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RESEARCH ARTICLE

Stratifying seamanship: sailors' knowledge and the mechanical arts in eighteenth-century Britain

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Abstract

A new genre of treatises on practical seamanship emerged in eighteenth-century Britain. Authored by a group of seamen with decades of experience on the lower deck of merchant and naval vessels, these texts represented the ship as a machine, and seamanship as a form of mechanical experiment which could only be carried out by deep-sea sailors. However, as this article finds, this group of sailor–authors had only a brief moment of authoritative legitimacy before their ideas were repackaged and promoted by land-bound authors and naval officers, and the progenitors of the 'science of seamanship' were deemed unfit participants in its ongoing practice. This article explores this brief moment, taking seriously the ideas and influences of the maritime milieu which spawned it, and arguing that the codification and circulation of 'useful knowledge' in eighteenth-century Britain often hardened social hierarchies. Examining seamanship forces us to question the progressivist linear trajectory of an increasingly open scientific culture during this period, and to focus instead on a repeating pattern in which the working knowledge of labourers and artisans was appropriated and its original practitioners denigrated.

Historians of navigational science and technology have long insisted that the ship was a crucial site in the production of useful knowledge. The codification of navigational practice and its development as a 'branch of applied mathematics' had begun in earnest in the Elizabethan period, but by the eighteenth century both naval and mercantile vessels acted as testing sites for the development of mathematical instruments.[1] By the end of the century, the use of instruments and lunar tables, and the ability to communicate theories of navigation within and beyond maritime circles, were conceived as a form of 'professional useful knowledge' across Europe.[2] Seafarers – officers in particular – were active participants in the production of navigational knowledge, charged with testing instruments and creating reliable data from which further improvements to navigational science could be wrought.[3] Most recently, Margaret E. Schotte has demonstrated the increasing

[1] Eric H. Ash, *Power, Knowledge, and Expertise in Elizabethan England*, Baltimore and London: Johns Hopkins University Press, 2004, p. 135.

[2] Timothy McEvoy, 'Finding a teacher of navigation abroad in eighteenth-century Venice: a study of the circulation of useful knowledge', *History of Science* (2013) 51(1), pp. 101–23.

[3] For officers as active participants in eighteenth-century navigational science see Jim Bennett, 'Mathematicians on board: introducing lunar distances to life at sea', *BJHS* (2019) 52(1), pp. 65–83; David Philip Miller, 'Longitude networks on land and sea: the East India Company and longitude measurement "in the wild"', in Richard Dunn and Rebekah Higgitt (eds.), *Navigational Enterprises in Europe and Its Empires, 1730–1850*,

importance of printed treatises and books in codifying navigational knowledge, and the thorough theoretical education which practitioners were expected to undergo by 1800.[4] Navigation in this period, historians have made clear, was undergoing a period of transformation which saw increasing codification and developments in instrument making, all of which were underwritten by significant investment from the British state and scientific institutions. Navigation was, to use Schotte's words, the 'big science' of its day.[5]

However, this focus remains a partial history of eighteenth-century shipboard knowledge. As all those who boarded a merchant or naval vessel in this period understood, navigation was but one half of a whole, with seamanship – the skills of reefing, furling, tacking and knotting, and the use of these skills to manoeuvre the wooden ship – its necessary counterpart. As a midshipman, the future vice admiral William Dillon noted that in his naval career he had 'two separate duties to learn – Seamanship and Navigation', and whilst the latter demanded regular sessions with a schoolmaster, the former would require years of observing and learning seamanship and its attendant nautical expression, which was 'nearly a language of itself'.[6] The Royal Navy took pride in the practical education of its officers in seamanship, increasing the minimum sea service a man could possess before qualifying as a lieutenant from four to six years in 1729.[7] An education in seamanship was understood to be a form of 'practical apprenticeship' and it was this 'practical grounding' which the Royal Navy prized, and which they believed stood them apart from their French and Spanish counterparts.[8]

In Britain, for much of the early modern period, the working knowledge of seamanship was primarily bound in the bodies and minds of experienced maritime labourers rather than being transmitted through books and instruments, as navigational knowledge increasingly was. Seamanship was thus transmitted up the social hierarchy rather than down it. Seamanship, and the provision of skilled seamen, was frequently discussed by contemporary commentators as a resource or a commodity, which needed to be regenerated through the upkeep of the coastal and fishing trades, described as seamen's 'nurseries'. Coastal nurseries allowed new generations of maritime men to master seamanship whilst young, before being put to sea to teach would-be officers and captains. Seamen were recognized, both by the state and amongst themselves, as skilled manual workers, who needed years at sea to hone their craft, and could then be deployed to pass on this knowledge as the living, breathing repositories of seamanship.[9] The value of these living repositories became particularly clear during the frequent periods of warfare of the mid- to late eighteenth century, when press gangs combed streets and taverns looking not for tinkers or tailors, but for experienced deep-sea sailors who wore the marks of their profession on their tarred and hardened hands.[10]

London: Palgrave Macmillian, 2015, pp. 223–49; Richard Sorrenson, 'The ship as a scientific instrument in the eighteenth century', *Osiris* (1996) 11, pp. 221–36. For officers as intertwined in scientific networks see Rebekah Higgitt, '"Greenwich near London": the Royal Observatory and its London networks in the seventeenth and eighteenth centuries', *BJHS* (2019) 52(2), pp. 297–322.

4 Margaret E. Schotte, *Sailing School: Navigating Science and Skill, 1550–1800*, Baltimore and London: Johns Hopkins University Press, 2019.

5 Schotte, op. cit. (4), p. 183.

6 M.A. Lewis (ed.), *Dillon's Narrative, 1790–1802*, vol. 93, London: Navy Records Society, 1953, p. 22.

7 N.A.M. Rodger, 'Officers and men of the Navy, 1660–1815', in Cheryl A. Fury (ed.), *The Social History of English Seamen 1650–1815*, Woodbridge: Boydell and Brewer, 2017, pp. 51–70.

8 H.W. Dickinson, *Educating the Royal Navy: Eighteenth- and Nineteenth-Century Education for Officers*, London and New York: Routledge, 2007, p. 31.

9 Jelle van Lottum and Jan Luiten van Zanden, 'Labour productivity and human capital in the European maritime sector of the eighteenth century', *Explorations in Economic History* (2014) 51(1), pp. 83–100.

10 Denver Brunman, *The Evil Necessity: British Naval Impressment in Eighteenth-Century Atlantic World*, Charlottesville: University of Virginia Press, 2013, p. 23.

Lower-deck seamen were excluded from instruction in new navigational instruments on British naval ships: one naval rating recalled that the notion of a seaman 'on the deck of a warship with a quadrant in his hand' would be seen as such a 'flagrant breach of discipline' that he would likely have been whipped.[11] However, when it came to seamanship, these same men became temporary mentors to their social superiors.[12] Onshore, the sons of middling and elite families were given at least a basic grounding in humanist education, and discouraged from immediately entering a technical apprenticeship. The requirement that future captains understand how to manoeuvre a sailing ship, however, superseded the pretensions of a land-bound education, and lent lower-deck seamen a peculiar role of pedagogical authority. Joining a ship as a teenager, many young gentlemen were initiated into their education when assigned a 'sea daddy', a skilled seaman who would show them the ropes as they went about their work.[13] This tutor was often the 'captain of the foretop' or another highly skilled role associated with an ability to work in the rigging and deftly amongst the sails. Whilst the boatswain might help direct new inductees to shipboard life, it was a wider strata of maritime labourers whose argot had to be deciphered, and whose movements were closely followed to benefit from their years of experience amongst the waves. Young midshipmen expressed frustration at having to interpret the gestures of men far below them on the rungs of eighteenth-century Britain's social hierarchy, but they were ultimately unable to resist the necessity of closely following the words and movements of experienced seamen.[14] In a period where, historians have argued, the respect and social leverage afforded the mental labour of 'philosophers, scientists, policy-makers and bureaucrats' was superseding that of manual labour, seamen persisted as respected authorities on seamanship on board British vessels.[15]

As this article finds, from the 1760s onwards seamanship was recast as a body of Newtonian mechanical knowledge and the skill of manoeuvring the wooden ship as a form of experiment which relied on the autopic authority of experienced seamen. The initial proponents of this newly devised vision of seamanship were not 'philosophers, scientists, policy-makers and bureaucrats', or even naval officers, but rather experienced seamen themselves, who argued that their time amongst the waves endowed them with the legitimacy to theorize and improve the ship. These works drew on a range of different modes of interpreting the natural world through empirical investigation, and applied them to the ship as a working environment. The vision of seamanship which emerged from their treatises was inherently embodied, representing maritime labourers as experimental natural philosophers whose authority was wrought of their active intervention in the material world, and through the manipulation of the ship as a machine. Historians have noted the existence of an increasingly 'disembodied epistemology' which had emerged with the seventeenth-century new philosophers, appropriating and nullifying the expertise of artisans and craftspeople, and which was supposedly rooted in British society by the eighteenth century.[16] In their extrapolation of the 'rules' of seamanship, however, seamen asserted their embodied knowledge and close observation at

[11] Robert Hay and Vincent McInerney (eds.), *Landsman Hay: The Memoirs of Robert Hay*, Barnsley: Pen and Sword Books Ltd, 2010, pp. 68–9.

[12] Hay, op. cit. (11), p. 32.

[13] Evan Wilson, *A Social History of British Naval Officers, 1775–1815*, Woodbridge: Boydell and Brewer, 2017, p. 26.

[14] See, for example, R. Vesey Hamilton and J.K. Laughton (eds.), *The Recollections of Commander James Anthony Gardner*, London: Navy Records Society, 1906, vol. 31, p. 34; and William Dillon's description of his own education in Lewis, op. cit. (6), pp. 14–15.

[15] Lissa Roberts, Simon Schaffer and Peter Dear (eds.), *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen, 2007, p. xiv.

[16] Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution*, Chicago: The University of Chicago Press, 2004.

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sea as essential to understanding the workings of the wooden ship: the wisdom of experienced maritime labourers was submitted to readers as indispensable, and the only way to generate knowledge which might improve ship construction and manoeuvring.

In codifying this knowledge, however, seamen had only a brief moment of authoritative legitimacy before their ideas were repackaged and promoted by middling land-bound authors and naval officers. Seamanship would became recast as a disembodied professional form of managerial knowledge rather than the tacit preserve of deep-sea sailors, and its original practitioners were written out of the maritime mechanical philosophy they had proposed. The initial sailor–authors had presented themselves as inheritors of the intellectual currents of the seventeenth century, using mechanical principles to investigate the interaction of natural elements and manmade structures, and proposing alterations to ship handling and design as a result of this honed mechanical expertise. The act of codifying their working knowledge, however, did not see maritime labourers inducted into communities of natural-philosophical investigation. Rather, between the 1790s and the 1810s, middling commercial authors appropriated the knowledge which seamen had presented, insisting that the new science of seamanship must be the preserve of the officer or captain, with seamen the unthinking mechanisms at their disposal. By the 1840s, seamen were even describing themselves as such. 'A ship', a seaman who had served in the Napoleonic Wars remembered, 'contains a set of human machinery, in which every man is a wheel, a band, or a crank, all moving with wonderful regularity and precision to the will of its machinist – the all-powerful captain'.[17] The wooden ship had become a machine, but the men who had first conceived of it as such were cogs, not controllers. This article tracks the emergence and trajectory of a form of maritime mechanical philosophy proposed initially by experienced deep-sea sailors, and through doing so considers the social and intellectual processes by which manual workers were excluded from early scientific communities.

Knowledge economies and social status

The social distinctions and interactions between those involved in early modern knowledge production have been the focus of multiple strands of scholarly enquiry. One of the most dominant, if not uncriticized, arguments on the transformation of knowledge economies during the eighteenth century is Joel Mokyr's conception of the 'Knowledge Revolution' in Britain and its attendant 'Industrial Enlightenment'. This theory of intellectual and scientific progressivism identifies a 'small elite in the West', versed in natural philosophy and with an increasing technical literacy acquired through print and participation in scientific societies who sought to 'open up' tacit and closed communities of knowledge once held by artisans and craftspeople alone.[18] Driven by 'ambition, curiosity, and altruism', this group supposedly realized the potential which might be unlocked if cerebral scientific *epistêmê* could be applied to tacit technical knowledge, or *techne*, creating a positive feedback loop of understanding and a synthesis of different bodies of knowledge, which Mokyr divides into the 'propositional' and the 'prescriptive'.[19] In Mokyr's analysis, this 'small elite' oversaw the opening up of tacit knowledge for the literate, allowing improvements to be made to technologies and practices which precipitated the Industrial Revolution.

[17] Samuel Leech, *Thirty Years from Home, Or A Voice from the Main Deck*, Boston: Charles Tappan, 1844, p. 40.

[18] Joel Mokyr, 'The intellectual origins of modern economic growth', *Journal of Economic History* (2005) 65(2), pp. 285–651, 322.

[19] Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy*, Princeton, NJ and Oxford: Princeton University Press, 2002, p. 20.

Recent years have seen a move towards reimagining the terms of such knowledge transfer, with historians seeking to challenge this intensely top-down approach. Often building on Edgar Zilsel's exploration of the interactions between artisans and scholars in the making of Western scientific method, historians have identified a range of knowledge brokers and mediators, who not only were situated to serve natural philosophers and nascent industrialists, but also had varying degrees of control over the terms of how their knowledge was imparted and interpreted.[20] This is part of a wider move within the history science to situate knowledge as produced in circulation and movement rather than fixed and formalized spaces, and as co-constructed rather than 'diffused' or transmitted by a narrow range of individuals.[21] As Kapil Raj has argued of the importance of focusing on knowledge 'circulation', the term 'suggests a more open flow' and 'the circulatory perspective confers agency on all involved in the interactive processes of knowledge construction'.[22] Writing on Europe in the early modern period, Ursula Klein has drawn attention to a group referred to as 'hybrid experts', who acted as gatekeepers to practical, technical know-how, and were often responsible for the first attempts at codification in such industries as mining and manufacturing. Klein asserts that these individuals were originally part of the community of skilled artisan workers, before collaborating and communicating directly with scientific communities and actively participating in the process of formalizing working knowledge for a reading public.[23]

The historiography on arenas of knowledge described as 'trading zones' similarly emphasizes the collaborative nature of knowledge production and transmission. Pamela O. Long in particular has been instrumental in developing this thesis in relation to a range of fifteenth- and sixteenth-century European examples, arguing that 'the interaction of artisans and humanists in trading zones bound by common interests and goals' led to a new empirical 'scientific' approach, which required formalization in a variety of published works.[24] This pre-dates by several centuries the intervention of Mokyr's 'small elite' and demonstrates that the practitioners of practical and embodied knowledge were valued collaborators in emerging scientific communities as early as the 1450s. The dynamics between scholars, natural philosophers, industrialists, artisans and labourers were shaped in fora such as building sites, mines and arsenals across the early modern world, bringing together practitioners of technical skill and possessors of theoretical learning who 'shared their respective expertise' through 'reciprocal communication'.[25] 'Interactional expertise' within these trading zones required the development of a shared language, which could only occur through continual interaction in relation to the same set of material processes, or 'boundary objects', as Peter Galison termed them.[26]

In many parts of mainland Europe and Britain in the sixteenth and seventeenth centuries, artisans were increasingly recognized as 'experts on natural processes' and

[20] Edgar Zilsel, 'The sociological roots of science', *Social Studies of Science* (2000) 30(6), pp. 935–49.

[21] James A. Secord, 'Knowledge in transit', *Isis* (2004) 95(4), pp. 654–72.

[22] Kapil Raj, 'Beyond postcolonialism … and postpositivism: circulation and the global history of science', *Isis* (2013) 104, pp. 337–47, 344.

[23] Ursula Klein, 'Introduction: artisanal–scientific experts in eighteenth-century France and Germany', *Annals of Science* (2012) 69(3), pp. 287–306; and Klein, 'Savant officials in Prussian mining administration', *Annals of Science* (2012) 69(3), pp. 349–74.

[24] Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400–1600*, Corvallis: Oregon State University Press, 2011, p. 129.

[25] Pamela O. Long, 'Multi-tasking "pre-professional" architect/engineers and other bricolagic practitioners as key figures in the elision of boundaries between practice and learning in sixteenth-century Europe', in Matteo Valleriani (ed.), *Structures of Practical Knowledge*, Cham: Springer, 2017, pp. 223–47, 225.

[26] Harry Collins, Robert Evans and Michael Gorman, *Trading Zones and Interactional Expertise: Creating New Kinds of Collaboration*, Cambridge, MA: MIT Press, 2010, pp. 12–13.

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were essential to the epistemological development of natural philosophy as it came to incorporate the mathematical and mechanical arts. Pamela H. Smith argues that the 'direct access to nature' and 'bodily experience' of artisans placed them, up until the middle of the seventeenth century at least, as co-producers of knowledge about the natural world and the forces which acted upon it.[27] Smith also makes clear, however, that the relationship between the new natural philosophers of the seventeenth century and artisanal communities was fraught; men like Robert Boyle and Robert Hooke increasingly sought to distance themselves from individuals they perceived as 'lowly practitioners'.[28] As the mechanical philosophy emerged from the cross-fertilization of natural philosophy, mathematics and mechanics, leading to the consolidation of a 'dominant mechanical tradition' by the seventeenth century's end, manual workers were increasingly considered unfit participants in its practice.[29]

Historians have thus identified the seventeenth century as a period of a formalization of the mechanical philosophy and a simultaneous disinheritance of artisanal participation in its practice. Classifying their knowledge as 'the mechanical arts', the 'new philosophers' actively distanced themselves from the embodied knowledge of artisans and manual workers.[30] At the same time, self-styled gentlemen 'experts' were positioning themselves between projects requiring knowledge of the natural world and state bureaucracies, coopting the knowledge of artisans and labourers in order to do so. As Eric H. Ash has argued in relation to the emergence of navigational 'experts', by the seventeenth century, 'personal, hands-on experience ceased to be a sufficient basis for expertise'. Ash has described the emergence of experts as 'black-boxing' natural philosophy by ensuring that navigational knowledge was increasingly expressed in complex mathematical terms which made its inner workings inaccessible to the majority of practitioners.[31] Practical knowledge was gleaned by Ash's experts, before conscious efforts were made to distance themselves from 'men who actually dirtied their hands performing the work in question, ideally while under the direction of an expert overseer'.[32] Knowledge became socially stratified into those who could understand the whole picture and oversee, often with the use of a written manual or treatise, and those who undertook its workaday practice.[33] As James Fisher has demonstrated in his recent monograph, agricultural knowledge was undergoing a similar process in the early modern period. Fisher explores the emergence of a stratum of 'expert mediators', usually estate stewards, who theorized and codified agriculture, establishing a new 'hierarchy of knowledge' which they sat atop. Through the publication of codified manuals, agriculture was elevated to a gentlemanly 'science' by the eighteenth century, which required the direction of overseers and assumed husbandmen and -women to be unthinking, unreasonable and incapable of improvement.[34]

This article contributes to the historiography on knowledge and social status by identifying another instance of this repeating pattern in the late eighteenth century. Historians of eighteenth-century Britain have tended to identify an increasingly open forum which, through programmes of public demonstrations, experiments and lectures,

[27] Smith, op. cit. (16), pp. 7, 185.

[28] Smith, op. cit. (16), p. 229.

[29] J.A. Bennett, 'The mechanics' philosophy and the mechanical philosophy', *History of Science* (1986) 24(1), pp. 1–28, 7; and Stephen Pumfrey, 'Who did the work? Experimental philosophers and public demonstrators in Augustan England', *BJHS* (1995) 28, pp. 131–56.

[30] Bennett, op. cit. (29), p. 8.

[31] Ash, op. cit. (1), p. 11.

[32] Eric H. Ash, 'Expertise and the early modern state', *Osiris* (2010) 25(1), pp. 1–24, 8.

[33] Ash, op. cit. (1), p. 204.

[34] James Fisher, *The Enclosure of Knowledge: Books, Power & Agrarian Capitalism in Britain 1660–1800*, Cambridge: Cambridge University Press, 2022, p. 105.

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ushered in new audiences for industrial improvement and mechanization.[35] This was a moment of relatively wide participation, with permeable boundaries between scientific communities and the wider public, before the hardening of disciplines of 'academic science' in the nineteenth century served to exclude this wider community of observers and interested parties.[36] However, as this article demonstrates, concerns over who should be included in and excluded from expertise in 'the mechanical arts', and anxieties over manual workers staking a claim to this through embodied first-hand experience, featured regularly in eighteenth-century discourse. This article demonstrates that tensions over participation in experimental and natural-philosophical investigation were present at the end of the eighteenth century just as they had been at the end of the seventeenth, although underpinned by new social and political realities.

Sailor–authors and maritime empiricism

As with so many maritime stories, ours starts in a dockyard. From the publication of Isaac Newton's *Principa Mathematica* in 1687, Britain's Royal Dockyards were identified as important potential sites for experiment.[37] Simon Schaffer has demonstrated the identification of naval dockyards by practical mathematicians and natural philosophers as arenas in which new theories about fluid resistance could be tested out through alterations to ship design. Just as Galileo had observed the relation between 'mathematical analysis and practical application' in Venice's Arsenale in the seventeenth century, so Newton and a generation of his followers attempted to capture the technical mastery of dockyard shipbuilders in order to perceive mechanical rules and principles.[38] In London, mathematicians such as Thomas Weston and James Hodgson attempted to marry the worlds of the Royal Mathematical School and the Royal Dockyards, using their expertise to 'weld these settings together'.[39] The ship seemed to provide an opportunity to utilize mechanical philosophy in the national interest through promoting improvements which men like Newton, Weston and Hodgson believed could never be carried out by shipwrights alone. The potential for applying mechanical and mixed mathematical principles to the ship was recognized and expanded on by several contemporary mathematicians such as William Emerson, who described the laws of motion in relation to ships in his 1758 treatise and insisted on the importance of 'Newtonian philosophy' to calculating the progress of ships.[40]

However, as numerous naval administrators were to find over the course of the eighteenth century, shipwrights and dockyard workers were not always entirely amenable to the 'trading zone' of which they were supposed to be part. Changing the curvature of a ship's hull required 'firm and sometimes violent challenges' to traditional artisanal practices in the dockyards, which were met with resistance by groups of skilled maritime workers fiercely protective of their time-honoured methods and processes. Larrie D. Ferreiro has demonstrated that Britain was peculiar in comparison with continental Europe in that its dockyards resisted professionalization for much of the eighteenth

[35] Larry Stewart, *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660–1750*, Cambridge: Cambridge University Press, 1992; Alice N. Walters, 'Conversation pieces: science and politeness in eighteenth-century England', *History of Science* (1997) 35(2), pp. 121–54; Liliane Hilaire-Pérez, 'Technology as public culture in the eighteenth century: the artisans' legacy', *History of Science* (2007) 45(2), pp. 135–47; Larry Stewart, 'Experimental spaces and the knowledge economy', *History of Science,* (2007) 45(2), pp. 155–77.

[36] Hilaire-Pérez, op. cit. (35), p. 147.

[37] Simon Schaffer, '"The charter'd Thames": naval architecture and experimental spaces in Georgian Britain' in Roberts, Schaffer and Dear, op. cit. (15), pp. 279–305.

[38] Schaffer, op. cit. (37), p. 287.

[39] Schaffer, op. cit. (37), p. 287.

[40] William Emerson, *Principles of Mechanics*, London: W. Innys and J. Richardson, 1754, p. 286.

century, before Samuel Bentham's overhaul of the hierarchy of work and installation of overseers from 1796 onwards.[41] As Schaffer shows, dockyard workers in Britain ultimately resisted the suggestions and demands presented to them by mathematicians, leaving the project of transforming ship design to test Newtonian mechanical principles within dockyards stymied in the 1760s.[42]

Ultimately it was an experienced seaman who would inherit this project, and first elucidate the ship's machinery, recasting the wooden vessel as a mechanical environment. In the early 1760s, the seaman-turned-naval-purser William Falconer undertook to write his *Universal Dictionary of the Marine* in the Royal Dockyard at Chatham, a project which claimed to 'fix' the language and practice of seamanship, providing a definitive, 'universal' view of the 'machinery' of the wooden ship. Falconer had been born to a poor family in the Netherbow district of Edinburgh before leaving to start a seafaring career, and was enjoying reasonable literary success following the publication of a poem titled *The Shipwreck*, which would go on to be published in multiple editions. He remained a 'humble sailor' for the entirety of his career, according to his nineteenth-century biographer, and served in the merchant service, before joining a naval ship and being promoted to purser.[43] It was following the success of *The Shipwreck* that Falconer persuaded the dockyard commissioner of Chatham, Thomas Hanway, to provide him with space to start work on a dictionary of seafaring terms. Falconer's biographer tells us that he was given use of the 'comforts and conveniences' of the captain's cabin of the forty-four-gun HMS *Glory* as it lay in dock in 1763.[44] Thomas Hanway's support for the project is unsurprising. His brother, Jonas, had set up the Marine Society six years before, which had the sole purpose of training boys and young men for sea service in as short a time as possible, to ready them for warfare. As Jonas Hanway put it himself in 1757, while Britain entered the Seven Years War, there was a need to create a 'quick succession of young mariners' for national defence, which the coastal nurseries were not naturally supplying.[45] Any means by which the long road to proficiency in seamanship could be shortened was a keen interest of Jonas's and, as one of the original subscribers to the Marine Society, Thomas would have been acutely aware of this.

There had been several other English maritime dictionaries before Falconer's attempt. Henry Mainwaring's *The Sea-man's Dictionary* of 1644 and William Boteler's later *Sea Dialogues* of 1685, which heavily plagiarized Mainwaring's earlier work, both offered explanations of different seafaring terms to 'make a man understand what other men say, and speak properly himself'.[46] However, unlike previous dictionaries and works concerning sailing and 'naval affairs', Falconer's book provided what he described as a comprehensive assessment of the 'machinery of a ship', through demonstrating 'the disposition of the rigging on her masts and yards' and 'the comparative force of her different mechanical powers'.[47] The dictionary did not merely provide 'translations' and explanations of maritime argot in plainer terms, but gave detailed expositions of how the mechanical philosophy could be applied to the ship whilst under sail and suggested according improvements in ship design. In his entry for masts, Falconer wrote of the need to position the main mast at the 'axis of the resistance of the water … in order to suspend the efforts of the

41 Larrie D. Ferrario, *Ships and Science: The Birth of Naval Architecture in the Scientific Revolution, 1600–1800*, Cambridge, MA: MIT Press, 2006, pp. 296–7.

42 Schaffer, op. cit. (37), p. 287.

43 John Mitford, *The Poetical Works of William Falconer, with a Life*, London: Little, Brown and Co., 1854, p. xii.

44 Mitford, op. cit. (43), p. xxi.

45 Jonas Hanway, *A letter from a member of the Marine Society*, 4th edn, London: J. Waugh, 1757, p. 8.

46 W.G. Perrin (ed.), *Boteler's Dialogues*, London: Navy Records Society, 1929, vol. 65, p. xxvii; and G.E. Manwaring and W.G. Perriny, *The Life and Works of Sir Henry Mainwaring*, London: Navy Records Society, 1921, vol. 56, p. 85.

47 William Falconer, *An Universal Dictionary of the Marine*, London: T. Cadell, 1769, p. 1.

water equally', suggesting a 'mechanical method to discover the axis of resistance' and including an accompanying diagram.[48] The seaman argued that although many works on seafaring had addressed 'astronomy, navigation, hydrography and natural history', there had been no attention paid to the ship's 'machinery' and the mechanical principles which acted upon the working of the rigging, masts, stays, blocks and sails.[49] Falconer's conception of the ship's 'machinery' was forged in line with the earlier dockyard application of Newtonian mechanical philosophy to wooden vessels. However, his working knowledge gleaned from his years living below decks and working in the sails and rigging was the essential resource, and allowed him to produce a view of the ship as a mechanical environment, detailing its parts and illuminating the role of the seafarer in manipulating them.

Falconer's *Universal Dictionary* took six years to compile, but was published in 1769 to wide acclaim, and republished in multiple editions throughout the 1770s and 1780s. Falconer would not live to see this success. He died in 1769, the year of his initial publication, after the passenger ship he had boarded for India foundered and sank without trace. The intellectual currents which Falconer contributed to, however, did not cease, and in 1777 another dockyard denizen published his own attempt to theorize and fix the rules of seamanship. William Hutchinson had started his seafaring career as a cook on a collier, before becoming a seaman and a privateer captain, and then eventually settling in Liverpool as 'dockmaster and water bailiff' from 1759. Hutchinson was an expert seaman who rose from relative obscurity to a position of significant maritime authority, and was also a keen inventor. During his time in Liverpool he designed reflectors for lighthouses so they could be better observed by ships nearing land, carried out experiments on ship models to ascertain the optimum form of hull design, and was the first person to begin measuring high tide at Liverpool, eventually producing a series of 'tide tables' from 1764 until 1793, which are still used today by climate scientists as the earliest reliable data on sea levels.[50] In 1777, Hutchinson published his first edition of *A Treatise on Practical Seamanship* which promised to 'fix the best rules for Practical Seamanship' by ensuring that these rules were tied to 'the laws of motion, the pressure of fluids, and the properties of the leaver'. These mechanical principles were, he wrote, well understood by 'British Philosophers and Mathematicians' as crucial to the ship's movement, but no sustained attempts had been made to explicate their workings at sea.[51]

Hutchinson drew his authority to impart this knowledge directly from his experience at sea, and throughout the treatise he represented his decades 'amongst the waves' as giving him the authority to communicate experiments. The author endeavoured 'to explain what I know from experience and observation'.[52] Although he lauded the developments of natural philosophy and mathematics onshore, Hutchinson insisted that their application to the ship needed to be conceived by seamen rather than shore-bound savants. After considering air pressure and its impact on the ship, he added that 'as a sailor' he could also observe that 'the weather often proves very different from what is pointed out by our weather-glasses, or by any of those other improv'd instruments or rules'.[53] The remainder of his section on the properties of air, as well as the sections on the pressure of fluids and identifying the centre of gravity of the ship, included observations on natural-philosophical laws, but were always couched in and moderated by his own experiences

48 Falconer, op. cit. (47), entry for 'mast'.

49 Falconer, op. cit. (47), p. 1.

50 Philip L. Woodworth, 'Three Georges and one Richard Holden: the Liverpool tide table makers', *Historic Society of Lancashire and Cheshire* (2002) 151, pp. 19–51.

51 William Hutchinson, *A Treatise on Practical Seamanship*, 1st edn., Liverpool: Thomas Cowburne, 1777, pp. iii–v.

52 Hutchinson, op. cit. (51), p. 25.

53 Hutchinson, op. cit. (51), p. 5.

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at sea. Hutchinson repeatedly states that he will 'venture sailor like' to add his own observations on events which had occurred at sea in the various crews of which he had been a part.[54]

Much of this recounting is framed as 'experiment': an 'accidental experiment made by a commander of a long and flat floor'd collier cat' or the 'very plausible experiment' undertaken by sailors who fixed a rudder to the 'stem of a sailing boat so it could be pointed to windward occasionally on either tack'.[55] The master of a collier and the crew on a small ship became, in Hutchinson's view, active participants in mechanical experiments. In recounting their stories and offering his own experiences, the treatise rooted its authority in empirical observation whilst representing the ship as a site of experiment in which the principles of Newtonian mechanical philosophy could be tested. Hutchinson's authority in writing was drawn from his repeated practical experience of the ship in motion and his residence, for years at a time, within the largest 'mechanical' object in existence. Historians have argued that from the middle of the seventeenth century onwards, artisans were frequently barred from participating in natural-philosophical discourse, experiment and investigation, and indeed, by the middle of the eighteenth century, manual workers seem to have been divested of their authority. However, Hutchinson represented maritime labourers as the perfect natural philosophers: they were experienced practitioners who performed the same routine actions to gather empirical evidence about what worked and what did not. 'Causes are best discovered', Hutchinson wrote, 'by their effect, from experience and observation we must find out true principles'.[56]

Given the trends of the previous century, whereby the experiential and embodied knowledge of artisans and labourers had been classified as inferior to that of the practitioners of the mechanical philosophy, Hutchinson's publication seems particularly radical. The author asserted that seamen were the natural authority in conducting mechanical experiments because of their embodied knowledge and decades of manual work. Although Hutchinson reported his difficulty finding a publisher, and published without a patron, *A Treatise on Practical Seamanship* proved to be popular, being followed by a 'considerably enlarged' second edition in 1787, and another in 1794.[57] In the 1787 edition, Sir Thomas Frankland of the Maritime School in London endorsed Hutchinson's treatise, citing its usefulness in instructing young gentlemen who were readying for a career at sea, adding that he wished the older 'Officers of the Navy would study it also'.[58] Just as on the decks of naval ships, it seemed, experienced seamen were continuing to instruct their social superiors in print.

Perhaps in response to the success of Hutchinson's work, this model of publication was to be taken up by several other experienced seamen, and a mode of maritime empiricism was expanded. In 1792, William Nichelson, who had been a seaman on merchant ships before becoming master attendant at Portsmouth throughout the American Revolutionary Wars, published his *A Treatise on Practical Navigation and Seamanship*. Nichelson similarly drew on the fifty-nine years he had 'used the sea', and the 'great deal of service' he had seen, to establish his legitimacy as an author.[59] Like Hutchinson, he also insisted that seamen needed to 'develop something of the Philosopher' and emphasized even more insistently that it was experienced seafarers who should be guiding developments in maritime mechanical philosophy: 'the Author

54 Hutchinson, op. cit. (51), pp. 85, 139, 203, all contain the same references to the author 'venturing sailor like'.

55 Hutchinson, op. cit. (51), pp. 14, 46.

56 Hutchinson, op. cit. (51), p. 32.

57 Hutchinson, op. cit. (51), p. v.

58 William Hutchinson, *A Treatise on Practical Seamanship*, 2nd edn, Liverpool: s.n., 1787, p. v.

59 William Nichelson, *A Treatise on Practical Navigation and Seamanship*, London: Gilbert and Wright, 1792, p. 317.

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of such remarks and directions should be a seaman, who can speak pointedly on such subjects from his own knowledge and experience'.[60] Accordingly, Nichelson's work was structured around occurrences and weather events he had encountered under sail and his observations on the best methods to rig, reef, furl, steer and haul, and to improve the ship whilst at sea. It was only through decades of cumulative observation and experience that a good working knowledge of seamanship could be arrived at, but for those who were deeply familiar with the ship, it could become a productive site of experimentation, forming new insights into how vessels should be designed and manoeuvred.

This is most thoroughly demonstrated in Nichelson's forty-page recounting of the voyage of the East India Company ship *Elizabeth* from India to England in 1764, aboard which he had acted as master. Whilst sailing 650 leagues off the Cape of Good Hope, the crew of the *Elizabeth* had encountered a storm which had almost wrecked the ship, and required them to sail for thirty-five days back towards the Cape without a working rudder. Nichelson's account of this period recounts the inventiveness and ingenuity of an experienced seafaring crew in the face of immediate danger. The ship again was represented as a site of experiment, as the author described in great detail the process by which the crew arrived at the invention of a temporary rudder, made by sawing part of the top mast and lashing it to the outside of the ship, which would form the main part of the new 'machine', then sawing an oak plank until it resembled a 'key' which could manipulate the mast's direction.[61] This narrative, just as with Hutchinson's treatise, spliced seaman's yarn with natural-philosophical experiment and reflections on potential improvement. Like Hutchinson's, Nichelson's work was well received. One lofty reviewer commented on the 'freedom of his remarks' and 'the *naivete* of his manner', adding that 'when he attempts to philosophise, we find it difficult to comprehend his meaning'. Despite this, however, the reviewer heartily recommended Nichelson's treatises, noting his reliability as an 'eye-witness' and stating that not only midshipmen and officers, but even the Lords of the Admiralty, would gain advantage from reading the words of this 'old seaman'.[62]

One year after Nichelson published, another experienced mariner wrote that he would make no apologies for his authorial style in relaying the rules of seamanship, as his new treatise would simply be 'as elegant as those whose time has been equally devoted to the duties of a seaman'.[63] Richard Hall Gower had been at sea with the East India Company for many years, and in his 1793 *Treatise on the Theory and Practice of Seamanship* he expounded the importance of seamen's maritime empiricism. Gower argued that mixed mathematics could be usefully applied to work out the centre of gravity of any ship. Unlike Hutchinson and Nichelson, Gower included a movable paper model of a ship in his work, with lettered parts which allowed readers to carry out their own experiments, which could then be applied at sea.[64] The '*theory* of practice' was here represented, so Gower claimed, with the 'profundity of Euler and the simplicity of Franklin'.[65] However, as with the previous authors, Gower's assessment of the ship was not pure abstraction and relied heavily on personal observation and the 'experimentation' which took place on long sea voyages. Amid his mathematical reckonings, the author explained how a sewing needle might be magnetized by rubbing with a knife and thus serve as a rudimentary compass and, echoing Nichelson, gave directions for the assemblage of a temporary rudder by threading

60 Nichelson, op. cit. (59), pp. 195, iii.

61 Nichelson, op. cit. (59), pp. 268–83.

62 *The Critical Review, Or, Annals of Literature*, London: S. Hamilton, 1798, pp. 142, 148.

63 Richard Hall Gower, *A Treatise on the Theory and Practice of Seamanship*, London: G.G. and J. Robinson and Gilbert, Wright and Hooke, 1793, p. iv.

64 Gower, op. cit. (63), frontispiece.

65 Gower, op. cit. (63), p. iii.

cables through windows to secure planks of wood in the place of a lost tiller.[66] Seamanship was inherently responsive to natural phenomena, and Gower makes clear that ascertaining universal theoretical precepts could only be done by those with practical experience. Although not drawn from as humble origins as Falconer, Hutchinson and Nichelson – his father was a member of the clergy – Gower's experience amongst the sails was represented as his primary source of authority in relaying potential improvements. The author also noted that the treatise should be purchased alongside Falconer's *Universal Dictionary of the Marine*, 'without which no officer should be'.[67] Maritime mechanical philosophy, penned by experienced seamen, was by the early 1790s an emergent and self-referential genre.

The ship was the perfect site of experiment in the eyes of the authors: a moving mechanical environment which passed through fluid and air and carried with it experienced observers. In the pages of their treatises, seamen insisted that their shipboard authority also extended into circles of mathematicians and natural philosophers on land and could be translated as expertise in mechanical philosophy. As Nichelson wrote in one of his many polemic asides, too many officers did not understand the ship as a working mechanical environment, and it was for experienced seamen to reinstate a pride in seamanship and to suggest improvements to ship design and manoeuvring. A wooden ship, he wrote, 'is not designed for a show, but is the finest piece of machinery in the World, and is intended for real service'.[68] In some regards, this picked up where the dockyard theoreticians of Simon Schaffer's analysis had left off in their designs to discover how the ship could be altered. However, this new generation of sailor–authors insisted that improvements to this most 'noble' machine could only be devised by those who had gained a tacit working knowledge of the ship under sail. Hutchinson noted his difficulty in finding a publisher due to his 'imperfections, as a scholar', and undoubtedly the comments on the '*naivete*' of Nichelson's manner were echoed elsewhere.[69] Regardless, these works enjoyed great success in the 1780s and early 1790s, running to multiple editions and recommended as essential reading for naval officers. As was also the case with teaching seamanship in person, maritime knowledge destabilized what might have been the usual social dynamics of knowledge diffusion, with the autopic and embodied experience of labouring men giving them authority over and above the social and cultural capital of their tutees.

The rise of the naval artist

By the early 1790s, many individuals who plied maritime trades must have noticed the success of this genre of treatises. One of these was David Steel. Steel was the owner of a highly successful navigation warehouse on the Minories in London, who in 1794 undertook to publish his own formalization of seamanship titled *The Elements and Practice of Rigging and Seamanship* which he could sell directly from his premises near the Thames. Steel set out to build on the foundations laid by previous maritime authors, proposing that the 'useful part' of any mariner's duty was 'the application of his theoretic knowledge to the various evolutions of a ship'.[70] Steel, however, had never been a seaman, and indeed had barely been to sea, so needed to garner considerable assistance in assembling and representing this 'useful' body of knowledge. Throughout the early 1790s, Steel

66 Gower, op. cit. (63), pp. 91, 93–4.
67 Gower, op. cit. (63), p. iv.
68 Nichelson, op. cit. (59), p. 212.
69 Hutchinson, op. cit. (51), p. v.
70 David Steel, *Seamanship, both in theory and practice: Illustrated with engravings*, London: David Steel, 1795, p. 107.

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attempted to conduct his own interviews with experienced seamen who passed through Tower Hill, close to where his warehouse was situated, in an attempt to capture some of the embodied working knowledge which had informed Hutchinson, Nichelson and Gower. Steel found, however, that the majority of seamen were decidedly unwilling participants in the type of knowledge circulation he had in mind, and those he approached did not want to talk to him, or to contribute to his volume. He wrote of the 'disinclination of many to be open in their communications, from the possession of their supposed secrets' which 'has often opposed the advancement of these volumes'. After years of trying he found he could persuade the 'liberality' of some of the 'best practical seamen' to share their working knowledge; a liberality perhaps aided with a well-placed payment. However, even where sailors spoke their craft, Steel found that he could not understand what they said, and the seamen were so 'inexpert in their use of the pencil' that they also could not draw to demonstrate their meaning. Steel's solution to this was to travel with a marine dictionary, likely Falconer's, and an illustrator, whose 'task was to elucidate by drawings the most complex figures and operations', thus fixing the slippery meanings of maritime language in a series of numbered illustrations.[71] Here, Steel proposed the need to bypass the language and explanation of seamen in order to arrive at a 'useful' knowledge of seamanship which represented the ship disassembled in parts.

Perhaps because of his apparent frustration with teasing out the meanings of deep-sea sailors' words and expressions, Steel elected to extract much of his understanding of seamanship from an additional source. As Richard Hall Gower noticed on his return from a voyage to India in 1794, sections of Steel's work were pulled directly from his own *Treatise on Theory and Practice*. Accusing him of plagiarism, Gower prefaced his second edition with an attack calling into question Steel's 'professional knowledge' of seafaring and his authority to write on a subject of which he had no practical experience.[72] This did little to stymie the popularity of Steel's work. In 1795 *Elements* was republished 'in a smaller form and in single volumes' after demand from a 'large part of the naval world, as an object of peculiar convenience and advantage to them'.[73] Steel wrote that he had become 'acquainted with the wishes and the wants of the naval world' for a manual on seamanship with labelled illustrative plates and was now 'sincerely desirous to contribute the efforts of his station to the promotion of maritime science'.[74]

In Steel's *Elements*, the contributions of the seamen he had pursued and plagiarized were largely invisible, and the ship was represented as a machine in parts, laid out and labelled piece by piece. Whilst the descriptive empirical accounts of Hutchinson, Nichelson and Gower had often placed the body of the sailor as central to the production of knowledge, David Steel's vision was disassembled and disembodied and distinctly lacking any reference to the 'experimental' knowledge of a crew. Steel seems here to have borrowed from the logic and layout of Denis Diderot's *Encyclopédie*, representing the ship as a world 'ordered by scientific precision rather than human skill'.[75] As with the original *Encyclopédie*, the author's aim was to inform middling and elite audiences, who could become at least linguistically expert in the disembodied craft they beheld without having to resort to interactions with manual workers. Whilst the ship had been explained by the

[71] David Steel, *The Elements and Practice of Rigging and Seamanship, Illustrated with Engravings*, London: David Steel, 1794, p. vi.

[72] Richard Hall Gower, *A Treatise on the Theory and Practice of Seamanship*, 2nd edn, London: G.G and J. Robinson, 1794, p. vi.

[73] Steel, op. cit. (71), p. iii.

[74] Steel, op. cit. (71), p. vi.

[75] William H. Sewell Jr, 'Visions of labor: illustrations of the mechanical arts before, in, and after Diderot's *Encyclopédie*', in Stephen Laurence Kaplan and Cynthia J. Koepp (eds.), *Work in France: Representations, Meaning, Organization, and Practice*, Ithaca, NY: Cornell University Press, 1986, pp. 258–86, 276.

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earlier sailor–authors as made up of mechanical parts, it had also been described as connected through the labour of its crew, who had to work to create new rudders and to salvage the ship under sail whilst responding to the forces of wind and wave. Steel's treatise bypassed this social process and instead deconstructed the ship through the explanations he could tease out from his unwilling interviewees; the sailors' working environment was now depicted as a fixed reality which could be rationalized and mastered by those who purchased the treatise. The skilled labour required to operate the ship was abstracted, allowing the author and reader to gain an overview of a mechanical environment without reference to the collective working knowledge which bound it together.

In promoting 'maritime science', Steel's treatise also represented a move towards a social stratification of seafaring knowledge. Steel wrote that its practitioners should be divided into ordinary seamen, who knew their craft but could not properly articulate it, and a small group of expert 'naval artists', made up of officers who might direct maritime labour with their superior understanding of seamanship. This invocation of the 'artist' was drawn from the development of a defined field of mechanical arts developed by communities of mathematicians and natural philosophers in the preceding century, and Steel thus reoriented and stratified the social background of suitable participants in the 'maritime science' he proposed. The residents of the lower deck, who had learned seamanship since childhood in coastal nurseries, could only ever hope to possess an inferior form of seafaring knowledge as compared to the artists who learned it from a book. Steel seems again to have been influenced by developments in France during the earlier eighteenth century, particularly the rise of the *artiste* as a paragon of useful Enlightenment knowledge. As Denis Diderot wrote, *artiste* was a 'noun that one gives to workmen who excel in the mechanical arts that need intelligence', as opposed to artisans, who were, as Paola Bertucci describes, 'workers that carried out mindlessly repetitive manual operations'.[76] By defining 'artists' in opposition to seamen, Steel's treatise provided a convenient means by which naval officers could conceive of their knowledge as superior on board ship, and severed the work of the hand from the work of the mind. The naval artist's role was to direct and oversee the operation of the ship's machinery, keeping a watchful eye on the seamen beneath him who knew the particular details of each part of the ship, but could not conceive of how the vessel worked as a whole machine. Experience might buy a seaman a close working knowledge of the ship's ropes and planks, but only the owner of Steel's manual, as an artist, could claim to oversee its operation.

Although he provided the manual from which they could work, Steel was not the first to propose the need for 'naval artists' to oversee seamen. In 1783, six years after Hutchinson published, Jonas Hanway recommended the instruction of two classes of boys who would be differently instructed in seamanship in his proposal for county naval free schools. For every hundred 'free scholars' intended for the lower decks, there would be six who paid a fee of thirty pounds per year and were designated 'artists'. They would be trained in command 'according to their rank and condition, that they may feel their own importance'.[77] These boys would pursue a different course of education than their poorer counterparts, in the scientific principles of the 'wonderful machine' which they were to take charge of.[78] The poorer free scholars would be shown images of ships, so that the different parts were 'rendered familiar' but would ensure that their knowledge was 'totally independent of the scientific part of navigation, or the

[76] Paola Bertucci, *Artisanal Enlightenment: Science and the Mechanical Arts in Old Regime France*, New Haven, CT: Yale University Press, 2017, p. 4.

[77] Jonas Hanway, *Proposal for county naval free-schools, to be built on waste lands*, London: Marine Society's Office, 1783, p. xvii.

[78] Hanway, op. cit. (77), p. xvii.

architecture of the ship'. The six artists, meanwhile, would learn the 'science' of seamanship from 'proper books'.[79] This chimes closely with James Fisher's assessment of the changes under way in the dissemination of a newly hierarchical agricultural knowledge in the eighteenth century.[80] In Steel's treatise, and in Hanway's design for naval schools, the separation between mental and manual labour was articulated as a clear hierarchy, with those who could glean an overview of the architecture of the ship and its scientific principles rendered superior to experienced seafarers who knew their work by experience alone.

As the 1790s progressed, the assumption that seamanship needed to be exhumed from the bodies and minds of sailors in order to educate a new managerial stratum of 'naval artists' was consolidated amongst contemporary observers. By 1799, the Scottish naval author John Clerk of Eldin felt emboldened to write a *System of Seamanship*, beginning with his lament that ordinary 'honest tars' could not participate in the 'noble art' of seamanship or improvement of the 'machine' they inhabited. 'What a pity', Clerk wrote, 'that an art so important, so difficult, and so intimately connected with the invariable laws of mechanical nature, should be so held by its possessors, that it cannot improve, but must die with each individual'. Seamen, in Clerk's view, could not 'arrange their thoughts; they can hardly be said to think', so that 'their art, acquired by habit alone, is little different from an instinct. We are as little intitled to expect improvement here as in the architecture of the bee or the beaver'.[81] Again, this echoes Denis Diderot's description of craft workers, that 'most of those who engage in the mechanical arts have embraced them only by necessity and work only by instinct'.[82] It also closely echoes the descriptions of husbandmen and -women earlier in the century detailed by Fisher, who 'acquire accidental knowledge, which they cannot explain, nor do they understand', and 'like Moles, blindly run on in the Tract their Fathers had made before them'.[83]

Middling authors on seamanship in the 1790s were thus drawing on a lingua franca which designated labouring men and women as mindless creatures, capable only of working by rote rather than devising improvement. Although beavers and bees were admired for their industrious societies in early modern Britain, they were also, like the mole, understood to work through blind repetition, and the drone had by the late eighteenth century become associated with the labouring classes.[84] Now that seamanship was recognized as a mechanical art and the ship as a machine, Clerk wrote that there was a dire need for seamen to be directed by a new stratum of naval officers who could 'furnish the seaman with a better machine and direct him to a more dextrous use of it'. Clerk's introduction of mathematical equations in his *System* to 'fix' the rules of seamanship does not once mention the sailor–authors who had preceded him, and frames the mechanical ship as an environment worked by invisible mindless operatives, overseen by a lone 'artist'.[85]

It is useful perhaps to place Clerk's argument about seamen within the immediate social and political context of Britain in the late 1790s. In the spring and summer of 1797, news of naval mutinies at Spithead and the Nore reverberated across the country,

[79] Hanway, op. cit. (77), p. 91.

[80] Fisher, op. cit. (34).

[81] John Clerk, *A System of Seamanship and Naval Tactics, Extracted from the Encyclopaedia*, Philadelphia: Thomas Dobson, 1799, p. 5.

[82] Denis Diderot and Jean le Rond d'Alembert (eds.), *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc*, Paris: Antoine-Claude Briasson, 1751, vol. 1, p. 29.

[83] Fisher, op. cit. (34), p. 105.

[84] Tammy Horn, *Bees in America: How the Honey Bee Shaped a Nation*, Lexington: University Press of Kentucky, 2005, p. 5.

[85] Clerk, op. cit. (81), p. 5.

as hundreds of seamen seized control of their vessels, expelled their commanding officers and issued lists of demands regarding pay and working conditions. Although historians have been divided on how extensive the politically radical elements were, it is clear that the implications of the mutinies were profound for contemporary observers, with the actions of the mutineers instilling a fear in many that seamen might not be the reliable, burly, loyal Jack Tars which they were often represented as in caricature.[86] The ease with which seamen seemed to assume autonomy from their commanders on mutinying ships was a subversion of the natural social order and proved deeply troubling to both the British state and the public.[87] Indeed, the very force which was supposed to protect Britain from French invasion now, it seemed, posed a real threat to the country's security. Efforts made by Clerk to excoriate seamen for their irrationality and mindlessness in 1799 need to be understood against this backdrop as well, as an attempt to cast seamen as incapable of political as well as intellectual authority.

Clerk's words were also part of the longer trajectory which this article has explored, however, and by the time he set pen to paper, naval officers were, it seems, already only too keen to fill the role of 'naval artist'. Mat Paskins's doctoral research has uncovered that from the late 1790s onwards, 'naval inventors' were the largest category of recipients of awards from the Society for the Encouragement of Arts, Manufactures, and Commerce and the number of 'naval inventions' by officers was greater than that of any other class.[88] As Paskins finds, the society 'never made any mention of premiums for naval purposes', yet, from around 1800, 'year after year, this is what candidates offered, and what prizes were given for'.[89] The majority of prizes were awarded to officers and captains for alterations to the wooden ship as a working environment, such as 'improved ship's capstan', a 'plug for raising empty casks', 'oars to be worked by one hand' and an 'instrument for ascertaining the Stability and Inclination of a Ship when under sail'.[90] Several naval men seem to have been working on multiple creations at the same time. In 1816, a Lieutenant Shuldam was awarded the 'gold Isis Medal' for his 'improved pullies and blocks' and the silver medal for 'improvement in working a capstan'.[91] This remarkable surge in naval interest in the society continued from around 1800 and well into the 1830s. All of the prizes given to naval men for their improvements of the wooden ship were awarded under the same category: 'mechanics'.

Paskins has pointed to the significant patronage available for naval inventions as a possible explanation for this dramatic increase. However, the existence of patronage for shipboard alterations, and the sheer volume of submissions, must also be tied to the recasting of seamanship as a mechanical art over the preceding fifty years. Officers possessed a new interest in making improvements to the ship, and took on the role of 'naval artist' in mastering their mechanical environment. None of the awards detail involvement from seamen in devising or enacting their inventions, and the prizes were given for the mental work of an individual rather than the collective embodied work of the ship's crew. This shift from a prizing of collective manual labour to individual mental acumen is further

[86] For two opposing assessments of the motivations of the Spithead and Nore mutineers see Niklas Frykman, *The Bloody Flag: Mutiny in the Age of Atlantic Revolution*, Berkeley: University of California Press, 2020, pp. 127–64; and Anthony G. Brown, 'The Nore Mutiny: sedition or ship's biscuits? A reappraisal', *Mariner's Mirror* (2006) 92(1), pp. 60–74.

[87] James Davey, *Tempest: The Royal Navy and the Age of Revolution*, New Haven, CT: Yale University Press, forthcoming, Chapter 7.

[88] Matthew Paskins, 'Sentimental industry: the Society of Arts and the Encouragement of Public Useful Knowledge, 1754–1848', PhD dissertation, University College London, 2014, p. 83.

[89] Paskins, op. cit. (88), p. 83.

[90] Paskins, op. cit. (88), pp. 83–4.

[91] *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce* (1816) 34, p. 30.

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represented in a 1793 publication of the Society for the Encouragement of Arts, Manufactures and Commerce which details the 'invention' by Captain Edward Pakenham of 'a substitute for a lost rudder'. The invention is remarkably similar to that described by Hutchinson and Nichelson several years earlier, but the account given of its creation is very different. Whilst Nichelson's representation of events emphasized the work of the crew in pooling their experience to arrive at the invention of their new 'machine', Pakenham's account describes him as a 'highly-esteemed inventor' and includes a plan of 'my machine', which he seems miraculously to have devised and wrought single-handedly.[92] The plan for a temporary rudder is almost identical to that designed by Nichelson's crew, but it would come to be known as 'Pakenham's Rudder', described as 'genius working for the benefit of humanity', and accordingly awarded a gold medal by the Society for the Encouragement of Arts, Manufactures and Commerce.[93] In reinventing the ship as a machine, sailor–authors had unwittingly set out the terms of a hierarchy of knowledge, which experienced lower-deck seamen could never hope to be at the top of. Seamen did not stop learning through experience in coastal nurseries, and were still relied upon for their skilled labour across the Royal Navy and merchant marine. However, theirs was now deemed to be an inferior form of knowledge learned by 'rote' which needed to be overseen and corralled by a stratum of expert 'artists' such as Pakenham.

By the beginning of the nineteenth century, then, lower-deck seamen were no longer suitable custodians or communicators of the new 'maritime science' of seamanship. In 1808, a former East India Company clerk named Darcy Lever published what would go on to be the most successful manual for educating the new class of naval 'artists' in their mechanical profession, with its popularity extending well into the nineteenth century. Lever's *The Young Sea Officer's Sheet Anchor* consisted almost solely of labelled drawings of the ship in parts, and went on to be published in new editions in 1819, 1827, 1835, 1843, 1853, 1858 and 1863.[94] Lever, like David Steel, had no seafaring experience himself and relied on 'quizzing many practical seamen' in order to extract the explanations he needed, and employing the services of William Butterworth, a former slave ship sailor, to set down the accompanying images. Lever's illustrated manual was met with critical acclaim: the *Anti-Jacobin Review* noted that it was the 'most complete Representation of all the Mechanical Operations of Seamanship, which has yet appeared', and the *British Critic* praised the 'perspicuity and copiousness' with which 'the vast Machine' was represented.[95] The book was conspicuously marketed at the new generation of naval artists and set out to instil in them the superiority of their mechanical knowledge. As Lever wrote, the inclusion of engraved plates rather than the descriptions of seamen themselves was essential, as a 'mere verbal explanation often perplexes the mind, for no one but a seaman can comprehend it; and he is not the object for whom such an aid is intended'.[96]

Conclusion

At the beginning of the eighteenth century, experienced seamen in Britain had been deemed suitable communicators of the practical skills of seamanship, if not of navigation. Indeed, it was this intrinsic authority which allowed men like Falconer, Hutchinson,

92 Edward Pakenham, *Captain Pakenham's invention of a substitute for a lost rudder*, London: Society for the Encouragement of Arts, Manufactures, and Commerce, 1793, pp. 6, 8.

93 Pakenham, op. cit. (92), p. 46

94 John H. Harland, 'Introduction', in Darcy Lever, *The Young Sea Officer's Sheet Anchor: Or a Key to the Leading of Rigging and to Practical Seamanship*, New York: Dover Publications, 1998, pp. iii–iv.

95 Harland, op. cit. (94), p. viii.

96 Harland, op. cit. (94), p. vi.

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Nichelson and Gower to generate a new strand of natural-philosophical discourse which placed a high value on their practical experience and framed it as a form of maritime empiricism. The agency which sailor–authors like Hutchinson, Nichelson and Gower had exercised in communicating and 'circulating' their knowledge beyond the bounds of their skilled community resulted not in the elevation of seamen as practitioners, but in their denigration as hapless handworkers in need of managerial oversight to direct their labour. The ship had long been a site where social hierarchies did not map directly onto hierarchies of knowledge. The recasting of the ship as a machine and of seamanship as a form of mechanical art ultimately allowed officers and captains to correct this somewhat, by elevating their own knowledge to the status of ingenious invention. As this article has demonstrated, this appropriation of knowledge was part of a pattern which repeated across the seventeenth and eighteenth centuries, whereby artisans and labourers who shared their working knowledge were systematically excluded from the communities of natural-philosophical thought which they had contributed to. Naval officers, drawn from middling and elite social backgrounds, were to take their place as the legitimate overseers of the 'noble machine' which they inhabited, with maritime labourers mere cogs in its operation. Treatises authored by experienced lower-deck seafarers were replaced by manuals which represented the ship in pieces, encouraging 'naval artists' to master the ship's working parts with a reduced recourse to the words, movements and skilled authority of seamen once on board ship.

The legacy of this social stratification is identifiable into the nineteenth century. *Sheet Anchor* went on to be considered the indispensable manual for naval officers, securing seamanship's status as a form of professional managerial knowledge which was the preserve of the upper echelons of shipboard society. To return to a quote from the opening pages of this article, by the 1840s the seaman Samuel Leech described the wooden ship as 'a set of human machinery, in which every man is a wheel, a band, or a crank, all moving with wonderful regularity and precision to the will of its machinist – the all-powerful captain'.[97] The logic of this dynamic continued to be taken up by officers and captains themselves. In the 1830s, the former naval captain Frederick Marryat wrote of the officer's mastery of the ship that, 'by long practice and experimental workings, he brings her under that control which almost verifies Byron's sublime idea, "She walks the waters like a thing of life"', and distinguished the shipbuilder and seaman from the officer experts who controlled and oversaw the wooden ship.[98] Of the natural authority of naval officers, Marryat cited as evidence the 'improvements which have emanated from scientific officers', including 'the chain cables of Captain Brown – the capstern and compass of Captain Phillps – the rudder of Captain Lehon', innovations which appear to have been the breakthroughs of lone naval artists.[99]

The invocation of mechanical expertise as a means of understanding the ship had opened seamanship up to the intellectual and social stratification which had attended the mechanical arts for over a century, and the middling and land-bound authors who plagiarized and followed the first wave of treatises took little time to assert that captains and officers, rather than the original proponents of shipboard mechanical philosophy, were the suitable participants in its continued development. It is essential to connect seamanship to other studies of the knowledge of manual labourers and artisans, as similar processes were occurring on farms, in workshops and in emerging spaces of scientific experiment earlier than the 1790s. Connecting these case studies and focusing on continuities within the history of knowledge offers important reminders that the codification of

[97] Leech, op. cit. (17), p. 40.
[98] Frederick Marryat, 'School of Naval Architecture', *Metropolitan Magazine*, 8 November 1833, p. 228.
[99] Marryat, op. cit. (98), p. 227.

practical skill consistently resulted in those of lower socio-economic status being excluded from early scientific communities. Rather than representing a moment of open public participation, the eighteenth century was part of a continuum of the exclusion of manual workers. As this article has shown, the 'circulation' of prized maritime knowledge in eighteenth-century Britain had the effect of hardening hierarchies based on social difference through the cultivation of a 'superior' means of knowing the wooden ship and managing maritime labour.

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