Chapter 7

'Perfectly correct': Russian Navigators and the Royal Navy

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The era of the Board of Longitude's existence, between 1714 and 1828, was also a remarkable period in the history of Russia's navy. At the beginning of the eighteenth century, Tsar Peter I set about reforming the Russian military following disastrous campaigns in the Great Northern War with Sweden, and created a substantial Baltic fleet centred on the new capital, St Petersburg.[1] To provide expertise for training sailors on Russian ships, Peter turned west, and in particular to Britain. These efforts inaugurated a steady traffic of experts and students between Britain and Russia in the eighteenth and early nineteenth centuries which helped transform Russian navigation practices into a form resembling, and sometimes advancing on, those of Britain. This essay explores the British role in developing Russian navigation and makes three arguments. First, while the Russians evidently relied greatly on British expertise during this period, the traffic was not one way. Russian institutions provided theoretical expertise, practical experimental resources, and generous patronage that played a role in shaping British solutions to navigational problems including finding longitude at sea. Russians were not passive recipients of British expertise, and some techniques, at least, emerged from transnational co-operation and the circulation of knowledge.[2]

Second, an examination of the techniques used to navigate on Russian ships makes clear that officers did not rely on any single method, such as an accurate chronometer, but used several different approaches, choosing the one most appropriate to a given situation. This diversity and opportunism supports criticisms of a historiography of longitude that has presented John Harrison's marine timekeepers as 'the' solution to the longitude in the eighteenth century.[3] Third, as Russian officers chose between many methods of navigation, so this process entailed complex relationships of trust in different instruments and personnel. Navigation was not just a technical procedure but an emotional, often unpredictable negotiation, and judgments of trust were critical in making decisions. British personnel, instruments and techniques helped Russians make such adjudications, and while Britishness was no guarantee of navigational reliability it was often taken into consideration in navigating decisions.

The rise of Russian navigation, 1700–60

In the seventeenth century, Muscovite Russia was more preoccupied with land than sea.[4] The Tsars pursued a land-based empire, annexing new territories and opening them to settlers. Prosperity depended on serfdom, and keeping the serfs fixed to their estates. Until the end of the eighteenth century, most Russian exploration focused on the land, charting new territories in the south and east and the vast regions of Siberia and Kamchatka. Mathematical and astronomical navigation (*korablevozhdenie*, *navigatsiia*, *moreplavanie*) at sea thus appear to have been virtually unknown in Russia before the end of the seventeenth century, though some compasses were manufactured in Kholmogory and may have been used in coastal areas.[5] A text known as 'The Starry Sky of the Archangel Sailors', surviving in six copies and dating from the seventeenth century, described the southing of stars, the compass rose, the means of finding true north, and the use of dividers. It also included the first known Russian star map. But since it contained errors Ryan has proposed that it is unlikely to have been used at sea.[6]

This situation changed in the reign of Tsar Peter I (*c*.1698–1725), who encouraged navigational education in Russia as part of an effort to build up a new imperial navy with newfound access to the Baltic via St Petersburg, the new port capital founded in 1703. Peter was personally interested in western navigation and studied with the Dutch master Jan Albertusz van Dam during a visit to the Dutch Republic in 1697.[7] He trusted foreigners to improve navigation in Russia and often positioned navigation at the forefront of broader educational reforms. Russian students were sent abroad to Venice and Dalmatia in the 1690s to learn navigation.[8] In 1701 Peter opened a School of Navigation in Moscow, while Russia's first book on navigation, published the same year, derived from the sea-manuals of the Dutch writer Abraham de Graaf.[9] Despite this Dutch connection, Peter chose to hire Scots and English to run the new Moscow school, reflecting both the high reputation of British navigation and a tradition of hiring Scots to serve in the Russian court.[10] Heading the new school was the mathematician and astronomer Henry Farquharson of Marischal College, Aberdeen, together with two alumni of the Royal Mathematical School at Christ's Hospital – Stephen Gwyn and Richard Price. Ryan has traced the history of the Moscow School of Navigation and notes that it was one of the first institutions to teach geometry, trigonometry and astronomy in Russia, to some 200 students aged between 12 and 17.[11] An extant manuscript, probably dating to 1703 and perhaps authored by Farquharson, indicates that students learned geometry, course plotting and dead reckoning through worked examples, and found latitude by means of observations of the height of the Sun using a Davis quadrant (backstaff), methods typical of late seventeenth-century English practice.[12] Ryan suggests the likely English provenance of this text, which took London as the prime meridian and included measures in English feet.[13]

In 1715 the School transferred to St Petersburg and was renamed the Naval Academy. Farquharson taught there until his death in 1739. The Naval Academy had its own press, and helped to introduce basic western ideas of spatial literacy and navigation to Russia. Under Farquharson's direction, members of the Naval Academy published handbooks on mathematics and navigation in the 1730s, including the first navigation book published by a Russian author, the Baltic fleet officer Stepan Gavrilovich Malygin.[14] In 1752 the Naval Academy was reformed and became the Naval Cadet Corps.[15] Trust in British expertise endured. After Farquharson's death the Russian government was keen to find a British replacement, and candidates included Matthew Mitchell, captain of the *Pearl* on George Anson's expedition of 1740–44, and the astronomer Thomas Wright of Durham. These men proved too expensive to hire but the royal naval schoolmaster of the *Penzance*, Thomas Newberry, was appointed professor of mathematics and navigation at the Naval Cadet Corps in 1757 and remained there five years.[16] After his departure, the Cadet Corps continued as a centre for British influence, publishing the first English grammars for Russians and the first Anglo–Russian dictionaries.[17]

Just upriver from the Naval Cadet Corps on Vasilevskii Island in St Petersburg was the Imperial Academy of Sciences, another institution created by Peter I to enhance education in Russia.[18] Again, Peter and his assistants relied on imported expertise to staff the new Academy, which included among its members prominent foreign savants such as the French astronomer and geographer Joseph-Nicolas Delisle and the Swiss mathematician Leonhard Euler. From its opening in 1725 the Academy devoted much attention to geography, exploration and navigation. The very first public assembly held there in 1727 consisted of a lecture on the problem of discovering longitude, discussed by the mathematicians Georg Bernhard Bilfinger and Jacob Hermann.[19] Bilfinger explained to an audience of nobles and officials who were unfamiliar with the sciences that mathematics was ‘excellent for Navigation’ and went on to explain the difficulties of using eclipse observations and timekeepers to find longitude at sea. Bilfinger looked to the work of British astronomer Edmond Halley for an alternative and suggested that Halley’s chart of magnetic variation based on multiple measures of magnetic declination might offer a future solution. He suggested that careful and exact measures in Russia needed to be made, ‘We may know in some years whether or not we can count on these measures, or whether they have to be abandoned’.[20]

As Raspopov and Meshcheryakov have shown, both before and after Bilfinger’s speech numerous measurements of magnetic variation were made across the Russian empire. Peter I decreed that Russian vessels must measure declination off the Russian coasts and the academic adjunct Friedrich Christoph Mayer made measurements on the site of the Academy in 1726. From the 1690s Russian nautical charts included magnetic declination and, from 1714, Peter inaugurated the translation and publication of numerous atlases of the Baltic Sea showing declination.[21] In the Russian Naval Regulations of 1720 Peter also ordered all new ships to be fitted with compasses, and in the following year established a compass manufactory in St Petersburg, overseen by the Admiralty Board.[22] Peter also sent Vitus Bering on an expedition to Kamchatka from 1725 to 1728, while the Academy organized a second Kamchatka expedition, again under Bering, in 1733 to 1743. Both voyages took many variation measurements.[23]

Ultimately, magnetic variation would not turn out to be a definitive longitude solution, but the Russians invested in other avenues of research. In 1732, perhaps in answer to Bilfinger’s call, one P. I. Roquette, watchmaker to the Empress Anna Ivanovna, sent a longitude solution to the Royal Society, where it was translated and discussed by the mathematician and astronomer James Hodgson.[24] The proposal hinged on various cosmological assumptions and the idea that longitude might be found using a combination of portable clocks and tables of the variations they underwent in different seasons owing to changes in air pressure, which Roquette claimed to have discovered. Hodgson, who digested the method for the Royal Society, was unimpressed,

> What answer must be given to a Man who is so very ignorant of the first principles of Astronomy and Philosophy, who has asserted so many falsehoods and calls them Demonstrations, and is so vastly fond of his Performance I leave you, Gentlemen, to determine.[25]

A much more successful contributor to solving the longitude was the academy's mathematician Leonhard Euler. Euler had considered a naval career as a young man and his interests in navigation were significant. He firmly believed that mathematics would improve the art. In an essay on the utility of higher mathematics, he wrote,

> no one, I imagine, would dare to question the utility of higher mathematics [for navigation]. If we consider the journey of a boat on the ocean, we will think first of the loxodromic curve, the invention of which assuredly may not be attributed to elementary mathematics. This curve is used to solve most of the problems that present themselves to anyone who wants to study the art of setting the course of a ship. The complete theory of navigation […] is so arduous, demanding such a deep knowledge of hydrostatics and mechanics that the help of higher analysis is of prime necessity.[26]

Euler reckoned mathematics was also essential to understand the ideal shapes for ships' hulls, the effect of cargo on a ship's equilibrium, and the art of arranging sails and steering in a contrary wind. He promoted the work of Johann Bernoulli on these questions and addressed some of them himself in *Scientia navalis*, completed in St Petersburg in 1738 and published in 1749. The treatise lay out the principles of hydrostatics and a scientific theory of shipbuilding which proved influential.[27] In England, the book was published in translation at the instigation of East India Company engineer Henry Watson in 1776, and Euler's ideas informed experiments to study ideal hull shapes made in Britain by Mark Beaufoy in the 1790s for the Society for the Improvement of Naval Architecture.[28]

Euler's first book of lunar theory, published in 1753, addressed the three-body problem and was important for navigation.[29] In 1755, at Euler's request, Tobias Mayer sent a set of lunar tables worked out using Euler's theory from Göttingen to the Admiralty, who referred them to the Board of Longitude in London as a submission for a reward.[30] In February 1765, after Mayer's death, the Board awarded £3000 to his widow for this contribution, with £300 awarded to Euler on the grounds that his calculations had been the basis of Mayer's tables.[31] Having tested Mayer's tables on a voyage to St Helena in 1761, Nevil Maskelyne published his *British Mariner's Guide* and, as Astronomer Royal, the first *Nautical Almanac*.[32] Euler participated in the election of Maskelyne to the St Petersburg Academy of Sciences in 1776.[33]

A member of the Russian Academy thus played a significant role in shaping British navigational practice. Euler also helped to spread news of the longitude reward and its applicants to Russian and German readers via his *Letters to a German Princess*, published in 1768 and addressed to a lay audience unfamiliar with the sciences. The book, consisting of a series of letters sent to the 15-year-old Sophie Charlotte of Brandenburg-Schwedt, included a long discussion of navigation techniques.[34] After describing dead reckoning, Euler explained how a timekeeper could be used to find longitude. While he approved the method, Euler regretted that a clock of sufficient accuracy would never be created, since even John Harrison's experiments had failed:

> About ten years ago […] an English artist pretended that he had constructed a timepiece proof against the motion of a ship at sea […] on which the inventor claimed and received part of the parliamentary reward proposed for the discovery of the longitude […] But since that time we have heard no more of it; from which it is to be assumed that this attempt has failed, like many others which had the same object in view.[35]

Euler went on to advocate, not surprisingly, astronomical methods of longitude determination, and measures based on the Moon's motions, via Mayer's tables in particular. He explained how the 'English nation, generously disposed to engage genius and ability' offered 'three prizes, for ascertaining the longitude' and made clear his view that 'Mr. Mayer is at this moment claiming the highest, and I think he is entitled to it'.[36] Discussions of navigation were thus not restricted to technical literature in eighteenth-century Russia, and protagonists in the search for longitude helped convey news of the British competition to new audiences. Euler also had a significant impact on British navigating techniques, reminding us that navigational knowledge did not travel in only one direction between Britain and Russia in the eighteenth century. Other Russian academicians sought to contribute to the longitude. The Academy's professor of chemistry Mikhail Vasil'evich Lomonosov wrote a dissertation on navigation in May 1759. Lomonosov proposed a form of marine chair for keeping a telescopic observer steady on board a ship, perhaps inspired by the marine chair of

Christopher Irwin, patented in March 1759.[37] While the consequences of Lomonosov's plans are unknown, another St Petersburg academician, Wolfgang Ludwig Krafft, devised new procedures for reducing lunar distances, which he sent to Maskelyne in 1794.[38]

Britain and the reform of the Russian Navy, 1760–1800

In 1770, the Empress Catherine II lamented that 'up to the year 1762 the navy has fallen little by little into annihilation'.[39] Ships were poorly constructed, badly supplied with artillery, and the organization of shipyards and naval administration needed reform. Catherine was determined to improve matters, leading to a renewed exchange between Britain and Russia's navies. While the Russian government preferred German and French academics, when it came to navigation they continued to employ Scottish and English experts to bring about improvements. Beginning in 1768, the Admiralty ordered ships' cannon and a steam-pump from the Carron Company of Falkirk.[40] Several Scots officers were taken into Russian service in 1764, including Lieutenant, later Admiral Samuel Greig, who distinguished himself in action against the Turks.[41] English officers were also hired. From 1770 to 1774, Charles Knowles served as an admiral of the Russian fleet, while Samuel Bentham, subsequently Inspector General of the Naval Works at Portsmouth, built ships for the Black Sea fleet for Empress Catherine's favourite Prince Grigorii Potemkin between 1780 and 1791.[42] Captain James Cook's former midshipman James Trevenan also joined the Russian Navy, serving from 1787 until his death in action in 1790.

Knowles set about transforming the Russian Navy along English lines, overseeing a series of reforms based on comparing the state of Russian ships and naval administration to English practice. Knowles included concerns about navigation in his recommendations to Catherine II,

> The vessels of Your Imperial Majesty are also extremely lacking in disciplined subaltern officers and a number of good Boatswain's mates to arrange and dispose the sailors to their respective duties, as much in the navigation as in the manoeuvring of vessels, in which I am well informed they are very defective, particularly in darkness and in bad weather.[43]

Knowles had experience with navigational improvement. He had recommended the Scots navigator and later natural philosopher John Robison to the Board of Longitude as the keeper of John Harrison's timekeeper on its trial to the West Indies in 1762. When Knowles went to Russia in 1770 he engaged Robison as his private secretary, and Robison was subsequently appointed inspector general of the marine cadets at the Russian naval base in Kronstadt with the rank of lieutenant colonel, where he remained until 1774.[44] Despite his concerns over navigation, Knowles's main preoccupation was improving shipbuilding in Russia and most of his advice concerned timber and hemp supply and the organization of shipyards and shipbuilding.

Russia's circumnavigations, 1800–30

Knowles, Greig and Bentham were engaged primarily to provide immediate leadership and assistance in wartime, helping to build up the Russian fleet to fight the Turks and the Swedes.[45] They were not explicitly hired to train Russians in British navigation methods, and their focus was on improving shipbuilding and construction, as had been Euler's in *Scientia navalis*. But subsequent Russian efforts did focus on training students in British naval and navigation techniques. In 1785, no doubt inspired by Cook's circumnavigations, the Russian government hired Joseph Billings, able seaman and astronomer's assistant to William Bayly on Cook's third voyage, to lead an overland expedition to Kamchatka and the Aleutian islands to investigate the fur trade. Billings was expected to train students from one of a number of regional navigation schools which had opened across the empire by that time. His instructions included the order to take 'five or six of the best scholars of the Navigation School' at Irkutsk, and 'to employ them […] in surveying and drawing charts'.[46]

Russian interest in the fur trade led to further naval developments in the early nineteenth century. Between 1803 and 1850 36 expeditions set out from St Petersburg to sail around the world to provision the Russian American Company's fur-trading posts in Alaska and open trade to China and Japan. Baltic German and Russian naval officers headed these circumnavigations, including Adam Johann von Krusenstern and Yuri Lisianskii on *Nadezhda* and *Neva* (1803–07), Vasilii Mikhailovich Golovnin on *Diana* (1807–09), Otto von Kotzebue on *Rurik* (1815–18) and Feodor Petrovich Litke on *Seniavin* and *Moller* (1826–29). As Vinkovetsky has shown, the voyages marked a shift in Russian imperial policy, giving a new role to the navy and maritime colonies in place of a traditional emphasis on land-based territorial acquisition.[47] The British overseas empire was part of the inspiration for this change, and the Russian circumnavigations marked a highpoint in British interaction with Russian navigation.

The Academy of Sciences supported these voyages. From 1787, academic astronomer Petr Borisovich Inokhodtsev lectured to naval officers on navigational science. Inokhodtsev had continued the Academy's programme of measures of magnetic variation in the 1770s, noting that Kursk's measures were anomalous, explained by very large deposits of iron ore in the region.[48] By 1803 another academic astronomer, Friedrich Theodor Schubert, began training naval officers and published a short textbook on the determination of latitude and longitude using astronomical methods.[49] Schubert also developed new instruments for the circumnavigators including a sextant, pocket chronometer and achromatic telescope. From 1813, he published the *Morskoi mesiatseslov* (Maritime Calendar), equivalent to the British *Nautical Almanac*. After the Krusenstern-Lisianskii voyage, another academician Platon Iakovlevich Gamaleia published *The Theory and Practice of Navigation* (St Petersburg, 1806–08), which used Krusenstern's experiences to formulate navigating methods for subsequent Russian voyages.[50]

The Academy took the problem of longitude seriously in these years and may have served as an alternative source of support for longitude schemes to the Board of Longitude. In 1803, the Academy was visited by the Pennsylvania surveyor John Churchman, who planned to solve the longitude by magnetic variation, a method of longstanding interest to the Russians.[51] Churchman was elected to the St Petersburg Academy, and proposed his method to the Russian Admiralty, though it is not clear what became of it. In English proposals for his method, Churchman used his status and connections in Russia to lend credit to his ideas.[52]

The main source of expertise sought by the Russians in navigation, however, continued to be Britain. British navigators and naval expertise continued to enjoy a high reputation, particularly after Cook's voyages became known in Russia.[53] In 1793, the Russian ambassador in London, Semen Romanovich Vorontsov, arranged for 14 young naval officers to travel to Britain to spend four years in the Royal Navy. Twelve more followed in 1797.[54] Half were dispatched to the Mediterranean while the other half served in the West Indies. When they returned to Russia in 1799 they were ardent anglophiles, prompting some to fear their loyalties might be divided:

> They spoke the language, and had a good deal the manners and appearance of British seamen […] They spoke openly in favour of England, and refused to throw aside their blue jackets and trousers, notwithstanding the emperor had issued two orders to that effect.[55]

Many of the circumnavigators came from this contingent. The first was Adam Johann von Krusenstern, a Baltic German native of Estonia, who like many Baltic Germans under Russian rule served in the Russian Navy. In May 1794 Krusenstern sailed to America in the British ship *Thetis* under the command of Captain Alexander Cochrane. Another Russian in the same squadron, sailing on *L'Oiseau*, was Iurii Lisianskii, a graduate of the Russian Naval Cadet Corps and a veteran of Russia's war with Sweden of 1788–90. Lisianskii fought with Rear-Admiral George Murray against American ships provisioning France, sailed to Halifax and the West Indies, then travelled across the United States, before joining Krusenstern on the *Reasonable*, captained by Charles Boyle and bound for the Cape of Good Hope. Krusenstern went on to India and China while Lisianskii travelled in South Africa.

This extensive experience and training led Tsar Alexander I to appoint Krusenstern and Lisianskii to lead the first Russian circumnavigation from 1803 to 1806, on the *Nadezhda* and *Neva*, both originally constructed in Britain. Other officers trained by the Royal Navy, or trained by officers who had trained in Britain, commanded subsequent circumnavigations. Vasilii Mikhailovich Golovnin, who served in the Royal Navy in the 1790s, took his ship *Diana* to North America in 1807–09, and then took the *Kamchatka* in 1817–19. Two of Krusenstern's officers, Otto von Kotzebue and Thaddeus von Bellingshausen, commanded voyages to the Pacific between 1815 and 1826. Golovnin's officers Ferdinand von Wrangell and Fedor Petrovich Litke sailed on *Krotkii* and *Seniavin* to North America in the late 1820s.

British navigational expertise was not exclusive to the Royal Navy, however. Another navigator on the Krusenstern voyage was a veteran of the East India Company.[56] As a youth, Hermann Ludwig von Löwenstern, another Baltic German, had tried to learn navigation with a Russian pilot. 'I went to a lot of trouble with it,' he wrote in his diary, 'but did not get very far'.[57] Instead Löwenstern joined the East India Company and spent five months learning English and navigation. Although he quit because he found life on a Company ship unbearable (full of 'wrangling, strife, envy, hate, deceit, cheating, egoism, uncharitableness, lies, and laziness'), Löwenstern nevertheless retained a great admiration for all things British.[58] He always spoke of distances in 'English miles' and admired English instruments. On board Krusenstern's ship *Nadezhda* when it landed in England on its outbound voyage, Löwenstern was delighted when the captain purchased him a sextant and chronometer from Robert Pennington.[59]

The Russian officers' enthusiasm for Britain and the Royal Navy thus included an admiration of British navigational instruments. This was a common attitude among the Russians. Even before the first Russian circumnavigation began, Lisianskii travelled to London to purchase instruments and two ships, which became the *Nadezhda* and *Neva*. The instruments included a reflecting circle, 12 inches in diameter, a ten-inch sextant, a three-foot transit instrument by Troughton and an 18-inch diameter astronomical quadrant by Adams. Lisianskii also bought four Arnold and two Pennington chronometers. All of these were shipped to the St Petersburg Academy of Sciences, where the astronomer Schubert tested and prepared them for the voyage. In the end, three of the chronometers were taken – an Arnold box chronometer, which Krusenstern reckoned was the best of the three, an Arnold pocket chronometer, which stopped for a time during the voyage, and a Pennington pocket chronometer. Krusenstern also used Mayer’s lunar tables, as revised by the astronomers Tobias Bürg and Charles Mason, and charts by the English cartographer Aaron Arrowsmith. When he left St Petersburg in *Nadezhda* in 1803, Krusenstern and his astronomer Johann Caspar Horner insisted on stopping in London to buy more instruments, which Löwenstern thought were ‘very nice’.[60]

Such arrangements became formalized for subsequent voyages, with a letter being sent to the Russian ambassador in London (Count Christopher Lieven from 1812 to 1834), to order instruments ahead of a voyage before an inevitable stop during the voyage to buy more and meet English makers.[61] Typically, Russian ships were equipped with logs and sounding machines by Edward Massey, telescopes by Tully, Dollond or Troughton, and chronometers by Arnold and Barraud. Maps were by Aaron Arrowsmith and John Purdy.[62]

Britain’s longstanding reputation for navigational and manufacturing expertise and Royal Navy training thus ensured Russians’ continuing use of British skills and hardware into the nineteenth century. But again it would be wrong to see this as one-way. Russian patronage and Russian voyages helped test and secure British innovations in navigation. Between 1819 and 1824, Peter Barlow, professor of mathematics at the Royal Military Academy, Woolwich, devised a method of correcting compass needles from local deviations due to the increasing quantities of iron used in ship construction. The technique, which involved placing a small disc of soft iron near the compass to offset deviations, received patronage from the Board of Longitude, who granted Barlow £500 to make experiments. Working with Barlow, the instrument-makers Gilbert devised a novel azimuth compass made from new brass, after it became clear that recast brass became magnetic.[63]

Barlow was also supported by the Tsar of Russia, Alexander I, who rewarded him with a gold watch and dress-chain, sent via the Russian ambassador Lieven, when his method was adopted by the Russian Navy.[64] Russian Imperial patronage could thus help establish new techniques in Britain and encourage their use in Russia. Krusenstern played an important role in this exchange, experimenting with Barlow's technique using the Gilbert compass at the Russian port of Kronstadt, and disseminating Barlow's work to Admiral Greig commanding the Russian marine station on the Black Sea. In 1824, Krusenstern's results were published in the *Philosophical Magazine* in Britain and no doubt his enthusiastic endorsement helped establish credit for Barlow's method.[65]

Certainly two years later in 1826, another Russian circumnavigator, F. P. Litke, collaborated with Barlow under the guidance of John Barrow, Secretary of the Admiralty. Litke and Barlow, together with Captain William Parry and Edward Sabine, fitted Litke's ship *Seniavin* with an 'invariable clock' which they tested at the Royal Observatory in Greenwich after Litke had arrived in Portsmouth on the usual stopover to collect instruments.[66] Litke also used Sabine's invariable pendulum on the voyage to demonstrate that the flatness of the Earth was greater than had earlier been derived from lunar inequalities.[67] Developing instruments and techniques thus came to benefit from Anglo–Russian co-operation.

Meanwhile, British instruments played a salient role in Russian navigating techniques on the circumnavigations. Once Russian ships embarked from Portsmouth, bound for the Atlantic, they proceeded using a variety of navigating methods. Much of the time, officers were keenly aware of weather, winds, coastlines, landmarks, lighthouses, birds, reefs, swells and other features of which they could take advantage to navigate near land. Navigators were opportunistic about these methods, using them when an appropriate situation arose. 'At this time of year,' wrote Litke at Portsmouth in November 1826, 'a favorable wind seawards is such a precious thing that one has to take the utmost advantage when one does blow'.[68]

Out on the ocean, technical methods became more urgent, demanding systematic and disciplined operations. The instructions for Bellingshausen's voyage of 1819–21 were explicit about how the ships should navigate. Every 24 hours, dead reckoning and observed position had to be 'determined by bearing and by the distance from some known point, wherever possible one whose latitude and longitude have been accurately determined'. If there was a discrepancy between the dead reckoning and observed position it needed to be investigated by using charts on which the reckoning was plotted, and by astronomical observations 'made as frequently as possible'. Latitude should be determined not only by observations of the altitude of the Sun at noon, but also the meridian altitude of twilight stars and ex-meridian altitudes of the Sun. 'For the longitude,' the instructions continued, 'lunar distances should be taken whenever circumstances permit, and the results of these observations should be compared with those given by chronometers'. Whenever the ships approached a point of known longitude, the chronometers should be re-rated. All observations were to be recorded in a log.[69] In sum, the normal way of navigating was by dead reckoning, checked against astronomical observations, which were in turn checked against the average reading of two or three chronometers, which were periodically set right in places of known longitude. Bearings were taken from a compass and speed, as Löwenstern wrote, with a log and line, or 'leash that can become longer or shorter' and an 'hourglass' or 'sand clock'.[70]

In practice, these acts of navigation were never simple matters of procedure or reliance on instruments. Löwenstern noted:

> In Kronstadt in 1803, after experimenting, we found that the second glass took 14 seconds to run. Krusenstern ordered the distance between knots to be made 46 fuss long […] On Russian ships of war, the second glass runs at 29 seconds, and the log line is set to 30 seconds; that is 50 fuss [feet] 11 zoll [inches] English from one another. That shows how imprecise the ship's calculations are.[71]

Navigating was a highly charged affair because mistakes could lead to catastrophe, and officers often recorded the fear, anxiety, danger and excitement that accompanied navigation. Litke learned lessons after he navigated a hazardous passage off the coast of Unalaska. He recalled,

> In the six years which have passed since then, I often go over the events of that day in my mind, and each time I reproach myself for exposing the ship and its crew […] to such danger. Extremes are met in all conditions in human life. Often misplaced prudence will lead to an unwise decision but, on the contrary, sometimes one must needs be bold to be prudent.[72]

Navigating was also frequently out of the hands of officers, as strong winds, storms and periods of calm dictated their ability to move about. When navigators did have the opportunity to make observations, find positions or plot courses, these acts demanded negotiation. Instruments and individuals were often deemed inadequate to determine the right action to take. On his voyage of 1785 Joseph Billings had a timekeeper on board his ship but did not consider it reliable. Off the coast of Kamchatka, 'The ship's reckoning still differing so materially from that of the time-keeper, induced Captain Billings to reject this method of ascertaining the longitude'.[73]

British instruments proved troublesome despite their reputation, and the marriage of academic theory and navigational practice might not be successful. Löwenstern repeatedly lamented the inaccuracy of reckonings and chronometers on the Krusenstern-Lisianskii circumnavigation:

> Without observations we would be lost. Enough effort has been put into devising Logs […] that are supposed to determine a ship's course, but a lot of what seems clear on paper is impossible in practice or at least very defective. None of them meet expectations, etc. Navigation owes its thanks to astronomy that it has reached its present perfection.[74]

Both Billings and Löwenstern noted the social component of these measures. Since measures were underdetermined, navigators had to assess each other's reliability to make navigating decisions. Löwenstern reckoned that the only trustworthy navigator on his ship was himself, writing in his diary that, 'It seems to me as if I were hired to ferret out the mistakes in the ship's reckonings'.[75] He lamented the excuses made by other officers for discrepancies between their reckonings and position, and how the excuse would be altered if it was found unconvincing: 'we find then immediately some other excuse. Then it must be the fault of the high seas, the waves, the drift'.[76] For Löwenstern, only astronomical observations provided closure for disputed measures. 'Seldom can we determine our position with certainty on the map without having made an observation'.[77]

Löwenstern placed his faith in himself and in astronomical technique over his fellows. Litke was equally reluctant to trust others. When he sailed from St Petersburg to Portsmouth in September 1826, he complained on reaching Elsinore that,

> Usually it is here that one takes aboard pilots for the North Sea, but very few of them really have the essential knowledge and experience to warrant their being any real help. On the contrary, it has happened more than once that because of the pigheadedness of these ships' pilots, navigators have found themselves in difficulties. That is why we find it more agreeable to proceed on our own.[78]

On reaching the southern English coast, however, Litke became more open to allowing pilots to take over. Choosing which pilot to trust depended on personal experience and familiarity.

> The pilots were not slow in coming aboard and, by a strange fluke, among them was a former acquaintance of mine who, nine years previously, had piloted the corvette *Kamchatka* through the Spithead roads. It was only natural to give him preference over the others.[79]

Record-keeping was another essential part of navigation and here too British practice played a role. Lisianskii noted how he 'scrupulously attended' to a journal of his chronometer readings every day. Other navigators reported this work as 'tedious'.[80] Stories of British navigators circulated indicating the dangers of improper record-keeping. Löwenstern reported the tale of William Robert Broughton, whose journals and charts were torn up by monkeys when his back was turned at Port Jackson in Australia in 1795. Broughton replaced the lost charts with inferior versions, leading him to a disastrous shipwreck off the coast of Japan.[81]

Russian solutions to problems of navigational trust thus depended on judgments of nationality, personality, and technique. Clearly, Russians reckoned British instruments and expertise would make for more reliable navigation than those of other nations, reflecting a longstanding tradition of trust in British navigational expertise. This trust was perhaps most manifest in a widespread admiration for James Cook, whose status among Russian naval officers in the early nineteenth century was very high, thanks in part to their British training.[82] Cook's stellar reputation with the Russians had a notable influence on navigation. Generally the circumnavigators followed Cook's routes from Europe to Cape Horn and the Pacific, and Russian voyages often visited places prominent on Cook's voyages, such as the place where he had been killed in Hawai'i. Travelling in the Pacific in the early 1820s, Otto von Kotzebue noted that his trip to Matavai Bay, Tahiti, was on account of the celebrity bestowed upon it by Cook.[83] He made sure, he wrote, to set up an observatory at Cape Venus on 'precisely the same spot where Cook's Observatory had formerly been erected'.[84]

Perhaps more significantly, Cook's measurements were taken as the standard against which to calibrate Russian instruments and measures. The Russians often referred their measurements to Cook's. When Krusenstern sounded Avacha Bay on the coast of Kamchatka he found 'the depths marked in Captain Cook's plan of Awatscha Bay perfectly correct. Indeed the whole plan of it […] is drawn with an accuracy that cannot be exceeded'.[85] Cook was the limit of perfection, and so served as a standard against which to make judgments. The journals of Bellingshausen's voyage of 1819–21 also recorded that they 'accepted the latitude […] as fixed by Captain Cook as true, correcting our own reading'.[86] On another voyage to the Pacific of 1815–18, Otto von Kotzebue wrote 'My calculation of the longitude of the Pallisers, agreed with that of Cook, within three minutes. Between our latitude and Cook's there was no difference; I therefore had no reason to complain of my time-keepers'.[87]

Conclusion

British training might raise fears of unpatriotic Russians, and British instruments might prove unreliable, but Captain Cook was 'perfectly correct'. National reputations played a role in Russian navigating decisions. This reflected an enduring interaction between the British and Russians which evidently benefitted both sides. The Russians admired British navigators and relied on British expertise in the construction of the navy from the reign of Peter I onwards. Russians learned a diverse array of navigating methods from the British, which they put to work on circumnavigations in the early nineteenth century. No one method, such as the use of an accurate chronometer, predominated, a situation common across European navies, as other contributions to this volume show. Britishness also figured in the routines of navigating on Russian ships, part of a complex process of adjudicating between methods, instruments, measurements and personnel in the effort to navigate successfully. Cook's reputation helped make some of these decisions easy, and his measurements even served to calibrate instruments. Britishness was no guarantee for navigational reliability, however, and was just one element in a series of judgments.

New ideas, methods, instruments and personnel also flowed from Russia to Britain in this period. The Academy of Sciences, the Russian court, and the Imperial Navy all provided theoretical and practical resources and patronage that helped transform and promote British innovations in navigation. The British, for their part, came to be much impressed by Russian navigators' contributions. In 1801, the barrister and political commentator William Hunter lamented that 'the Russians are far from being expert navigators'.[88] But the view was quite different by the 1840s. English translations of accounts of Russian circumnavigations proved popular, and one translator considered Kotzebue's voyage to be of 'great importance to geography and navigation'.[89] The English geographer Alexander Findlay reckoned Russian charts produced on the voyages were the best available for some regions, and Charles Darwin used the charts and accounts of Litke, Bellingshausen, Kotzebue and Krusenstern to develop his theories on coral reefs.[90] Britain's knowledge of the oceans thus depended in significant ways on Russian expertise.

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[1] On Petrine reforms and the navy in particular, see James Cracraft, *The Petrine Revolution in Russian Culture* (Cambridge, MA: Harvard University Press, 2009), pp. 40–96; E. J. Phillips, *The Founding of Russia's Navy: Peter the Great and the Azov Fleet, 1688–1714* (Westport, CT: Greenwood Press, 1995).

[2] See Roy MacLeod, 'On Visiting the Moving Metropolis: Reflections on the Architecture of Imperial Science', in *Scientific Colonialism: A Cross-Cultural Comparison*, ed. by Nathan Reingold and Marc Rothenberg (Washington DC: Smithsonian Institution, 1987), pp. 217–49; Michael H. Fisher, *Counterflows to Colonialism: Indian Travellers and Settlers in Britain, 1600–1857* (Delhi: Permanent Black, 2006); Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (London: Palgrave Macmillan, 2010).

[3] See J. A. Bennett, 'Science Lost and Longitude Found: The Tercentenary of John Harrison', *Journal of the History of Astronomy*, 24 (1993), 281–7; J. A. Bennett, 'The Travels and Trials of Mr Harrison's Timekeeper', in *Instruments, Travel and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century*, ed. by Marie-Noelle Bourguet, Christian Licoppe and H. Otto Sibum (London: Routledge, 2002), pp. 75–95; Richard Dunn and Rebekah Higgitt, *Finding Longitude: How Ships, Clocks and Stars Helped Solve the*

Longitude Problem (Glasgow: Collins, 2014); Katy Barrett, '‘Explaining’ Themselves: The Barrington Papers, the Board of Longitude, and the Fate of John Harrison', *Notes and Records of the Royal Society*, 65 (2011), 145–62.

[4] Valerie Kivelson, *Cartographies of Tsardom: The Land and Its Meanings in Seventeenth-Century Russia* (Ithaca: Cornell University Press, 2006).

[5] O. M. Raspopov and V. V. Meshcheryakov, 'Magnetic Declination Measurements over European Russia and Siberia in the 18th Century', *Geomagnetism and Aeronomy*, 51 (2011), 1146–54, (p. 1146).

[6] This text is summarized in W. F. Ryan, 'Navigation and Modernisation of Petrine Russia: Teachers, Textbooks, Terminology', in *Russia in the Age of Enlightenment: Essays in Honour of Isabel de Madariaga*, ed. by Roger Bartlett and Janet M. Hartley (Basingstoke: MacMillan Press, 1990), pp. 75–105 (pp. 88–9).

[7] Ryan, 'Navigation and Modernisation', p. 91.

[8] A. V. Solov'ev, 'Russkie navigatory sredi iuzhnykh slavian', in *Iubileinyi sbornik Russkogo arkheologicheskogo obshchestva v korolevste Iugoslavii* (Belgrade, 1936), pp. 291–301; A. Florovskii, 'Moskovskie navigatory v Venetsii v 1697-1698 gg. i rimskaia tserkov', in *Ost und West in der Geschichte des Denkens under der Kulturellen Beziehungen. Festschrift für Eduard Winter* (Berlin, 1966), pp. 195–9.

[9] Il'ia Kopievskii, *Kniga, uchashchaia morskogo plavaniia* (Amsterdam, 1701); see Ryan, 'Navigation and Modernisation', p. 89.

[10] Paul Dukes (ed.), *The Caledonian Phalanx: Scots in Russia* (Edinburgh: National Library of Scotland, 1987); *Scotland and the Slavs: Cultures in Contact 1500–2000*, ed. by Mark Cornwall and Murray Frame (Newtonville, MA: Oriental Research Partners, 2001).

[11] Ryan, 'Navigation and Modernisation'; see also Nicholas Hans, 'The Moscow School of Mathematics and Navigation (1701)', *Slavonic and East European Review*, 29 (1951), 532–6;

Nicholas Hans, ‘Henry Farquharson, Pioneer of Russian Education’, *Aberdeen University Review*, 38 (1959), 26–9; D. Fedosov, ‘A Scottish mathematician in Russia: Henry Farquharson in Russia (*c*.1675–1739)’, in *The Universities of Aberdeen and Europe: The First Three Centuries*, ed. by Paul Dukes (Aberdeen, 1995), pp. 102–18; Robert Collis, *The Petrine Instauration: Religion, Esotericism and Science at the Court of Peter the Great, 1689–1725* (Leiden: Brill, 2012), pp. 70–4.

[12] The untitled manuscript is catalogued as ‘Russian MSS: Navigation Treatise on: 17th cent.: Russian’, British Library, Sloane MS 3227. Ryan, ‘Navigation and Modernisation’, pp. 84–7, summarizes the contents.

[13] Ryan, ‘Navigation and Modernisation’, p. 87.

[14] Stepan Gavrilovich Malygin, *Sokrashchennaia navigatsiia po kartie de-rediuksion* (St Petersburg, 1733). Malygin was a graduate of the Moscow School of Navigation before serving in the Baltic fleet; another text was Fedor Ivanovich Soimonov, *Ekstrakt shturmanskago iskusstva iz nauk prinadlezhashchikh k moreplavaniiu sochinennyi* (St Petersburg, 1739). Soimonov was also a graduate of the Moscow School of Navigation, serving in campaigns against the Swedes and Turks. He made a hydrographic survey of the Caspian Sea between 1719 and 1727; Leonid Arkad’evich Gol’denberg, *Fedor Ivanovich Soimonov* (Moscow: Nauka, 1966).

[15] F. F. Veselago, *Ocherk istorii Morskago kadetskago korpusa: s prilozheniem spiska vospitannikov za 100 liet* (St Petersburg, Tipografīi Morskago kadetskago korpusa, 1852).

[16] John H. Appleby, ‘Mapping Russia: Farquharson, Delisle and the Royal Society’, *Notes and Records of the Royal Society*, 55 (2001), 191–204, (pp. 200–1).

[17] For example, Mikhail Permskii, *Prakticheskaia angliskaia grammatika perevedennaia c angliskago iazyka na rossiiskii* (St Petersburg, 1766); Prokhor Ivanovich Zhdanov, *Novyi slovar’ angliiskoi i rossiiskoi* (St Petersburg, 1784).

[18] Michael Gordin, 'The Importation of Being Earnest: the Early St. Petersburg Academy of Sciences', *Isis*, 91 (2000), 1–31; Iu. Kh. Kopelevich, *Osnovanie Peterburgskoi Akademii nauk* (Leningrad: Nauka, 1977).

[19] Georg Bernhard Bilfinger, 'Discours prononcez dans le premiere Assemblée solonelle de l'Académie Imperiale des Sciences le 27. Decembre 1725 à Petersbourg', *Bibliothèque Germanique*, 13 (1727), 164–200, especially 195–200; Georg Bernhard Bilfinger, *Sermones in primo solenni Academiae scientiarum imperialis conventu die XXVII Decembris anni 1725 publice recitati* (St Petersburg, 1727).

[20] Bilfinger, 'Discours prononcez, p. 200 (all translations are my own unless otherwise stated).

[21] Raspopov and Meshcheryakov, 'Magnetic declination measurements', p. 1147.

[22] Raspopov and Meshcheryakov, 'Magnetic declination measurements', p. 1148.

[23] Raspopov and Meshcheryakov, 'Magnetic declination measurements', pp. 1148–53; on the second expedition see J. L. Black, *G. F. Müller and the Imperial Russian Academy* (Kingston and Montreal: McGill-Queen's University Press, 1986); B. G. Ostrovskii, *Velikaia Severnaia ekspeditsiia 1733–1743 gg.* (Arkhangel'sk: Sevkraigiz, 1935).

[24] The translated scheme, 'A System of the Celestial Sphere followed by a Method for finding the Longitude upon Sea by P. I. Roquette, Watch Maker to her imperial Russian Majesty. St Petersburgh June the 24th, 1732', is in the Royal Society, EL/R1/77, fols 174–83; Hodgson's summary and comments are in James Hodgson, 'Abstract concerning Mr Roquette, watchmaker to her Imperial Russian Majesty, with his proposal to find longitude at sea with the help of two portable clock or watches', Royal Society, Cl.P/22ii/59, fols 285–90.

[25] Hodgson, 'Abstract concerning Mr Roquette', fol. 289v.

[26] Leonhard Euler, 'Commentatio de matheseos sublimioris utilitate', trans. by Robert E. Bradley and C. Edward Sandifer, in *The Early Mathematics of Leonhard Euler*, ed. by C.

Edward Sandifer (Washington, DC: Mathematical Association of America, 2007), pp. 381–6 (p. 385).

[27] Johann Bernoulli, *Essai d'une nouvelle théorie de la manoeuvre des vaisseaux* (Basel, 1714); Leonhard Euler, *Scientia navalis seu tractatus de construendis as dirigendis navibus*, 2 vols (St Petersburg, 1749); for background, see Horst Nowacki and Larrie D. Ferreiro, 'Historical Roots of the Theory of Hydrostatic Stability of Ships', in *Contemporary Ideas on Ship Stability and Capsizing in Waves*, ed. by Marcelo Almeida and Santos Neves (Dordrecht: Springer, 2011), pp. 141–80.

[28] Leonhard Euler, *A Compleat Theory of the Construction and Properties of Vessels*, ed. by Henry Watson (London: Elmsley, 1776); Simon Schaffer, 'Fish and Ships: Models in the Age of Reason', in *Models: The Third Dimension of Science*, ed. by Soraya de Chadarevian and Nick Hopwood (Stanford, CA: Stanford University Press, 2004), pp. 71–105.

[29] Leonhard Euler, *Theoria motus lunae exhibens omnes eius inaequalitates* (Berlin: St Petersburg Academy of Sciences, 1753).

[30] Eric Forbes, 'The Life and Work of Tobias Mayer (1723–62)', *Quarterly Journal of the Royal Astronomical Society*, 8 (1967), 227–51 (p. 239); Mayer and Euler's work is explored in Steven A. Wepster, *Between Theory and Observations: Tobias Mayer's Explorations of Lunar Motion* (New York and London: Springer, 2009).

[31] Longitude Commissioners to the Navy Board concerning payments to Mayer and Euler, 13 June 1765, National Maritime Museum (hereafter NMM) ADM/A/2572 <http://cudl.lib.cam.ac.uk/view/MS-ADM-A-02572/1> [accessed 25 March 2015]; Ronald S. Calinger, 'Leonhard Euler: Life and Thought', in *Leonhard Euler: Life, Work and Legacy*, ed. by Robert E. Bradley and C. Edward Sandifer (Amsterdam and Oxford: Elsevier, 2007), pp. 5–60 (pp. 49–50).

[32] Derek Howse, ‘Navigation and Astronomy in the Voyages’, in *Background to Discovery: Pacific Exploration from Dampier to Cook*, ed. by Derek Howse (Berkeley and Los Angeles: University of California Press, 1990), pp. 160–84 (pp. 169–70).

[33] See the membership certificate in ‘Papers of Nevil Maskelyne’, NMM REG09/000037 <cudl.lib.cam.ac.uk/view/MS-REG-00009-00037/1> [accessed 25 March 2015].

[34] Leonhard Euler, *Letters of Euler, on Different Subjects in Natural Philosophy addressed to a German Princess*, trans. by David Brewster, 2 vols (New York, 1835), II, 135–85; Ronald S. Calinger, ‘Euler’s *Letters to a Princess of Germany* as an expression of his mature scientific outlook’, *Archive of the History of the Exact Sciences*, 15 (1975–76), 211–33.

[35] Euler, *Letters of Euler*, II, 170–1.

[36] Euler, *Letters of Euler*, II, 185.

[37] Mikhail Vasil'evich Lomonosov, ‘Razmyshleniia o tochnom opredelenii puti korablia’, in *M. V. Lomonosov, izbrannye proizvedeniia v dvukh tomakh*, ed. by E. P. Karpeev, S. P. Mikulinskii, G. E. Pavlova and G. B. Stepanov, 2 vols (Moscow: Nauka, 1986), I, 286–327; thanks to Richard Dunn for pointing out the connection to Irwin, and mention of Lomonosov’s design in C. G. Kratzenstein, ‘Sella marina observandis eclipsibus satellitum Jovis accommodata’, *Acta literaria universitatis Hafniensis Anno MDCCLXXVIII* (1778), 217–28.

[38] ‘A rigorous and easy rule of the nautical practice for reducing the observed distance of the Moon and the Sun or a fixed star into their true distance; presented by W. L. Krafft, Member of the Imperial Academy of Sciences at St Petersburg’, St Petersburg, 22 July 1794, Cambridge University Library (hereafter CUL) RGO 14/32: 44–52 <http://cudl.lib.cam.ac.uk/view/MS-RGO-00014-00032/91> [accessed 25 March 2015].

[39] ‘la Marine est tombée peu à peu presque en aneantissement jusqu’en l’année 1762’ Manuscript copy of the correspondence between Empress Catherine II of Russia and Admiral

Sir Charles Knowles relating to the organization, building, provisioning and manning of the Russian Navy, in English and French, NMM LBK/80, no date or numeration.

[40] R. P. Bartlett, 'Scottish Cannon-founders and the Russian Navy, 1768–85', *Oxford Slavonic Papers*, 10 (1977), 51–72.

[41] A. G. Cross, 'Samuel Greig, Catherine the Great's Scottish Admiral', *Mariner's Mirror*, 60 (1974), 251–65; Cross provides detailed profiles of Britons serving in the Russian Navy in chapter 5, ''Sur le pied anglais': Shipbuilders and Officers in the Russian Navy', in his *By the Banks of the Neva: Chapters from the Lives and Careers of the British in Eighteenth-Century Russia* (Cambridge: Cambridge University Press, 2007), pp. 159–221; see also R. C. Anderson, 'British and American Officers in the Russian Navy', *Mariner's Mirror*, 23 (1947), 17–27.

[42] Philip H. Clendenning, 'Admiral Sir Charles Knowles and Russia, 1771–1774', *Mariner's Mirror*, 61 (1975), 39–49; on Bentham in Russia, see Ian Christie, *The Benthams in Russia, 1780–1791* (Oxford: Berg, 1993); Simon Werrett, 'The Panopticon in the Garden: Samuel Bentham's Inspection House and Noble Theatricality in Eighteenth-Century Russia', *Ab Imperio*, 3 (2008), 47–70.

[43] 'Il manque aussi extrement aux Vaissaux de Notre Majesté Imperiale des officiers Subalternes disciplinés, et un nombre de Bons Boatmans maats pour arranger et disposer les matelots a leurs devoirs respectifs, tant dans la Navigation que dans le manoeuvre des Vaisseaux, en quoi j'ai eté bien informé qu'ils sont fort defectueux, particulierement dans l'obscurité et dans le mauvais tems.' Correspondence of Catherine and Admiral Knowles, NMM LBK/80.

[44] On Robison, see John Playfair, 'Biographical Account of the Late John Robison, LL. D. F.R.S. Edin. And Professor of Natural Philosophy in the University of Edinburgh', *Transactions of the Royal Society of Edinburgh*, 7 (1815), 495–539 (pp. 501–5, 509–12).

[45] Knowles said he was hired 'for the better Construction, Equipment, Discipline and future preservation of the Russian Navy.' Correspondence of Catherine and Admiral Knowles, NMM LBK/80.

[46] Instructions to Billings, appendix no. 5 to Martin Sauer, *An account of a geographical and astronomical expedition to the Northern parts of Russia [...] performed by Commodore Joseph Billings, in the years 1785, etc. to 1794* (London, 1802), pp. 29–49 (p. 33).

[47] Ilya Vinkovetsky, 'Circumnavigation, Empire, Modernity, Race: The Impact of Round-the-World Voyages on Russia's Imperial Consciousness', *Ab Imperio*, 1–2 (2001), 191–210; Ilya Vinkovetsky, *Russian America: An Overseas Colony of a Continental Empire, 1804–1867* (Oxford and New York: Oxford University Press, 2011); Glynn Barrett, *Russia in Pacific Waters, 1715–1825: A Survey of the Origins of Russia's Naval Presence in the North and South Pacific* (Vancouver: University of British Columbia Press, 1981).

[48] Glynn Barrett, *The Russians and Australia* (Vancouver: University of British Columbia Press, 1988), pp. 144–5; Raspopov and Meshcheryakov, 'Magnetic declination measurements', p. 1153.

[49] Friedrich Theodor von Schubert, *Anleitung zu der astronomischen Bestimmung der Länge und Breite* (St Petersburg, 1803).

[50] P. Ia. Gamaleia, *Vyshniaia teoriia morskoi iskustva* (St Petersburg, 1801–04). Gamaleia was born in 1766 and graduated from the Naval Cadet Corps in 1783. He fought in the fleet in the 1780s and began teaching in the Cadet Corps in 1791, where he remained until 1811. He also published *Teoriia i praktika korablevozhdeniia* (St Petersburg, 1806–08). I have not been able to consult these works.

[51] See A. R. T. Jonkers, *Earth's Magnetism in the Age of Sail* (Baltimore; London: John Hopkins University Press, 2003), pp. 121–6.

[52] See Churchman's correspondence with the Board of Longitude, CUL RGO 14/42: Correspondence on magnetic variation, 56^{r}–141^{v}, especially 140^{r}–40^{v}, Churchman's *Proposals for publishing a new Edition, with Improvements, of the Magnetic Atlas or Variation Charts of the Whole Terraqueous Globe* <http://cudl.lib.cam.ac.uk/view/MS-RGO-00014-00042/115> [accessed 25 March 2015]; Silvio A. Bedini, *With Compass and Chain: Early American Surveyors and their Instruments* (Frederick, MD: Professional Surveyors Publishing Company, 2001), 547–56.

[53] Simon Werrett, 'Russian Responses to the Voyages of Captain Cook', in *Captain Cook: Explorations and Reassessments*, ed. by Glyn Williams (New York: Boydell & Brewer Press, 2004), pp. 179–200.

[54] On Russians in the Royal Navy see A. G. Cross, *By the Banks of the Thames: Russians in Eighteenth-Century Britain* (Newtonville, MA: Oriental Research Partners, 1980), pp. 165–73; S. A. Kozlov, 'Morskie voiazhi russkikh ofitserov na britanskikh sudakh v 60–90-e gg. XVIII v. Na puti k pervomu krugosvetnomu puteshestviiu rossiian', in *Putevye zapiski IU. F. Lisianskogo I. F. Kruzenshterna 1793–1800: predystoriia pervogo puteshestviia rossiian vokrug sveta*, ed. by S. A. Kozlov (St Petersburg: Istoricheskaia illustratsiia, 2007), pp. 6–51.

[55] William Hunter, *A Short View of the Political Situation of the Northern Powers* (London, 1801), p. 46.

[56] On East India Company navigation, see David Philip Miller's chapter in this volume.

[57] Hermann Ludwig von Löwenstern, *The First Russian Voyage around the World: The Journal of Hermann Ludwig von Löwenstern, 1803–1806*, ed. and trans. by Victoria Joan Moessner (Fairbanks, Alaska: University of Alaska Press, 2003), p. xix.

[58] Löwenstern, *The First Russian Voyage*, p. xix.

[59] Löwenstern, *The First Russian Voyage*, p. 12.

[60] Löwenstern, *The First Russian Voyage*, p. 17.

[61] Thaddeus Bellingshausen, *The Voyage of Captain Bellingshausen to the Antarctic Seas 1819-1821*, trans. by Frank Debenham, 2 vols (London: Hakluyt Society, 1945), I, 24.

[62] Barrett, *Russians and Australia*, pp. 143–6.

[63] Peter Barlow to the Commissioners of the Navy, 4 May 4 1822, in 'Compass Transcripts of manuscripts, An article from the Surveyor concerning Flinders written by May, unpublished, 1952, transcripts of correspondence, Matthew Flinders to Peter Barlow, 1822–5, Digest of Navy Board Correspondence concerning the compass, 1822–32', NMM MAA/20.

[64] Anonymous, 'Varieties, Literary and Miscellaneous', *Monthly Magazine, or British Register*, 59 (1825), 274–6 (p. 275); John Purdy, *Memoir, Descriptive and Explanatory: To Accompany the New Chart of the Atlantic Ocean and Comprising Instructions, General and Particular, for the Navigation of that Sea* (London, 1825), pp. 283–4; Antony E. Fanning, *Steady as She Goes. A History of the Compass Department of the Admiralty* (London: HMSO, 1986), pp. xxix–xxx.

[65] A. J. von Krusenstern, 'On the Local Attraction of Vessels – In a Letter from Admiral Krusenstern of the Imperial Russian Navy to Peter Barlow, Esq., F. R. S.' *The Philosophical Magazine and Journal*, 64 (1824), 283–7.

[66] Frederic P. Litke, *Voyage Around the World, 1826–1829*, *Volume 1. To Russian American and Siberia*, ed. by Richard A. Pierce, trans. by Renée Marshall (Kingston, Ontario: Limestone Press, 1987), p. 4.

[67] Litke, *Voyage Around the World*, p. ix.

[68] Litke, *Voyage Around the World*, p. 6.

[69] Bellingshausen, *Voyage [...] to the Antarctic Seas*, I, 24–5.

[70] Löwenstern, *The First Russian Voyage*, p. 71.

[71] Löwenstern, *The First Russian Voyage*, p. 427.

[72] Litke, *Voyage Around the World*, p. 98.

[73] Martin Sauer, *An Account of a Geographical and Astronomical Expedition to the Northern Parts of Russia* (London, 1802), p. 207.

[74] Löwenstern, *The First Russian Voyage*, p. 67; see also p. 427.

[75] Löwenstern, *The First Russian Voyage*, p. 82.

[76] Löwenstern, *The First Russian Voyage*, p. 70.

[77] Löwenstern, *The First Russian Voyage*, p. 70.

[78] Litke, *Voyage Around the World,* pp. 2–3.

[79] Litke, *Voyage Around the World*, p. 3.

[80] Urey Lisyansky [Iurii Fedorovich Lisyanskii], *A Voyage Around The World in the Years 1803, 4, 5, & 6* (London, 1814), p. 22; Glynn Barrett, *The Russians and Australia* (Vancouver: University of British Colombia Press, 1988), p. 76.

[81] Löwenstern, *The First Russian Voyage*, p. 396. The wrecked ship was the *Providence*, which sunk in May 1797.

[82] See Werrett, 'Russian Responses'.

[83] Otto von Kotzebue, *A New Voyage Round the World in the Years 1823, 24, 25, and 26*, 2 vols (London, 1830), I, 145.

[84] Kotzebue, *Voyage of Discovery into the South Seas*, I, 176.

[85] A. J. von Krusenstern, *Voyage round the world, in the years 1803, 1804, 1805, & 1806*, trans. Richard Belgrave Hoppner, 2 vols (London, 1813), I, 216.

[86] Bellingshausen, *Voyage […] to the Antarctic Seas*, I, 102.

[87] Kotzebue, *Voyage of Discovery into the South* Seas, I, 155.

[88] Hunter, *Short View of the Political Situation*, p. 45.

[89] H. E. Lloyd, 'Translator's Preface', in Otto von Kotzebue, *A Voyage of Discovery, into the South Sea and Beering's Straits, for the purpose of exploring a North-East Passage […] in […] 1815–1818*, 3 vols (London, 1821), I, vi; other translations included Krusenstern,

Voyage around the world; Lisiansky, *A voyage round the world*; and Georg Heinrich Langsdorff, *Voyages and Travels in Various Parts of the World during the Years 1803, 1804, 1805, 1806, and 1807* (Carlisle, 1817).

[90] Alexander George Findlay, *A Directory for the Navigation of the Pacific Ocean* (London, 1851), p. 522; Charles Darwin, *Geological Observations on Coral Reefs, Volcanic Islands, and on South America: Being the Geology of the Voyage of the Beagle, Under the Command of Captain Fitzroy, R.N., During the Years 1832 to 1836* (London, 1851), pp. 90, 162–3 and passim.