

time for its inclusion. There is a key or legend to each chart identifying by colour Allied and Central Powers' ships' movements, miniscule but clear vessel shapes, and a scale, not at all difficult to follow. Apart from an occasional city or town appropriate to the action covered, land mass is simply coloured by country—concentration is focussed on the actions at sea.

The whole is laid out in strict chronological order, except for the area campaigns, which makes for easy location by raid or operation. The index is detailed. A count shows tracks for 23 naval battles and operations, 35 area campaigns and dispositions, such as mining; 15 'events' such as the naval bombardments of the Belgian coast, and Operation Albion by eight German squadrons in the Gulf of Riga in October, 1917; seven world-wide cruises by German armed merchantmen.

For example, the chart for the German high-speed raid on the Dover Strait patrol between 2200 and midnight on 25 February 1917 by two German forces, places five destroyers to the northern section, off the Thames estuary, and five more attacking the four RN destroyers patrolling the mine barrage buoys off Dover. The area shown is from the British coast to France at Calais, track charts for the German forces and RN ships, plus others sent out in support. Yellow shaded areas show movement-limiting sandbanks; there are lists of ships involved and potential (RN) support nearby, the Squadron commanders were Korvettenkapitans Tillesen and Albrecht, Captain Henry for the RN at Deal.

A unique world map shows the Strategic Communications coverages, by cable and radio, for Germany and Britain in 1915, a first to allow for strategic controls, good or evil, in naval warfare.

This volume can be used as a valuable reference or, especially for the unusual actions, it can be examined out of fascination with the almost unknown—The Battle of the Åland Islands on 2 July 1915, or of the Strait of Otranto (to prevent the exodus of the major Austrian squadrons) 14-15 May 1917, or even the surrender of the High Seas Fleet, 21 June 1916 - the last in the book. A most enjoyable volume.

Physically, this is a large format publication (32 x 24 cm), printed in China, similar in quality to the US Naval Institute series on warships, such as their 'German Capital Ships of the Second World War, (Breyer & Skwiot, 2012, USNIP) reviewed here previously.

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Larrie D. Ferreiro. *Bridging the Seas. The Rise of Naval Architecture in the Industrial Age, 1800-2000*. Cambridge, MA: MIT Press, www.mitpress.mit.edu, 2020. xviii+386 pp., illustrations, notes, bibliography, index. US \$50.00, CDN \$66.00, paper; ISBN 978-0-262-53807-7.

A certain professor of naval architecture at MIT, Captain Corky Graham USN, used to teach a course on Ship Design (emphasized as "Big-S, Big-D") of which the central tenet was that "the best ship is the one that gets built". This was a statement of the realpolitik of ship production, that recognized all the disparate factors and compromises that went into the successful introduction of a new ship into a fleet (either merchant or naval). It particularly distinguished between the contributions of the three associated disciplines of ship design, ship theory, and naval architecture in juggling the project management trinity

of cost, schedule and performance. In this emphasis, 'Big-S, Big-D' focused not on science and technology as the prime determinants of the outcome, but rather on the human activity which reconciled many conflicting influences and constraints; technical, economic, and political.

In this book, the second in a pair tracing the history of naval architecture from 1600-2000, Ferreiro takes a similar tack, telling the story not principally in traditional terms of the evolution of equipment, but rather in terms of the intertwined development of ship theory, ship design methods, and the evolving status and education of the ship designers themselves. As in the first volume, *Ships and Science* (MIT, 2007), it is the history of a craft, in the sense of a creative activity, which (while increasingly technological) shows distinct traces of the many varied personalities involved.

The author tells the tale of this evolution through the intertwined themes of predictability, standardization, and professionalization. First, he expounds on how the introduction of steam, iron and steel obviated the tradition of knowledge from centuries of wooden shipbuilding, providing a motivation for the embrace of science in attempting to calculate and predict ship characteristics, such as strength and powering. Subsequently, the advent of vertically integrated shipyards (responding to the increasing cost of ships, and hence, the owners' need for tighter control of costs, performance, and risk) led to the increasing development of standards for engineering and production, and the rise of ship classification societies.

This, in turn, led to the professionalization of the design function and the associated development of dedicated education paths outside of the traditional shipyard apprenticeship model. As in the previous volume, the inter-

play between the development of ship theory and its practical application plays a large part in the story. In the modern world it is often (and mistakenly) taken for granted that engineers can calculate no-matter-what, and that safety and performance is absolutely determinate. The history of the development of ship stability calculations and standards through the 1800s (and to the mid-1900s) is a prime illustration of the three general elements necessary to achieve this determinacy: first, an adequate theoretical basis for calculation; then, a sufficient and economic means of computation; and finally, an appropriate criterion of acceptance (or safety). The loss of the innovative and controversial warship HMS *Captain* in 1870 is the classic cautionary tale in this respect: although large-angle stability theory had been developed by Atwood and Vial du Clairbois in 1798, and an effective means of computation had been developed by Barnes by 1861, the lack of an established and agreed criterion of safety to apply to the results precluded a compelling demonstration of the risk to the vessel before she sailed on her third (and last) voyage. Indeed, the significant labour involved was a disincentive to performing the calculation at all. The author quotes the British naval constructor William White, who acknowledged in 1871 that "naval architects had simply to decide whether or not it was worth the trouble to perform an elaborate calculation in order to ascertain the variations in stability of any ship designed by them." (282). [This reviewer can attest to this labour from personal experience; even using a 'fast' method (developed in 1884 and still in use until the computer age, employing the Amsler integrator and tabular hand-calculation) developing a full set of stability curves for a single ship was a full week's concentrated effort.]

And even then, having calculated the variation of stability, came the question of what did it mean: as late as the 1914 SOLAS Convention, it could still be said “It is not practicable to determine the amount of stability which a ship ought to have in order to be safe” (179). Ship stability criteria remains today an active and debated field of research ...

Ferreiro outlines the development of naval architecture as a profession, evolving from its master-shipwright origins in the late 1700s, through the term draughtsman embodying both the drawing and calculation function by the 1880s, and then on to the status of an engineering discipline. He notes the domino sequence of world-wide development of schools of naval architecture and associated learned societies, development of national systems of governance of standards, and the development by world navies of professional Corps of Naval Constructors (naval architects). He also draws attention to the differences in national ship design culture and practice—it will be amusing to naval architects trained in the US/UK tradition to learn (189) that French naval architects use in their calculations the absolute density of water compared with a vacuum (vice air) and hence, include in their weight estimates, a line item for the amount of air in the hull! The difference in national naval architectural cultures spawned the research field of comparative naval architecture, particularly active in the 1970-80s, assessing the difference in US and Soviet warships (the latter showing the influence of Italian design practices on Russian ship design, p. 296).

Running through the book are examples of the influence of ship design tools on the design process. First, the need to support calculations drove the ship design process into the drawing office. In the twentieth century, the ad-

vent of computers enabled the development of ‘ship synthesis’ programs that allowed wider exploration of the ‘design space’, although this capacity for advanced analysis did beget increasing demand for yet more studies to justify the expense of shipbuilding programs (inspiring a reference to Parkinson’s Law “work expands ...” . 295). This development of tools, in turn, fostered innovation in how the design process was conceived, progressing from cautious evolution from known results, to a progressive spiral approximation to a balance solution, through optimization, system-engineering, and open-architecture interface-specification. Even in this more sophisticated incarnation of the design process, there are echoes of the earlier dilemma of calculation: what are the criteria of success, the figure-of-merit for adjudicating the result? Another important modern-era tool of the ship design process is the model towing tank, as well as other assorted experimental basins. Ferreiro details both the world-wide proliferation of towing tanks (by tradition, all baptized with a vial of water from Froude’s original tank) and the development of international scientific collaboration in the development of towing tank methods and standardization benchmarks. It is noted that the scientific rigour of the experimental facilities was not always well-respected, as when in 1919 the Commandant of the Washington Navy Yard (which hosted the USN’s first tank) declared the tank available for the swimming pleasure of officers and their families!

The above examples give only a flavour of the many interesting twists and turns in the history of the practice of naval architecture. This book is very highly recommended. It is plentifully footnoted with many interesting and obscure references for the specialist

reader, but well-written and accessible for the non-specialist. As a minor quibble, for a volume which purports to give the designers of ships “their place in history” (310), the book could have benefitted from an appendix of ‘Person-ages’ similar to that in the predecessor volume. A larger criticism would be of the publisher for not seeing fit to publish this important volume in a similar hardback format.

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Skip Finley. *Whaling Captains of Color—America’s First Meritocracy*. Annapolis, MD: Naval Institute Press, www.usni.org, 2020. xv+287 pp., illustrations, tables, appendices, notes, bibliography, index. US \$42.00, cloth; ISBN 978-1-68247-509-6. (E-book available.)

Skip Finley uses a wide range of sources, including log books and historical records from seafaring towns, as the wellspring for his fascinating and unusual story about the largely forgotten whalers of colour, some of whom rose to command and own whaling vessels. Lasting slightly over two hundred years, the American whaling industry was an enormously complex and evolving enterprise consisting of more than 2,700 ships of various types, sizes and capabilities. Whaling was vulnerable to weather, war, faulty management, errors in judgement, disease and, perhaps most importantly, depletion of a non-renewable resource. The industry attracted slavers, pirates, deserters, renegades, thieves and murderers, as well as investors, gamblers, con-men and, fortuitously, some clever inventors. This activity, largely based in New England and Long Island and Quaker administered, was one of the first to apply meritocracy to

its workforce with little regard to ethnic and racial diversity, especially as applied to men of colour. The sources of labour for these two centuries were first Native Americans, then local residents and vagabond white mariners, slaves and former slaves, and later, an influx of men from Cape Verde, a ten-island archipelago off the west African coast.

Slavery was abolished in Massachusetts by 1776. All the Northern states followed suit by 1805, although the last slave received manumission in New York in 1827. It was legal to keep an owned slave in Connecticut until 1848. Rhode Island was the capital of the slave trade at the time of the Revolutionary War and but, by 1840, the number of slaves in the state’s census totalled five. These four states had significant whaling fleets. Inter-marriage took place between former slaves and Native Americans and soon the Black-Native American “Mustee” offspring population grew. Some white politicians saw interracial marriage as a method for gradually diminishing Indian blood, thus fostering the disappearance of the aboriginal population. Native Americans, however, were granted rights by Congress that caused this scheme to backfire. Indians had rights to Native lands, but Blacks could not legally be landowners. Being tribal members by marriage provided potential land ownership for impoverished Blacks. Many males from these families, as well as their native “brothers-in-law”, opted to go to sea onboard whalers.

Whaling life has been written about in many books highlighting mutinies, desertions, floggings, drunkenness, scurvy, fire at sea, falls from aloft aboard ship, stove boats, drownings, lightning strikes, hulls crushed in ice and occasional deaths by a sea creature like a shark or sperm whale attacks.