Connecting the Oceans: The impact of global steam in the nineteenth century

A conference organized by the Society of Nautical Research and the SS ‘Great Britain’

SS ‘Great Britain’, Bristol, 6–7 September 2019

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Editor’s Note

Nigel Blanchford
Editor, Topmasts

The conference, Connecting the Oceans: The impact of global steam in the nineteenth century, jointly organized by the Society for Nautical Research and the SS Great Britain Trust, was opened by the Chairman of the Society for Nautical Research, Admiral Sir Kenneth Eaton, who welcomed the delegates to the Brunel Institute. He commented that 2019 marks the fiftieth anniversary of The Society for Nautical Research co-ordinating the salvage of the SS Great Britain in 1969, and this provided the reason for the joint conference to consider the impact of the development of steam propulsion on many aspects of the nineteenth century.

We are pleased to present in this, our second Topmasts Special Issue, a record of the papers that were read. For a number of reasons, mainly because their papers were being published in other journals, some speakers at the conference have been unable to provide written copy of their conference paper. Where this has happened, the abstract that they provided has been included here.
Opening Remarks

Sir Ken Eaton
Chairman, Society for Nautical Research

The changes in the nature of long-distance naval and commercial shipping in the nineteenth century were profound and we will hear much of this today and tomorrow.

The Society for Nautical Research, founded in 1910, has played a major role in promoting international scholarship in naval and maritime history and in preserving and promoting the maritime heritage of Britain. It ensured the survival of Nelson’s flagship, HMS Victory, in the 1920s, was instrumental in founding the National Maritime Museum at Greenwich in 1937 and the Royal Naval Museum at Portsmouth in 1972 and continues to have close links with both institutions.

The SNR was first involved with the SS Great Britain in 1967, then a hulk in the Falkland Islands, when in November 1967 Ewan Corlett, an SNR member, first wrote to The Times newspaper suggesting something should be done about saving the ship. Richard Goold-Adams, also a member of the SNR, and later a member of the SNR Council, became chairman of ‘The Great Britain Project’ here in Bristol. He has strong claims to the title of being the ‘founder’ of the SS Great Britain project with Ewan Corlett as the ‘practical leader’. In these early days the SNR held the funds accrued as a result of the public appeal; the monies were transferred to the SS Great Britain project in 1971, the hull having arrived in Bristol in 1970.

Brunel’s first ocean-going steamship was the SS Great Western of 1838. She was an oak-hulled paddle wheel steamship, the first steamship purpose-built for crossing the Atlantic, and the initial unit of the Great Western Steamship Company. Designed by Isambard Kingdom Brunel, Great Western proved satisfactory in service and was the model for all successful wooden Atlantic paddle steamers. The SS Great Western worked to New York for eight years and was scrapped in 1856 after serving as a troop ship during the Crimean War.

The SS Great Britain was, and remains, an extremely important part of this country’s Maritime Heritage. She was launched by Prince Albert in 1843. Advanced for her time, she was designed by Isambard Kingdom Brunel, for the Great Western Steamship Company’s transatlantic service to New York. While other ships had been built of iron or equipped with a screw propeller, the SS Great Britain was the first to combine these features in a large ocean-going ship together with watertight bulkheads and a double bottom. She was the first iron steamer to cross the Atlantic, which she did in 1845, in the time of 14 days. Her four decks provided accommodation for a crew of 120, plus 360 passengers who were provided with cabins, and dining and promenade saloons. She later carried thousands of immigrants to Australia.

The development of steam ships made a major contribution to Britain’s imperial empire in the nineteenth century. The Royal Mail Steam Packet Company founded in 1839, was given an initial contract by the government
to provide a twice-monthly service to Barbados and Rio; the first service sailed from Falmouth on 1 January 1841. Other worldwide routes were added over subsequent decades including to the Crimea in the 1850s. The company initially built 14 side paddle ships, and in 1847 acquired the SS Great Western.

For hundreds of years the Royal Navy had been a wooden navy, propelled by sails and equipped for point blank broadside action. In the nineteenth century it effectively ruled the world’s oceans. Although tenders and small vessels became steam powered earlier in the century, it was not until 1860 when HMS Warrior was commissioned that iron and steel began to replace wooden walls. Even then, Warrior was essentially a 40-gun broadside wooden frigate, with armour plating, an iron hull and steam power. Steam powered, but with sails for sailing ocean distances. Warrior was quickly made obsolescent, as the advent of exploding shells brought the end of point blank broadsides, and 1871 saw the launch of the mastless and more capable HMS Devastation.

I have always felt that the unsung heroes of these early steamships were the stokers, firemen and trimmers, shovelling coal in intense heat. An adequate supply of coal was necessary to make global steam power at sea possible. How much did these ships consume and how much could they carry. The SS Great Britain could carry enough coal to get her to New York where she could load enough coal to get back to Britain. But to cover the world’s oceans coal had to be available in ports all over the world, both for commercial shipping and the Royal Navy. So the government established coaling stations, from Shanghai to the Falklands, Malta to Cape Town, and everywhere in between.

However, the need for coal supplies is not the only change brought about by the transition to steam and many others will emerge in the course of this conference.
The Steamship and the Making of a Globalized World

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Big claims have been made for the steamship as a revolutionary force in creating the modern world, and there is much truth in this. It was a genuinely transformative technology that revolutionized international trade, human mobility and communications. The economic, business and technological aspects of the steamship have long been studied by historians, but other sides of the phenomenon remain less clear. This paper is intended to raise some of those questions in the hope that they might be a useful backdrop to others discussed in the Connecting the Oceans conference.

Most of the issues considered here are about the impact of the steamship on seafarers, and on maritime communities on shore. Steam changed everything, from wages and working conditions to the cultural and psychological meanings attached to being a seafarer. Some of its effects improved the lives of seafarers and their families, but others were damaging, and few were straightforward.

One of the best-known advantages of the steamship was that it made voyages more predictable as passenger and cargo liner services ran to timetables, making international travel and tourism more attractive, and creating globalized commodity chains. This is less often seen as a step forward for seafarers, yet there is much evidence to suggest it was exactly that.

All seafarers working in the half-century after 1840 had their lives changed by the development of the steamship, even if they never set foot on one. The transition from sail to steam took decades, and every step required a realignment in the world’s labour markets. As is well known, only companies carrying better-off passengers and subsidized mail for short distances could justify the expense of running the first ocean steamships in the 1840s, but a series of technological and infrastructural leaps drove those costs down. Steam was already having an impact on the North Atlantic by the 1850s, with London and Liverpool, then Hamburg and New York becoming home ports to major steam liner companies as the century went on. The Suez Canal (1869) created a shortcut from Europe to India and China and helped a rapid shift to steam in the East.

Ironically, of course, part of the continuing work for sailing ships in the 1860s and 1870s came from carrying coal from British coalfields to ports on the routes between Europe and Asia, so that the steamships could refuel. Sailing ships continued to carry some bulk cargoes economically between the Pacific and Europe into the 1930s. The length of the transition, and the great complexity of trading patterns, meant that several generations of seafarers had to adjust, and take important life decisions on the road from sail to steam.

The steamship did bring some regularity, predictability and order to the
lives of seafarers, but we need to remember that they were starting from a very low base. With a few exceptions, the long-distance sailing-ship sector had always given seamen little job security or means of planning from one voyage to the next. So already in the 1850s optimistic commentators were pushing the idea that steam would transform the lives of seafarers at work and at home. As the reforming *Morning Chronicle* newspaper hoped on 20 April 1857, seafarers ‘will be less eccentric, and will require more and more to be treated like other people’.

That short quotation encapsulates many issues in the lives of seafarers. The common idea that they did not fit the norms of nineteenth-century society had far-reaching implications for the way they were treated, and also for the way they came to see themselves and their identities as seafarers. There is also the sense of a new kind of seafarer demanding fairer treatment, no longer out of sight and out of mind while at sea, and perhaps no longer expected to live in the squalid boarding houses, bars and brothels of waterfront districts.

As the century went on, some of these prophecies came true. The social survey pioneer Charles Booth found many seafaring households in London’s East End in the 1880s. Men might have been away at sea a lot, but their voyages were shorter and their return more predictable. Systems were slowly being built to channel their wages directly to their wives and children. Increasing proportions of them were better off than average, albeit in poor neighbourhoods. Mariners and their families were beginning to look like part of the urban working class, and no longer a transient pre-industrial rabble.

This is not to say, of course, that the steamship was some kind of workers’ paradise. Huge insecurities remained. Crews were still paid off at the end of each voyage, and while they might be engaged for the next one immediately, shipping companies had little obligation or responsibility for continuing employment. Catering staff, growing in numbers as ocean liners became larger and more luxurious, could be fired at the whim of passengers as well as officers. Most notoriously, the firemen and trimmers who worked in the stokeholds were only employed while they had their health, which was not very long. Shovelling coal and maintaining furnaces in temperatures of 50° Celsius, stokehold men suffered high levels of illness, premature ageing and demoralization.

It is no accident that the stokehold men came to symbolize the worst aspects of steamships. The novelist James Hanley used the suicide of a fireman to represent the expendability of working men who could no longer keep up with the physical demands of the machines. The playwright Eugene O’Neill had Yank the Fireman descend into madness when confronted with the inequalities of Gilded Age America. The well-known maritime writer Frank Bullen feared that firemen were subject to working conditions far worse than most shore employment, and certainly very different from traditional seafaring. In his book *With Christ in Sailor Town*, published in 1901, Bullen wrote that firemen – in his view understandably – were given to ‘furious outbursts of intemperance after a spell of such misery on shipboard as few respectable folks ashore have any idea of. The lives of these men are so bitter, their outlook so hopeless, that no language can be considered too forcible in which to present their claims.’

Even away from the harsh work of the stokehold men, shipping
remained a dangerous occupation. Overall, there is a clear case to be made that the steamship saved lives and made maritime work and travel safer. But within that broad trend there were still serious hazards. The long, slow road towards shipping safety in the nineteenth century is well known. Tellingly, the most ambitious early initiatives grew out of concern for the loss of passengers, and especially emigrants, rather than the casualty rates of working seafarers. Nonetheless, a series of parliamentary enquiries and royal commissions across the rest of the century gradually revealed the dangers of seafaring. They did so against the backdrop of conditions that were actually worsening for sailing-ship mariners. Sailing-ship owners drove down costs, equipment, maintenance and skilled manning levels. They believed that their sector was in terminal decline, and their seafarers often paid the price for that.

So the question of whether the steamship saved the lives of seafarers remains complicated. There is no doubt that steamship men were lost at a far lower rate than their sailing-ship counterparts, in terms of the number of mariners employed in each sector. But because the steam fleets were expanding so quickly, the actual number of seafarers lost at sea increased year after year in the late nineteenth century. We also need to remember that the statistics were always distorted by the higher safety standards of the flagship liner operators, whose ability to attract paying passengers was tied to their reputation for avoiding accidents. Seafarers in the less visible world of tramp cargo steamers suffered death rates well above the averages for the steam sector overall, and closer to the numbers for sail.

The shipping industry’s long transition to steam also gave it a formative role in the globalization of the maritime workforce and the diversification of occupations at sea. There are many issues here, and the rest of this paper will address three of them briefly. First is the increasing complication of gender roles and identities at sea. Government regulation of passenger shipping, and travellers’ demands for better service drove a major cultural change with the rise of catering and service staff at sea. This actually pre-dated the rise of the steam, but it was with the development of the large passenger steamship that these occupations grew to become a significant component of the maritime workforce. Some of these new workers were women, and their presence raised questions about the gendered character long attributed to seafaring, which was not only a male-dominated occupation, but often considered masculine in an exaggerated sense.

In fact, the number of women employed on steamships even at the start of the twentieth century remained very small; only hundreds compared to the tens of thousands of men who were the mainstay of catering and service departments on board. Women were employed in very restricted roles, usually looking after children. The fact that they were present at all, however, confirmed the wider prejudice that service staff were not real seafarers, and perhaps therefore not real men. Frank Bullen recognized the hugely responsible jobs done by senior stewards and the men and women in their departments, but also knew that a great divide separated them from other members of the crew.

As the largest liners became more akin to floating hotels, some maritime occupations became similar to those on land, making seafaring less special and less eccentric. We need to remember, however, that this came with threats as well as benefits. If it made it possible for more people – men and
women – to earn a fair living at sea, it also forced changes in the working lives and occupational identities of the existing workforce.

It is also important to remember that the maritime labour market had an unusual geographical reach. Away from the North Atlantic lines, many of the coal-shovelling and firebox-managing jobs in the stokeholds were done by seafarers of Asian or African origin by the end of the nineteenth century, and this raises another issue in the part that steamships played in globalization. Europe’s shipping fleets had always been famous – even notorious – for their diverse and international labour force, and this extended to the polyglot and immigrant-dominated US merchant marine of the early nineteenth century.

With the rise of steam, maritime labour became even more transnational, diverse and mobile, albeit in rather peculiar ways. As the world’s largest merchant marine, British shipping was still led by British officers, but increasingly depended on foreign or colonial seafarers. As British sailors sought better jobs on steamships, the sailing-ship berths they left behind were taken by Scandinavians and other north Europeans. While Atlantic steamship firms like Cunard crewed their vessels with British seamen, Elder Dempster worked the West Africa routes with firemen from Liberia, P&O depended on workers from India and East Africa and firms working the Far East trades recruited large numbers in China.

The steamship therefore became a spatial metaphor of race and empire, with a hierarchy that correlated race with the position of a crew member in relation to the waterline. Stokers and firemen down in the heat of the boiler rooms were likely to be African or Asian, or of such descent, while the deck crews and officers were mostly white and European. This diversifying, yet segregated, workforce raises important questions about transnational labour, and the mixture of exploitation and opportunity that accompanies the movement of workers into global industries. Seafarers may have been in the world’s most diverse industry, but in large parts of it they worked in homogenous groups, defined by race, nationality and the desirability of the job. Seamen from Asia and Africa could work on steamships, but in the harshest roles, and for less pay. Initially, Asian and African seafarers performed tasks that white mariners considered beneath them, so were generally accepted, albeit in a manner that reinforced the discrimination against them. Attitudes toward them hardened appreciably in times of recession in the industry, and in the aftermath of the world wars in the twentieth century, when Asian seamen were seen as posing a direct threat to the employment of white mariners.

What does all this mean for culture and identity in seafaring? Seafarers often had a fierce occupational identity that they were keen to emphasize, even during long spells on land, and even after they had left the sea altogether. Public opinion in most countries was conflicted about seafarers. There were long-standing stereotypes about the characteristics and behaviours of mariners, and these persisted into the age of steam. Seafarers were accorded a wide range of attributes associated with extremes of masculinity; sometimes they were violent, irresponsible, drunken heathens, sometimes childlike, easily led innocents who needed to be mothered by the state or by charities. Their courage was rarely questioned, but was also associated with less desirable attributes like recklessness.

There are interesting ironies and paradoxes here. While the number
of men working in deep-water sailing ships declined in late century, and steamships became the normal workplace of the seaman, the popular image of the seafarer was still someone who worked in sail, with the traditional attributes – good and bad – of a ‘proper’ sailor. This was despite the fact that it was also common to characterize sailing-ship men as a residual group who could find nothing better. Voyages in sail came to be seen as a young man’s game as the century went on, to be followed as soon as possible with a regular berth on a steamer, especially if a man wanted to settle down and get married. All this seemed to confirm the views of waterfront missionaries and social reformers, that the sailing-ship mariner was a feckless youth who had to be infantilized and controlled, before perhaps growing up to be a responsible adult working on steamers.

What seafarers themselves thought of this is harder to discern. Some were clearly uneasy about the implication that steam made them less manly, and no longer really seamen. If those catering jobs on liners had raised questions about masculinity, the steamship itself was also a challenge, and one that has echoes across a wider range of modernising society. Did working on steamers – even in the deck department – become a routine industrial occupation, where a man was just another employee of a large company, wearing a uniform and bound by rules invented by office managers rather than the traditional relationship between captain and crew? This posed a profound threat to ideas about craft, skill and self-determination, and caused much soul-searching. Well-known maritime writers of the early twentieth century such as Alan Villiers struggled to explain the transition from sail to steam as it happened in people’s minds, as well as in technical and economic aspects. It proved hard to shift the perception that real seafaring was still about sailing ships.

There is another echo in the work of men like Villiers that seemed nostalgic, anti-modern and hopelessly backward-looking at the time they were writing in the 1920s, but which now raises one of the most pressing questions in our own age of globalization. The steamship, of course, was a key element in a much wider environmental disaster. Carboniferous capitalism, the great complex that harnessed the power of fossil fuels to drive global economic growth at unprecedented speed, was also the foundation of our current crisis. While Villiers knew nothing of climate change, he was not alone in having a sense of unease about the end of sail. In his book *The Set of the Sails* he recalled a conversation with an old crewmate who foresaw a future where the mad rush for mechanization had exhausted the world’s sources of power; humanity could not work its new machines, but was also unable to go back to the old ways because it no longer knew how to cooperate with nature. Why, worried Villiers, give away the free propulsion provided by the wind?

That is just one of the echoes that come down to us from the rise of the steamship and make us reconsider our own era of globalization. I think there is a clear case for taking a closer, but also a wider, view of the long transition from sail to steam as an element in the making of a globalizing world, and particularly the challenges facing trans-national, diversifying and often vulnerable workforces in an era of great change and uncertainty. There are many lessons for us here, but especially I think we can see the rise of the steamship as a historical laboratory for how we deal with complex, integrated systems that have unforeseen consequences on a global scale.
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From Sail to Steam

Changing health risks and requirements for seafarers

Tim Carter
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William Collingridge, who was Medical Officer of Health to the Port and City of London, writing in 1902, characterized the diseases of seafarers into those due to the special character of marine employment, those due to the habits of seafarers, diseases of climate and diseases from living conditions at sea.¹ He was writing at a time when steam had overtaken sail as the dominant motive power for the British merchant fleet, but also at a time when there were still considerable numbers of merchant ships powered by sail. He also commented that ‘there is unfortunately no reliable record of sickness in the Merchant Marine’.

The second half of the nineteenth century had seen major changes in the work and life of seafarers at steam took over. In parallel there had been ever more regulation, both in terms of safety from the introduction of load lines and specifications of precautions for cargo stowage, and in terms of knowledge about health risks, especially from infections, and the controls introduced to prevent harm.

Injury and disease on sailing and steam ships

Deaths from accidents in sail and steam shipping were investigated by the 1885 Royal Commission on Safety of Life at Sea. Between 1875 and 1883 22,188 seafarers had been killed in accidents. This was a risk of one in 75 overall, but for sailing vessels the risk was more than double at one in 35. Collingridge also compared mortality in merchant shipping with that in the Royal Navy. For 1899 the findings, expressed as mortality per 1,000, were

<table>
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<tr>
<th></th>
<th>All causes</th>
<th>Injury</th>
<th>Disease</th>
</tr>
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<tbody>
<tr>
<td>Merchant Marine</td>
<td>9.6</td>
<td>7.4*</td>
<td>2.2</td>
</tr>
<tr>
<td>Royal Navy</td>
<td>4.9</td>
<td>1.3</td>
<td>3.6</td>
</tr>
</tbody>
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*Approximately four times as many deaths from ship losses as from personal injuries.

These data indicate that merchant seamen formed a high-risk occupational group, particularly in terms of death from injury, especially when compared with the Royal Navy. Occasionally information for single ships is also available. For instance, records from SS Great Britain over the lifetime of the ship suggest that there were at least seven crew deaths associated with the use of sails, but none associated with steam propulsion. However one young passenger did fall into the engine room through an open skylight and died.

Causes of death while working, including those from disease, were recorded for merchant seamen from the 1880s, but this did not include information on job or ship type. Most of the available information on non-fatal illness comes from hospital case series, especially from the Dreadnought Seamen's Hospital in Greenwich. One notable case series reflected the pattern of illness seen at the end of a long oceanic voyage under sail. This was collected at the English Hospital in Callao, Peru, in the late 1860s. The surgeon there was Thomas Roe, ex-Royal Navy, and someone who appreciated the importance of collection and analysis of health information from his earlier career. This case series is still available as it was one of the few bits of objective evidence provided by British consuls, who were asked to provide information to the Marine Department of the Board of Trade on 'the condition' of British seamen as part of the ongoing parliamentary discussions about whether it was unseaworthy seamen or unseaworthy ships that were the cause of excessive loss of life at sea.

Callao was booming at the time, with massive growth in the international trade in guano as a fertilizer. This was exported in sailing ships that had either come round Cape Horn or across the Pacific, often after transporting Welsh coal for use by the Royal Navy or steam liner companies to coaling stations around the world.

Roe’s series of 606 cases comprised

251 scurvy  long eliminated in the navy but still a problem in transoceanic merchant shipping because of the poor quality or insufficient quantity of lemon juice carried and the failure to enforce consumption.
84 venereal  probably some chronic cases but many new ones from the renowned brothels of Callau
45 accidents  either on board (cargo and ship handling) or in port (violence, alcohol)
40 fevers  such as enteric and malaria recurrences, but also the presence of endemic typhus in Callau
30 dysentery  contaminated food or water, also responsible for enteric fevers
26 rheumatism  living conditions and work demands on board
10 abscesses
97 other conditions

Note: italics are author’s commentary

As can be seen these diseases fall into several of the categories suggested by Collingridge. Given the lack of the information to make detailed comparisons between sail and steam and between different trades and jobs on board, further analysis is based on fitting a range of contemporary anecdotal material into these categories.

The special character of marine employment
The move from sail to steam led to huge changes in the nature of work at

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3 Replies of British Consuls to a Circular Letter from the Board of Trade Requesting (1) Suggestions with Regard to the Merchant Shipping Bill of 1869, (2) Returns and Answers on Certain Points Connected with Merchant Shipping. C630 (London, 1872), 155–9.
sea. There were fewer injury deaths on steam ships. This is a consequence of a lower proportion of ship losses as well as less work aloft and on deck in adverse weather conditions when handling sails. The presence of steam power also reduced the physical work demands by making use of donkey engines for anchor and cargo handling.

Steam had its own new risks as well as introducing new categories of crew members, engineers and stokers. Hot conditions in the stokehold led to stoker’s cramps and heat stroke, especially in the tropics, as well as to injury risks from burns, scalds and explosions and from mechanical entrapment.

The habits of seafarers
There was continuing concern during the nineteenth century about the physical and moral condition of seamen. These discussions related both to their capability and their reliability at sea, and their moral welfare and salvation when ashore. Abusive employment conditions, alcohol, casual sex, debt and lack of foresight were all seen as damaging. To a large extent this dialogue was based on the situation that pertained in the sailor towns of ports and the uncertain employment conditions under sail.

The move to steam altered many aspects of seafaring life. Vessels had more predictable passage times and scheduled liner services developed. Employment became more predictable, allowing regular leave periods that were compatible with a shore-based home and family life. The many mission-based welfare initiatives had transformed the opportunities available to seamen in port, even if not all chose to use them, and this led to a decline in the worst aspects of sailor-town abuse.

It is difficult to speculate on the consequences of these improvements in welfare in terms of injury and illness, venereal infections excepted. However all could be expected to be beneficial. Set against this was increased concern about a new group of employees, the stokers. They were seen as having some of the dissolute characteristics of the previous generation of sailing ship crews, such as a love of brawling, gambling and alcohol. More seriously there was continuing but unverified concern about an excess risk of mental illness and suicide among stokers.

Diseases of climate
There was a considerable folklore on the direct effects of tropical climates on seafarers, while exotic infections were a real hazard. Infectious disease was a major cause of illness and death among nineteenth century seafarers, some 40 per cent of the Callao case series were infections. The mechanisms of infection were only beginning to be understood by the end of the century and, apart from quinine and vaccination against smallpox, there were no effective preventive or curative interventions. Because of their exposure in the tropics and in insanitary port areas the risks were far higher than for other members of the British population. Seafarers were also an important source for outbreaks of infectious disease in ports and beyond.

Paradoxically, the shorter passage times of steamships increased the risk of transmission of infections as on sailing ships outbreaks would often spread among a crew but then ‘burn out’ while still at sea on month long voyages. By contrast, a seafarer on a steam ship could easily become infected abroad and bring a disease back to their home port within the two
to three weeks that were the incubation periods of some infections.

**Diseases from living conditions**
The fo’c’sles of both sail and steamships where ratings slept and lived when off duty were damp, cramped and full of air that was both stale and heavy with smoke. These were predisposing factors for acute respiratory disease, tuberculosis and rheumatism. Wooden hulls leaked, steel ones were plagued with condensation, but the advent of steam meant safer and more effective heating, while clothes drying became feasible.

Diet was monotonous on long voyages, with reliance on preserved or dry ingredients until the rather later adoption of canning and then refrigeration. The shorter passage times of steam ships enabled fresh produce to be available for a greater proportion of the time. Cooking methods were slow to improve. Fresh water was often tainted or limited on sailing ships, but the presence of a boiler on steam ships made distillation of sea water a possibility thus eliminating shortages and providing sufficient to allow improved personal hygiene and fresh water clothes washing. Microbial contamination of water, whether at source in port or during storage on board still had the potential to cause severe outbreaks of infection.

**Fitness requirements**
The 1867 Merchant Shipping Act, which was mainly concerned with the health of seamen, can be seen as one of the steps, along with certificates of competence, to respond to concerns about the condition of seamen and its contribution to the toll of death at sea. This included, among other provisions, for medical fitness assessment prior to work at sea. This was for many years voluntary, but with one important exception that arose from the move from sail to steam with steamships’ increased speed and a course that could be set without reference to wind direction.

From the 1850s there was progressive standardization of navigation lights. The only colours that could be used with filters in front of the yellow flame of an oil lamp were red and green. It was soon found that near misses and collisions were occurring, as some lookouts were unable to distinguish between these colours because of the congenital colour vision defects found in around 5 per cent of males. Compulsory testing was made part of the examinations for competence of masters and mates. Initial test methods were flawed and led to unacceptable discrimination. It was not until a test case in 1910 that new and better methods were introduced.  

Apart from colour vision the tasks on steamships were less physically demanding compared with those under sail. The exception being stokers, whose arduous tasks were only eliminated with the move to oil fired boilers or to diesel propulsion.

**Conclusion**
The lack of reliable information on injury, disease and death in merchant seamen makes detailed investigations of the health impact of the move from sail to steam impossible. Using the limited available data and contemporary commentary it is possible to build up a picture of risk

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4 Carter, T., *Merchant Seamen’s Health, 1860–1960: Medicine, technology, seafarers and the state in Britain* (Woodbridge, 2014), 101–15. Note, many of the other issues considered in this article are also discussed in this book.
reduction and a reduction in arduous work requirements. This is to an extent confounded by other changes arising from better understanding of prevention, improved regulation and enhanced provisions for the welfare of seamen in port. The exceptions to this trend were an increase in the scope for the transmission of infectious diseases from port to port, the work demands of being a stoker on a coal fired ship and the new challenges posed to lookout duties by new aids to navigation.

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Steam and the Resurgence of Germany as a Maritime and Naval Power 1871–1914

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Despite long maritime traditions, German sea power suffered a period of steady decline after the end of the Hansa in the seventeenth century. When the German Empire was founded in 1871, the German merchant fleet ranked only fifth in Europe, while the newly established Imperial Germany Navy was considered a *quantité négligeable* in international politics. However, during the years spanning from the founding of the German Empire to the outbreak of the First World War, both the German merchant fleet and the Imperial German Navy were to become the world’s second-ranking, making Germany, if for one generation only, the most important sea power after Britain. If German unification in 1871 had delivered the political framework for this remarkable development, steam power had enabled it technologically.

In contrast to Britain, the triumph of steam occurred rather late in Germany, but when it did, it did so with tremendous pace. In 1850 the statistics list only 22 ocean-going steamships, but 3,655 sailing vessels registered in Germany. Although British steamships had seen transoceanic service from the late 1830s on, German shipowners were reluctant to embrace the new technology. When the HAPAG started its transatlantic service in 1848, the company preferred to use the sailing vessel *Deutschland* as its flagship. However, as early as 1856, the HAPAG also started steam-powered transatlantic services with the two ships *Borussia* and *Hammonia*, both of which had been built by Caird & Company in Scotland. The same year, the first German-built oceangoing iron steamship was launched by the Schichau shipyard in Danzig. It was a cargo steamer, by coincidence also named *Borussia*, but unlike its namesake from Britain not fit for the high seas and rather used for trade within the North Sea and Baltic region.

However, in spite of these landmark events in the 1850s, steam shipping expanded rather slowly in Germany during the decades that followed, and besides, German shipowners continued to prefer British-built ships. It was not before the 1880s that both steam shipping and shipbuilding saw considerable advance in Germany. In 1882 the HAPAG for the first time had two of its major vessels ordered from German shipyards, the *Rugia* (Vulcan Stettin) and the *Rhaetia* (Reiherstieg). The breakthrough of steam did not occur until the 1890s, a decade during which German shipbuilders made rapid technological progress. In 1889 the *Augusta Victoria* went into service, the first HAPAG flagship ordered from a German shipyard (Vulcan Stettin). The year 1893 marked a watershed, as steamer tonnage registered in Germany started to exceed sailing tonnage. In the person of Kaiser Wilhelm II, Germany now also had a maritime enthusiast as its ruler, who pushed German shipowners to buy German-made vessels. On the other hand, there were almost no government grants to support the evolving shipping industry. The only
exception were subsidies for mail steamers bound for east Asia, Australia and Africa, which had been put in place during the colonial upsurge of the mid-late 1880s and made it mandatory that all German vessels serving on these routes had to be built in German shipyards. However, as the Atlantic trade routes were the most important at that time, the impact of this legislation on Germany’s transition to steam shipping was negligible.

From the turn of the century onwards, German-built ships started to compete with British ships in a contest for technical superiority. It began in 1897, when the Norddeutsche Lloyd ordered a series of four twin-screw four-stacker passenger liners, the Kaiser class. Built by the Vulcan shipyard in Stettin, they were the first German-built ships awarded the Blue Riband for the fastest crossing of the Atlantic. After the award had been taken back by the Mauretania and Lusitania, German shipowners engaged in a race for the biggest ships in the world instead. The result marked the very pinnacle of Imperial Germany’s shipbuilding, the HAPAG trio Imperator, Vaterland and Bismarck, launched between 1912 and 1914. They were each close to 1,000 feet in length, exceeded 50,000 grt and featured steam turbines, which generated up to 100,000 hp in case of the Vaterland.

On the eve of the First World War, almost 90 per cent of the German merchant fleet tonnage was steam powered, a ratio comparable to that of Britain. Not only that, Germany’s merchant fleet had also grown from roughly 1 million nrt in the year of German unification to more than 3.5 million nrt in 1914, making it by far the most dynamically growing merchant fleet of Europe. The combination of rapid modernization and fast tonnage growth led to an impressive increase in overall performance. Due to the superior efficiency of steam over sail, by 1914 the German merchant fleet had 50 times the transport capability it had in 1825 and more than 10 times that of 1871.

Despite this rise in transport volume, Germany’s merchant fleet numbered around 5,000 ships in 1914 – barely more than there had been in the 1860s. It was the growing average size of the ships, not so much their actual number, that was responsible for the growth of merchant tonnage. For example, ships exceeding 5,000 grt represented only one-eighth of

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Germany’s merchant fleet in 1913, but accounted for roughly 40 per cent of its tonnage.

However, the progress of steam did not mean that the evolution of sailing ships was at a standstill. Rather, sail occupied niches where it could still compete, most notably the trade routes to south-west America. A famous example are the Flying P-Liners of the shipping company F. Laeisz. In 1902 their five-mast Preussen set a new benchmark in size and speed of sailing vessels. During the years 1900 to 1914, the number of sailing ships registered in Germany was even slightly increasing, after it had been declining during the last two decades of the nineteenth century. In fact, although steamships accounted for roughly 90 per cent of Germany’s merchant tonnage by 1914, still more than half of its merchant ships remained sailing vessels.

As a result of technological change, the overall structure of Germany’s merchant shipping was altered. In the early 1870s, the realm of German merchant shipping had not been that different from the old days of the Hansa, as German vessels predominantly traded with the Baltic region, western Europe and the British Isles. During the decades that followed, overseas trade, especially with the Americas, but also Asia and Africa, became increasingly important. While the overall tonnage of Germany’s North Sea shipping companies tripled between 1870 and 1900, the tonnage of its Baltic shipping companies went down to half. On the North Atlantic, German shipping evolved, yet with a considerable gap, into the second most important factor after British shipping. German shipping also fared
second on the trade routes to South America and Asia by the turn of the century. The German share of traffic in the Suez Canal increased from 3 per cent to 15 per cent between 1882 and 1910 – in absolute numbers, it grew almost twenty-fold. Between 1890 and 1910 the share of German shipping also doubled in many European ports. However, on the eve of the First World War, around half of Germany’s own seaborne imports and exports were carried on foreign ships, with British vessels maintaining a prominent share.

In contrast to the merchant fleet, steam had been used at least as an auxiliary drive in most vessels of the Prussian/German navy from the mid-nineteenth century on. This however should not be taken as an indicator of industrial progress, but rather the opposite. Until the early 1870s, Prussia/Germany, lacking a modern warship industry of its own, used to buy most of its vessels in Britain, thus benefitting from Britain’s technological superiority in warship building. A prime example was the Prussian flagship König Wilhelm, launched in 1868 and built by Thames Ironworks in Blackwall, fitted with a single-expansion steam engine and 28,000 square feet of sails. Also, the first major warships to join the newly established Imperial German Navy in the early 1870s, the Deutschland and Kaiser – despite their patriotic names designed by Sir Edward Reed and built by the British shipyard Samuda Brothers – still featured full sets of masts and riggings.

As Germany’s own warship industry progressed, auxiliary sails continued to remain a defining feature of German vessels long after they had been abandoned in the Royal Navy. The reason for this was primarily Germany’s lack of strategic overseas coaling stations at a time when coal consumption of ship engines was still excessive. While the first British warship with turret armament, the Devastation (commissioned 1873), was steam-powered exclusively, the first German vessel of this type, and first German-built ironclad, the Preußen (commissioned 1876), still featured a set of auxiliary sails. The first German-made warships without sail were the armoured corvettes of the Sachsen class, built around 1880. However, their limited cruising range confined them to coastal defence duties. Until the late 1880s the vast majority of ships in the Imperial German Navy remained steam–sail hybrids. It was not before the early 1890s with the commissioning of the Brandenburg class, the first modern German battleships, that this era ended for good. Also during the 1890s, many of the older hybrid vessels had their rigging entirely removed, engines modernized and additional coal bunkers added. Therefore, for the German navy and the merchant fleet, the 1890s can be taken as a breakthrough period in the transition from sail to steam.

Warship building then progressed rapidly from the turn of the century onwards, after Admiral Tirpitz was put in charge of naval armaments. In 1908 the Nassau, the first German Dreadnought-type battleship was launched, though unlike HMS Dreadnought, still featuring a triple expansion engine. In 1909 the first German battlecruiser equipped with steam turbines followed with the Von der Tann, and the first oil fired, turbine driven German battleships, the Kaiser class, were launched in 1911.

When Tirpitz had come to office in 1897, Germany had occupied the fifth rank among the navies of the world. By 1914 Tirpitz had managed to push the Imperial German Navy to become the second biggest and most
modern after Britain’s. This endeavour would have been unimaginable without the industrial capacity and technological know-how acquired by Germany in a comparably short span of time.

Despite these successes, the resurgence of Germany as a naval power during the reign of Wilhelm II, in contrast to the revival of its merchant fleet, remains an ambivalent achievement. Inspired by a zero-sum concept of international trade, Tirpitz responded to an ever-growing degree of international exchange and global interdependence with a national, monodirectional armaments scheme, that directly targeted Germany’s most important trading partner Britain. Paradoxically, instead of further promoting German merchant traffic and economic expansion abroad, as Tirpitz had originally intended, the growth of the High Seas Fleet had the opposite effect. It helped paving the way for the conflict that eventually led to the final loss of maritime power acquired during the Imperial era. As a result of the First World War, Germany would not only lose its High Seas Fleet, but also 90 per cent of its merchant shipping tonnage.

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I. K. Brunel’s Crimean War ‘Stealth’ Gunboats

Alistair Roach
Hon. Secretary SNR and Brunel Institute Volunteer

The Crimean War (October 1853–March 1856) is often considered to be one of the first ‘modern’ wars and was, perhaps, the turning point as far as steam and the Royal Navy was concerned. The British went to the Baltic in the spring of 1854 with a fleet of large, deep draught vessels which were not suitable for close coastal operations. Although, on the whole, they were successful in blockading the Russian fleet there were problems attacking or destroying any of the land based forts. In Britain there had been a huge and publically expressed disappointment that the forts had failed to be destroyed and the public and press opinion perceived it a failure.5

A completely different sort of naval force was required. ‘The Great Armament’ of 1855–6 set out to rectify this and produced about 180 of what was perceived to be the necessary type of vessels – gunboats - all steam powered but built of wood. In February 1855 the Admiralty announced that the new ‘Baltic Fleet’ would consist only of steam ships.6

Brunel keenly followed these discussions and noted that there was a need for gunboats that could effectively attack the Russian forts. Although his ideas didn’t actually come to fruition it can be seen how innovative they were and how he collaborated with other engineers of the day. In a memorandum Brunel had sent to the Admiralty, he stated:

The principle is simply the fixing of a very heavy gun in a floating shot-proof chamber, or casement, exposing the smallest possible surface; that surface to be in such form as to be struck by shot only at a very oblique angle . . . and thus everything on board will be perfectly protected.7

A great number of Brunel’s drawings and other papers are held at the Brunel Institute on loan from the University of Bristol.8 Within the collection there are 46 pages of drawings that refer to gun boats in some way. On examination it would appear that past interpretation of some of these drawings may need re-examining and re-interpreting. For example, some drawings listed as ‘gun mountings’ may in fact depict water jet propulsion nozzles.

There is a picture (attributed to Brunel’s niece Lady McCarthy) which depicts Brunel’s Duke Street office in about 1845. A model boat shown on the floor is thought to depict John Scott Russell’s ‘wave-line theory’ and the principle of ‘the solid of least resistance’.9 Brunel used this theory

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5 P. Duckers, The Crimean War at Sea: The naval campaigns against Russia 1854–56 (Barnsley, 2011).
7 I. Brunel, The Life of Isambard Kingdom Brunel, Civil Engineer (Stroud, 2006).
8 University of Bristol Library Special Collections ref. DM162/ The Brunel Collection (1824–1953), 70 archive boxes, 22 rolled plans and 4 plan chest drawers.
9 G. S. Emmerson, John Scott Russell: A great Victorian engineer and naval architect
when designing the *Great Eastern* and it was thought that Brunel’s early gunboat designs may relate in some way with the model in the study, but this idea is tenuous.

Brunel’s ‘first’ gunboat design appears to date to October 1852, as opposed to October 1853 when the Crimean War started. Many of his folio books have been rebound and it has been noted that some pages are not in chronological order, which could be the case in this instance.

His double-ended craft has similarities to a model gunboat, now held by the National Maritime Museum, which had been ‘proposed’ by Maudslay, Sons and Field. Henry Maudslay, and later his son Thomas, worked closely with both Marc and Isambard Brunel for a number of years. The company was renowned for very reliable and efficient marine steam engines and by 1850 they had supplied over 200, many to the Royal Navy. The model in question, although dated around 1868, may illustrate an earlier design.

In this first design Brunel had drawn circles in the amidships section on the plan (figure 1). Some people have interpreted these circles as either single or twin screw propellers but this has to be questioned. Twin screws, or to be more precise twin shafts, did not appear until the mid to late 1860s. It could be that these circles may depict boilers. At this stage in the evolution of the steam ship, the cylindrical fire-tube locomotive boiler was fitted to a wide variety of naval ships. Two boilers were installed in the 20-hp and 40-hp vessels and, in common with the majority of steam ships, they were placed forward of the machinery (in this case under the gun platform) and the funnel uptake rose from the after end of the boilers.

During this time there appeared to be much collaboration between Brunel and Scott Russell and also with John Ericsson (who later designed and built the American *Monitor* in 1862).

Ericsson was also competing with Captain Cowper Coles RN regarding

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the design of rotating gun turrets. Ericsson used a cone method while Coles used a roller system. It is believed that it was either Marc or Isambard Brunel who gave him the idea of using a railway type turntable for turret mechanisms. Brunel may have been working on similar ideas using a turret as one of his folios, dated 1855, shows a wider gunboat than his other drawings with a circular gun turret, as opposed to a fixed forward-firing cannon.

Brunel's later designs also incorporated a novel form of propulsion. He decided to choose steam driven water jets as opposed to using the propeller. He wrote,

The mode of propelling may be by a screw, but I prefer a jet . . . as it exposes nothing whatever to be injured by shot. Whether propelled by jet or not, I should have two small lateral jets for directing the vessel.

There are 11 pages in Brunel’s sketchbooks that relate to water-jet propulsion. In 1840 he worked closely with John Ruthven, the Edinburgh-based engineer, to trial a rotary steam engine coupled with a fan to supply compressed air through the fire grate for locomotives. Ruthven converted this idea into his water jet steam boat ‘invention’ and in 1846 carried out a display of it by driving a 12-foot-long model boat. He also had a passenger carrying 40-foot-long version made to show its feasibility. 11

Brunel wrote,

In all probability the enemy have thrown stones and other obstacles, and placed infernal machines round the detached forts, to impede a close approach . . . they (the boats) should have strong bottoms under the engine room, and the rest of the body be so subdivided into compartments that they should be proof against serious damage from rocks and infernal machines.

 Interestingly Brunel was also incorporating watertight compartments into the build of the Great Eastern although it was not common practice at the time.

The ‘infernal machines’ he was also talking about were in fact mines, often electrically detonated. The Russians set more than 1,500 mines in the Gulf of Finland during the Crimean War which led to the first successful mining in history and that in turn led to the first minesweeping operations.

One intriguing aspect of Brunel’s gunboat designs is that, at the latter end of 1855 into 1856, he suddenly changed the hull shape (figure 2).

It was around this time that serious questions were being asked by some engineers and scientists, such as William Rankine and William Froude, about the overall effectiveness of Scott Russell’s ‘wave-line theory’. With the search for better stability, as larger guns were being considered, Brunel may well have sought inspiration from elsewhere.

By December 1855 Brunel was advocating using a gun capable of carrying a 12-inch solid shot weighing some 200–250 pounds. William Armstrong and Brunel had been working together on gun design and were also developing rifled barrels and breech-loading mechanisms, as was Maudslay.

It is unknown why Brunel changed his hull shape. He may have been looking not only for greater stability but also a lower profile in order that his gun boats would be less conspicuous, and more difficult to hit when approaching a target.

The question leads to a variety of thoughts which, although conjectural, may be worth considering. We know from Brunel’s biographers that shortly after his death, Captain Claxton went to the Admiralty to retrieve a model of the gun boat Brunel had thought so highly of. The model could not initially be found but one official exclaimed, ‘Oh I know, it’s a duck-shooting thing, is it not, painted white?’

Brunel’s last drawings, although of a different scale, closely resembled the design of a wildfowling gun punt.

Wildfowling punts were normally painted white or light grey (or, if one wants to be pedantic, the colour of a kittiwake’s back) and it is certainly known that during the American Civil War blockade runners painted their ships a ‘mist grey’ to hide in coastal fog. Fog is also common in the Baltic and Brunel may have had this idea of camouflage to make his boats less conspicuous. He also advocated that, instead of a vertical funnel, the steam and smoke from the engine should be ejected through an oblique aperture right aft thus further enhancing any screening effect desired.

There is another intriguing connection relating to gun punts. Not only do the plan shapes coincide virtually precisely, albeit on a different scale, but there is also a connection with the Surveyor of the Navy, Sir William 12 L. T. C. Rolt, *Isambard Kingdom Brunel* (London, 1989), 290.
Symonds who was well known to Brunel.

Sir William had assisted Brunel with the design and building of the *Great Western* steam ship some twenty years earlier. His brother, Captain John Symonds, was also in the navy and he, in turn, was a great friend of Lieutenant Colonel Peter Hawker, who had written the definitive work *Instructions to Young Sportsmen in All That Relates to Guns and Shooting*. Hawker wrote, ‘In 1822 I contrived, and in 1824 built, a punt which I have been using, and improving on, ever since.’ There is a footnote in the book where he states,

> My punts have always had more beam and more flam than those of other shooters. This was much admired by a first rate seaman — my friend Captain John Symonds RN. He was at the building of the ‘Vernon’; and I am told she has more beam, etc., than any other of our frigates; and to her excellence — I believe there is not a question; and since this (in 1837), my last new punt has been honoured with the highest approval of his brother Sir William Symonds RN.

Had there been a discussion between Sir William and Brunel about the best hull shape for a gun boat that would manoeuvre easily in shallow water, be easily propelled and remain relatively inconspicuous?

Brunel’s thoughts behind joining armour plating (on average 4 inches thick) was similar to a tongue-and-groove system as he thought that rivet holes in the plate would weaken them. He also formed the ‘turret’ part into a teardrop shape so it gave an oblique angle to enemy fire from any angle. The main body of the boat, without machinery or armament, weighed approximately 154 tons. The fore and aft bodies were not actually part of the main hull but were both hollow structures to give a better run through the water but provided no buoyancy as such. Some people describe Brunel’s boats as being ‘semi-submersible’, which is in fact a misnomer. In today’s parlance it would be known as a Low Profile Vessel (LPV) as it was not designed to actually submerge, or partially submerge, but to run awash, thus helping to minimize detection.

Brunel also considered getting these boats to the theatre of war and wrote,

> They might easily be placed in an outer shell of iron of good form, which could be rigged complete and so constructed as to give up its burden when arrived in the seas where it is to act — in fact, a ship in the class of small screw colliers, made to open at the bows and its contents floated out ready for action.

Although Brunel’s gunboats never came to fruition he will always be remembered as being at the forefront of technological thinking and design, and his ideas can still be seen today albeit in a modern guise, e.g. ships with opening bow doors, or well decks, or perhaps the latest generation of fast, water-jet powered, camouflaged, low-profile, semi submersible ‘stealth’ gunboats.

It should perhaps be mentioned that although many people have carried out research on the Brunel archive over the years there is still much to be

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13 Lt Col. P. Hawker, *Instructions to Young Sportsmen in all that Relates to Young Sportsmen* (London, 1837), 411.
discovered. When dealing with any collection, there can be no presumption that previous researchers were correct and there should always be a constant re-examination and, if need be, a reassessment or reinterpretation of available facts. Although some of the above ideas put forward could be deemed conjectural it is hoped they will, at least, stimulate further discussion and thought.

Alistair Roach holds an MA in heritage and archaeology and an MPhil, his research thesis being on ‘Model Boats in the Context of Maritime History and Archaeology: An investigation into their usage between the ninth and nineteenth centuries AD in north-west Europe’. He is an associate of the Chartered Institute for Archaeologists and a fellow of both the Royal Historical Society and the Royal Society of Arts. He is the Hon. Secretary of the Society for Nautical Research, an independent researcher and assists at the Brunel Institute.
Steam propulsion was a developing feature of ocean transport over the course of the nineteenth century. At first steam propulsion was inhibited by wooden hull construction and paddle-wheel propulsion, but iron hull construction, screw propulsion and the development of the compound steam engine had enabled steam to become the dominant means of marine propulsion on short and medium-haul routes by the second half of the century. However, the as yet inefficient use of steam as a propulsion medium had debarred its economic use on the long-haul trades for all but heavily subsidized mail and passenger services, where deadweight carrying capacity was a secondary consideration.

Meanwhile, the need to move coal cargoes out to bunkering stations and the growth of deadweight return cargoes from afar to fuel the Industrial Revolution, had led to a latter-day burgeoning of sail on the long-haul freight trades. The opening of the Suez Canal in 1869 did not at first lead to an economic solution to the ‘tyranny of distance’.

The principle of triple expansion engines using higher steam pressures was well understood when the distinguished engineer, Alexander Kirk, designed the first meaningful unit in 1874, but it was not until 1882 that the first truly effective high-pressure triple-expansion steam propulsion package embracing engine, boiler, corrugated furnace and surface condenser was brought together in the steamer Aberdeen, enabling at a stroke the economic application of steam on the long-haul freight trades, sounding thereby the eventual death knell of sail.

**Early development of steam propulsion**

Steam marine propulsion first manifested itself on the inland waterways and rivers of the east and west coasts of the USA, Great Britain and Europe in the late eighteenth and early nineteenth centuries, the work of such innovative promoters as Fulton, Fitch and Lord Dundas.

Milestones in the progressive development of steam propulsion as the prime mover in the longer-haul passenger and mail services were

- 1835 India using an overland connection via the Isthmus of Suez linking the Peninsular & Oriental Steam Navigation Co. (P&O) and Bombay Marine steamers
- 1840 regular transatlantic services initially spearheaded by Brunel’s *Great Western* in 1838
- 1840 locally based paddle wheelers extended from India to China; and from Valparaiso to Callao
- 1841 Royal Mail Steam Packet Co. (RMSP) services to the West Indies and the Isthmus of Panama
1852 the P&O finally established a branch line service to Australia from Singapore
1853 the Clydeside marine engineer, John Elder, launched the concept of compound engines as an economic solution for medium–long-haul freight
1856 paddle steamers of the Pacific Steam Navigation Co. (PSNC), powered by Elder compound engines, were operating on the West Coast of South America linking with the Royal Mail’s Caribbean steamers via the Isthmus of Panama
1865 Alfred Holt developed the compound engine in a class of steamers designed for the China trade, realizing the ultimate potential of the compound engine

It would be a further 17 years before a fully effective triple-expansion steam propulsion package would realize the economic potential of steam on the longest-haul freight trades.

Steamer construction and propulsion

Early steamers had generally been built of wood and propelled by paddle wheels. Indeed, major carriers such as P&O, Cunard, RMSP and PSNC still persisted with new-build wooden hulled, paddle wheel propelled vessels into the mid-nineteenth century, inhibited in part by overt Admiralty conservatism which insisted that vessels engaged in the carriage of royal mails under government contracts, vessels which they saw as potential auxiliary warships in time of conflict, should be so constructed and propelled. The Admiralty contended that wooden hulls were less vulnerable to shot than iron, until proven decisively wrong at the battle of Sinope in 1853, when the wooden-hulled Ottoman fleet was torn apart by Russian explosive shells.

Paddle-wheel propulsion had served the evolution of steam power reasonably well, but for long-haul freight services, it had distinct limitations, specifically that

- paddle wheels were vulnerable and easily damaged
- they produced huge drag in the sailing mode, unless of the de-mountable type (generally unsuccessful/dangerous)
- they were inefficient in other than relatively calm seas, especially when rolling
- hull design had to be compromised to ensure wave flow along the length of the hull did not produce ‘hollows’ at the paddles, leading to long, narrow hull forms, limiting freight capacity
- inefficiencies occasioned by change of draught associated with coal consumption/cargo operations en route.

Experiments in the application of screw propulsion, based on the Archimedes screw were conducted in the early eighteenth century, but real progress was dominated by two inventors, farmer Francis Pettitt Smith and Captain John Ericsson, both of whom took out patents on their concepts in 1836. The two concepts were markedly different; Smith’s propeller was essentially an Archimedes screw mounted on its shaft in an aperture of the
stern frame forward of the rudder, while Ericsson’s comprised inner and an outer propeller discs, each mounting eight circumferential blades, the propeller being mounted behind the rudder.

Smith commissioned a 34-foot launch in which he mounted an Archimedean screw-type propeller two feet in diameter, with a 2-foot 5-inch pitch made up of two complete turns, powered by a 6 hp steam engine. During trials in 1837, the screw broke in half – and the vessel immediately increased speed. The significance of this fortuitous accident was not lost on Smith! Sea trials proved the efficacy of Smith’s propeller and, with encouragement from the Admiralty, Smith then constructed a full-scale experimental ship, the 3-masted schooner-rigged Archimedes, 237 tons, in 1838. Various Archimedean screw-type propellers were tried out on the ship, in the course of which speeds of nine knots were achieved. In 1840 Archimedes was successfully proved against Royal Navy controlled paddle wheel propelled cross channel packets from Dover. Admiralty prejudice against screw propulsion was finally laid to rest in a series of competitive trials in 1845 culminating in the ‘tug-of-war’ between the new-built screw sloop, HMS Rattler and the equivalently-powered paddle wheel sloop HMS Alecto, in which Alecto was famously towed stern foremost by the Rattler at about 2 knots.

Brunel’s Great Britain undertook the first transatlantic voyage by a screw-propelled iron vessel in July 1845. It is interesting to note that seven years later, Cunard commissioned their last wooden paddle steamer, the Arabia II, for the North Atlantic Mail Service.

Wood had distinct disadvantages in an emerging merchant ship requirement, notably

- size-for-size, a wooden hull weighed half as much again as iron
and wood construction occupied, giving considerably greater cargo carrying volume

- wood did not provide sufficient strength to withstand stresses inherent to screw propulsion, nor the strength to accommodate hull sizes necessary for emerging long-haul freight trades
- wood was prone to the ravages of boring worms and the fouling of marine growth, unless expensively coppered
- suitable wood was becoming an increasingly scarce commodity, at least in the UK.

Thus, by the mid-1850s the future of long-haul steam freight lay in iron construction and screw propulsion. However, iron-built ships still had significant hurdles and prejudices to overcome, such as

- marine fouling, for which there was not yet a simple solution, gave rise to the need for inter-voyage dry-dockings to sustain speed; reasonably effective anti-fouling paints formulated from toxic mixes of arsenic, mercury and copper were not forthcoming until the latter part of the nineteenth century
- the adverse effect of iron upon vessels’ compasses which had led to several high-profile casualties
- the deleterious effect of sweat on delicate cargoes inherent to iron-built ships, which necessitated careful attention to hold ventilation, both design and practice.

Steam pressure leading to coal economy

By the mid-nineteenth century the efficiency of marine steam propulsion had not reached a stage in terms of coal consumption and the logistics thereof to make steam propulsion on the long-haul freight trades an economic proposition. It had long been recognized that the quest for fuel economy was inexorably linked to higher steam pressures and the design of engines to accommodate such. The evolution of high-pressure steam offered a number of well-understood advantages, essential to the economic use of steam on the long-haul freight trades. In summary,

- fuel economy, since the higher the pressure, the less fuel would be used
- with less fuel needed, then either more space was available for cargo and/or there might be a longer duration between bunkering ports
- with less fuel consumed, less manpower was necessary for stoking the furnaces, hence more cargo could occupy space formerly taken up by crew accommodation.

But the achievement of these economic advantages was contingent upon a number of evolving technologies,

- the design and construction of boilers to contain the high pressures involved safely; the Board of Trade limited boiler pressures to 25 psi pending the development of more advanced boilers in the mid-nineteenth century
• the construction of furnaces that could withstand the high pressures
• the design and construction of ancillary services to support the steam power train, such as forced draught, surface condensers, evaporators and steam super heaters
• the design and construction of engines to utilize a high-pressure steam supply.

And there were also public prejudices to be overcome in terms of the safety of high-pressure steam, following all too many tragic accidents along the path.

The earliest marine steam engines had derived from land-based applications utilizing the single-expansion of steam, delivered at very low steam pressures in a band 1.5 psi to 25 psi. Such engines expanded steam through only one stage, either through one or multiple cylinders, each operating at the same steam pressure; in either case, the exhausted steam passed directly to a simple condenser for conversion back into feed water. Single expansion was ferociously inefficient in terms of coal (or wood) consumption and the jet condensers used introduced saltwater into the
feed water with inevitable consequences in terms of boiler corrosion and salt accretion on the boiler tubes. Single expansion engines extended up to mid-1860s.

The next stage of development was the compound engine, whereby higher-pressure steam in the range 30 p.s.i. to 75 p.s.i. was expanded through two cylinders, first through a small-diameter high-pressure cylinder, the exhausted steam therefrom passing into a larger-diameter low-pressure cylinder and thence to a condenser to recover the steam to water. In 1804 the English engineer Woolf patented the concept of multiple expansion as a means of reducing heat loss and in 1824 the American engineer James Allaire commissioned what was believed to be the first compound engine employing the expansion of steam in two stages, but problems along the way prevented the concept advancing. In 1854 the Clydeside engineers John Elder and Charles Randolph built a compound engine for the coastal steamship Brandon. The coal consumption on this vessel was about 3½ lb per indicated horsepower (ihp), against comparable vessels’ 4–4½ lb per ihp. Brandon was followed by two highly successful compound-engined paddle steamers for the Valparaiso to Panama service of the PSNC. Complementary improvements to increase the efficiency of the steam engine included steam-jacketing of cylinders to reduce heat loss in the expansion stage arising from condensation within the cylinders, improved condensers for the spent steam and the introduction of forced-draught air supply to the furnace, improving thereby its combustion capacity and/or its ability to burn poorer quality coal. Over the period 1850 to 1885, compound engines held sway and set the door ajar for long-haul freight steamers.

The P&O held into simple single expansion engines until the early 1860s and thereafter entrusted the engining of their next series of steamships to neo-compound engines designed by the London engine builder, Edward Humphrys. Humphrys’ design, while fuel efficient (said to be less than 2lb per ihp per hour), proved unreliable in service, necessitating re-engining with compound engines after only five years in service at vast cost. Adding to these woes, P&O were not prepared for the challenges and opportunities posed by the opening of the Suez Canal in 1869, not least, their huge Egyptian infrastructure associated with the overland transit to Suez – hotels, fuel dumps, overland and canal transportation – was made redundant almost at a stroke. A combination of these elements very nearly bankrupted the company.

In the spring of 1851 Liverpool engineer Alfred Holt began working as a marine engineering consultant, initially for Lamport and Holt in which company his brother George was a partner. Holt had served his apprenticeship as a locomotive engineer with the Liverpool and Manchester Railway Company before becoming interested in marine engine development as an integral part of steamship owning. The relative sophistication and compactness of locomotive engineering coloured much of Holt’s thinking. Holt’s early involvement in shipowning started with a line of seven steamers engaged on the West Indies trade, but this venture became less profitable in the face of intense competition and he sold all but one of the ships, the Cleator, in 1864. From the outset Holt recognized the importance of fuel economy as the key to successful long-haul freight movements by sea and he set about re-engining Cleator with a compact
compound engine of his own design, the small high-pressure cylinder being placed vertically below the large low-pressure cylinder. The engine was powered by steam at a pressure of 60 psi. The fact that Holt had been allowed to use high-pressure steam was a function of improved boiler construction technology and Holt’s persuasive powers with the Board of Trade. The outcome of this re-engining was a ship which was faster, while reducing fuel consumption by around 40 per cent over previous ships of his ownership. Commercial trials with Cleator demonstrated that a hitherto short sea trading vessel could now be operated profitably on long haul freight hauls such as Brazil.

Armed now with the technology for medium- to long-haul freight carriage, Alfred Holt engaged in vigorous discussions with his brother and business partner Phillip, in respect to which trade this new technology could be profitably deployed. They settled upon the Far East trade, hitherto the exclusive freight domain of the clippers and the heavily subsidized mail steamers of P&O. Alfred Holt embarked upon an ambitious programme in concert with the Clydeside ship-builder John Scott, to build a class of three steamers at a price of £156,000, which would be capable of steaming about the Cape of Good Hope non-stop to the first bunkering station at Mauritius. These steamers were powered by a modified version of the Cleator’s tandem compound engines, with the small high-pressure cylinder now mounted above the low-pressure cylinder (which became the Holt’s standard for compound-engined ships) operating at a steam pressure of 60 psi. The Agamemnon-class ships, which commissioned in 1865–6, were each of 2,280 grt, 309.5-foot registered length and 945 ihp. They were outstanding ships for their time, which proved capable of economically carrying relatively large freights over long distances. Indeed, they effectively opened the medium-long haul freight trades to steam. To quote Griffiths, ‘Holt the engineer had designed a machine which satisfied the needs of Holt the shipowner.’
The Suez Canal, 1869

The Suez Canal opened in 1869, confirming Holt’s foresight in the development of cost-effective steamers. His fleet, now enlarged to five like vessels with a further nine vessels on order, makes interesting comparison with the mighty P&O. The one, a London City-based establishment company, arrogant with a strong whiff of divine right, technically relatively incompetent, propped up by massive government mail subsidies and caught off-guard by the opportunities and challenges posed by the Suez Canal; the other, a north-west engineer-turned-shipowner, supported by the likes of managing agents John Swire in the Far East and Mansfields in Singapore, technically competent, leanly managed without subsidies, hungry for trade and at peace with the opportunities offered by the Suez Canal.

It is interesting to note that the first tea cargo through the Suez Canal was by way of the auxiliary steamer *Erl King* heralding a brief but largely unsuccessful attempt to address the long-haul freight trades by way of custom-designed sailing ships with auxiliary steam to propel them through calms and canals. Their propellers were designed to be lifted clear of the water by way of a lifting frame built within the stern of the ship, to avoid drag when under sail.

Racing tea steamers

The ousting of the clippers from the China tea trade by steamers led to on-going competitive racing between a new breed of tea steamers, notably Skinner’s *Castles* and McGregor, Gow & Co’s *Glens*. The days of the racing tea steamers were short-lived, the prime vessels being hopelessly uneconomic. (Skinners’ *Stirling Castle* of 1882 achieved speeds of 18.4 knots, on a consumption of 150 to 180 tons of coal per day, stoked by up
to 111 firemen. The vessel only lasted three voyages in Skinner’s service. P&O and Holts did not engage in racing. Holt came under significant pressure from John Swire to field faster ships, but Holt defiantly resolved to maintain an economic, reliable service at the expense of speed.

The burgeoning of sail, 1860–80

It is a common misconception that the opening of the Suez Canal spelled the death knell of sail; this was far from the truth. In fact, the early 1860s had seen an unprecedented burgeoning of sail on the long-haul freight trades attributable to a massive increase in trade as produce from distant parts was needed to fuel the industrial revolution at home – jute from India; rice and timber from Burma and South East Asia; wool and ores from Australia; nitrates and ores from South America; wheat from West Coast North America and Australia; and in particular, the need to economically move coal stocks around the world to feed the encroaching steamers at worldwide bunkering stations. True, Suez promoted the economic entry of steam into the Far East trade with resultant eclipsing of sail on the crack clipper route within ten years, but on the longest hauls, particularly Australasia, steam remained an uneconomic proposition.

The need to keep coaling stations about the world in stocks of coal to feed the emerging steamer requirement kept a large fleet of sailing ships gainfully employed; P&O alone was said to employ 170 sailing colliers to ‘feed’ 50 steam ships. Worldwide commercial bunkering stations sprang up, including Mauritius, the Cape Verde Islands, Tenerife, Galle/Colombo, Aden/Perim, Valparaiso/Callao and Bombay.

The carriage of coal out to worldwide bunkering stations by sail, is a study in itself, outwith the scope of this paper. Owners of collier tonnage sought to secure paying back-to-back cargoes or to incorporate the
coal run within more complex trading patterns. The ‘triangular service’ undertaken by such extreme clippers as Thermopylae was one such trading pattern. Started around 1865, crack main line cargo clippers following discharge of outwards cargoes in Australia, took on cargoes of New South Wales coal for the Far East to owners’ account, selling their cargoes at the coaling stations at Hong Kong, Nagasaki, or Shanghai, before loading a homewards tea cargo from the Chinese tea ports.

The supremacy of sail on the long-haul freight trades continued, in the absence of an economic long-haul steam solution, into the last third of the nineteenth century, supported not only by the availability of cargoes, but also by the increasing economy of sail over that period as a long-haul cargo carrier, brought about by a combination of factors, including

- changes of ship design away from extreme speed to cargo carrying capacity necessary to accommodate deadweight cargoes
- reductions in manning facilitated by rig improvements and the introduction of labour-saving devices such as brace winches and steam auxiliary machinery to assist raising of anchors and spar handling
- improved navigation competence stemming from mandatory certification of Masters and Mates under the great Merchant Shipping Act of 1854 leading to shorter sea passages.

Prominent among the savings accruing to a more intellectual approach to navigation was the work of Lieutenant Mathew Fontaine Maury USN, whose systematic correlation of wind and current data from hundreds of log books published in 1855, revolutionized route planning. The practical realization of Maury’s work in terms of the increased economy of the sailing ship may be found in the following two examples,

- the time occupied in sailing from Baltimore to the Equator was cut from an average of 41 days to 25 days
- the average time from the UK to Melbourne was cut from around 125 days to 92 days.

Maury also established the existence of a ring of prevailing westerly winds between Latitude 40° and 50° south which circumscribed the earth, leading to greatly improved passage times home from Australia via the Cape Horn. Such advances in navigation led to fast sailing ships being able to compete on almost equal terms with steam via Suez on the Australian trade.

**Triple-expansion steam**

There was an inevitability that steam would ultimately displace sail as the prime carrier on the long-haul freight trades. Work by Holt, Elder and Scott, together with the opening of the Suez Canal, had facilitated the displacement within a decade of sail on the crack China tea trade and other medium-haul freight trades.

Improved boiler design and ancillary equipment had led to a steady increase in boiler pressures from the mid-1860s, but the means were not to hand to effectively capitalize upon such increased pressures within the
perceived maximum efficient operating pressure of a compound engine, 70 psi. However, the principle of expansion of steam delivered in the range 75 to over 150 psi through three progressively larger diameter cylinders was well understood.

Several experimental applications of triple expansion had been tried out in the period leading-up to the mid-1870s involving small engines installed in river/inshore applications. In 1874, Liverpool ship-owner W. H. Dixon commissioned John Elder, for whom the renowned engineer Alexander Kirk was then working, to build a vessel incorporating significantly higher steam pressures delivered by a Rowan and Horton water-tube boiler as a means of achieving fuel economy; Kirk’s challenge was to produce an engine which would effectively utilize the high pressure steam deriving therefrom. Dixon’s steamer, Propontis was fitted with a triple-expansion engine designed by Kirk, which in itself proved very effective; unfortunately, the 150 psi water-tube boiler was in advance of prevailing technology and failed in the short term, necessitating its replacement with a Scotch gas-tube boiler operating at 90 psi.

There followed an eight-year interregnum, during which Kirk changed employer to become the technical director of Robert Napier’s build yard. Finally, in 1881, Napier’s contracted with George Thompson Jnr’s Aberdeen Line, a long-established, highly respected, ultra-conservative operator of sailing ships on the Australian trade, to build their first steamship, the SS Aberdeen. Given Thompson’s conservative approach, it is significant that they took the potentially high-risk route of launching into steam using a relatively untried technology, a reflection upon Kirk’s persuasive powers and arguably, the progressive technical mind of George Thompson’s son, Cornelius Thompson, a qualified naval architect and partner of the Company and head of their Aberdeen shipyard, Walter Hood & Co.

The 350-foot Aberdeen was essentially a cargo steamer with accommodation for 45 first-class passengers, and the potential for using ’tween deck spaces for the carriage of up to 650 immigrants in de-mountable accommodation. The vessel was powered by a triple-expansion steam engine of effectively the same design as that installed in Propontis, with
cylinders of 30-inch, 45-inch and 70-inch diameter with a 54-inch stroke, supplied with steam at a pressure of 125 psi from two double-ended Scotch boilers. From the outset, *Aberdeen* was a success, with an extremely economical coal consumption of 1.28 lb per ihp per hour, outstanding against a prevailing average consumption of around 2 lb per ihp. This success had its origins in a number of factors,

- the skill of the engine designer and the courage and foresight of the owner
- the construction of the two double-ended, triple-furnace, drum-shaped boilers installed. The boilers were built of rolled steel plates, strongly stayed in excess of Lloyds Register requirements within the steam space
- the installation of Fox’s patent corrugated furnaces within the boilers. The corrugated configuration provided the strength necessary to withstand the collapsing forces imposed upon the flue by pressure within the boiler. Their grates were adjustable in length, shorter for high grade Welsh coal and longer to accommodate lower calorific value coals such as would be available for bunkering in New South Wales
- the installation of advanced surface condensers which enabled boiler feed water to be clear fresh water, avoiding efficiency fall-off through salt accretion on the gas tubes and corrosion
- steam-jacketing of the intermediate and low-pressure cylinders to minimize internal condensation and heat loss

**SS Aberdeen** and her succeeding sisters economically opened the long-haul freight trades to steam, and within a short period of time, triple-expansion engines displaced compound engines as the prime movers of merchant tonnage, remaining so until after the Second World War (all 2,700 ‘Liberty’ ships were so propelled). Developments of the concept included the introduction of quadruple-expansion engines in vessels requiring greater speeds and high-pressure water tube boilers as a lighter, more compact source of steam supply. By the end of the nineteenth century, steam turbines made their appearance as prime movers where speed rather than economy was the driving force, and from the early 1920s, diesel propulsion began to make inroads into the triple-expansion steam plant for economy of operation. But both the turbine and the diesel had their disadvantages; for simplicity of operation and reliability in service over a full range of speeds, the triple-expansion steam engine remained the engine of choice for over 70 years.

There is a rich irony that steam on the long-haul freight trades was effectively introduced by Thompson’s deeply conservative Aberdeen Line, internationally renowned for the quality and speed of its sailing clippers. Sadly, financial conservatism held Thompson’s progress in steam back whereby it took 12 years to place five vessels of the Aberdeen-class into service, by which time their advantage had been lost and Thompson’s decline had started.

With steam finally economically deployed on the long-haul Australian trade, the days of the clippers which had held sway in the wool trade
homewards were over. Magnificent clippers were forced, for want of cargo, to pick up tramping cargoes homewards, often involving ballasting across the Pacific to the west coast of the USA for grain. The finest of them all, *Thermopylae*, was forced to accept tramping homewards cargoes of New South Wales oil shale for Rotterdam before she was sold to Canada. Sail continued into the late 1930s with the magnificent sail freighters of the Finnish shipowner Gustav Erikson and the German Ferdinand Leitz bringing home cargoes of nitrate from the west coast of South America and grain from Australia. The German ‘Flying P’ *Pamir* continued in commercial sail after the Second World War until her capsize in a hurricane in the North Atlantic in 1962 with the tragic loss of 80 lives; effectively the last act of freight carriage under sail.

**Captain Peter King FNI** is a master mariner with over 62 years continuous service in the merchant shipping industry embracing a wide range of subdisciplines. His abiding passion is maritime historical research. A Fellow of the Nautical Institute and a Liveryman of the Honourable Company of Master Mariners, his published researches have included a definitive history of George Thompson’s Aberdeen Line and papers on the schooner *Supply* 1832–61. He has lectured broadly on merchant maritime historical subjects. He is a member of the Society for Nautical Research Member and the Australian Association for Maritime History.
Abstracts

Making Connections Possible:
The businesses that drove the global expansion of steam

Helen Doe

In any discussion of nineteenth-century steam companies, the usual suspects are mentioned such as Cunard, P&O and Royal Mail. These were the success stories and they were the survivors of a competitive race to win business. Examining the successful ones can make it look relatively simple but new technology needed new business models, new ways of thinking and plenty of investors prepared to take risks.

Where did the engineers such as Brunel, Napier and Elder fit into this as they strove to develop new ideas to take steam around the world? What about the day-to-day management of the business? Success often comes after the lessons learned from failed ventures. An examination of some of the many failed schemes, particularly in the early days of ocean steam, provides evidence of the variety of factors that could make or break an enterprise. Investors, influencers, location, politics and opportunity all played their part in addition to the brilliance of their engineers.

Dr Helen Doe is a maritime historian who has published extensively on nineteenth century sail and steam, including co-editing and contributing to the award-winning Maritime History of Cornwall and her book The First Atlantic Liner: Brunel’s Great Western steamship. She has a PhD from the University of Exeter where she has been a lecturer for some years. She is a Fellow of the Royal Historical Society, Vice-Chairman of the British Commission for Maritime History, a member of the UK Government’s Council of Experts for National Historic Ships and trustee of the SS Great Britain.

Mechanising Migration:
Transnational relationships, business structure and diffusing steam on the Atlantic

James Boyd

The diffusion of steam into the transatlantic migration system of the nineteenth century, one of the most important developments in the history of human demography, is often explained by the technical progress of ships, which made the carrying of migrants under steam profitable. Existing historiography posits that early, basic paddle steamers were sustainable only with government mail contracts, while later iron screw steamers allowed breakthrough, as an inevitable commodity in the emigrant trade. These conventions mask a number of consistent, historically significant factors that were critical to the viable use of steam, and its ultimate use in emigrant markets. Data on steam company formation, durability and accounting for the mid-nineteenth century show that technical thresholds
are a not sufficient to explain the transfer to steam shipping of migrants. Determinative factors were interregional relationships at the nexus of engineering and demographic change, and, critically, the abandonment of capitalizing novel steam lines, a strategy that could not support the technology. This paper demonstrates that beyond technical developments, steam became usable because of endogenous transfer within well-established sailing services, a pivotal strategy adopted by those connected to centres of both innovation and migration.

James Boyd is Research Fellow in the Brunel Institute, a collaboration of the SS Great Britain Trust and University of Bristol. James’ research considers the evolution of Atlantic transit, technological systems, and international migration. He was previously Research Associate at the University of Cambridge, and post-doctoral scholar at the German Historical Institute, Washington DC.

Steamship Modern:
Boredom and repetition in the temporal rhythms of colonial steamship travel

Jonathan Stafford

In the first decades of global steam navigation, the steamship’s unprecedented speed was characterized as a break with tradition, a means of transportation which, like the steam train, embodied the nineteenth-century preoccupation with the revolutionary potentialities of technologies of mobility. A wealth of scholarship has explored the culture of acceleration which prevails as one of the dominant discourses of modernity, a category of experience largely rooted in the nineteenth-century revolution in mobilities. Such radical acceleration, the ‘annihilation of space and time’, can be witnessed in the steamship service between Britain and the colonial East which emerged as an expeditious alternative to the slow sailing route in the late 1830s. Yet the subjective experience of those at the cutting edge of this revolution – the colonial passengers who travelled on board these ships – remains under-explored. Accounts of steamship travel describe the experience of this unprecedented mobility as one of monotony, temporal discipline, and repetition, at odds with the more familiar discourse of speed and fragmentation. Applying insights from mobilities scholarship to the social history of maritime travel, this paper will examine the ship as both a means of transportation which revolutionized colonial mobility, and as a significant site for exploring emergent cultures of temporality in a global context. This will foreground the mobile subject of the steamship passenger as the key to understanding the nature of this change. The archive of colonial steamship travel narratives will be used to develop insights into steamship temporality and its broader significance for shaping conceptions of the modern world.

Jonathan Stafford is an interdisciplinary scholar of the sea, with a particular focus on maritime mobilities, landscape and culture. His PhD (2015) was a cultural history of the entry of steam propulsion into colonial
shipping in the mid-nineteenth century. He is a postdoctoral research fellow in the Department of Culture, Media and Visual Studies at the University of Nottingham.

\textit{To steam, or to sail, that is the question}

Morten Tinning

In February 1899 a local newspaper in the Danish maritime town of Svendborg printed a letter to the editor entitled ‘Shipping in Svendborg and its surrounding region’. The author was the then 62-year-old sea captain and local shipowner, Peter Maersk Moller (1836–1927) - later co-founder of the Danish shipping company Maersk. In the letter Moller forcefully asserted his belief in the rising importance of steamships and the imminent demise of the sailing ship and articulates an urgent need for the establishment of a local steamship company and the need for local shipyards to gain experience with the building of iron-hulled steamships. The response he got from the local maritime community was not at all what he expected and the public debate that followed soon became heated as several prominent members of the local maritime community put forward their own predictions and visions of the future; including views on maritime economy, geography, communications, technology, education, tradition and culture, safety at sea and not least the role of the Danish maritime industry in society. By analysing this debate in detail, this paper will examine some of the competing narratives, mindsets and visions of the future present in Danish maritime industry at the threshold of the twentieth century.

Morten Tinning is a PhD fellow at the Centre for Business History at Copenhagen Business School (CBS) and a curator at the Maritime Museum of Denmark in Elsinore. Current research interests include the transition from sail to steam, maritime ethnology and maritime business history.

\textit{Weathering the Storm:}
\textit{The struggle of a West Country harbour to survive the transition from sail to steam in the late nineteenth century}

Tim Beattie

In the early nineteenth century Falmouth was a confident, prosperous medium-sized port. It was, according to John Wilson Croker, Secretary to the Navy and MP for Bodmin, one of the world’s largest natural harbours. It offered a ‘first and last’ haven on the busy waters of the western approaches and it was home port for the celebrated Post Office Packet Service to South America and Lisbon. Many ships arriving in the Channel from the Atlantic were instructed to call at ‘Falmouth for orders’ and would make use of the docks services to repair the ravages inflicted by their long sea voyages. By 1850, however, the sailing packet ships had been withdrawn and replaced by Samuel Cunard’s Liverpool-
based Steam Packet. At the same time the advantage of being able to offer provisioning, repair and dock facilities at the entrance to the English Channel all but evaporated with the advent of steam and Falmouth’s land communications, which were notoriously poor even after the arrival of a railway line in 1865, provided little incentive for ships to offload there if the cargo’s final destination was London or the home counties.

Tim Beattie gained a PhD from Exeter University in 2013, and has subsequently published two articles in The Mariner’s Mirror and a book, British Privateering Voyages of the Early Eighteenth Century (Boydell, 2015). Since then he has been working as a volunteer at the Bartlett Maritime Research Centre and Library at the National Maritime Museum, Cornwall where he has been researching the history of Falmouth Harbour. Tim is a retired lecturer and part-time farmer.

The ‘Invisible’ Entrepreneurs: Aspects of female entrepreneur-ship in Greek shipping of the early 20th century; the case of Marigo Kulukundis

Dimitra Kardakaris

Investigating female entrepreneurship in early twentieth-century Greece, this paper examines Marigo Kulukundi, one of the few such cases on which sufficient sources exist. It intends to show that the history of women’s participation in the shipping business and within the framework of Local Island and Greek economy is a continuation long-standing, established practices than a gradual introduction of new ones. As one would expect in this male-dominated era, the managing of these companies and their local and overseas offices was at the hands of each male head of the family and his closer male relatives (brothers, cousins, sons, etc.). However, a persistent phenomenon, appearing in virtually every one such family was that all female relatives (sisters, wives, aunts and especially widows) appear as shareholders in ships and even in managing positions, at times influencing the general business policy of their families to an important degree. One such woman was Marigo Kulukundis of Kasos, a tiny island in the south-east Aegean, from which originated Marigo’s clan, the Kulukundis family, one of the most prominent Greek shipping families of the twentieth century. Coming from humble origins, as owners of a several sailing ships, they became a great international conglomerate managing hundreds of ships, with offices in Syros, Piraeus, London, New York, Brazil and Australia. Marigo and other women like her steadily played their important but always ‘invisible’ part for the success of the family business.

From 1796 to 1860, the United States Navy relied upon a steady stream of African American sailors to fill their ranks. The navy paid less and punished more than the merchant marine. The United States Navy (USN) was more brutal than even the French or British navies. As a result, the USN found itself constantly short of the able-bodied white sailors it wanted to employ. The USN employed well-trained sailors of color, many of whom grew up in ports and working on ships, to fill that shortage instead. These sailors made up to 20 per cent of the navy’s enlistments. The presence of people of colour in the service, however, became an issue of national debate. However, even when a controversy over black sailors’ testimony influenced the outcome of the election of 1840, black sailors continued to serve in deck roles. It was not until steam and steel became the predominant form of naval locomotion and ship construction that African Americans moved from mostly deck roles, working guns and manning sail, to service ones, such as cooks and stewards. This paper will use records in the National Archives and Records Administration in Washington DC. It will show how the USN’s progressive revolution created space into which the change in the types of skills required to man a ship led to a switch in the people employed on a ship. It is argued that, without the need for specialized skills like managing rigging, the USN could expand its labour supply without failing to meet its strategic goals.

Zachary Kopin is a PhD candidate at the University of Michigan. His work focuses on race and law in the Atlantic World. He holds two 2014 BA degrees from the American University in Washington DC, one in music and the other in history. He earned a masters in history from the same institution in 2015. While attending university in DC, he interned at Naval History and Heritage Command, the Woodrow Wilson Center, and the National Archives and Records Administration. He spends his summers working with the Constitution Hill Museum in Johannesburg, South Africa.