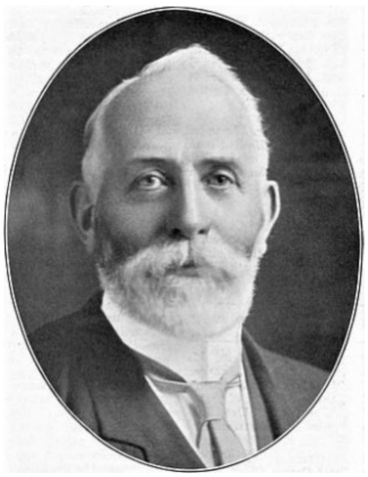
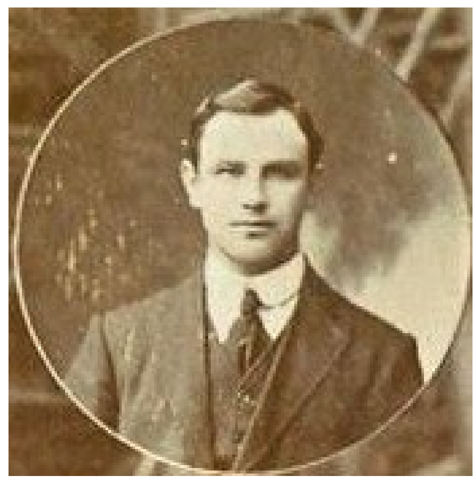
A QUIET SEA

RMS TITANIC



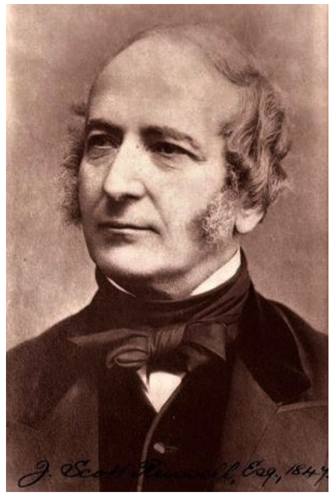


CARLISLE & WILDING

TITANIC – CARLISLE AND WILDING

INTRODUCTION

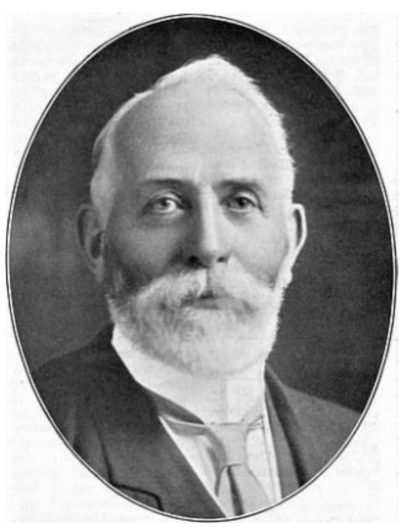
In 1865, engineer and naval architect John Scott Russell defined the perfect naval architect as an individual who is erudite in all aspects of ship design and construction; able to build, launch and put a ship into service; predict how fast she will go and how she will behave at sea; and determine what she will carry, earn and cost to operate. Most important of all, the ship will do exactly what the naval architect says she'll do. *



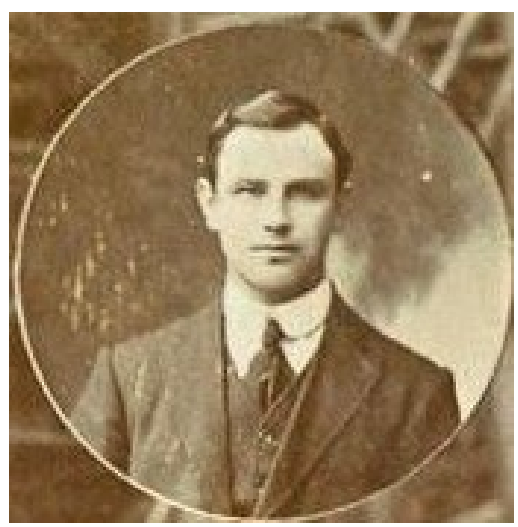
John Scott Russell (1808-1882)
Credit: Wikipedia

Shipbuilders Harland & Wolff had their Guarantee Group on board Titanic's maiden passage. Thomas Andrews, Managing Director, naval architect and head of the drafting department, had with him eight skilled employees and apprentices to iron out any kinks in the new liner. All perished, and Andrews, a charismatic and popular figure with shipyard workers, became legendary for his actions and behavior during the sinking. He did, it was said, the old firm credit. Depicted in popular culture as Titanic's designer, Andrews worked with his colleagues Alexander Carlisle and Edward H. Wilding. Both played key roles in the ship's design and construction and, being intimate with the ship's design details, testified at the post-disaster British Inquiry.

Thomas Andrews (1873-1912)



Alexander Carlisle (1854-1926)

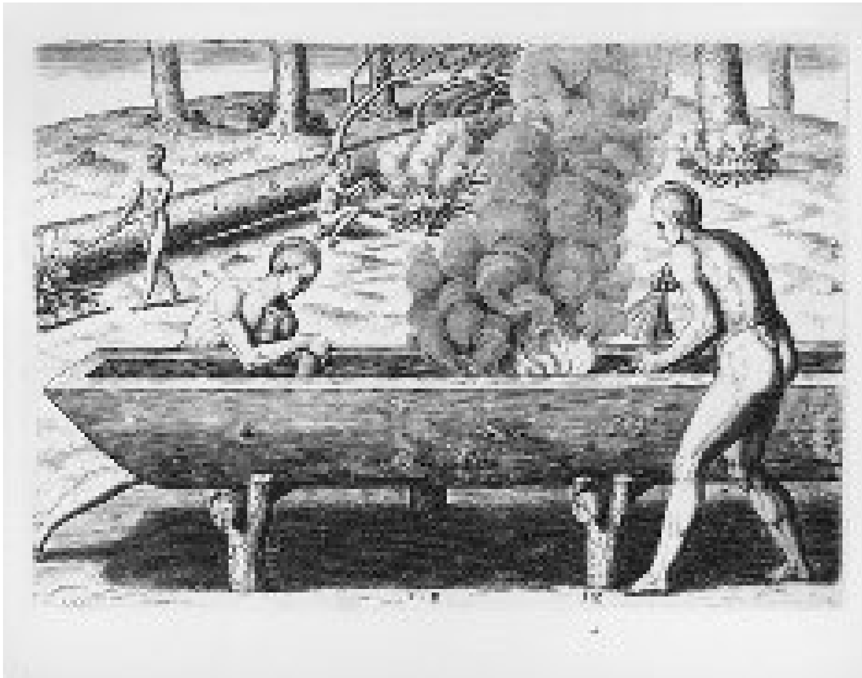


Edward Wilding (1875-1938)

Titanic's principal designers
Credits: Wikipedia & Titanic Belfast

NAVAL ARCHITECTURE

Naval architecture didn't hit its stride until the early 1800s. Long before it became a formalized academic pursuit and profession, vessels were built by lashing together logs or reeds and hollowing out logs that were buoyant, maneuverable, and capable of safely carrying people and cargo.

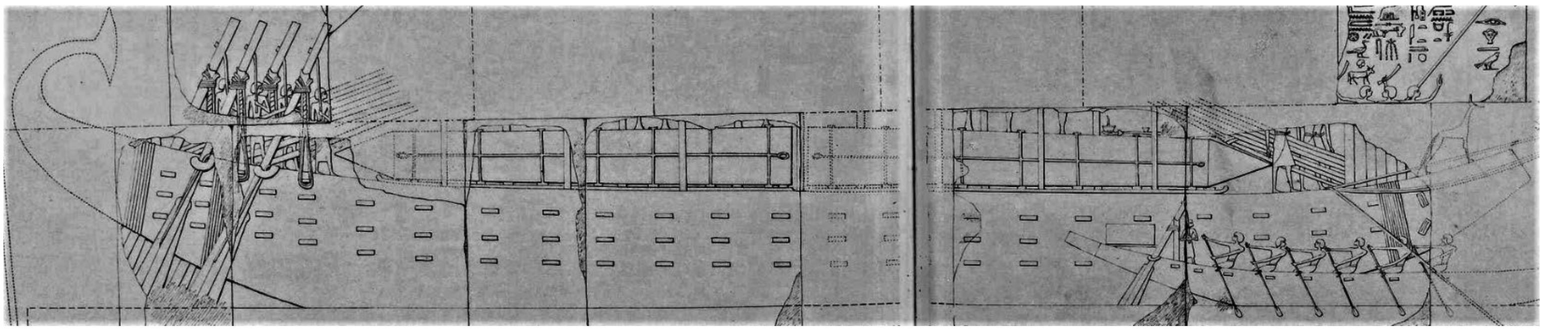


Transforming a log into a dugout canoe
Credit: Wikipedia

The desire for something lighter and more economical led to the coracle, rudimentary framing covered with hides made watertight. Small, light and easily transported, it was likely the first framed and covered vessel. It appeared simultaneously in Wales (noted by Julius Caesar when he invaded Britain), India and Tibet.

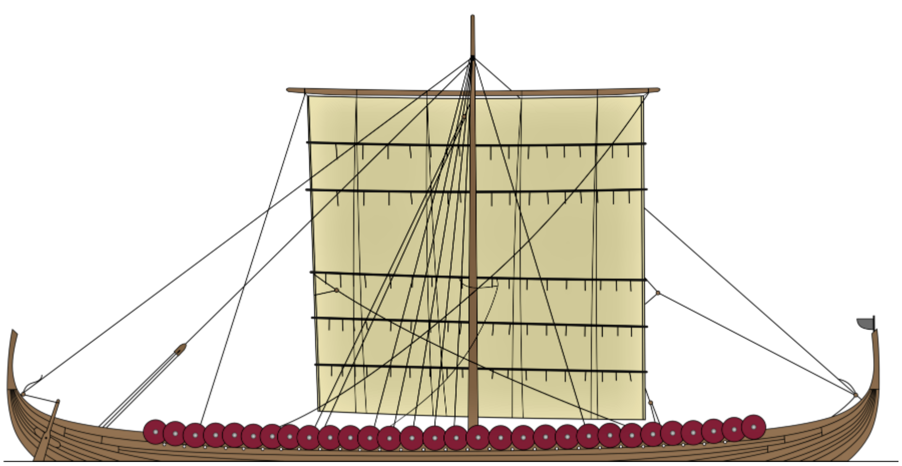
Coracle
Credit: Wikimedia Commons

Paddling about was suitable for short trips in protected waters, but greater distances could be covered using the power of the wind. In Egypt, dependable northerly winds would push a vessel with sails south along the Nile. For the return trip, the consistent northbound current would carry the craft back home, assisted by oars. A mortuary temple contains a bas relief of a barge carrying two obelisks for the Amun temple. The barge, propelled by a sail and oars, is said to have been 120 cubits (200 feet) long. To carry the great weight of the obelisks, the barge was fitted with multiple, side-by-side rope trusses on vertical stanchions from bow to stern, to provide the necessary longitudinal strength in calm waters. A homogenous internal framing system to provide hull strength had yet to be developed.



Hatshepsut's barge
Credit: Wikipedia

An enduring method of building an ocean-going hull that was light and rugged is exemplified by the Viking longship. Her clinker planking (the edge of one plank longitudinally overlapping and riveted to its neighbor), combined with internal framing, made for a hull that was flexible and strong. To seal the planks, a mix of spun animal hair dipped in pine resin was introduced between the planking laps. The versatile longship was used for cargo, trade, war and exploration. Perfected over time, the longship's sound boatbuilding tradition remains in use today. Fitted with oars nearly the full length of the hull, replica longships could reach 15 knots, or over 17 mph, under sail. Long and shallow, the double-ended longship was maneuverable, able to challenge the high seas or operate inshore in water as shallow as 3 feet. Unmatched for grace of line, the longship was fast and able at sea.



Longship in profile
Credit: Wikipedia

Gokstad longship showing clinker planking
Credit: Wikipedia

Longships covered great distances in the era of Viking exploration. However, as versatile as they were, they were essentially open boats with minimal shelter and little in the way of creature comforts. Longships lacked one component that would make them suitable to house and protect passengers and cargo on the high seas: a deck.

By the 15th century, vessels emerged that were able to carry cargo, safely house passengers and crews and sustain themselves at sea for extended periods. The carrack became popular in Europe and linked Mediterranean, Baltic and North Sea ports through trade. They were able to navigate through the difficult Straits of Gibraltar before reaching the Atlantic. Carracks from Genoa explored the North Atlantic as far as Iceland and Greenland. Unlike the longship, the hull planking of the carrack was carvel planked, laid on edge to present a smooth surface. A tumblehome hull (the vertical slope of the sides toward the deck level) made for a more stable and sea-friendly vessel. Fitted with three or even four masts, carracks had rounded high bows and sterns and a generous amount of freeboard (the distance from the top of the hull to the waterline), which helped keep things dry. The carrack was a successful design and developed into the multi-decked galleon by the 17th century. As vessels became more intricate to build, previously held "rule of thumb" methods in shipbuilding slowly morphed into scientific and mathematical methods of construction.

Carrack replica Vila do Conde
Credit: Wikipedia

El Galeon, galleon replica in Quebec City
Credit: Wikipedia

ART & SCIENCE

CHAPMAN

Fredrik Henrik af Chapman is credited as the first person to introduce analytical methods to shipbuilding. Born in 1731 in Gothenburg, Sweden, he was the son of naval officer Thomas Chapman and Susanna Colson, daughter of a London shipwright. He went to sea at an early age, and as a youth gained experience in Swedish shipyards, becoming a skilled draftsman. With money saved from his labors, he moved to England to continue as a shipwright. Returning to Sweden, he partnered with a merchant and opened a small shipyard. Realizing, in his early 30s, that he needed more sophisticated mathematical knowledge to design a ship, he sold his portion of the shipyard and moved to Stockholm to study with Baron Fredrik Palmqvist. After 2 years, he left to pursue his education in England, joining study programs at various British dockyards.

Fredrick Henrik af Chapman (1721-1808)
Credit: Wikipedia

He absorbed an immense amount of knowledge but came under suspicion by naval authorities. France and England were heated rivals, and Swedish and Danish workers were thought to spy on British shipbuilding methods. His work was confiscated, and he was arrested on charges of trying to get shipyard workers to spy in British yards. Confined to his home for 30 days, he paid a daily fine during his arrest. Eventually, most of his work was returned to him, and he moved to The Netherlands and France, where he was able to continue his studies.

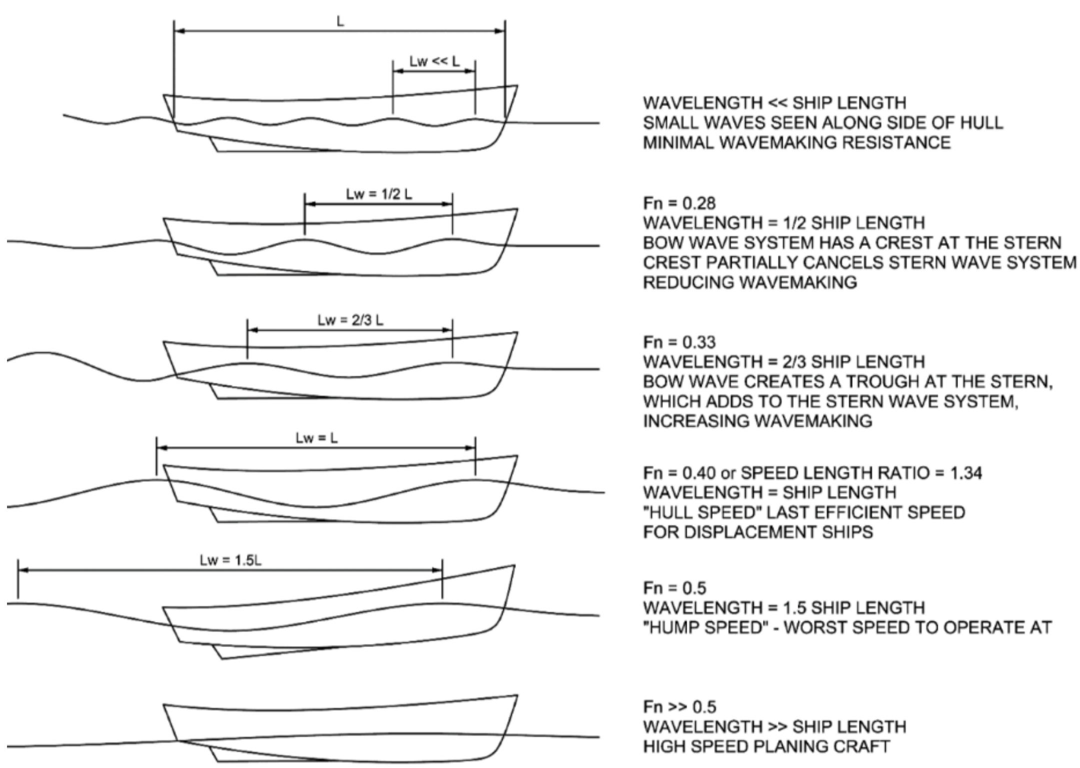
The experience served him well when consulting on warship design for Sweden. He improved dockyard facilities in his home country to include proper ventilation for workshops, improving cranes and advancing pumping machinery. His innovations furthered ship design, although his ideas to improve ship construction and standardization of parts ran into opposition from those who wanted to retain established methods. Disputes were settled by the Swedish Board of Admiralty, and Chapman’s efficient ideas prevailed. In 1769, he was given a free hand to design the country’s warships. But opposition remained, leading to sabotage in new ships that he built. Chapman’s extensive use of mathematics considered the whole ship: rigging, water resistance, weights, stability and calculating the volume of the hull. He sought real-world values for his designs and built a testing tank to study model hulls, pulled through the water to better understand their hydrodynamic qualities. In his later years, he went on to manage the Karlskrona shipyard, where he pioneered prefabrication for ship construction, cutting building times considerably. He authored several books on naval architecture and received the noble rank of ‘af Chapman’ in 1772 for his achievements. He died of unknown causes in 1808 at the age of 86.

FROUDE

William Froude was born in 1810 in Devon, England to Robert Froude and Margaret Spedding. During his career, he would take up the question of what it takes to get a ship moving through water with the least effort. After graduating first in mathematics at Oxford, he found work as a surveyor with the South Eastern Railway, He became familiar with the great engineer Isambard Kingdom Brunel. Recognizing talent, Brunel gave the 27-year-old Froude the major responsibility for building a section of railway. He used his time to develop a more efficient way to determine track transitions and introduced improvements to bridge building. His railroad work completed, Froude returned to naval architecture. He also married Catherine Holdsworth in 1839 and had two children, Robert, who went on to become a naval architect and engineer, and Eliza.

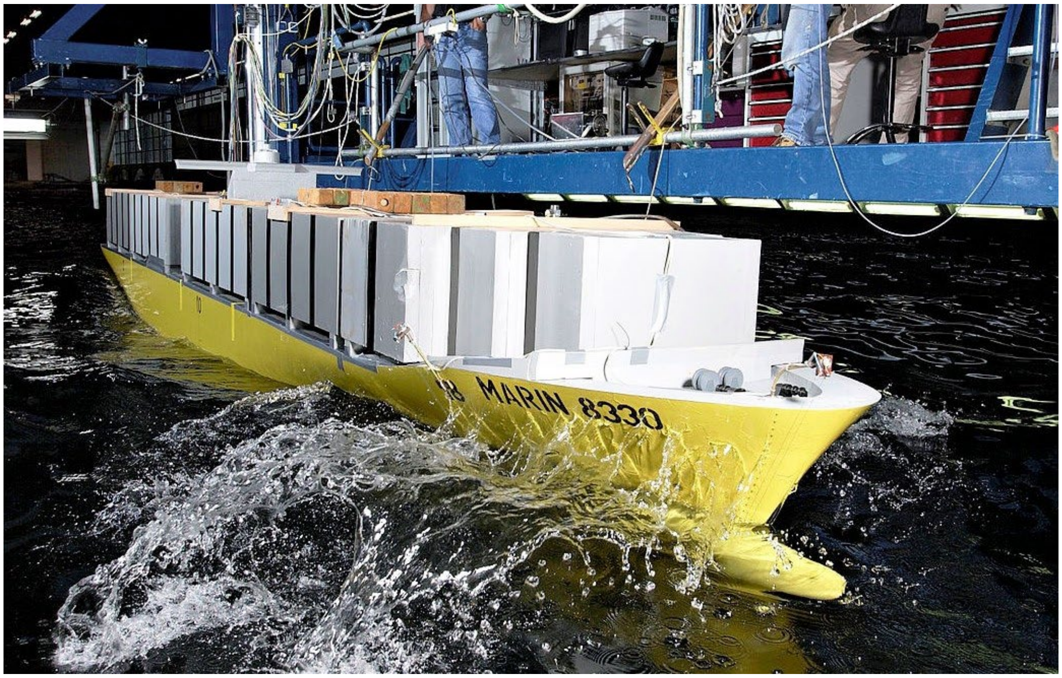
William Froude (1810-1879)
Credit: Wikipedia

Friction in water appears counterintuitive, but water resistance has posed a challenge to naval architects designing for speed, carrying capacity and economy of operation. The size and shape of the hull have everything to do with how a ship moves through the water. The wetted surface (the underbody from the waterline to the keel) is the portion of the hull that is in contact with the water. How smooth or rough the hull surface is determines the frictional resistance; even water viscosity (salt or fresh) plays a role in hull resistance. Generally, long, narrow hulls (but carrying less cargo) can slip through the water while wide and fuller hull shapes (carrying more cargo) require increased power. As a vessel accelerates, the water piles up into an ever steeper and deeper bow wave. As the ship forges ahead, fewer but larger waves form along her hull until there is a wave at bow and stern. This is the maximum point of efficiency. But there is nothing gained from more speed other than forcing the ship to "climb" over her bow wave, wasting fuel and increasing the struggle.



Wake action. Fn-Froude Number
Credit: Wikimedia Commons

The Froude number, much like the Mach number for aircraft, describes the velocity of the medium, air or water, that the object is moving through. The Froude number also provides the ability to scale up model tests to represent full-size ships, as their respective wave patterns are identical. Froude experimented in testing tanks with models up to 12 feet. Naval architects do their best to streamline the underwater parts of the hull, including appendages like rudders and propeller shaft struts, to make a ship go faster and do so economically.



Modern container ship in testing tank
Credit: Wikipedia

At the behest of Brunel, Froude took up the subject of ship stability and speed and applied it to Brunel's giant screw and paddle steamer of 1859, Great Eastern. Presenting his testing tank work to the newly formed Royal Institution of Naval Architects, Froude showed that models are effective in determining the actions of a real ship. This was confirmed by the Admiralty, which led to the first purpose-built public-funded testing tank. Froude validated others' theories regarding hull resistance to further stock the toolbox of future naval architects. He also developed the first water brake dynamometer to measure the torque produced by an engine. Froude's methods were so accurate, they continue to be used today.

When Froude's wife Catherine passed away in 1878, leaving him devastated, Froude accepted a tour to South Africa from the Royal Navy. While on his journey, he contracted dysentery and passed away in May 1879 at age 68. Highly respected for his work, he was given full naval honors at his burial. Froude's death cut short his research to determine the efficiency of propeller blades. Robert carried on his father's work and presented the finished papers to the Royal Institution of Naval Architects.

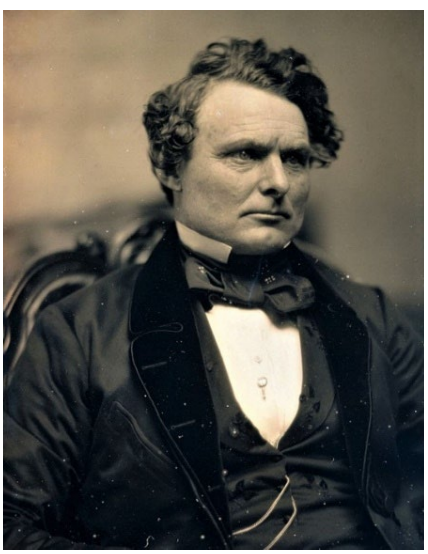
WOODEN WALLS

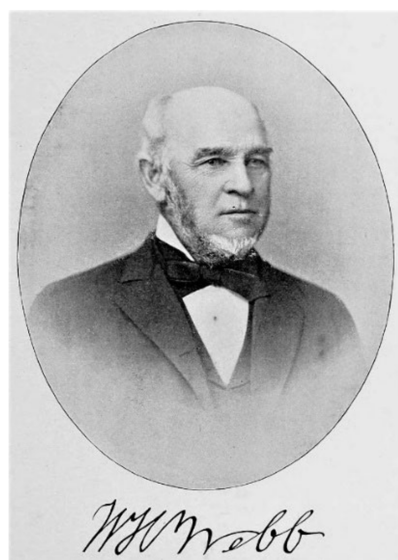
By the end of the 18th century, ship design and construction were becoming more complex, especially for naval vessels, which carried heavy armaments. It was no easy task to select, cut and fashion timbers into frames and planking; design a sailing rig that permitted the ship to be maneuvered; and train and provision the ship's crew. Naval architects produced robust vessels for trade and war. Ships of the line, the floating bulwarks of England, were symbols of power and influence. Warships were designed to protect the country by remaining at sea for years, blockading enemy ports and enforcing the country's colonial trade interests. Ships of the line were expected to engage in brutal combat at close quarters. They carried 64 to more than 100 guns and were built to deliver and absorb punishment. They were manned by hundreds of sailors and marines. Ship handling and battle skill won the day. The last surviving ship of the line, HMS Victory, carried 841 crew and was armed with 104 guns.

HMS Victory, stern view
Credit: Wikipedia


HMS Victory, showing heavy timber construction
Credit: Wikimedia Commons

THE QUEST FOR SPEED

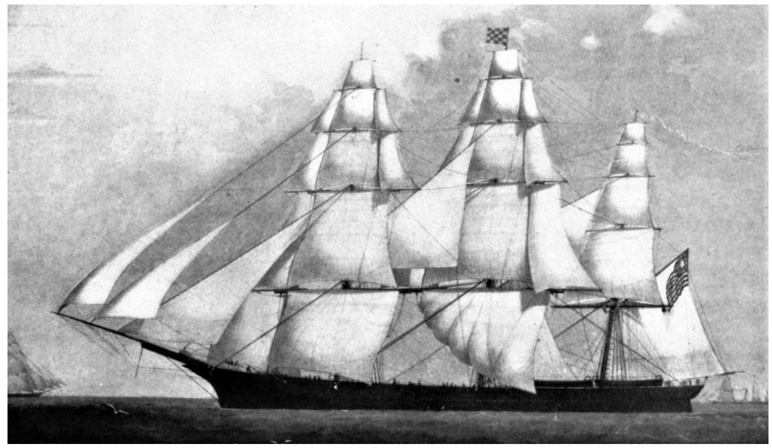

Donald Mackay (1810-1880)
Credit: Wikipedia


William Webb (1816-1899)
Credit: Wikimedia Commons

Stiff competition for worldwide trade demanded fast delivery to seize premium cargo rates and passenger business. This bred an obsession for speed in the late 1840s. To satisfy this need, naval architects developed extreme hull forms with sharp bows and hollow lines. Thus, the clipper ship was born. But the slim hulls and fine lines came at the expense of cargo capacity. Other than finer hulls, little changed in construction methods—a heavy framing system sheathed with thick planking. For larger vessels, diagonal iron straps were introduced to stiffen the hulls. The popularity of clipper ships began to decline in the late 1850s due to the allure of steamships and the economic panic of 1857 (eroding trust in banks and loans). Nevertheless, the glamorous clipper ships became legendary and were considered the high-water mark of ship design at the time, with American naval architects Donald Mackay and William Webb taking the lead.

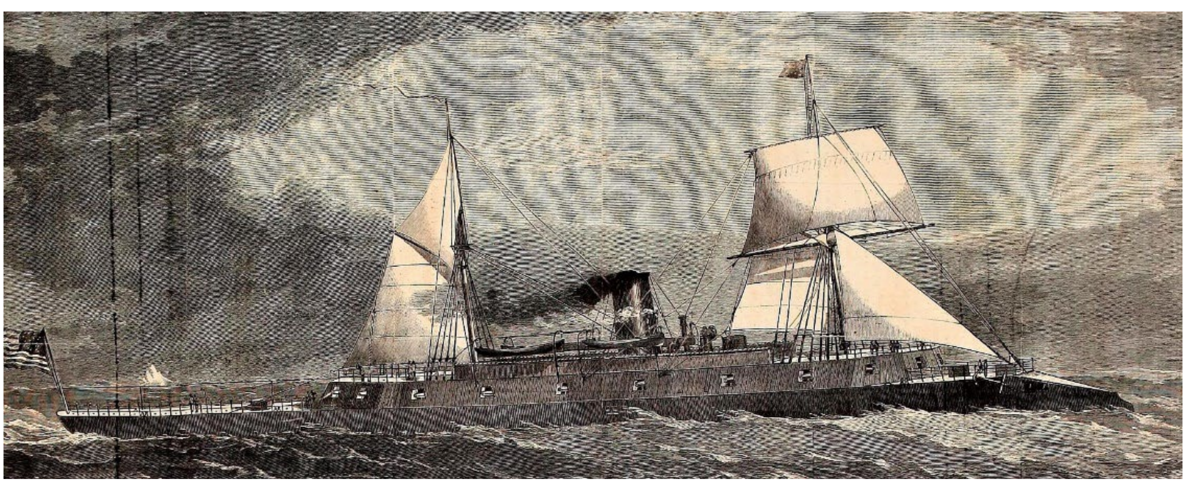
The California gold rush spurred the desire for fast ships, such as Mackay's famous Flying Cloud and Webb's Challenge. Carrying passengers eager to dig for gold was so lucrative, a ship's construction costs could be covered on the first trip. Flying Cloud held the record for fastest passage: 89 days, 4 hours from New York to San Francisco in 1854 (a record that stood for 135 years until surpassed by a modern sloop in 1989). Twenty years later, Flying Cloud ran aground at St. John, New Brunswick, broke her back and was burned for her metal.

Mackay's Flying Cloud
Credit: Wikipedia



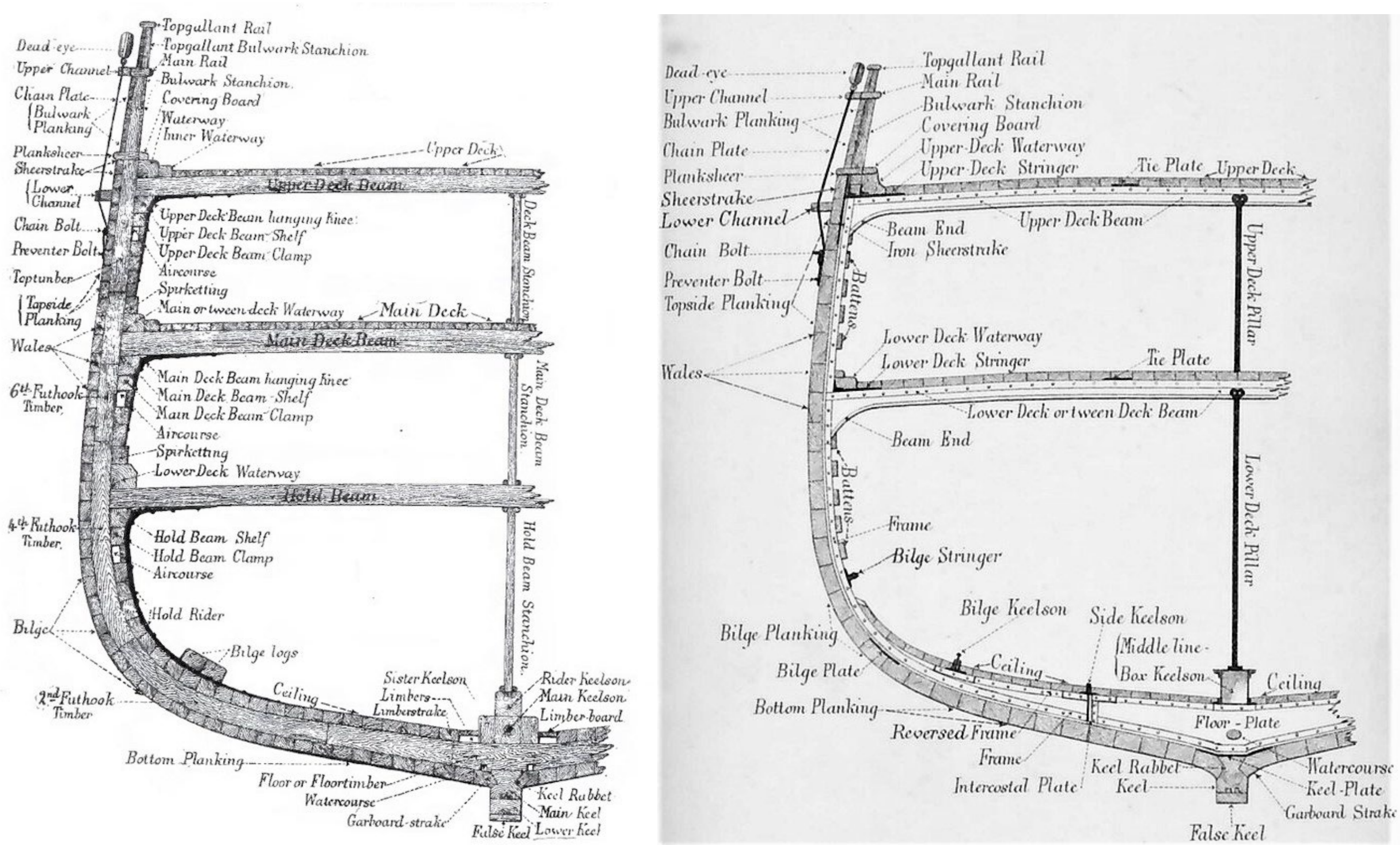
Webb's Challenge
Credit: Wikipedia

William Webb designed the extreme clipper Challenge in 1851 to make the fastest passage to San Francisco. Her captain was offered a $10,000 bonus if he set a record. Driving his crew hard, he lost seven men, and his ship ran into heavy weather. The wretched conditions led to mutiny, and any chance of the ship making a record passage was lost. At the height of the clipper ship era, Webb built what was considered to be the most beautiful clipper ship afloat, Young America, in 1853. She was described in the press as the "acme of perfection." Webb also built steamships, including a huge ironclad, USS Dunderberg.



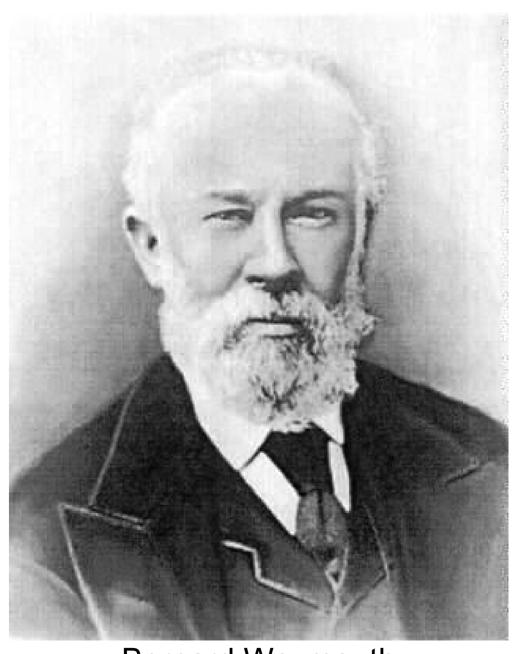
USS Dunderberg
Credit: Wikipedia

Unlike the American vessels, carrying prospectors to dig for gold, British clippers fiercely competed in the tea trade to China. Hercules Linton and Bernard Weymouth designed the legendary champions, Cutty Sark and Thermopylae, respectively. Whereas American clipper ships were built from soft woods and became waterlogged and wore out after a few years, British vessels were of composite construction: hard, tough wood planking, like oak and rock elm, fitted over iron frames. Their captains never claimed excessive daily runs or speed records, as did their American counterparts. British composite clippers were sturdy vessels that were good in light airs and could take a driving, holding on to sail and using the vagaries of the winds to make consistent passages from England to China.



Midship sections: Wooden hull, (L) composite hull, (R)
Credit: Wikimedia Commons

Hercules Linton
Credit: Wikipedia



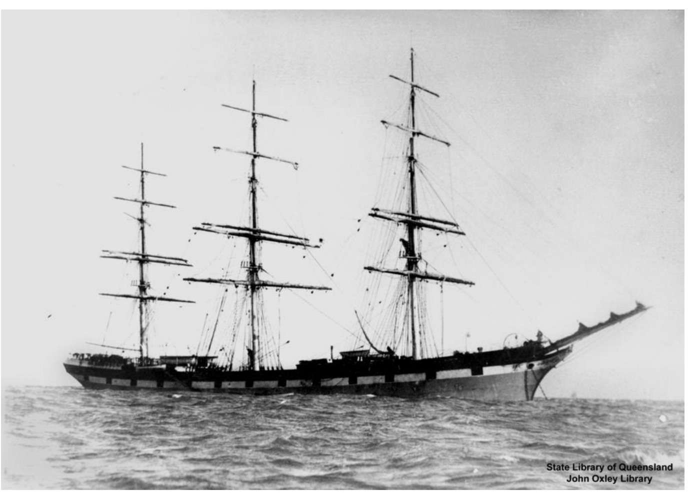
Bernard Weymouth
Credit: Doric columns

Linton’s Cutty Sark
Credit: Wikipedia

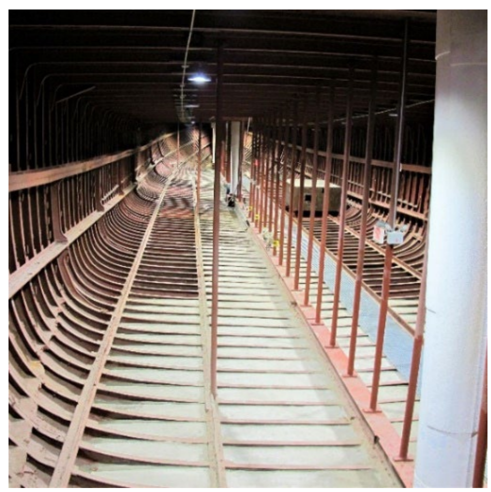
Weymouth’s Thermopylae
Credit: Doric columns

STURDY AND SLOW

As the clipper ship declined, the iron windjammer emerged. These were bluff-bowed vessels that eschewed the fine lines of the clipper ship. Although larger and slower, with their small crews, they proved economical to run and were able to turn a profit. Standardization allowed for rapid construction. The iron ships showed such little shape (essentially a rectangular box) that it was said, “they were built by the mile and cut by the fathom.” Yet, they had a grace about them and served England well until World War I swept them from the seas. Their full hull forms, easily three times the volume of a clipper ship, allowed them to load thousands of tons of cargo and goods.

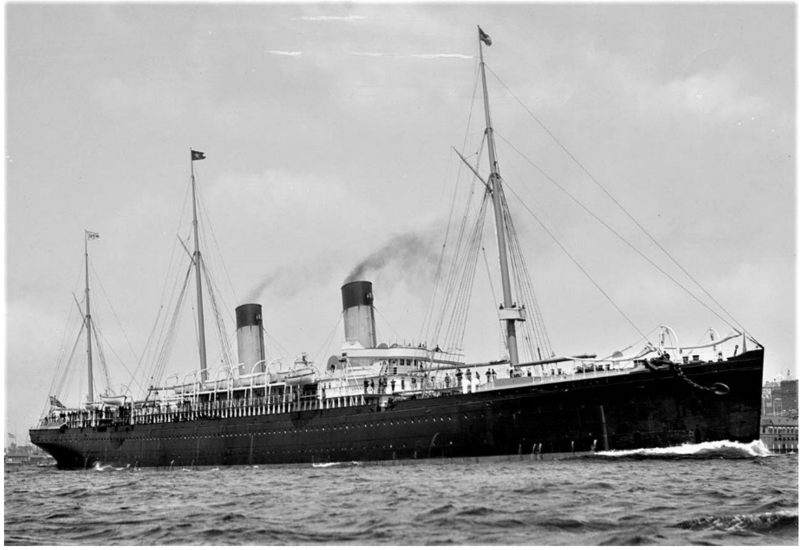


British iron ship Allerton 1884
Credit: Wikimedia commons



Sister vessel Wavertree interior preserved
at the South Street Seaport Museum, NYC
Credit: Author

The lure of a fast passage was impossible to resist, however. Regular delivery of cargo and passengers drew attention away from windjammers and towards steamships. Sophisticated metallurgical processes led to steel hulls. Designing a modern ship required a cavalcade of skills and know-how that included machinery, bunkers for fuel, hotel services for passengers and even mechanical refrigeration. The idea of the express transatlantic liner, a steamship able to maintain a consistent schedule, haltingly started in the 1830s. White Star Line commanded an early lead in the 1870s and 1880s with a series of impressive liners, such as Teutonic. But larger and faster ships required standards of construction. Classification societies were established to organize and regulate the means and methods of design.



SS Teutonic, 1889
Credit: Wikipedia

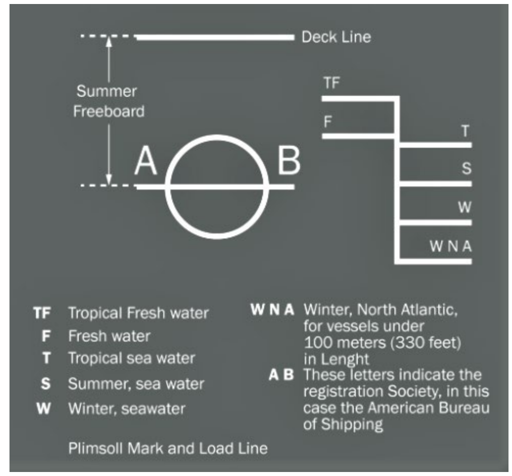
SAFER SHIPS

Standardization to ensure quality of design and construction and build safer ships became the focus of businessmen, exporters, shipowners and mariners. Reduced risk against loss went hand-in-hand with good construction and competent operation. Loss of ships and damage to cargo could be apportioned to a group that would offer compensation for losses for a piece of the profits. The interested parties would gather to discuss how best to share the risk. Lloyd’s Coffee House, owned by Edward Lloyd, became the venue for these discussions. Safe operation of the ship was as important as the ship herself. At first voluntary, then mandatory, examinations were instituted in the mid-1800s in Britain and America to evaluate the competence of those who wanted to be mariners and marine engineers.

Lloyd’s Coffee House
Credit: Wikipedia

Lloyd’s establishment provided dependable news about ship movements and cargo for those interested in insuring the vessels. But before signing on to provide insurance, or underwriting, interested parties had to have some assurance that the vessels could safely carry their cargo and be competently operated in all sea conditions. Lloyd’s Register, which appeared in 1760, listed ships and classified them according to the quality of their construction. Unscrupulous shipowners would self-insure and claim exorbitant losses when their overloaded ships sank. To guard against this, in 1885, Samuel Plimsoll, a politician and social reformer, devised a system of loading marks that are painted on the ship’s hull. Each level indicated the deepest the ship could be loaded for a particular condition and thereby ensure her stability. A series of struggles with shipowners ensued, and after various incarnations, the general condition of a ship, assessed yearly, was established as either good, middling or bad. Lloyd’s A1 was the highest rating. Each maritime nation had its own classification society, but they were bound to the same rules of good construction, providing guidance for naval architects to this day.

Samuel Plimsoll (1824-1898)
Credit: Wikipedia



Plimsoll mark
Credit: Knight’s Modern Seamanship

PROFESSIONAL SOCIETIES

To promote the art and science of ship design, the Royal Institution of Naval Architects (RINA) was established in 1860 with a charter by the monarchy of Queen Victoria. Some of the great engineers of the day, including John Scott Russell and John Penn, founded the society to better organize and combine the needed research into ship design. Three women were admitted as members in 1919: mechanical and nautical engineer Eily Keary, naval architect Blanch Thornycroft and engineer Rachel May Parsons, founding President of the Women's Engineering Society.

In America, The Society of Naval Architects and Marine Engineers (SNAME) was founded in 1893. As with RINA, SNAME was established to further the art and science of naval architecture and to include engineers from other related fields. William Webb, the famous clipper ship designer, was a founding member of the society. Both organizations are worldwide and establish Codes of Ethics for their members.

RINA coat of arms
Credit: Wikipedia

SNAME emblem
Credit: Wikipedia

TITANIC

PIRRIE & ISMAY

The driving forces behind Olympic, Titanic and Britannic were Lord William James Pirrie, Chairman of Harland & Wolff and J. Bruce Ismay, Managing Director of the White Star Line (and Titanic survivor). In 1901, they embarked on the construction of the major liners Celtic, Cedric, Baltic and Adriatic, dubbed the “Big Four.” The first three ships were, sequentially, the largest in the world, Adriatic barely losing out to the German liner Kaiserin Auguste Victoria in 1906.

Following White Star’s minor loss of prestige, rival Cunard placed into service the turbine-driven Lusitania and Mauretania in 1907. In one stroke, Cunard, lagging behind the competition for years, had not only the largest but also the fastest liners in the North Atlantic. White Star was determined to reclaim its glory and build a trio of superliners to establish weekly transatlantic service.

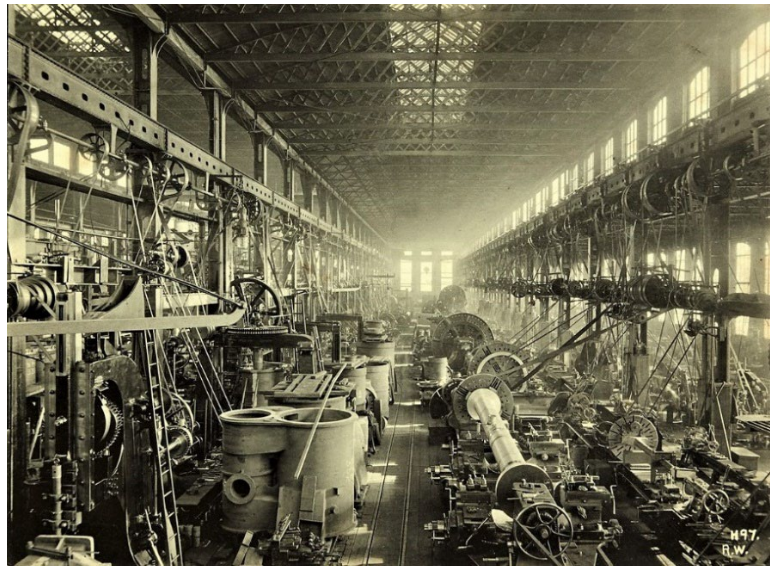
Pirrie and Ismay were contemplating moving White Star services from Liverpool to Southampton, the latter being closer to London, reducing rail times. They also included a stop at Cherbourg to gather continental passengers. Over dinner and wine, the subject of how to exceed the two new Cunard ships took center stage. The two men sketched out a trio of vessels that would be the answer to their great rival. The ships were too large for existing docks; new berths would have to be built, and piers in New York City would have to be lengthened. Architect Alexander Carlisle credited the design of the new ships to Pirrie. While Pirrie oversaw the draughtsmen, his main focus was garnering new business for Harland & Wolff, leaving design detail in the capable hands of Carlisle and fellow designers Edward Wilding and Thomas Andrews.

Lord Pirrie (L) and Ismay at Harland & Wolff
Credit: Wikimedia

CARLISLE

Alexander Montgomery Carlisle began his career at Harland & Wolff as an apprentice in 1870, when he was 16. An apprenticeship took 5 years, and boys were expected to become proficient in all aspects of shipyard work, including drafting, machinery, plating, electrical work and joinery.

Harland & Wolff drafting shop
Credit: Wikimedia Commons



Engine and turning shop
Credit: Wikimedia Commons

Carlisle's skill and ambition led to his appointment as General Manager and chief naval architect of Harland & Wolff in 1890, followed by an appointment as Chairman of the Board in 1907. He presented the plans for Olympic to White Star early in 1908, retiring from the firm in June 1910, before Olympic was launched later that year. Thomas Andrews, nephew of Lord Pirrie, was given the position of Managing Director and continued work on the Olympic and Titanic. Carlisle stayed active and became a member of the Merchant Shipping Advisory Committee on Life-Saving Appliances. Having a hand in designing new lifeboat davits to accommodate more boats, his recommendation to the Board of Trade to double the lifeboat capacity on the new liners was rejected in 1911. Carlisle's influence on liner design was apparent: his trademark sheer sweep of the ships' hulls and the balanced appearance of funnels, masts and upperworks were unmistakable. Oddly, Carlisle preferred traveling in German liners and rarely crossed the Atlantic on British ships. He never sailed on Olympic.

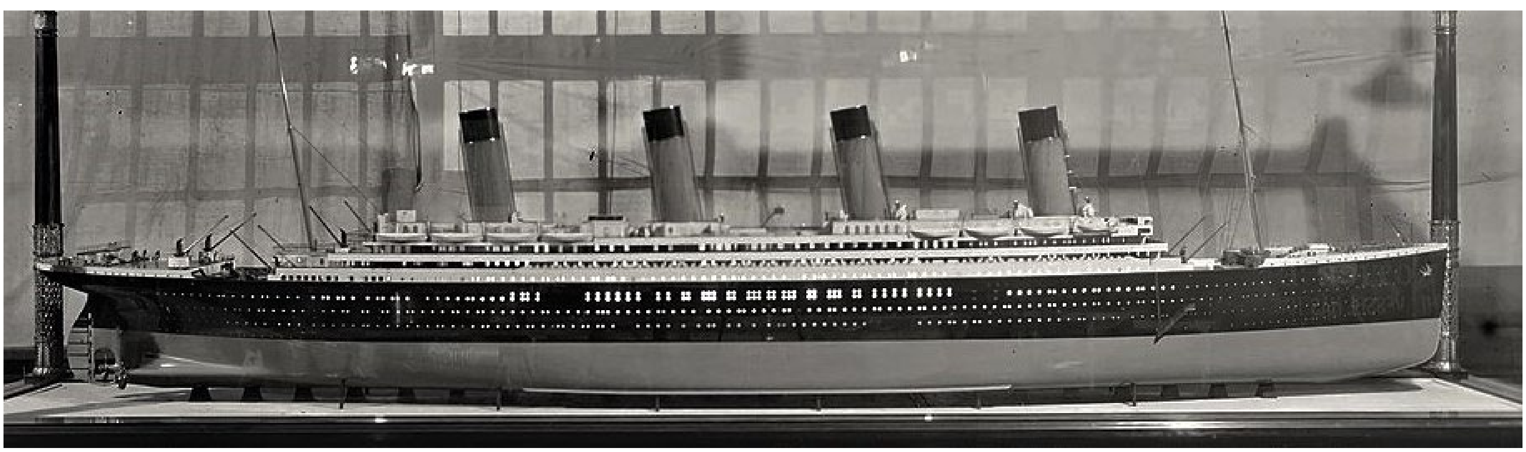
The loss of Titanic overwhelmed Carlisle. During the memorial service on April 19, 1912, his frail appearance was shocking, and he fainted when Handel's Dead March for Saul was played and the liturgy chanted. When he passed away in 1926, no formal prayers were said, no hymns sung. But Carlisle had asked that the "Merry Widow" be played at the end of the service. His remains are held in the Golders Green Crematorium in North London, marked by a memorial tablet.

WILDING

Edward H. Wilding, born in Lancashire, England in 1875, was indispensable to the design of the Olympic class. Starting at Harland & Wolff in 1904, he played a significant role in designing many of the largest White Star liners and those of the Hamburg Amerika line, which Harland & Wolff were building for Germany. Like many young men of the day who pursued a career in ship construction, Wilding joined the Royal Corps of Naval Constructors in 1890. Five years later, he was awarded a temporary position as Assistant Constructor and went on to attend the Royal Naval College at Greenwich.

Royal Naval College at Greenwich
Credit: Wikipedia

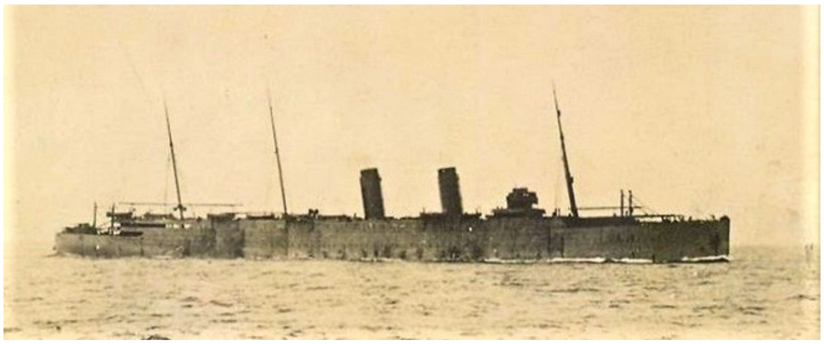
As part of his studies, Wilding spent time at a number of dockyards to gain experience and immerse himself in construction and design techniques. His grasp of the particulars of naval construction would serve him and Harland & Wolff well. Completing college in 1898, Wilding was sent to an English Channel battleship (an older battleship so called because it patrolled the English Channel) for further practical experience. His talents led to an assignment at the Admiralty Experimental Works, where he worked on special calculations for the model testing to predict power requirements for ships. Wilding advanced rapidly and in 1904, at age 29, joined Harland & Wolff's design department. Wilding visited the Lusitania during her construction. Traveling on the Cunard vessel in 1908, he was given the run of the ship and watched the turbine machinery in operation.



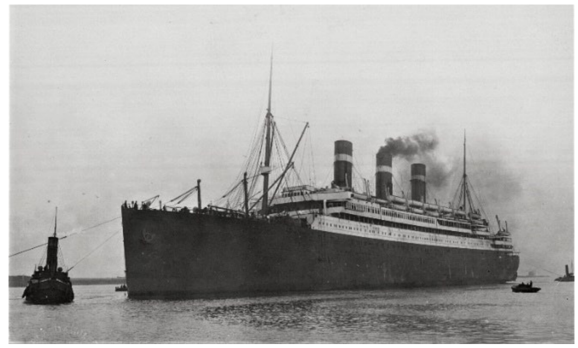
Builder's model of Olympic & Titanic
Credit: Wikimedia Commons

Working hand in glove with Thomas Andrews in designing the new superliners, Wilding's skills, his "scientific side," were put to good use. Wilding accompanied Andrews and his Guarantee Group from Harland & Wolff Belfast to Southampton to get a brief picture of Titanic's performance at the start of the maiden passage. Four days later, Titanic met her tragic end. With Carlisle retired and Andrews lost on Titanic, it fell to Wilding to provide the most up-to-date technical information to the Board of Trade Commission Inquiry in 1912 regarding the loss of the ship. The following year, Wildling was made one of the managing directors of Harland & Wolff, and he assumed charge of the design department 2 years later.

In 1915, during World War I, Wilding traveled to New York to provide a deposition to the Southern District Court of New York regarding White Star's liability for Titanic. It appears that he departed in June to return to Belfast. Widely respected, he was called upon numerous times to offer his perspective on Titanic. He received government honors in 1920 for his overall efforts during the war. He had been heavily involved with the construction of the SS Belgenland for the Red Star Line. Only partially complete on the eve of the war, she was named Belgic and rushed into service as a troopship and freighter. Returned to Harland & Wolff after the war, Wilding immersed himself to finish the new liner and get her into service. He made the ship's maiden voyage from Antwerp to New York in 1923 so he could observe the ship's performance.



Belgic as completed for war
Credit: Wikipedia



Belgenland Red Star Line service 1923
Credit: Wikipedia

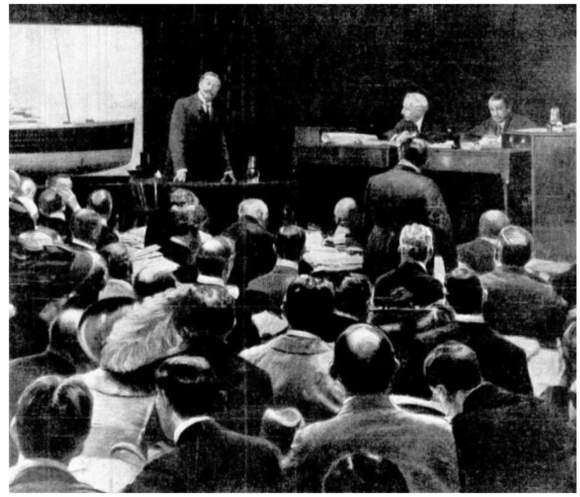
Wilding remained with Harland & Wolff until shortly after Lord Pirrie passed away in 1924. Two years later, Wilding became involved with river shipping in Argentina, making several trips up the Rio Parana, a river second in length only to the Amazon. His many travel journals, photos and rare postcards were given to the Royal Geographical Society, of which he was a member. He passed away in 1938 at the relatively young age of 63. His contribution to understanding the tragic loss of Titanic was invaluable. His ashes were scattered at the Landican cemetery near the river Mersey.

BRITISH WRECK COMMISSIONER'S INQUIRY (BWCI)

Both the British and Americans conducted investigations into the wreck of the Titanic. The U.S. Senate hearings were far more demanding and critical of Titanic's owners and officers. J.P. Morgan's International Mercantile Marine had a controlling financial interest in White Star for 25 years and owned 60% of Titanic, so the Senate focused more on the operational deficiencies than the technical ones. Carlisle and Wilding were not called for the Senate hearings and participated only in the British inquiry.

For 42 days, the BWCI presented a procession of Admiralty lawyers, technical experts, professional mariners and others to learn why Titanic sank. The pursuit of truth involved questioning nearly 100 witnesses, including surviving passengers and crew and those involved in the rescue. High Court Judge John Charles Bigham (Lord) Mersey was a maritime and commercial attorney who unsuccessfully dabbled in politics. He came out of retirement when called to head the official Board of Trade hearings into the loss of various steamships, including Titanic and Lusitania. Highly skilled, Mersey was so sought after for legal work, he became one of the wealthiest lawyers in Great Britain. However, he was accused of protecting the Board of Trade and shipping interests from culpability in the disaster. Impatient with witnesses, yet seemingly objective, his deductions and conclusions were questioned by authors and other maritime experts. In his later years, Lord Mersey suffered from deafness but continued working until his death at age 89 in 1929.


Lord Mersey
Credit: Wikipedia


The British inquiry
Credit: Wikimedia Commons (The Graphic)

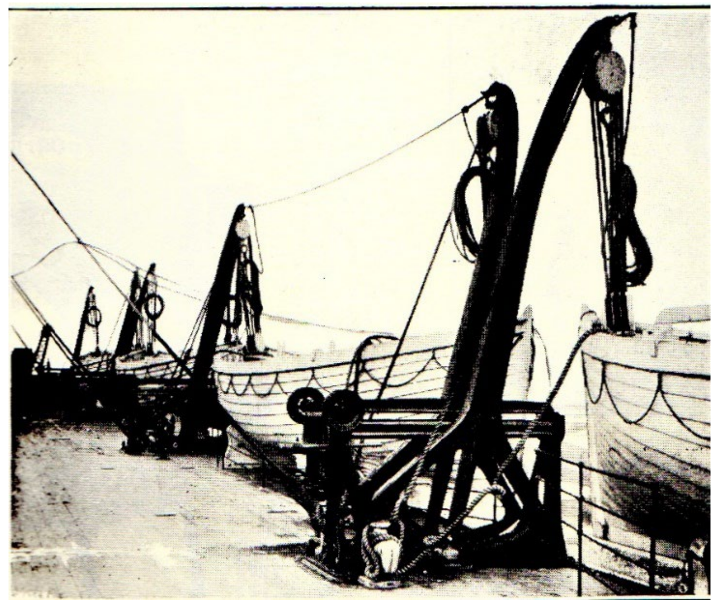
CARLISLE TESTIMONY

The vexing dilemma of providing ships with lifesaving equipment, which dogged the Board of Trade in the 19th century, was two-fold. On one hand was the difficulty of fitting enough boats with the apparatus to safely launch them. The second, more murky issue was the influence of shipowners, who wanted to keep their costs down and had sway with the Board of Trade, the regulating body. With the horrific loss of life on Titanic, the only answer to the bothersome question was lifeboats for all.

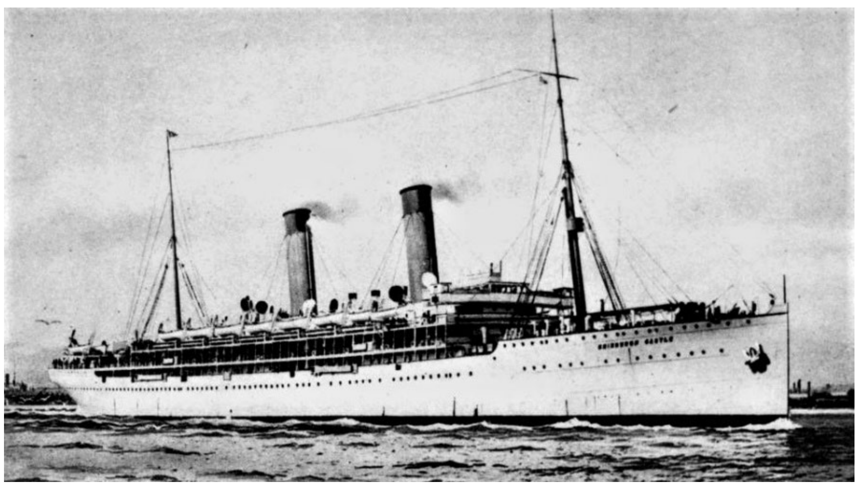
Wreck Commissioner Butler Aspinall, representing the Board of Trade, began Carlisle's questioning. He asked Carlisle about an interview he gave to the "Daily Mail," regarding lifesaving equipment on Olympic and Titanic in June 1910, just prior to his retirement. Radial davits were widely used but required the boat to be pushed and shoved to rotate the davits to clear the deck, a time-consuming operation before lowering. The arduous process was reversed to stow the lifeboat. Launching a boat with the labor-saving Welin davit was simpler; after unhinging the outboard boat chock, the two davits were cranked outboard traversing the boat sideways to clear the side of the ship. They also had the ability to plumb the boat when cranked inboard to set it smoothly back on the deck chocks. Each davit could be operated by one deckhand.

Carlisle, at the time chairman of Harland & Wolff's managing directors, describes his idea for having each pair of davits hold four boats, up to a total of 64. (The Board of Trade did not require more than 16. White Star slightly exceeded this number and supplied 20 boats, including four collapsibles.) Carlisle presented his concept to the Swedish Welin Quadrant Davit Company in anticipation of Board of Trade changes to lifeboat capacity. In 1909, he presented a draft design of the proposed davits to Pirrie, Ismay and Ismay's co-director. The purpose of the meeting was the vessels' decorations, but Carlisle took the opportunity to introduce the new davit design. Carlisle stressed that the cost would be negligible and the new davits would give White Star a head start on complying with the new regulations. After brief consideration by the group, the davits were incorporated into the new ships. He also submitted his plans to the Shipping Advisory Committee, where other steamship company officials were present to consider the new davits, before Olympic and Titanic entered service.

Radial davits on Lusitania
Credit: Wikimedia commons



Welin quadrant davits on Olympic
Credit: Shipbuilder special 1911 edition



Edinburgh Castle 1910
Credit: Wikipedia

Before Carlisle retired, the new davits were test fitted to the Union Castle liner Edinburgh Castle in 1910. When asked about how much time it would take to launch multiple boats, Carlisle expressed confidence that with good organization, 32 boats could be launched in 30 minutes; 64 in an hour. But the sea would have to be calm; in rough seas, all bets were off. He testified that throughout his efforts to incorporate the new davits, he stressed to those in charge that there were not enough boats on Titanic. One of White Star's concerns was that if they included additional boats in Titanic, they would have to retrofit all their ships at considerable cost. When asked if White Star could have taken the initiative and fitted more boats to their new ships, Carlisle replied that they could have. He was asked what would be the effect on the ship's stability by adding as many as 64 boats to the top deck? Carlisle stated that ships are tested for a range of stability and any deficiencies could be compensated for by adding more ballast or lightening the upperworks of the vessel.

The line of questioning then turned briefly to watertight subdivision. Although offering no detailed opinion regarding the height of Titanic's bulkheads, he thought they went up fairly high, and that going too high offered no advantages. Likewise, he did not support longitudinal bulkheads that run fore and aft (as in warships), but offered no reasoning, other than that he had never built a warship. Carlisle said he preferred that transverse bulkheads only be used in merchant ships and that as few watertight doors as necessary should be employed, commensurate with the practical access for working the ship. He also reminded the court of the contrast between merchant crews and naval crews: warship crews are trained to deal with battle damage, whereas merchant crews' ability to handle damage is limited.

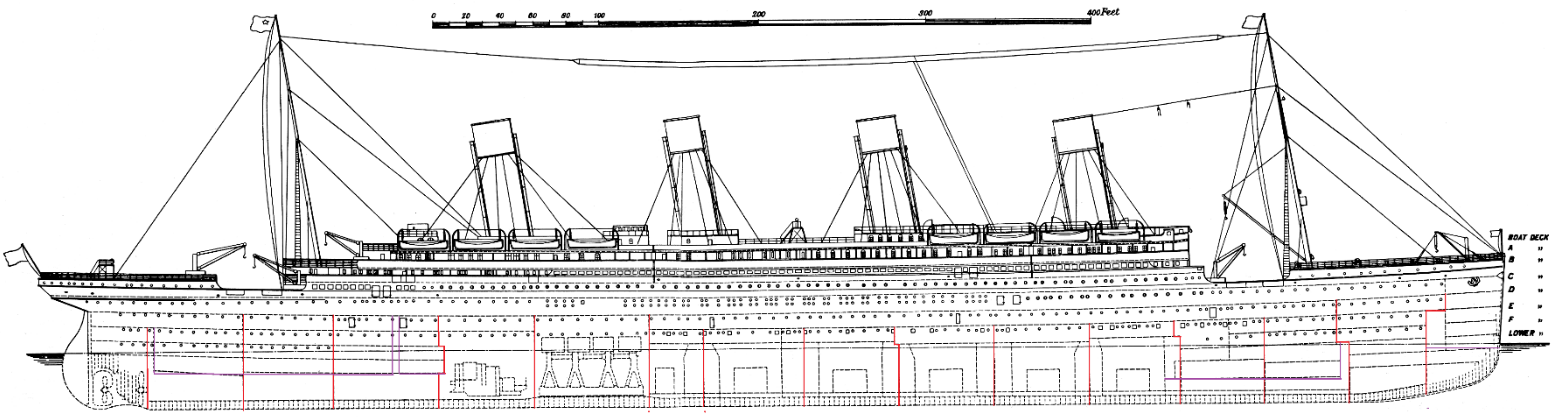
When asked about his financial interests in either Harland & Wolff or White Star, Carlisle simply stated that he had none. The questioning then returned to the cubic capacity of the lifeboats for ships of 45,000 or more gross tons; it was the same as for a 10,000-ton vessel carrying fewer passengers. Board of Trade regulations at the time stated that if a vessel was fitted with a certain number of watertight compartments, and carried wireless operators, she could be exempt from carrying additional boats. In that case, even boats that were already shipped could be removed, according to Carlisle. The issue wasn't pressed, and Carlisle was excused from further testimony.

WILDING TESTIMONY

How the largest ship in the world could founder on her maiden passage required the expertise of the professional who knew the most about Titanic. It was up to Edward Wilding to assemble the puzzle of what befell Titanic after she hit the iceberg. He was questioned by barrister and judge Sidney Rowlatt, later infamous for hindering the independence movement in India. Referring to a Harland & Wolff drawing of Titanic, Rowlatt wasted no time getting into technicalities, asking about her draft and displacement (34 feet 7inches and 52,310 long tons, respectively). (A long ton is 2,240 pounds). He asked about the height between the ship's decks, with the answers in his hands. Wilding rattled off the numbers and said Titanic conformed to all current Board of Trade regulations and American immigration laws. Wilding even gave the page numbers in the reference book that Rowlatt was holding, which provided the answers to his questions. Rowlatt discussed the machinery arrangement, the main and auxiliary sources of power for the wireless set, how lighting and the internal communication system of telephones worked. They went into the passenger accommodations, escape routes and how high the boat deck was from the normal waterline: 60 feet. They briefly touched on any locked barriers that would have prevented Third-Class passengers from reaching the boats. Wilding stated that, to the best of his knowledge, all barriers, except for emergency doors to keep passengers out of the boiler rooms and other machinery spaces, could be readily lifted by hand or were left open for convenience and posed no impediment to access to the boat deck.

Titanic was built with 15 watertight bulkheads, forming 16 watertight compartments. She could safely tolerate two flooded compartments (one ruptured bulkhead) anywhere along her length. The compartments were 50-70 feet long, so damaging one bulkhead would flood 100-120 feet of the ship's length without threatening her safety. The most critical anticipated scenario Titanic could survive was to have the first four compartments open to the sea, or about 200 feet of her length, from the stem to the bridge. Wildling was asked if the bulkheads had been resistance-tested by filling a space with water, and he replied that they had been built to Lloyd's standards of construction and that it was not normal practice to fill a compartment with water to test the bulkheads. Exceptions were made for the forepeak and double bottom tanks, which were pressure-tested. Wilding explained about bulkhead construction: thicker plates on the bottom and the spacing of stiffeners and rivets.

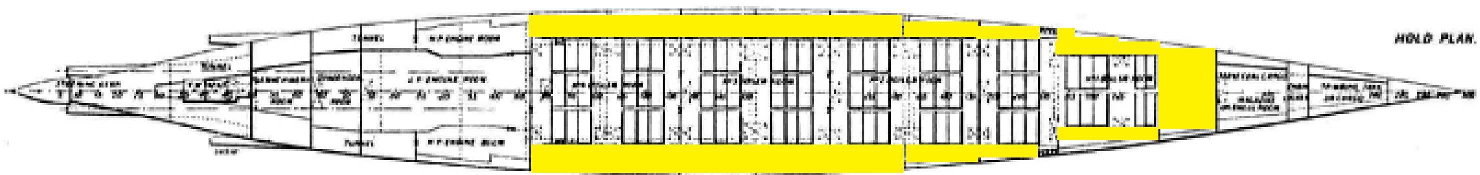
Titanic also had watertight flats (partial decks) fore and aft. Forward, the orlop deck was watertight in that the forepeak trim tank closed off the first compartment in the bow. In addition, there was a watertight firemen's tunnel at the bottom of the ship. The firemen would go down a spiral ladder from their quarters forward, then proceed aft to the forward boiler room. This provided a passage for the firemen to reach their stations without going through passenger spaces. The after watertight flat ran from the aft end of turbine room to the afterpeak tank. This sealed off the shaft alley tunnels and protected the after portion of the hull in the event of a propeller shaft failure. The dynamos (electrical generators) and fresh water tanks were covered by this watertight flat as well. The dynamo room, located on the centerline, was also protected on the sides by the port and starboard fresh water tanks. Little mention is made of Titanic's watertight flats in many descriptions of the ship. It is usually assumed that other than the fore and aft peak tanks, she had none. As all the damage was forward and about 20 feet below the surface, the after watertight flats were of no use in preventing progressive flooding the night of the collision. Regarding not fitting longitudinal bulkheads, Wilding explained that the ship's stability could be impaired if a side compartment filled with water, imposing a large list that could overtop the transverse bulkheads on the low side, allowing water into the deck boundary and threatening the ship's stability.



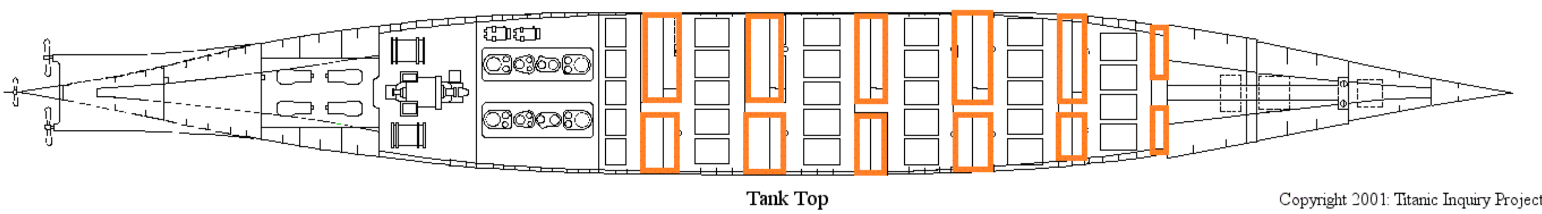
Olympic & Titanic watertight subdivision.
Vertical bulkheads in red, horizontal watertight flats and trunks in purple.
Credit: Shipbuilder, special 1911 edition, modified by author.

Questioning then turned to the water that engine department witnesses saw rapidly rising in the spiral stairwell from the firemen's tunnel shortly after the collision. Wilding deduced that the iceberg penetrated the hull, narrow so far forward, at the bottom of the spiral stairwell trunk to a depth of about 3-4 feet. This was enough to begin flooding the passage up to forward boiler room No.6. Some confusion arose with the Commissioner regarding the term "floor," which Wilding used to describe the structure. Wilding explained that a "floor" was a vertical structural member that was part of the bottom of a ship's framing system, and not like the familiar floor in a building. Once the confusion was cleared up, the officials revisited the subject of the water entering the firemen's tunnel. They were curious about the breach in the spiral stairwell trunk, as the ice had to puncture through the ship to breach the trunk. This further raised the question about double sides. If Titanic had been so fitted, or fitted with a narrow double skin, would water have been prevented from entering the interior of the ship?

Wilding said it was probable that such an arrangement could protect against minor damage, but there were other long-term items to consider. He pointed out that there would be less internal usable hull volume affecting earning potential; a confined space difficult to keep in good order regarding corrosion; additional construction costs and a volume useless for the stowage of coal or fresh water. Longitudinal bulkheads, placed further away from the ship's side, as fitted in the Cunard ships Lusitania and Mauretania, created a relatively large space used as a coal bunker. These bulkheads were fitted with numerous bunker doors (blocked by coal and hard to close) that Wilding viewed as a drawback. Mr. Rowlatt turned to the subject of pumping and asked about the cause of the damage so far aft in Boiler room No. 4. Wilding surmised that Titanic touched further aft before starting her turn away from the iceberg, the effect of the rudder being put over quickly.



Lusitania showing side coal bunkers in yellow
Credit Wikimedia Commons
(no scale)



Titanic hold plan. Transverse bunkers in brown
Credit: Titanic Inquiry Project
(no scale)

When asked about his calculations regarding the size of the hull breach, Wilding theorized that the ice bumped along, opening various holes in the hull. With the knowledge at hand, and engine room survivors' statements, he calculated the collective damage to the hull to be about 12 square feet and at an assumed depth of 25 feet. His estimate for the initial rate of flooding was about 250 tons per minute. Wilding then briefly described the gravity-type watertight doors, their closing and securing mechanisms.

A question was raised as to whether Second Officer Charles Herbert Lightoller sent men to open the port gangway door forward on deck E, although it was casually stated that the evidence was sketchy. Gangway doors, located in the ship's steel side, were to be used in emergencies to load lifeboats after passengers were guided below from the upper decks. The only indication that the door was open is that the rate of flooding appeared to increase and was accompanied by a list to port, evidence that a new opening was allowing a large quantity of water to enter the ship. Was it on Captain Smith's order, or was Lightoller acting on his own, out of fear that fully loaded boats would buckle when lowered? This remained unanswered, but Wilding confidently stated that the boats, built by Harland & Wolff, passed their weight test beyond the normal load capacity.

The officials' final question was what could have been done to stem the flow of water into the ship. The use of collision mats was not practical because of the nature of the damage and the dozens of men required to handle and position it overboard, not to mention the time consumed in finding and covering multiple holes. The officials put forward the idea that an umbrella-type apparatus could be thrust through a hole and opened, and water pressure would seal it against the hull. However, Wilding said that finding a submerged hole would be impossible. The barristers and judges asked if there was anything a diver could do. Wilding replied that it was highly unlikely. And, besides, time was not on their side.

Wilding testified for 2 days and presented as complete a picture of Titanic's construction, equipment and damaged condition as possible. It was not accepted that the ship suffered a massive hull failure, despite eyewitness accounts, mostly from passengers. The officers' accounts were given more weight, given their maritime experience. They strongly affirmed that Titanic sank in one piece. Seven decades later, they were proven wrong.

EPILOGUE

Three-hundred seventy nautical miles southeast of Newfoundland, the Woods Hole research vessel Knorr was scanning the sea bed with the Argo, Woods Hole's undersea towed camera sled. Knorr was under contract to the Navy to conduct annual expeditions and keep the system in good working condition. In 1984, the wrecks of two lost submarines, Thresher and Scorpion, were closely studied by Dr. Robert Ballard, in charge of the project aboard Knorr. They took the lessons learned with them in 1985, when Knorr ventured into the area where Titanic sank to find the debris field that would lead them to the wreck.

RV Knorr
Credit: Wikimedia Commons

After Titanic sank, there were numerous proposals to raise the ship. In 1914, a scheme to use electromagnets placed on barges to winch up the ship was a flight of fancy. A number of plans in the ensuing decades considered balloons, ping pong balls, injecting molten wax into the hull, introducing glass spheres (able to resist the great pressures) into the ship and, of all things, freezing the wreck in an iceberg that would float it to the surface. All these proposals supposed that the ship was intact.

On a relatively calm sea, a pilot aboard Knorr controlled Argo between 50-100 feet above the sea floor. Constant vigilance was needed to make sure the systems were functioning as intended. The scanning system operators had to maintain a constant and accurate depth over the bottom, make camera adjustments, monitor sonar sensors and use every precious minute to find the great ship. After scanning for a week, their efforts paid off in the early hours of September 1, 1985. At a depth of 12,500 feet, the area presented a deceptively tranquil picture: a subtle landscape with slight, undulating hills. A widely scattered debris field began to appear. Then, a substantial find: one of Titanic's boilers, sitting alone on the bottom, came into view. Initial excitement was tempered by the violence that befell the dismembered ship. Titanic was split in two, and the sea floor was littered with her entrails.

Seventy-three years after her loss, the world rediscovered history's most famous shipwreck. The site was mapped, artifacts recovered and the rate of deterioration studied. The hull failure sequence was determined and countless theories put forward to explain the shattered wreck. Sophisticated exhibits were built and received with much excitement worldwide. A blockbuster movie earned huge sums, and her untimely fate far exceeded the interest she generated in 1912. Her popularity continues. After 40 years of service, the Knorr went back to work until 2014. In 2016, she was given to the Mexican Navy.

How would Carlisle and Wilding have reacted to the scene of their ruined ship? They designed a well-built and sound vessel, but she was overpowered by the damage she sustained. Rightly or wrongly, she became a mythical symbol of the hubris that will conquer nature, but the unsinkable ship was brought down by nature instead. Rather than a celebrated maiden voyage, she became a mass grave. John Scott Russell's description of a naval architect is a lot to live up to. But even the best professionals can't prepare for the unpredictable and the unprecedented.

Sources: Find a Grave, British Wreck Commissioner's Inquiry, Titanic Memorials, Socialist Democracy, Titanic Fandom, Wikipedia, Encyclopedia Titanica, Titanic Belfast, Titanic Facts, US Naval Institute, The Penguin, YUMPU, RMS Titanic, Ship of Dreams, Grace's Guide to British Industrial History, Newspapers.com, Maritime Heritage Project, NY Times (Times machine), Oceanus

"A naval architect should be able to design, draw, calculate, lay down, cut out, set up, fasten, fit, finish, equip, launch and send to sea a ship out of his own head. He should be able to tell beforehand at what speed she will go, what freight she will carry, what qualities she will show in a sea, - before it, athwart it, against it, - on a wind, close hauled, going free, - what she will stow, and carry, and earn and expend. On his word you should be able to rely, that what he says, his ship will infallibly do."

John Scott-Russell 1865
Civil Engineer, Naval Architect, Shipbuilder