and ship assignments. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.
and the stars. They shaped life at the Depot based on their needs, ordering how tasks were completed, when, and by whom. Their rapid adoption by the Navy led to widespread use on American vessels. In turn, this Naval proliferation enabled more American mariners to learn how to use them. Knowledge of these instruments led immediately to Americans’ reliance on marine chronometers for all kinds of seafaring ventures.

Goldsborough’s successor at the Depot demonstrates how knowledge contributed to Americans’ reliance on these instruments. While most Navy vessels cruised the seas dealing with pirates or rescuing hapless missionaries, exploring expeditions provided a prestigious way for Naval officers to help increase international respect and power for the United States. However small in size, marine chronometers were crucial to the Navy’s improved perception across the globe before 1850. Goldsborough’s successor understood these instruments’ role through his own working knowledge of them. Lieutenant Charles Wilkes spent only a few brief years at the Depot, but it was long enough for him to learn how it operated and how to communicate its value to the Commissioners. However, Wilkes’ biggest contribution to American marine chronometer adoption was through his work as a user. Trained as a land surveyor before enlisting in the Navy, Wilkes understood how to use timekeepers to map land more accurately and navigate across it more confidently.37

37 As Steven Dick notes, “The success of the U.S. Navy’s Depot of Charts and Instruments was related to this American exploration imperative by virtue of the need for chronometers and instruments aboard ships (including Wilkes’s) to determine longitude, as well as the need for astronomical observations for comparison with those made on the Wilkes expedition.” Steven J Dick, Sky and Ocean Joined: The U.S. Naval Observatory, 1830-2000 (Cambridge: Cambridge University Press, 2007), 13-14.
He stepped into the role of Officer in Charge at the Depot effortlessly, which led to his rapid reassignment as leader of the first major Exploring Expedition of the Pacific Ocean in 1838. The Commissioners recognized his skills as a marine chronometer user and promoted him quickly to improve the Navy’s international renown.

Wilkes’ knowledge of the Depot and his expertise in charting and surveying influenced the way he equipped the seven vessels for this expedition. He ordered five chronometers for the “principal vessel” and four for each secondary ship—one pocket and three marine. Wilkes understood how to use chronometers and associated tools for surveyor’s work on land, and he probably taught his entire crew how to use these devices during their expedition. While mariners had already traversed the Pacific Ocean safely, Wilkes and the Commissioners understood that they would meet unexpected dangers. They would be alone in unfamiliar seas, reliant only on each other and the supplies they brought with them (Figure 7). Wilkes knew how important marine chronometers could be in times of peril. While he and his fleet could not avoid these surprises, it was his duty to record them with accurate charts and descriptions so

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38 Pocket chronometers were essentially a form of hybrid marine chronometer and pocket watch. “Board of Naval Commissioners: Letters Sent to Naval Officers, 28 April 1815-29 August 1842,” Records Collection of the Office of Naval Records and Library, Record Group 45, E-308 I-18, Vol. 2 of 2, National Archives, 234.

39 Marine chronometers have a long history of their users learning on the job. On Captain James Cook’s first voyage in 1768, astronomer Charles Green accompanied the voyage and taught many of the crew how to use a Nautical Almanac, take observations of the moon, and calculate the ship’s location. Green taught many crewmembers regardless of rank, thereby making the job of one individual suddenly accessible to many at sea. Larcum Kendall’s first marine chronometer went on this same voyage, and some of these crewmembers may have also learned how to incorporate its timekeeping into navigation. Dunn and Higgitt, Ships, Clocks, and Stars, 128-131.
future ships could steer around them. In the years leading up to the expedition, Wilkes’ letters reveal his enthusiasm for marine chronometers and his recognition of their necessity to the Expedition’s successful return.40

Figure 7    USS Vincennes at Disappointment Bay, attributed to Lieutenant Charles Wilkes, circa 1840. Wilkes and his crew sailed throughout the Pacific and Antarctic Oceans, using the marine chronometers to chart islands and shallow waters, some of which are possibly lurking under the ice in this painting. Courtesy Peabody Essex Museum.

40 “Letters Received by the Navy Department Relating to Preparations for the Expedition 20 May-31 December 1836,” Records of the United States Exploring Expedition Under the Command of Lieutenant Charles Wilkes, 1838-1842, M75 Roll 1, National Archives.
The Commissioners implemented Wilkes’ policy for all Naval missions thereafter, assigning an average of three to five chronometers per vessel and station. Of all the supplies that Wilkes ordered for his ships, he was most particular about the charts and instruments. His specificity related to his background, but it also mirrored the elevating status of marine chronometers within the Navy. Before 1838, these instruments had been confined to a few ships and the Depot. However, Wilkes motivated a shift in chronometer procurement that significantly increased the Navy’s acquisition practices. His background as a user of marine chronometers altered the Navy’s approach to both procurement and use of these instruments for the remainder of the century.

Naval demand for marine chronometers and confidence in American and English makers to provide them created the first sizable American chronometer market. Records from this period indicate that very few individuals outside the Navy had access to marine chronometers, but these instruments became more widely available through the 1830s. While the Officer in Charge of the Depot performed the groundwork for instrument procurement and cared for every chronometer in the Navy’s possession, the Commissioners were involved in chronometer care from the Depot’s inception. These methods of care were crucial to both civilian and Naval practices for chronometer procurement and use for the rest of the century. As the Navy

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41 This data comes from letters sent by the Commissioners authorizing chronometer assignment to various ships, but also appears in charts requested by the Commissioners reporting the chronometer traffic through the Depot. “Letters Received from the Officer in Charge of the Depot of Charts and Instruments, 10 June 1831-27 August 1842,” Records Collection of the Office of Naval Records and Library, Records of Boards and Commissions, 1812-1890, Record Group 45, E-321 I-18, Vol. 2 of 7., National Archives.
discarded unwanted chronometers, civilian mariners gained the opportunity to experiment with them. However, even before the Navy’s enthusiasm for marine chronometers, Bond’s first instrument and Captain Curtis’s affection for it invited Americans to explore this new device. Marine chronometers needed skilled users and maintainers, a partnership that connects Bond and Curtis’s experiment to the Navy’s complete adoption of these instruments by mid-century. These collaborations provided an example for future mariners to adopt marine chronometers into their navigational practices and gave them confidence that they could care for them.

Whether civilian or Naval, relationships between maintainers and user allowed marine chronometers to weave themselves into the fabric of American maritime life. However, evidence of their use is scarce. Anecdotes from civilian mariners after 1850 reveal how later users implemented the same practices as Curtis and Navy officers. These instruments’ inclusion and omission in written records reveal their success in altering daily life and interaction. The ways that marine chronometers controlled maritime life are crucial to understanding the networks they created and expose their rank as the most important tool on board.
Chapter 2

USEFUL TOOLS AND PRIZED POSSESSIONS

In the early hours of May 17, 1892, two crewmembers on the Minott ship St. Charles ignited a coal gas explosion when they took a lantern below decks. Both men died when catapulted up through one of the hatches, and the ship fractured from bow to stern and quarter deck to bilge. The Captain, asleep in his quarters, was “dangerously injured…as he was found under about 300 lbs of wreckage, and groaning.”42 The ensuing fire decimated the ship within hours, the remaining crew frantically collecting valuables and injured sailors in a hasty escape.43

The value of the Captain’s marine chronometer became clear through First Officer A.C. Stevens’ accident report. After describing the Captain’s rescue from his stateroom, Stevens immediately addressed the chronometer’s status:

The mate got the Captains Chronometer. It was 10 feet from where it was kept and was still running. It was impossible to get in the cabin to stop any length of time as the gas and smoke would suffocate…The Mate was searching for the Captain’s watch and chain, and the man on deck sang out ‘she is going down.’…so he abandoned the search for the watch and chain…All hands have lost about all their clothing…We have neither Compass, Chart, light, book or Pacific Coast Almanack.44

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This passage provides a vivid image of the chaos: tools and materials thrown everywhere, sailors and lifeboats flying. The mate could not fully enter the cabin; as vessels of this era typically had both fore and aft exits for the captain’s quarters, the mate likely used the aft exit while the interior of the ship collapsed during his search. Based on Stevens’ graphic description, the marine chronometer was probably between the captain’s bedside and the aft-most wall of the cabin. The mate knew precisely where to look for the instrument—possibly an indication that he had used it before and was confident in its location. The marine chronometer was the first object the crew searched for, and the only one to be saved. Its survival and inclusion in this report prove how important the instrument was to the entire crew.

The marine chronometer used on board the St. Charles reveals how marine chronometers were regarded as useful tools and prized possessions by the end of the nineteenth century. Ships’ officers and captains on other vessels went to similarly extreme measures to own and care for marine chronometers after 1850, and evidence of their determination remains in letters, ships’ accounts, and sometimes on the instruments themselves. The design of marine chronometers themselves had become standardized and accessible to mariners of all kinds (Figure 8). The instruments and their cases were always nearly the same size, allowing mariners to store any chronometer in the same place. Standardized design and size also assured mariners that they could provide the same standard of care for different marine chronometers. While many chronometer makers continued to experiment with different types of springs and other internal components, many instruments from this time period used the same type of balance and movement such as the components in the Negus
The gimbals could be easily operated to flip the instrument over and wind it, and the winding key even had its own space in the upper left corner of the chronometer above.45 According to the object files for this Negus chronometer, it was powered by a “plain compensation balance” and included a “spring foot detent.” A compensation balance
case. The maker or retailer made sure to include the firm’s name on the dial, reminding the users and owners where they could go to have the instrument repaired or buy a replacement. These objects and the documentary records associated with them reveal that mariners relied entirely on marine chronometers in open ocean navigation. After 1850, marine chronometer makers, instrument owners, and shipyards collaborated to support these instruments’ use at sea. By the last quarter of the nineteenth century, marine chronometers were the most important instrument on the ship.

**Claiming Marine Chronometers**

First Officer A.C. Stevens used the words, “the Captain’s Chronometer” when he explained what survived after the *St. Charles* exploded. This is one instance where a chronometer clearly belonged to one individual: the captain. Other evidence of these instruments’ ownership appears in documentation from the Sewall family’s shipyard records in the late nineteenth century. The longest continuously-operated shipyard in Bath, Maine (c. 1761-1965), the Sewalls’ adaptability in both ship design and business model allowed them to outproduce and outlast nearly every competitor.46 They were and spring foot detent allowed the chronometer to be powered consistently over its entire period between windings, and different makers used variations on these simple yet delicate components. They were also often made in the English brass foundries and shipped to chronometer makers in England and America. Notes from Mr. Griffith, specialist at the Prescot Museum, England, 19 February 1888. Object file for T.S. & J.D. Negus Marine Chronometer No. 732, Accession number 69.101.

46 In 1829 the firm launched *Emulous*, the first vessel built for the Sewalls’ own accounts. Prior to 1829, the Sewalls built ships for other mercantile firms and the Navy, but this ship began the firm’s foray into mercantile management and ship
an incredibly successful commercial firm, due in part to their clear communication with their captains all over the world.\textsuperscript{47} Letters between captains and the Sewall home office reveal the firm’s advocacy for their captains and captains’ families in all matters, including chronometer ownership.

Marine chronometers may have belonged to one individual, but that did not mean they always left the ship with the owner. When Captain James G. Baker left his ship \textit{Sterling} for some time off, Acting Captain Goodwin took the helm. During his absence, Baker left many of his own tools on board for Goodwin’s use—including his chronometer. There was an unspoken code that the marine chronometer belonged to the captain, but occasionally landlocked agents violated this convention.

Baker’s letters to the Sewalls demonstrate the significance of marine chronometer ownership in the nineteenth century, and they reveal that other individuals in maritime America were unaware of the practice. The Sewalls decided to sell the \textit{Sterling} in San Francisco, midway through the round-trip voyage from Boston. Even though Captain Baker was not on board, the Sewalls needed to notify him of the sale. All of Captain Baker’s personal effects and equipment were still on board, including the marine chronometer. Goodwin was responsible for all of these articles in Baker’s absence, but could not always answer questions in Baker’s place. The Sewalls wrote to Baker when a question arose about the chronometer in particular. While ownership themselves in addition to building vessels for other companies. Sewall Family Papers, MS 22, Maine Maritime Museum.

\textsuperscript{47} By the last quarter of the nineteenth century, Arthur Sewall was in charge of the Sewall firm in Bath, Maine. Every letter from captains of Sewall vessels is addressed to him, and each response is sent either by Sewall personally or his personal assistant, but it remains identified as a family firm well into the twentieth century.
Goodwin collected many of Baker’s possessions, he failed to protect this instrument during the ship’s sale:

As soon as I heard she was sold I wrote him what might not to go with ship in regard to Chro + Ship. A Chro is always considered a private property & had I been thru it should not have gone. The Chro. I have now I took out of the A.E. when I sold her in Liverpool + bought of Richard Baker when I took the Sterling & I think Goodwin would have taken her out had it not been for Mr Chesebrough…48

Baker was unequivocal about American practices of marine chronometer ownership: the chronometer was always the property of the Captain. As such, the instrument should not have been sold with the ship. Baker intimated that Goodwin knew this ownership practice and should have stopped its sale. Because Goodwin faltered when faced with the San Francisco agent, Mr. Chesebrough, Baker needed to intervene and write the agent directly. As Baker recounted to Sewall, though, his letter did not reach San Francisco in time:

I spoke to Mr C about the Chro he says it is no use for me to talk + will have to go with the ship.49

The chronometer was sold with the Sterling, and Baker blamed Mr. Chesebrough for the mishap. However, despite Baker’s obvious unhappiness about the situation, he did not mention it in any subsequent letters. Baker remained friendly in later letters to the Sewalls, indicating that the mishap ended quickly and he did not blame the firm for


the error. In fact, the Sewalls probably paid Baker for his mistakenly sold instrument out of the *Sterling’s* proceeds. Although the Sewalls may not have fully understood who owned this marine chronometer, Baker’s correspondence reveals that marine chronometers belonged to individual Captains.

Marine chronometers were valuable to captain and crew, but they were also prized by mariners’ family members on shore. As personal property of the captain, a marine chronometer passed from mariner to family when captains died at sea. Widow Purington had no source of income after her husband died, but she inherited all of his personal effects. Captain Purington worked on board one of the Sewalls’ vessels for many years. When he died at sea, his possessions passed to his widow in concept. Unfortunately, they remained out of her physical reach. Another Sewall captain claimed the chronometer, night glasses, and other valuable items, and Mrs. Purington had no way of retrieving them. The Sewalls were the only ones who could help her recover the items. She needed these valuables returned because selling her husband’s tools was one of the few ways that she could make money.

Mrs. Purington corresponded with several other Sewall captains to attempt selling her husband’s tools. However, she was confined to her home in Lisbon Falls, Maine. She could not reach the captain who had claimed her husband’s possessions as he remained at sea. Nor could she travel to Bath to speak with the Sewalls or any other captains in person about these valuable items. She finally resorted to writing the Sewall office for help in retrieving her husband’s property and legally selling it to a new owner:

Capt Healy has arrived and wishes to buy the Chronometer that was my Husbands…The Chro I want to sell very much for the money I need. I think Capt Lincoln very much to blame for taking what belonged to Capt Purington without my leave…I as not know [him] and is very
doubtful if I will see him, and how can I settle with him for Chro. I have the receipt what Capt P paid for it and Capt Healy says he will pay the same for it. It is doubtful I ever have another so good a chance for selling it as the present. Can you not take the Chro then settle with Capt Lincoln.\textsuperscript{50}

Fortunately for Mrs. Purington, the Sewalls helped facilitate the sale. Considering the price that Captain Healy was willing to pay for it, Captain Purington likely cared for his marine chronometer exceptionally well. Both captains would have known it to be a reliable instrument. Healy’s willingness to pay a high price for this chronometer and Lincoln’s unwillingness to return it to Mrs. Purington demonstrate the importance of marine chronometers to maritime life. These captains also reveal the lengths that mariners would go to retain them. Without the Sewalls’ help, this chronometer’s ownership and use at sea would have remained problematic for years to come.

Throughout correspondence relating to marine chronometers, the Sewalls demonstrated their fair dealings and continued efforts to care for employees and tools no matter the owner. Even though Captain Lincoln tried to claim Purington’s marine chronometer, the Sewalls refused to let him keep it without paying its rightful owner. They coordinated its sale to another captain who would use it properly and who paid a fair price for it. Similarly, the Sewalls corrected their own mistake when Captain Baker’s chronometer was accidentally sold with the Sterling. Even when the chronometer’s ownership was confusing, the Sewalls mediated between owners and possessors to protect their captains and tools. This dedication to caring for objects and people demonstrates the importance of marine chronometers in systems of

navigational instruments and practices. These relationships between people and space in Sewall documents reveal the networks of the preservation and use of marine chronometers and their status above all other devices at sea.

Ownership Through Use: Sewall & Co. and T.S. & J.D. Negus

While marine chronometers were the personal property of the captain, the Sewalls remained involved in any business related to the chronometers on board their vessels. By the 1870s, the Sewalls had a close business relationship with T.S. & J.D. Negus, marine chronometer makers and retailers in New York City. For the remainder of the century, Negus sold most of the chronometers owned by Sewall captains. In addition to selling instruments, however, Negus also occasionally repaired these captains’ instruments. Marine chronometers were integral to a captain’s ability to survive, but these instruments were equally important to the shipyard’s commercial success. Thanks to the close business relationship between the Sewalls and T.S. & J.D. Negus, Sewall captains acquired reliable instruments at reasonable prices and could have them carefully repaired if necessary. The Sewalls’ involvement in these arrangements demonstrates the importance of marine chronometers not only to the captains who owned and used them but to the shipyard who managed these networks of communication.

The Sewalls’ relationship with T.S. & J.D. Negus had several important benefits for the chronometer firm, shipyard, and captains in the Sewalls’ employ. By this time, T.S. & J.D. Negus were recognized as reliable chronometer makers, retailers, and maintainers throughout the world. Their instruments were comprised of high-quality components assembled carefully and adjusted accurately. They were reputable, thorough, and conveniently located in New York City. Many Sewall
voyages stopped in New York to pick up cargo and crew; these captains could either visit Negus’s shop to collect their instruments or Negus could easily bring them to the wharves. Negus provided both the instrument and its transportation for the convenience of their clients, and their connection to the home office in Bath assured complete and prompt payment for these devices.

Much like the Board of Navy Commissioners mediated correspondence between the Depot and Bond & Son, the Sewalls passed relevant information from Negus to their captains. The Sewalls’ involvement in correspondence improved clarity and efficiency. As Captains moved between ports depending on cargo, wind, and tides, communicating with them was extremely difficult. Negus frequently wrote directly to the Sewall office most often, trusting the shipyard to distribute their information among captains scattered across the globe. Funneling correspondence through the home office guaranteed clear communication and high-quality service for both the users and retailers of marine chronometers.

While Goldsborough was unable to convince the Board of Navy Commissioners to work with just two chronometer makers, the Sewalls recognized the benefits of working only with T.S. & J.D. Negus. The Sewalls seemingly agreed to direct their captains to purchase chronometers from this firm before any other. This agreement provided Negus with a steady income from a guaranteed source. In exchange, Sewall captains received better prices for the chronometers they needed. By assuring quality and payment, Negus and the Sewalls established a network of communication that provided support for both captains and their chronometers across the globe. Negus filled many orders for Sewall captains between 1879 and 1896, and their letters reveal confidence in their own products:
We can furnish you with a new chronometer of our own make best quality, warranted for Two Hundred and twenty five Dollars ($225) cash. The reputation and superiority of our chronometer is so well known that you can refer upon our making a careful selection from our stock on hand should you grant us with the order.\textsuperscript{51}

Negus also offered a range of other options for captains on a lower budget, but demonstrated the relationship between price and quality by comparing these other options to their own instruments:

We have secured hand chronometers of various prices and qualities from One Hundred Dollars up to one Hundred and forty Dollars. We can sell you a fine running London made (I Fletcher make) chro that we have resprung recuperated and put in good order for one Hundred and forty Dollars ($140) cash. It has our name on it and we warrant same…In naming these prices we beg to assure you that they are bottom prices. We offer you one of our make at $225 when $250 is the regular price.\textsuperscript{52}

As seen in the Navy Commissioners’ letters earlier in the century, chronometer firms in the United States were both making and retailing instruments. Negus was able to provide a variety of instruments for captains on any budget but highlighted the better quality of their own devices over any others they could sell. No matter whether a captain bought a Negus-made instrument or one they simply retailed, the captains, Sewalls, and Negus benefitted from this arrangement.

Mariners relied on an international network of maintainers, often returning to the same firms in specific ports, but the strength of a relationship between maintainer


and user sometimes superseded all else. Alternatively, captains could try working with an unknown firm in a foreign port: a risky choice with a chronometer when their lives and livelihood depended upon it. With such a bond, the most logical process to repair a broken chronometer was to send it to the most reliable firm—even if that firm were across an ocean. Captain Otis utilized this relationship between the Sewalls and Negus when he decided that his chronometer needed extensive repairs, but he and his instrument were in Dublin.

Otis trusted Negus to fix his chronometer quickly and carefully. Rather than risk working with an unknown firm in Dublin, Otis chose to send it back to Negus through an independent shipping firm. Unfortunately, the transaction became complicated due to the shipper’s inexperience with marine chronometers:

We have at last effected a settlement with the European + American Express, for the damage done chronometer belonging to Captain Otis. They at first would not listen to the claim, and as the report of the Collector at Custom House, “was that the damage to Chronometer, was caused by bad packing…” by persisting and threatening suit they have at last compromised at $25, our total bill for internal + external damage was $38. We think this is doing pretty well as we at one time thought we could get nothing. We enclose our bill of items for Repairing +c + for freight from Dublin which we paid on receipt of Chronometer. We have made the bill to you as requested.\footnote{\textit{T.S. & J.D. Negus to Arthur Sewall & Co., 16 August 1886. “Correspondence incoming T.S. & J.D. Negus,” Sewall Family Papers, MS 22, Box 116 Folder 27, Maine Maritime Museum.}}

Captain Otis must have known how to pack his own marine chronometer as the instrument was a lifeline for captain and crew. Negus had been in business for decades and were clearly able to sell and repair marine chronometers. Unfortunately, neither party could account for an inexperienced shipper. Despite the mishap, Negus...
advocated for Otis and his chronometer by negotiating repayment for damages. Sewall captains could rely on Negus to defend their instruments even if they were on the other side of the world. Even though the shipping firm damaged the instrument, Negus was able to repair it and arrange for the shipper to pay for some of the damages. The chronometer must have caused Otis much worry during the four-month argument with European & American Express. Both user and maintainer understood the chronometer’s delicacy, but other shipping agents did not necessarily comprehend its worth or fragility.

This letter also proves that the Sewalls understood marine chronometers’ role in their own mercantile success because the shipyard paid for the repairs. Whether this expense eventually came out of Otis’s wages, or whether the Sewalls absorbed the cost from the cargo’s profits, the chronometer’s maintenance was directly linked to the shipyard’s expenses. This transaction demonstrates the absolute necessity of the home office to appropriate chronometer maintenance and use: the relationship between Sewall and Negus remained intact for so long partially because of the Sewalls’ willingness and ability to pay promptly. This shipyard’s continued mercantile prosperity could have only helped support the marine chronometers on its ships. While the captains were the everyday users of these instruments, employees at the Sewall office in Bath could be trusted to make the right decision for the company, their captains, and their captains’ personal property.

The Sewalls and Negus learned from this experience with European + American Express. In 1888, Negus sent a cleaned and repaired marine chronometer by train, but this time provided explicit instructions about the best way to transport the instrument:
We have sent it in the transporting case, so that it can be carried by the strap, and from our experience we find that a chronometer gets better handling carried this way, as the character of the instrument can be seen. We hope it will reach you in good order; it has been running very steadily on our rate books.\textsuperscript{54}

These specific instructions helped ensure the chronometer’s continued accuracy from its departure in New York to its arrival in the captain’s hands. This final letter demonstrates that these instruments were the most valuable tool in the mariner’s toolbox, but users relied on land-based maintainers to communicate the instruments’ importance and fragility to agents. In these examples of marine chronometer use, the instrument stands prominently in the center of a system where its utilization relies directly on its reliability. Affirmation of chronometer reliability occurred on land, but users could only realize the instrument’s inaccuracy at sea.

Thanks to Negus’ close relationship with the Sewall shipyard, the chronometer firm’s letters included details about chronometer repairs that may have otherwise been forgotten. In addition to corresponding through a home office, however, Negus occasionally communicated directly with an instrument’s owner. Negus likely affixed repair or cleaning records to Sewall captains’ chronometers, but no extant instruments display this Sewall/Negus connection. In other cases, inscriptions directly on the dial face were an elegant addition and contained crucial data about an instrument’s past (Figure 9). The information that Negus added to the dial of the Tobias & Co. marine chronometer gave its user necessary information to understand two things: how Negus’s work could change its reliability and how to prepare for future repairs. The

Figure 9  M.I. Tobias & Co. Marine Chronometer No. 105, Liverpool, 1808-1825. The inscription at the center reads, “A new balance & balance spring applied and readjusted by T.S. Negus & Co. 84 Wall St. N.Y.” As the glass bevel was stuck to the drum, the reflection demonstrates how a user would have moved around to see the numerals and inscription in person. M867, image taken by the author courtesy Peabody Essex Museum.
inscription also told later maintainers about repairs to the instrument if the user chose to take it elsewhere for service. Finally, the engraver chose a script that complemented the names and numbers already on the dial, suggesting that the words were meant to be part of the original design. Unfortunately, there is no date ascribed to this repair; without it, the inscription acts more like an advertisement for Negus than a full record of chronometer maintenance. Nevertheless, using the space on the dial of the chronometer itself allowed Negus to permanently entwine its business with this instrument. While most nineteenth-century marine chronometers have been divorced from their users, a select few still have their records of maintenance. The evidence on these instruments themselves provide the final piece of the puzzle in understanding the systems of marine chronometer use and care in nineteenth-century America.
Chapter 3

PARTNERS IN ACCURACY: MARINE CHRONOMETER MAINTENANCE

The chronometer rescued from the *St. Charles*’ wreck in 1892 disappeared from documentary records after the accident report. According to First Officer Stevens, the remaining crew waited briefly for rescue near the wreckage, then set off to find land. He included a longitudinal reading when they departed—126.12—but made no reference to the chronometer. Did he use the instrument before the ship exploded and remembered the results of that reading, or did he use it in the lifeboat after it was thrown ten feet into the air? Because Stevens only noted latitude on the following day, he probably remembered the last chronometer reading rather than trying to use the instrument again.\(^{55}\) The chronometer was probably useless after the accident, but the crew made sure to rescue and carry it to land. The instrument’s significance to all on board predicated their decision to save it before all other objects—compasses, logbook, almanac, or the captain’s watch and chain. Even broken, it was the most valued item on the ship.

By the mid-nineteenth century, marine chronometers were common tools on civilian and naval vessels—so much so that they incited an entire industry for their care. When the remaining crew of the *St. Charles* arrived in San Francisco on May 26, the captain had died. After his death, the chronometer became the property of his beneficiaries. While these individuals were not identified in the accident report, they could have easily found someone to repair the instrument. San Francisco was home to

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many highly qualified maintainers by the end of the nineteenth century, as were many other port cities around the globe. Mariners relied completely on the expertise of these individuals: the clockmakers, jewelers, and nautical instrument makers who cleaned and repaired these devices whenever necessary. Unlike temporary repairs to woodwork or sailcloth, the labor required to fix marine chronometers was highly specialized. It could only be completed by skilled individuals on land.

Maintainers used whatever means necessary to provide their clients with functional instruments promptly—an important skill when port visits could range from a few days to just under a month. Surviving chronometers provide important evidence about how watchmakers identified components and how maintainers rearranged within the makers’ system. Most chronometer parts are stamped with numbers, intended to distinguish corresponding pieces of one mechanism. However, these numbers do not always match between plates, barrel, and movement of the same instrument. These differences indicate that maintainers used their available resources, mixing pieces of different instruments to meet client deadlines and needs for functional instruments. Even if components were not originally intended for each other, they were often of similar size and shape and could replace each other in different instruments.

Maintainers’ utilization of these available materials comprises an important and often-hidden part of an instrument’s physical journey. Fortunately, some maintainers also left more accessible evidence of their work. Three record-keeping methods appeared most prominently with nineteenth-century marine chronometers:

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57 For further examples of parts numbers and how they differ within one instrument, see Appendix A.
inscriptions on the instruments themselves, rate assessment sheets, and labels that simultaneously advertised the maintainer’s business and recorded a chronology of work done to the instrument. Taken together, these records reveal the vast network of maintainers that marine chronometers utilized to persist in their use and reliability at sea.

**Dial Inscriptions**

While the identity of the engraver who inscribed “1812-1815” on Bond’s first marine chronometer remains anonymous, the act of carving information into the metal fits within longstanding clock and watch repair practices. These inscriptions appeared on the interior surfaces of a dial or movement, only visible as a maintainer dismantled the instrument. The dial of a marine chronometer is a single spun sheet of brass cut into a circle and then coated in a silvering solution. After the numerals and names were engraved on the face and the movement was assembled, it was the last part of the instrument to be affixed to the movement. Maintainers who made a physical record in this way could not have intended to communicate their work to the owner or user of a marine chronometer, as it would have been inaccessible to those individuals. Instead, it was a message across time and space between the skilled craftspeople who worked on these instruments in port cities around the globe.

The dial from a Litherland Davies & Co. marine chronometer provides another example of this record-keeping practice (Figure 10). Maintainers recorded the work

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Litherland Davies & Co. emerged from the Liverpool shop of Peter Litherland in 1816, but their instruments do not appear in many collections in the United States. This firm utilized the strong network of brass foundries in the nearby county of Lancashire, building their instruments out of English-made component parts and retailing them to mariners passing through Liverpool. Although the movement itself
Figure 10  Litherland Davies & Co. Marine Chronometer Dial, Liverpool, 1834-1899. Note the “WIND” inscription at “24” on the power indicator, signifying to the user that the mechanism should be wound with twenty-four hours remaining on the current wind. 1991.35, courtesy New Bedford Whaling Museum.

no longer exists, the serial numbers on the dial indicate that it was made after 1834. Tony Mercer, *Chronometer Makers of the World: With Extensive Lists of Makers and Craftsmen*, Rev. ed. (London: Robert Hale, 2004), 191.
they did on this instrument on the back of its dial at two distinct times: 1862 and 1892 (Figure 11). The silvered coating was polished off its face long ago, and this dial’s inscriptions are only visible today because the rest of the instrument has been missing since at least 1991. The information hidden beneath the dial participates in this network of chronometer assessment and repair seen earlier in the century, but the location of these inscriptions reveals that their information was intended for maintainers alone. When the instrument was still intact, the inscription would have been entirely hidden from users, indicating that the information they contain was intended for a particular group of people.

Figure 11 Litherland Davies & Co. Marine Chronometer Dial reverse. The top inscription reads, “A new Balance Spring by John G. Fosler 1862.” The bottom inscription is practically illegible except for the date of 1892, and appears to be in a different hand. 1991.35, courtesy New Bedford Whaling Museum.
Both the presence and content of these inscriptions provide crucial information about marine chronometer care, revealing the language and system of maintainers in nineteenth-century port communities. While one is illegible except for the date of 1892, the top inscription reads, “A new Balance Spring by John G Fosler 1862.” The balance spring was an essential part of the instrument: it allowed the movement to have a steady source of power between windings rather than ticking faster when first wound and slowing down at the end of its cycle. Due to their importance and delicacy, balance springs were one of the most frequently repaired parts of spring-driven timekeepers. According to New Bedford City Directories, Fosler identified as a chronometer maker for at least two decades. While he only appeared in documentary records a few times, he was demonstrably entrenched in the timekeeping and maritime communities of southern New England. Fosler demonstrated his understanding of the balance spring’s importance to future maintenance through his inscription. The act of physically imprinting information in this location indicates Fosler’s desire to make note of his work in a permanent way. It was a signal to other maintainers, not to the users of marine chronometers.

Invisible to owners and users of marine chronometers, notations like the one by Fosler reveal a sublevel of instrument care: a system of communication between


60 John Fosler, “Improvement of Time,” The Congregationalist, June 29, 1866, GT3004376141, Gale.
maintainers alone. While Fosler’s exact motivations for inscribing the back of the Litherland Davies & Co. dial remain a mystery, a few theories seem plausible. It was likely Fosler’s choice to inscribe the dial in this way, but the instrument’s owner may have preferred not to have any visible marks on his chronometer or its case. Another possibility is that Fosler did not trust that a separate paper record would remain with the instrument, and this was a way to ensure future awareness of his work. The first step in cleaning or repairing a marine chronometer is gaining access to the movement; this necessitates removing first the dial and then the plates above and below the mechanism. Without removing the dial, none of the other components or this inscription would have been accessible. No matter the rationale, Fosler chose a permanent method and recognizable location, ensuring that all future maintainers would know of his alteration to the movement and when he completed it.

This type of inscription appears to be somewhat rare. Fosler’s choice to communicate solely within the network of maintainers continued as standard practice to the turn of the twentieth century, but other examples of maintenance records display intentional communication between maintainers and users of these instruments. Some of Fosler’s contemporaries chose to record their work on or near the instruments in more obvious locations. These conscious choices relate directly to a marine chronometer’s utility and the user’s ability to trust a maintainer’s work.

61 To preserve instrument integrity, I did not remove the dials from any complete instruments during examination. While it is possible that other chronometers had similar notations underneath the dial, no such work was noted in any object records and the act of removing the dial could have damaged the instruments.
Trusting Time: Rate Assessments

Figure 12  Henry Frodsham Marine Chronometer No. 2267, London, 1839-1840. Note the interior case with ivory or bone plaque and exterior case of a different wood type with green baize lining. These linings were typically filled with horsehair or other padding to cushion the chronometer during transit. M2267, courtesy Peabody Essex Museum.
Whenever a chronometer was cleaned or repaired, a maintainer would also assess its reliability through a process called rating. Rating a chronometer needed to be done on land because it consisted of comparing its time to that of extremely accurate clocks in the workshop. After collecting all time stamp data, the maintainer could then calculate whether the timekeeper was fast or slow in comparison to the home port’s time, and to what extent in either direction. He then translated that information onto paper for the user’s easy access and clear understanding. Mariners used this information when calculating longitude to account for the mechanism’s error as well as their own, thereby refining the ship’s position at sea. While these judgments were initially transmitted in letters, by the mid-nineteenth century many maintainers used standardized forms to communicate an instrument’s number and maker, owner, and test results. Rate results were vital to a mariner’s ability to navigate properly: without accurate ratings, a chronometer could send a ship in the wrong direction and even send the crew to their death. While these forms often got separated from their instrument, a few corresponding instruments and rate forms still exist together. One lucky and rare survival is a Henry Frodsham chronometer no. 2267 (Figure 12). Amazingly, many of its rate assessment forms remained with the instrument in the Peabody Essex Museum’s collection today.62 These forms reveal the chronometer’s voyages and some of its maintainers between 1864 and 1886 (Figure 13).

62 For a complete table of the dates and related information from these rate forms, see Appendix B.
Figure 13  Bond & Son rate form for Henry Frodsham marine chronometer no. 2267 dated July 11, 1867. While Bond & Son was based in Boston, they retailed their instruments in several other cities like New York and Philadelphia. Chronometer firms collaborated with each other to provide their own instruments to a wider market, as demonstrated by Bond & Son’s arrangement with John Bliss & Co. and William Harpur as seen here. Object record files for M2267, courtesy of Peabody Essex Museum.
The combination of instrument and rate forms provides a wider image of the international network of maintainers in the maritime world. The maker of this marine chronometer, Henry Frodsham, advertised himself as the successor to Parkinson & Frodsham in England; considering the numerous Frodsham family members in the marine chronometer business all over the country, this was an ideal way to distinguish both his business and the quality of his instruments. No. 2267 was likely built between 1839 and 1840, and by the time of the first extant rate form associated with it, the instrument had probably traversed the seas many times. Two captains, Bradford and Beadle, seem to have alternated use of this marine chronometer: Bradford on the ships Garnet and Frederic Tudor between 1864 and 1869, then again in 1874 on an unidentified vessel; and Beadle on the Mindoro between 1870 and 1874, then again between 1878 and 1886. Very little information remains about these two captains or their vessels, and it is unclear which of them personally owned this chronometer. As a result, these rate sheets are some of the only reliable documentation about the movement of this chronometer across the globe. The individuals identified on them begin to demonstrate the vast scope of this network of maintainers by the late nineteenth century.

These rate assessments reveal the absolute necessity of maintainers’ work because this instrument’s rate changed erratically over its career. For example, Bond & Son first rated it as losing 2 6/10 seconds daily in 1864, then gaining 9/10 seconds daily in 1866, and then gaining 3 2/10 seconds daily in 1867. This kind of fluctuation

63 Chronometer ownership will be explored in-depth in the next chapter, but it is very likely that Bradford and/or Beadle personally owned this instrument. Unfortunately, no further documentation indicates who specifically owned this chronometer.
in a chronometer’s rate was normal; while designed to resist external factors and maintain consistent time, chronometers are not wholly immune to minor variations. By tracking this chronometer’s oscillations, Bradford and Beadle could trust the instrument to sustain a certain level of accuracy during a voyage, and they confidently adapted their calculations to account for these changes. As these forms reveal, captains’ faith in a chronometer’s consistency relied entirely on the work of maintainers. Whether intentionally or not, the maintainers of this marine chronometer communicated and collaborated with each other, Bradford, and Beadle to uphold this instrument’s accuracy for over twenty years.

Treatises on chronometer care from the nineteenth and twentieth centuries advocated for regularly-scheduled cleaning and rating.\(^64\) The rate assessments for this instrument are somewhat sporadic, but they reveal that Bradford and Beadle rated their chronometers as regularly as possible, aiming for once every six months.\(^65\) However, there are several unexplained gaps between forms’ dates. One possible explanation is that some rate forms are missing. These forms were typically half or full sheets of paper, and they could not always fit inside the case. This separation of object and document was common; as demonstrated by this chronometer’s rate forms, its ownership and care schedule were relatively fluid. Without a full knowledge of this

\(^{64}\) While Bowditch does not directly address chronometer maintenance in his explanations on how to use a marine chronometer, he begins several pages by establishing the instrument’s accurate rate before proceeding. Nathaniel Bowditch, *The New American Practical Navigator*, 8th ed. (New York: E. & G.W. Blunt, 1836), 183.

\(^{65}\) This is seen in forms dated June 1864 and April 1865 and other forms throughout the years of 1866, 1868, and 1871.
chronometer’s complete journey during these decades we can only speculate that it was cleaned and rated with consistent frequency.

Another explanation for these gaps is the limitations of the maintainer network itself. Bradford and Beadle worked with numerous chronometer makers and observatories around the world, but they favored several maintainers in particular. These included Bond & Son of Boston, Thomas Tennet in San Francisco, Alexander Cairns in Liverpool, William Welchert in Cardiff, and the Government Observatory in Bombay.\textsuperscript{66} Trust between user and maintainer was paramount, and the nature of this relationship may be the reason why Bradford and Beadle returned to these individuals time and again. Alternatively, they may have been the only trustworthy maintainers in the ports that these two captains visited. Marine chronometer maintenance was an integral and vital part of many port economies, but that did not translate to every port housing a reputable maintainer. By using the same firm every time, Bradford and Beadle could trust that the marine chronometer’s variability remained within a range. Even if the maintainers’ reference clocks were slightly off-beat, the chronometer would always be accurate with respect to that shop’s reference point. These forms reveal accuracy to be a relative concept, and returning to these same maintainers ensured regularity in the assessments as much as in the instrument itself.

Not only do these rate assessments reveal a clearer understanding of where this chronometer traveled between 1864 and 1886, they prove that Bradford and Beadle

\textsuperscript{66} Further research may reveal whether Bombay required all chronometers to be rated by the government at the ship’s entry into port; however, it is also possible that the Observatory was the workshop of Bradford and Beadle’s preferred maintainer in the port. Bradford in particular favored the Government Observatory rather than a privately-operated firm, returning here at least three times between 1864 and 1868.
understood the importance of the instrument and its regimented care. Without updated rates on a regular basis, human error during use of the instrument could have been compounded. Inaccurate calculations endangered both the individuals on board and the success of the voyage. Thanks to the work of maintainers across the globe, this particular marine chronometer was reliable for more than two decades. The rate assessments enabled captains to use marine chronometers confidently and accurately, guiding both vessel and crew safely and quickly all over the world. The maintainers identified on these forms could be trusted to provide reliable information in a clear and concise manner for sailors to use their marine chronometers. Their forms’ direct method of communication is a clear and powerful reminder of the absolute necessity of proper chronometer maintenance.

These papers are an incredibly survival, especially because of their association with an extant instrument. Due to a chronometer’s status as a tool, these documents superseded each other as time and use progressed, rendering past ones obsolete. Holding on to prior assessments of an instrument’s reliability was not a typical practice for marine chronometer users, so the danger of these documents becoming destroyed or separated from the instrument was high. Consequently, other maintainers chose one other method to document their work: labels that both identified chronometer maintenance and provided a constant, visible reminder to users of their (hopefully) excellent work.
Visible Journeys: Maintainer Labels and the *Louisiana*


Most marine chronometers in New England collections have no direct connection to the vessels they guided, but there are a few exceptions. The William French chronometer that may have been used on the *Rousseau* is one object that was saved because of its connection to a community symbol, and the marine chronometer
in Figure 14 is another historically significant exception. Hutton & Imray no. 338 was retained by the Houghton family of Bath, Maine; this same family built and owned the ship *Louisiana* between 1873 and 1895 (Figure 15). The ownership of this chronometer remains murky; whereas Sewall captains’ correspondence clearly demonstrates that they owned their own chronometers, the Houghton family retained ownership of this instrument into the twentieth century. Five different captains ensured this chronometer’s meticulous care at sea and maintenance on land, but whether any of them personally owned the instrument remains a question yet to be answered. Regardless, the mahogany case itself is an especially rich resource for evidence of maintenance with no less than five different labels referencing work done to the instrument between 1880 and 1890 (Figures 16 and 17). In combination with the ship’s chronology of port visits, the labels on this instrument identify the type of work done to it, when it was completed, and by whom. In small yet prominent ways, they reveal the maintainers’ active roles in maritime life even after the instrument left the shop.

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68 Amory Houghton, chronology of port visits for the ship *Louisiana* of Bath, Maine, 2018.
Figure 15  John Hughes (English, 1806-1880), *Starboard Broadside View of the Louisiana, 1873-1880*. Hughes was one of many marine painters based in Liverpool that painted ships from all nations that came into the port. Oil on canvas, image size 22 x 35, framed size 31 ½ x 44 inches. 92.047, courtesy Maine Maritime Museum.
Figure 16  Front of brass-bound mahogany case for Hutton & Imray Marine Chronometer No. 338, London, 1856-1878. In addition to the brass escutcheon, bindings, and spring-release for viewing the chronometer, there are four labels from various ports, and an engraved bone or ivory name plate for the maker. This plate is a holdover from earlier sextants and octants: mariners could take the necessary readings, then write them down immediately for later calculation. They could then rub the pencil marks away, cleaning it for future use. 1976.050, courtesy Maine Maritime Museum.
The labels on this instrument case, in combination with the corresponding port visits, reveal captains who cared for their instruments to the best of their abilities within the confines of unpredictable maritime life. As established with Bradford and Beadle’s Frodsham marine chronometer, maintenance was intended to be routine. However, the length of time between chronometer cleanings was not standard. The nature of mercantile business required captains to arrange for chronometer care whenever time and location allowed: during extended port visits, and only in those ports where a trusted maintainer could be found. The labels on this chronometer

69 Accounts for the Sewall ship *Eric the Red* indicate that Captain Joseph Small had his chronometer rated in Cardiff in February 1873 and again in Galway in May 1873. He continues to charge this kind of work for the marine chronometer to the ship’s accounts, but it is unclear whether he was suspicious of its reliability or he had it rated in every port with a reliable maintainer. “Accounts and summaries for Capt. Small
provide intriguing clues regarding the instrument’s international journeys and care. They vary in size, shape, and decoration; most obviously, they differ in the type and degree of information displayed. The label at the center of Figure 17 sports the name of a well-known maintainer in Havre: “F. Rötig.” Printed in black ink on a white oval sticker, its handwritten inscription corresponds to one of several times the *Louisiana* stopped in Havre that year: “Cleaned August 1888.” This first label reveals one clear way that maintainers recorded their work all over this instrument.

The length of time that the *Louisiana* remained in Havre was clearly enough for a maintainer to clean and rate a chronometer. This work included dismantling the entire movement, cleaning each individual piece, waiting for it to dry, reassembling it completely, and finally rating it for accuracy. All told, these were time-consuming tasks, begging the question of how long a maintainer needed to complete a single instrument from start to finish. Captain Cyrus W. Oliver steered the *Louisiana* into Havre on August 4, 1888. While in port, she collided with the *Ville de Buenos Ayres*, a French steamer. Both ships sustained major damage, and the *Louisiana* likely remained in Havre longer than planned as she did not arrive in Penarth, England—the next stop—until September 4. As Rötig wrote “August” and not “September” on this label, he could likely clean a chronometer and return it to the user in under twenty-seven days: the maximum amount of time that the *Louisiana* was likely in Havre before leaving for Penarth.

1871-1875 and undated,” Sewall Family Papers, MS 22, Box 302 Folder 16, Maine Maritime Museum.

70 Amory Houghton, chronology of port visits for the ship *Louisiana* of Bath, Maine, 2018.
Another label, partially covered by Rötig’s, further proves that marine chronometer cleaning could be done in under a month (Figure 18). This one is a more common design for the late nineteenth century—square-shaped with a blue border decoration and handwritten notation in the center. No printed text appears on this label; only the words, “Cleaned Feb 1883” and the initials either “YY” or “YG.” The Louisiana stopped in Liverpool between February 17 and March 15, 1883. As the label only mentions February, this maintainer likely completed his work in under twelve days—reducing the time frame for cleaning and rating a chronometer to well under one month. The labels on this chronometer reveal that maintainers provided standard cleaning services in a few short weeks—an important practice for busy port cities that may have had competing maintainers. These labels demonstrate the need for dependability between mariner and maintainer for marine chronometers. Not only did mariners need to trust their instruments, they needed assurance that maintainers could provide accurate services as promised. If maintainers were able to work efficiently and return reliable instruments, users could return to them for consistent service over time—a trend that may also be apparent in another label on this case.
One final label on the case exterior includes just enough information to incite questions about the maintenance networks of this marine chronometer (Figure 19). On its dirty white surface the words “HOROLOGIE” printed up the left side and
“LOUISIANA” in script at the center indicate another time when this instrument was repaired in a French-speaking port. While badly faded, the printed letters across the top of the label may also say “F ROTIG,” the same maintainer as identified on the 1888 label inside the lid. The Louisiana stopped in Havre twice before 1888:

December 31, 1881, to February 10, 1882; and July 6, 1886 to August 4, 1886.\(^7\) Both times the *Louisiana* was in port for at least twenty-eight days, allowing more than enough time for it to be cleaned. It is entirely possible that Rötig cleaned this marine chronometer at least once prior to 1888, but this sticker’s placement on the case exterior unfortunately means that the label is irreversibly damaged and difficult to read. Nevertheless, this label demonstrates another variation of this maintenance recording method. In the decades after it was first applied, it likely served both as advertisement and avenue of communication for instrument maintenance. Users on the *Louisiana* had a quick reference to maintainers for future work in that port and a record of that chronometer’s care readily available and visible. These labels reveal a narrative of maintenance that the chronometer could then employ to remind its users of required care throughout its life.

Whether or not records of it were accessible to users, marine chronometer care was absolutely essential to these instruments’ functionality at sea: without the work of maintainers on land, users at sea literally would have been lost. Fosler communicated his repairs on the Litherland Davies & Co. instrument solely to his own network of maintainers. Balance springs were required in order for users to trust their chronometers, but the users did not necessarily need to know when a balance spring had last been replaced—just that it would work as designed. The rate forms completed by several maintainers for Bradford and Beadle’s chronometer reveal two users’ pursuit of information. Only maintainers could provide the requisite data for this chronometer to perform as designed, furthering these captains’ business interests and

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\(^7\) Amory Houghton, chronology of port visits for the ship *Louisiana* of Bath, Maine, 2018.
keep their crews safe at sea. Unlike in Fosler’s case, the information contained in rate assessments was absolutely essential to the user’s success with marine chronometers. They trusted maintainers to communicate accurate, necessary information in a clear manner. Finally, the work of identified and anonymous maintainers on the Hutton & Imray chronometer off the *Louisiana* demonstrates the middle of this communication spectrum. These labels shared information that both users and maintainers needed in order to gauge the everyday reliability of the instrument and the extent of future maintenance requirements. This chronometer’s visible record of maintenance was presented in a format and language that would be clear to both maintainers and users. The range of detail and methods demonstrated on these three instruments reveals the complexity of the marine chronometer network. Wholly integrated into maritime American life, marine chronometers had now established their own networks of maintenance and use. Human interaction supported and perpetuated these networks well into the digital age.
CONCLUSION

“...for be it Polar snow or torrid sun, like a patent chronometer, his interior vitality was warranted to do well in all climates.”

~Herman Melville, Moby-Dick; or, The Whale, 1851.

By the time American audiences read this description of Starbuck, Chief Mate of the doomed whaling ship, Pequod, marine chronometers were a well-established tool of the mariners’ trade. Whether whaleman, Navy officer, or merchant captain, American mariners relied on marine chronometers for open-ocean travel. These instruments provided accurate measurements of time and enabled mariners to cross the ocean more safely and quickly than before. To support such an extensive system of users, networks of maintainers also formed all over the world from Boston to Liverpool, San Francisco to Calcutta. These webs of users and maintainers introduced Americans outside of seafaring communities to marine chronometers. Most of Melville’s readers had never and would never go to sea, but they may have seen a chronometer. Walking past a watchmaker’s shop, the average city-dweller might have spied one on display in a window or in pieces on a work bench. Land surveyors occasionally used them, perhaps taking one out of its case when stopping through a frontier town. These instruments had become ingrained in communities and economies all over the country. Even landlocked readers would have understood Melville’s metaphor.

Marine chronometers would not have become so embedded in American maritime culture without the work of two partnerships early in the century. William Cranch Bond likely did not know the impact his first marine chronometer would have until after Captain Curtis tested it for him. This partnership between clockmaker and
sea captain opened the door for Bostonians to consider the marine chronometer as a viable maritime tool. Bond and Curtis’ first experiment gave marine chronometers a foothold in the United States, and it provided crucial information to refine American chronometer designs as the century progressed.

Thirteen years after Bond and Curtis’s experiment, the Navy’s Depot of Charts and Instruments formalized the chronometer’s introduction into maritime America. While the Board of Navy Commissioners gave the final orders, the Officers in Charge of the Depot established protocols for marine chronometer acquisition, care, and disposal. Passed Midshipman Goldsborough convinced the Commissioners that the Depot was the Navy’s biggest asset: without proper care for the marine chronometers within its walls, the United States could never become a respected maritime power. Lieutenant Wilkes understood marine chronometers’ potential contribution to the Navy through his expertise as a user. His Exploring Expeditions relied entirely on marine chronometers for the production of accurate charts and the safety of the fleet. The ways that the Navy bought and utilized marine chronometers, whether at the Depot or on the open ocean, set an example for civilian mariners. Together with the work of Bond and Curtis, the Navy established standard protocols for chronometer use and care. Their collaborations established direct links between land, sea, and sky—forming a microcosm of the network that more fully developed around marine chronometers later in the nineteenth century.

Marine chronometers quietly became the most important instrument on board many American ships. They were interwoven in both systems of navigation onboard and networks of provisioning and repair on shore. Marine chronometers were the first objects to be rescued if a ship was sinking, as in the case of the St. Charles. Captains
like James G. Baker asserted their personal ownership of these instruments even if they had loaned them to another mariner. Beneficiaries of deceased captains, like the widow of Captain Purington, went to great lengths to retrieve chronometers even if it was only to resell them. Shipyards like Sewall & Co. also recognized the importance of marine chronometers to their mercantile success, mediating between makers and users in instrument procurement, transportation, and repair. These relationships between marine chronometers and their users at sea reveal the significance of these devices by the middle of the nineteenth century.

By the second half of the nineteenth century, there was an entire industry for marine chronometer maintenance. Evidence of these craftspeople exists in documents and on the instruments themselves. The ways that maintainers chose to communicate their work depended on the recipient and the nature of the work they completed. Some of these individuals, like John G. Fosler, intentionally communicated with each other on instrument components that would never have been seen by a chronometer user. Other forms of communication provided crucial information intended for the users. Rate assessment forms provided captains like Bradford and Beadle with the necessary context to understand their chronometer’s accuracy, giving them the confidence to calculate their ship’s location with precision. A final form of communication offered a middle-ground between the maintainer-only and maintainer/user methods. Labels adhered to the instruments and cases included information that could be utilized by both maintainers and users, blurring the lines between these two groups and integrating the land and sea components of chronometer maintenance. Firms like that of Rötig in Havre provided labels that reminded the user where they could return for similar service. They also revealed past maintenance to future maintainers. These sub-
levels of chronometer care exposed the land-and-sea networks that supported marine chronometer acquisition, use, and maintenance well into the twentieth century.

Weighty yet transportable, fragile yet sturdy, marine chronometers were both treasured and taken for granted in the nineteenth century. Their movements and cases were almost always made from high quality brass and hardwood, and evidence of their use appears through their maintenance. The styles of engraving, case construction, and case decoration demonstrate that these objects were not simply tools; they were beloved works of art. Their stories of use and maintenance on American vessels demonstrate their impact on a global level. They were more than quotidian objects for nineteenth-century mariners: they altered Americans’ very perception of time and space.
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Gunnison, Almon. Memories Stirred by a Blazing Fire of Driftwood Taken from the Old Rousseau. New Bedford: H.S. Hutchinson & Co., 1895.


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Logbook of the Ship President 2nd, William J. Robinson, Master. 28 April 1875-3 February 1877. KWM #31A, Reel 3, New Bedford Whaling Museum.

Logbook of the Ship Rousseau. 8 November 1837-10 December 1840. ODHS #484, Reel 276, New Bedford Whaling Museum.


Logbook of the Ship Rousseau, Pardon Taber, Jr., Master. 9 May 1849-3 June 1853. KWM #178, Reel 17, New Bedford Whaling Museum.


“On the Accuracy and Rate of Chronometer Readings Aboard an Unidentified Vessel at Sea,” 16 November 1859. VFM 1626, George Blunt White Library, Mystic Seaport Museum.


Sewall Family Papers. MS 22, Maine Maritime Museum.


Stevens, A.C. “Statement of First Officer and Crew on the Wreck of the St. Charles,” May 27, 1892. MSS 733, Box 6, Folder 2, Baker Library, Harvard Business School.


Appendix A

NINETEENTH-CENTURY MARINE CHRONOMETERS IN SELECTED COLLECTIONS

The tables below act as a catalogue for the instruments that comprised the material-based research for this study. Divided by owning institution and object type, these objects revealed the diversity of information available on the instruments themselves. An * signifies that the instrument could not be removed from the drum.

SMITHSONIAN MUSEUM MARINE CHRONOMETER

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MYSTIC SEAPORT MUSEUM MARINE CHRONOMETERS

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<td>Brass-bound mahogany</td>
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<td>Tobias &amp; Levitt 118</td>
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MYSTIC SEAPORT MUSEUM CHRONOMETER DIAL PLATES

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NEW BEDFORD WHALING MUSEUM CHRONOMETER DIAL PLATE

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<td>Date</td>
<td>1850-1860</td>
<td>1808-1825</td>
<td>c. 1839-1840</td>
</tr>
<tr>
<td>Dial Inscr.</td>
<td>French Royal Exchange London No. 4985</td>
<td>M I Tobias &amp; Co LIVERPOOL 105 “A new balance &amp; balance spring applied and readjusted by T.S.”</td>
<td>Frodsham LATE Parkinson &amp; Frodsham So. Castle St. LIVERPOOL 2267</td>
</tr>
<tr>
<td><strong>Accession No.</strong></td>
<td><strong>M800</strong></td>
<td>**M867 ***</td>
<td><strong>M2267</strong></td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Plate Nos.</strong></td>
<td>Bottom plate “French Royal Exchange LONDON No 4985”</td>
<td>Bottom plate “M I Tobias &amp; Co 105/4720 Liverpool”</td>
<td>1790</td>
</tr>
<tr>
<td><strong>Drum No.</strong></td>
<td>1790</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Case Type</strong></td>
<td>Brass-bound mahogany</td>
<td>Brass-bound mahogany</td>
<td>Brass-bound hardwood</td>
</tr>
<tr>
<td><strong>Case Inscr.</strong></td>
<td>“105” in round ivory plaque lower center front case; “A.R. Crocker” engraved into brass plaque in case top</td>
<td>“2267” in round brass plaque lower center front case; “FRODSHAM, SUCCESSOR TO (PARKINSON &amp; FRODSHAM) MAKER to the ADMIRALTY, LONDON” in rectangular bone or ivory plate on lid</td>
<td></td>
</tr>
<tr>
<td><strong>Case Labels</strong></td>
<td>Round sticker with geometric medallion center design, “Thomas Tennet San Francisco” with set square and compass, center of lid interior; Numerals notations in pen on the inside of case itself, back of lid interior above hinges below glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accession No.</strong></td>
<td><strong>75.060A</strong></td>
<td><strong>71.187.2</strong></td>
<td>**G91.131.4 ***</td>
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<td>------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>1856-1878</td>
<td>1800-1899</td>
<td>1847</td>
</tr>
<tr>
<td><strong>Dial Inscr.</strong></td>
<td>Hutton &amp; Imray LONDON Sold by Wm DESILVA Liverpool</td>
<td>Wm Bassnett Liverpool</td>
<td>Norris AND Campbell Liverpool</td>
</tr>
<tr>
<td><strong>Dial No.</strong></td>
<td>338</td>
<td>205</td>
<td>553</td>
</tr>
<tr>
<td><strong>Plate Nos.</strong></td>
<td>Top 338, Bottom 379 338</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drum No.</strong></td>
<td>379 338</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Case Type</strong></td>
<td>Brass-bound mahogany</td>
<td>Brass-bound mahogany</td>
<td>Brass-bound mahogany</td>
</tr>
<tr>
<td><strong>Case Inscr.</strong></td>
<td>“Hutton &amp; Imray” on ivory front plate</td>
<td>“Sch William 1869” on round plaque centered on lid</td>
<td>“N 54” (?) on interior left hinge</td>
</tr>
<tr>
<td><strong>Case Labels</strong></td>
<td>Square sticker with black printed &quot;Horologerie&quot; on left &quot;Havre&quot; on bottom and &quot;Louisiana&quot; in script, to right of name plate outside of case; sticker with notched corners and blue border over top of rectangular printed sticker right front of escutcheon; inside upper left of box oval printed sticker for F Rötig in Havre, dated cleaning August 1888; partially covers rectangular sticker with blue printed border noting a cleaning in Feb 1883 with initials</td>
<td>Sticker with red border and notched corners with script &quot;Repaired and Cleaned February 1891&quot; and stamped &quot;MICHAEL RUPP &amp; CO./ NEW YORK.&quot; inner upper left side of case lid; shield-shaped sticker with red borders [likely from same firm] inscribed &quot;17/s&quot; inside lid, lower left corner just above hinge</td>
<td>&quot;MULTEDO GENOVA&quot; in print, filled in as Schooner Bright and Capt. Curtis, no. 104 to right of escutcheon; &quot;JULIUS GOLDS__JEWELER CHRONOMETERS RATED AND ADJUSTED 3 AND 5 SOUTH ROYA ST. MOBILE, ALA.&quot; no. 107, Capt left blank, partially visible &quot;Sch Bright&quot; as lower edge of label (and top right corner) are torn away; Label filling interior case lid from Multedo e Figli in Genova shows a</td>
</tr>
</tbody>
</table>
"YY" (?) upper back of case at left corner red bordered sticker with notched corners and ink no. 348

Cleaning and oil change in June of 1920 for chronometer Norris & Campbell no. 553; also inscribed "30x-y" lower left in pen on this same label
## Appendix B

**RATE SHEETS FOR FRODSHAM CHRONOMETER NO. 2267**

<table>
<thead>
<tr>
<th>Date</th>
<th>Firm &amp; Location</th>
<th>Captain</th>
<th>Ship</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 11, 1864</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain Bradford</td>
<td>Garnet</td>
<td>Slow—losing 2s 6/10 daily</td>
</tr>
<tr>
<td>Dec 23, 1864</td>
<td>Gov’t Observatory Bombay</td>
<td></td>
<td></td>
<td>Slow—losing 2/10” daily</td>
</tr>
<tr>
<td>April 12, 1865</td>
<td>G. Grant &amp; Sons, Calcutta</td>
<td>Captain Bradford</td>
<td>Garnet</td>
<td>Fast—gaining 50/100 daily</td>
</tr>
<tr>
<td>May 24, 1866</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain J. Bradford</td>
<td>“Fred’k Tudor”</td>
<td>Fast—gaining 9/10 daily</td>
</tr>
<tr>
<td>Oct 29, 1866</td>
<td>Gov’t Observatory Bombay</td>
<td></td>
<td></td>
<td>Fast—gaining 2s 7/10 daily</td>
</tr>
<tr>
<td>July 11, 1867</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain J. Bradford</td>
<td>“Fred. Tudor”</td>
<td>Fast—gaining 3s 2/10 daily</td>
</tr>
<tr>
<td>Feb 12, 1868</td>
<td>Gov’t Observatory Bombay</td>
<td></td>
<td></td>
<td>Fast—gaining 4s 4/10 daily</td>
</tr>
<tr>
<td>Aug 20, 1868</td>
<td>Alexander Cairns, Liverpool</td>
<td></td>
<td></td>
<td>Fast—gaining 0/0/2 daily</td>
</tr>
<tr>
<td>Sept 7, 1868</td>
<td>Solomon Marks &amp; Son, Bute Dock</td>
<td>Captain Bradford</td>
<td>Ship “Fredk Tudor”</td>
<td>Fast—gaining 1s 4/10 daily</td>
</tr>
<tr>
<td></td>
<td>Observations (est 1819), Cardiff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 8, 1869</td>
<td>H. Necker, Hamburg</td>
<td>Captain Bradford</td>
<td>Frederic Tudor</td>
<td>Fast—gaining 5/10s daily</td>
</tr>
<tr>
<td>Jan 26, 1870</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain Charles Beadle</td>
<td>Mindoro</td>
<td>Slow—losing 1s 5/10 daily</td>
</tr>
<tr>
<td>Dec 13, 1870</td>
<td>G. Falconer &amp; Co., Hong Kong</td>
<td></td>
<td></td>
<td>Fast—gaining 3s 6/10 daily</td>
</tr>
<tr>
<td>Jan 3, 1871</td>
<td>Norris &amp; Son, Rio de Janeiro</td>
<td></td>
<td></td>
<td>Fast—gaining 9/10 daily</td>
</tr>
<tr>
<td>Date</td>
<td>Firm &amp; Location</td>
<td>Captain</td>
<td>Ship</td>
<td>Rate</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>March 19, 1871</td>
<td>Thomas Tennet, San Francisco</td>
<td></td>
<td></td>
<td>Fast—gaining 1.5 daily</td>
</tr>
<tr>
<td>Sept 22, 1871</td>
<td>Alexander Cairns, Liverpool</td>
<td></td>
<td></td>
<td>Fast—gaining unclear, sheet ripped</td>
</tr>
<tr>
<td>Nov 5, 1872</td>
<td>Joseph Sewill, London (?) 30 Cornhill, Royal Exchange</td>
<td></td>
<td></td>
<td>Slow—losing 3/10 daily</td>
</tr>
<tr>
<td>Jan 30, 1874</td>
<td>William Welchert, Cardiff</td>
<td>Captain Bradford</td>
<td></td>
<td>Slow—losing 5/10 daily</td>
</tr>
<tr>
<td>Aug 2, 1878</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain Charles Beadle</td>
<td>Mindoro</td>
<td>Slow—losing 6/10 daily</td>
</tr>
<tr>
<td>Jan 6, 1886</td>
<td>Bond &amp; Son, Boston</td>
<td>Captain Charles Beadle</td>
<td></td>
<td>Fast—gaining 6/10 daily</td>
</tr>
<tr>
<td>April 30, 1910</td>
<td>Charles C. Hutchinson, Boston</td>
<td>Peabody Museum</td>
<td></td>
<td>Fast—gaining 1/10 daily</td>
</tr>
</tbody>
</table>
## Appendix C

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1603 Vesel Rd, Wilmington, DE, 19810  
**EMAIL:** Kitzy@winterthur.org  
**PHONE:** 302.222.1262

**PUBLICATION INFO:**  
"Times of the Trade: Marine Chronometer Use in 19th-century Maritime America." Winterthur dissertation

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Print Name and Title: [Signature]
Date: 10/19/13
Maine Maritime Museum grants permission to Katherine Fitzgerald to reproduce images of the following objects as part her thesis for the Winterthur Program in American Material Culture:

75.060  Chronometer made by Hutton & Imray, used on ship Louisiana
92.047.1  Oil on canvas portrait of ship Louisiana by John Hughes

Kelly Page
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