DOWNLOAD PDF FIGHTING SHIPS IN THE AGE OF STEAM

Chapter 1 : Warships from the Age of Sail, Tall Merchant Ships, Famous Tea Clipper Model Ship

Fighting Ships in the Age of Steam Hardcover - October 12, by Len Ortzen (Author) â€º Visit Amazon's Len Ortzen Page. Find all the books, read about the.

The following day, Rear Admiral John L. Worden broke his flag in her, and she became flagship of the European Station. A week after, she reached the Mediterranean, Russia declared war on Turkey. Consequently, Trenton and the other ships of the squadron alternated tours of duty in the eastern Mediterranean protecting U. On 9 May, she departed Villefranche for Smyrna, Turkey , and â€" but for a run to Salonika from 9â€"13 June with Marion â€" remained there until 25 August, when the flagship left the eastern Mediterranean behind to return to Villefranche. Next, Trenton visited Marseilles for two weeks in mid-September; then steamed back to Villefranche on the 18th and remained there until Christmas Day, when she put to sea to return to the eastern Mediterranean. Reentering Smyrna on the second day of , she showed the flag there until 16 March, when she sailed for Piraeus, the port-city for Athens, Greece. On 17 July , she headed for Gibraltar , and on the 24th exited the Mediterranean. Trenton resumed her cruises between Mediterranean ports, adding Genoa, Naples, and Tangiers to her itinerary in the spring of She was back at Villefranche late in September. The warship remained in the western Mediterranean until early April On 3 April , she headed east once more. After stops at Naples and at Alexandria, Egypt, the warship began cruising the Aegean again. After a visit to Marseilles on 7 June, the flagship left the Mediterranean for the third time during this deployment and made another cruise to English, Belgian, and Dutch ports. She arrived in Hampton Roads on 12 October, and three days later moved up the York River for the Yorktown centennial celebration. There, she was decommissioned on 9 November She visited ports in China, Korea, and Japan, carrying out various diplomatic missions. On occasion, Trenton sent landing parties ashore in China and Korea to protect American nationals and other foreigners during periods of internal unrest. The warship completed this tour of duty in the spring of ; departed Yokohama, Japan on 9 May; retraced her voyage back across the Indian Ocean, through the Suez Canal and the Mediterranean Sea, and across the Atlantic to reach Hampton Roads on 2 September. She entered the Norfolk Navy Yard on 9 September and was decommissioned for repairs on 17 September Pacific, See also: Samoan crisis On 16 May , she was placed in commission once again. On 25 July, she exited Hampton Roads and headed south for Brazil. En route, Trenton stopped at St. After touching at St. Thomas on the return voyage, she dropped anchor in New York harbor on 3 November. Wrecked ships in Apia Harbor, Upolu, Samoa soon after the storm. The view looks northwestward, with the shattered bow of the German gunboat Eber on the beach in the foreground. The German gunboat Adler is on her side in the center distance. Almost three months later, on 30 January , Trenton sailed for the Pacific. The voyage took her more than a year to complete, for she had to steam around Cape Horn at the southern end of South America. Six days later, on 16 March , while still at anchor in Apia harbor, Trenton was wrecked by the Apia cyclone. Out of men on the crew of Trenton, only one life was lost. A dynamo, engine, and lights were installed in the summer of The successful use of electricity on this ship led to the installation of electricity on the first ships of the New Steel Navy.

Chapter 2 : [TMP] "What age of sail era to choose?" Topic

The age of steam and iron As the Industrial Revolution unfolded in the 19th century, the age of wooden-hulled sailing ships gave way to that of steam-powered iron ships. Phenomenal changes took place in nearly every aspect of warship design, operation, and tactics.

Tonnage tons Hulk Originally a large ship used either as a transport or for carrying merchandise, particularly in the Mediterranean where hulks ranged up to about tons. It was contemporary with the carrack and occasionally described as such. In general, any large and unwieldy ship of simple construction with a rounded bow and stern was described as a hulk. The sails were almost a relic of the Middle ages, while the hull was double ended, flat floored rather boxy type of affair, very good for carrying the maximum amount of cargo on the Yorkshire rivers and canals. A small cabin was located in the extreme stern. Lee boards were fitted and the mast could be lowered so that bridges could be negotiated. A heavy rail was carried round the stern and on this were carried a lifebelt or two, plus navigation lights. Typically, they were 5 metres long, and 1. Often they had metal runners on the sides of the keel. They were outfitted with sails and oars, and could be rowed or paddle across the Strait. When the ice grew too thick, the crew and male passengers in exchange for a lower rate, would pull the boat across the ice. The vessel was equipped with leather harnesses to attach the crew to the vessel while pulling, also protecting them from drowning when the ice gave away. Ironclad Ironclad warships, frequently shortened to just ironclads, were wooden ships or ships of composite construction wooden planking on iron frames sheathed with thick iron plates for protection against gunfire. The first uses of iron for naval protection occurred in the Far East in the 16th century, but the heyday of the ironclad came in the midth century, when ironclads supplanted wooden ships, and then were themselves replaced by ships made of steel. Junk Chinese sailing vessel with varying numbers of masts and whose sails are comprised of bamboo sail battens with a long overhanging counter. The English name comes from Malay dgong or jong, but is also known by the French word "Jonque". Junks were originally developed during the Han Dynasty BCE CE and further evolved to represent one of the most successful ship types in history, and are still in use today. Ketch A two-masted sailing vessel similar in appearance to a yawl but with the mizzenmast stepped forward of the rudder post. The Ketch is usually fore-and-aft rigged is commonly rigged to have square sails, and has a tonnage ranging from to tons. Often tasked to the role of a bombard vessel. Knorr The most common type of longship, the knorr was the workhorse of Viking cargo ships, the mainstay of the Icelandic traders. The best-known example of a knorr is the Gokstad ship. A knorr could carry up to 20 tons of cargo, or a volume equal to 3 tons of vathmal finely woven homespun wool cloth , or 30 tons of flour-milled grain, or 5 tons of whole-grain barley. A knorr relied mostly upon its sails, having only 4 to 7 pairs of oars and a crew of 15 to 20 men or less. Consequently the knorr used oars only for specialized tasks, such as docking, or keeping the bow into the wind during a storm. All longships used a single square-rigged sail made of vathmal secured with ropes made of seal- or walrus-skin. This posed some danger in storm conditions, and the Icelandic annals record the loss of often several cargo ships each year. When referring to multiple Knorr vessels, the correct term is "Knerrir" Launch A small boat used to travel from a boat to shore, carrying people or supplies. Typically this type of vessel is only equipped with oars but may were modified as shown on the left with basic sails. Liberty ship An American merchant ship of the late Second World War period, designed for rapid building in large numbers, resulting in the earliest class of welded ships. Although these ships were not sail powered vessels and therefore really not supposed to be on this list these ships truly embodied the true spirit of the sail ship era and have been included out of respect for that Liburnian With two oar banks. Used from around BC, initially as a pirate vessel. Later adopted by the Romans who used it as a standard warship. As a pirate, the vessel was usually painted blue-grey as a rudimentary form of camouflage. The Romans borrowed the design from foreign cultures. They used it for raiding on the coast of Illyria, Yugoslavia. They also used it in piracy in the Adriatic and near various islands. It was possibly copied from craft used by the Britons, who themselves had copied a Pictish type of craft from Scotland. The Romans adopted the design in the first century BC. Sometimes, however, for better oar power, the Romans built the liburnian as a bireme. In later

Roman times, the liburnian was a different craft altogether, but the Romans retained the same name as the new craft was also intended for war purposes. The liburnian had several uses: Longship Oar powered Viking ship with one square sail constructed for speed Lorcha Sailing vessel with a western style hull and Chinese style rigging Lugger A sailing vessel with a lugsail rig, normally two-masted except when they were used for smuggling or as privateers, when a mizen was stepped right aft. There is some disagreement as to when the lugger came into use, however, a chart published as early as shows a two-masted vessel with what appears to be a lugsail forward equipped with vangs and a bonnet, a bowsprit, a spritsail, and a lateen mizen sheeted to an outrigger. Lugsails are also mentioned by many writers of the 16th and 17th centuries. Man of war Term refers to ships armed with cannon and propelled primarily by sails as opposed to a galley â€" propelled primarily by oars. Developed in the Mediterranean in the 15th century from earlier roundships with the addition of a second mast to form the carrack. The 16th century saw the carrack evolve into the galleon and then the ship of the line. A first-rate man of war, such as the HMS Victory was armed with or more guns as many as The gun HMS Coronation was a second-rate man of war. A seventy-four, a common ship carrying 74 guns, was a third-rate man of war. A sixth-rate man of war carried only 20 guns. First and second-rate men of war had three gun decks. It took over 2, oak and elm trees to build a second-rate man of war. Mersey Flat Two masted, doubled-ended barge with rounded bilges, carvel build and fully decked. Nao three or four masted sailing ship developed in the Mediterranean in the 15th century. It had a high rounded stern with an aft castle and a forecastle and bowsprit at the stem. It was square-rigged on the foremast and mainmast and lateen-rigged on the mizzenmast. Nave Lateen-rigged sailing ships, also known as Navi. Strong and swift Spanish ship probably a galley which in the old fleets played a part equivalent to that of the Fragatas. It is double-ended with the mast steeped well forward, painted black with a single gaff sail. Mostly clinker-built, it would carry around 25 tons of goods. Wherries were able to reach larger boats just off coast and take their cargoes off to be transported inland through the broads and the rivers. Packet The packet ship was the workhorse of the passenger service. It has been said that the packet was born of necessity, because she had to withstand the violence of brutal seas and the stress imposed by hard case masters who strove to keep a schedule under all conditions. Her crew were often called packet rats because of their dubious backgrounds. Packet ships were sturdy, full-bodied, and somewhat tubby in appearance. In the era of sail, the typical packet measured about 1, tons, a rough indicator of cargo-carrying capacity. In length, these ships averaged about feet, and in breadth, about 35 feet. The largest packet sailing vessel was the Monarch of the Sea, measuring 1, tons and feet long - not quite as long as a Boeing airplane. In contrast with modern vessels, even this ship was relatively small. Paddle steamer Steam-propelled, paddle-driven vessel, a name commonly applied to nineteenth century excursion steamers. Pantserschip A Dutch ironclad. By the end of the nineteenth century, the name was applied to a heavy gunboat designed for colonial service. Patache A swift dispatch row-sailing vessel used for courier and reconnaissance service, but sometimes for coastal patrols. Penteconter An ancient warship propelled by 50 oars, 25 on each side. Pinnace Small two masted vessel often used for carrying messages between the larger vessel of the fleet Pinque A small square rigged vessel. A small square-rigged ship with a narrow and overhanging stern, often used for the carriage of masts. In the 15th and 16th centuries the name was loosely applied to all small ships with narrow sterns, a fairly common design. Also known as a pink. Polacre Type of seventeenth-century sailing vessel, similar to the xebec. Frequently seen in the Mediterranean. It sports three single-pole masts, often with a lateen hoisted on the foremast which is slanted forward to accommodate the large lateen yard and a gaff or lateen on the mizzen mast. The mainmast is square rigged, after the European style. Also known as a polacca Pontoon Generic term for a type of boat with a flat deck attached to airtight flotation tubes or logs. This very basic boat design has existed in one form or another throughout all of human history. Uses for this class of vessel are typically be limited only to local river, canal, or lake uses. Pram A small dinghy, originally of a clinker construction and called in English, as in Danish, a praam. It has a transom at both ends, the forward one usually small and steeply raked in the traditional design. Proa A Proa is a multihull vessel consisting of two usually unequal parallel hulls, superficially similar to an outrigger canoe. Found in many configurations and forms, it was developed as a sailing vessel in Micronesia Pacific Ocean , and forms of it may be found as far as Madagascar and Sri Lanka. The word proa comes from

perahu, the word for boat in Malay, which is similar to the Micronesian language group. On the upper row three rowers hold one oar, on the middle row - two rowers, and on the lower row - one man to an oar. A fast multiple-masted sailing ship. Saettia Small lateen rigged Venetian sailing vessel Sampan A sampan is a Asian skiff constructed of wood, ranging from twelve to fifteen feet long and generally propelled by two oars. Some sampans include a small shelter on board, and may be used as a permanent habitation on inland waters. Schooner Fore andAft The Fore and Aft Schooner is a rig that is fairly modern, being popular still for some trades in the Pacific where sailing ships are still employed in small numbers. The chief advantage of this rig was that it was very economical with man power. It became very popular, and some very large schooners were built, the largest being the " Thomas W Lawson " which boasted 7 masts, all the same height, with gear and sails that were more or less interchangeable.

Chapter 3 : Age of Sail - Wikipedia

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Here, he explains how the Parsons turbines, with a combined impulse and reaction design, were used in ships. Now back to the Parsons steam turbines used in ships in foreign countries. It attained a speed of It was about twice as long as the first ship and had 9, HP. It achieved a speed of Each had 22,HP turbines. A bunch more steam turbine ships followed and the later ones had the new Parsons combined impulse and reaction design. After there came a string of French merchant and Naval vessels like machine gun bullets. It had Parsons steam turbines but the other 5 had recip steam engines. The discussion was now over and the steam turbine had won. Many German merchant and Naval vessels followed. BBC in Mannheim started building steam turbines for these ships. Strangely, however, Germany did not build many merchant vessels in these early years. The speed was The US in ordered three small scout cruiser Naval vessels, all of the same size for evaluation purposes. The two turbine-powered ships had practically the same coal fuel consumption and the recip ship used more. The US Navy therefore started ordering Parsons W steam turbines for some of its battle ships to follow. They were for passenger service between Boston and New York. Then 3 more of about the same kind came along. In , the US Navy ordered five destroyers with Parsons steam turbine all at one time. Six more destroyers were ordered in and fitted with Parsons steam turbines. There were no large merchant transatlantic ships listed made by the US up to , the end of the book and I could not find any on the web up to this date. However, later on, the US got into the act. It was powered by a 28, HP 4 cylinder triple-expansion steam reciprocating engine rotating at RPM with a steam throttle pressure of psig. This man-of-war ship had a top speed of 21 knots. It later went to the Pacific to fight the Japanese. Presently, it is on display at its permanent berth at the San Jacinto Battleground on the Houston, Texas ship channel for all to see and tour. People from all over the world come to see it. I still have a copy of the printed program and brochure. Another ship, the most important one having 4 shafts, was ordered in by the Imperial Japanese Navy and had the new Parsons impulse-reaction design in it being built by the Vickers Company. They were moderate in size and speed. These ships were made from to On her trials in July of she attained a speed of In , Italy had on order four large battleships, a scout cruiser, several torpedo-boat destroyers and a torpedo boat, all powered by Parsons turbine designs. Italy had by gone wild for Parsons steam turbines. It had a 25, horsepower Parsons designed turbine and attained a speed of The turbines were built in Austria. Austria as of had a battleship on order and forthcoming turbine driven destroyers and torpedo boats. Austria had also switched to steam turbines for its war ships. Sweden and Denmark ordered their first turbine war ships, a 7, HP set designed to sail at 21 knot, a cruiser and a torpedo boat, each having 4, HP. Two more countries had gone for steam turbines by All countries were joining the steam turbine band wagon. These ships are to have speeds of 32 knots. China embarked on a steam turbine ship program by with two cruisers to be used to train officers and men. They were to have Parsons turbines and the ships were to have speeds of 20 knots. A third one was under construction with pieces being shipped from England to Australia. I have skimmed over what has been written in the book which covers many details, photos and drawings for those who might be interested in a specific ship or drive system. The point that is being made is that the whole world was taken in by the new Parsons steam turbine designs to drive ships of all different kinds, more economically and at a higher speed than was ever done before, thanks to Sir Charles A. The way of traveling and fighting by sea had changed dramatically. In his next article, the author writes about geared steam turbines and their applications.

Chapter 4 : Naval ship - The age of steam and iron | theinnatdunvilla.com

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Both could create gaming difficulties. Thank you also for the link. Easy to play but comprehensive. I respectfully disagree that was the most distinctive thing. I think there were several things: Steeply raked, high sterns Riotous proliferation of carving and decoration, especially around the stern galleries The mizzen lateen sail Huge lanterns on the stern rail For illustration and inspiration! Langton are mostly useful for the period from through ish. Many of the larger "state" ships of the 2nd and 3rd ADWs also served in the 1st ADW, but a large number of the ships in the s still had a very "galleon" look about them. There is an apparent change in coloration in the period, which could be managed by just painting the models differently. By the s the available art seems to show some changes to structure and style that may not be possible to replicate with paint. PST On a different tack: About 20 years ago I decided the galleon era from was actually a perfect wargaming period, because there was almost no such thing as fleet tactics, and with few exceptions, big battles with dozens or hundreds of ships tended to become giant scrums, which is exactly the way gamers play naval games. If you want to command a ship rather than a fleet then the War of is the obvious one. The most beautiful ships. The greatest variety of battles and tactis. The most balanced power among the fleets. The greatest number of ships. Do you want other? Following on from this there are a lot more scenarios available for the Napoleonic era, some factual, some fictional, as a result of the huge volume of work on the period. PST For the larger ADW, you could break it down to different squadron fighting each other, which is what usually happened. You have more use of fireships which adds another factor. There are some great fights during this period, sadly it is rather neglected. This has ever been one of my favorite aspects of the three Anglo-Dutch Wars, and there were lots of other see-saw 17th C. The Venetians and Ottomans were still fighting over the Eastern Mediterranean all the way through the s too, and they were still using galleys the whole time. Galleys appeared as auxiliaries in a lot of the other Mediterranean contests too. I agree the 17th C. I really like R. They cover from the Armada up, and as I remember were pretty simple while still looking like they would give a good game. For a sailing ship game they were easy to play. Being the first game we played single ship vs.

Chapter 5 : Sunset Cruises â€“ The Remarkable Voyages of Historyâ€™s Last Sailing Warships - theinnat

Filled with colorful artworks, expertly written background text, and useful specifications of warships, Great Warships from the Age of Steam is a visually lavish guide to major fighting ships from the s to the end of World War II.

We have many to choose from, including famous tall ships from the Age of Sail, plus other home decor and gift ideas. Named for the large masts and stunning collections of billowing sails, these amazing ships helped expand and redefine the world during the Age of Sail. Find your favorite tall ship model and enjoy the beautiful looks and masterful designs of Handcrafted Model Ships. Nothing captures the history, romance and adventure of the open seas more than a fully-rigged tall ship plying the waves with a strong wind at her back. Full sails billowing in a steady breeze as sea spray washes the face of her crew, the tall ship is an icon of a past age. Handcrafted Model Ships proudly offers a vast collection of tall ship models designed to appeal to every taste, purpose and budget. Only when powerboats began to overtake them was the term retroactively applied to these classic sailing ships. I must go down to the sea again, to the lonely sea and the sky, All I ask is a tall ship and a star to steer her by. Humans have been harnessing the power of the wind to sail boats since antiquity, but in ancient times the limitations of construction and seafaring technology meant that sails remained at best a companion to traditional oar-power. From the rowed biremes and triremes of ancient Greeks and Romans to the masted galleys of Medieval Europe, oarsmen remained critical to the operation of a vessel at sea. This changed with the coming of the Age of Sail, starting when oar-propelled galleys played their last major naval role at the Battle of Lepanto. A key factor in the elimination of oarsmen was the refinement of naval cannon. Banks of oarsmen fulfilled both requirements. However, the development of gunpowder and subsequent refinement of naval cannon allowed ships to engage in stand-off combat. Boarding was less important and eliminating galleries of rowers opened space for batteries of cannon. Thereafter, ever-larger and improving sailing ships were the height of maritime technology, and the era of the tall ship was born. Tall ships were not only warships, many were trade ships carry exotic goods or treasures between distant Far Eastern, African or American shore to Europe. As trade routes became more firmly established and distant lands better explored, tall ships launched the European Colonial Era. Settlers from Europe spread across the globe and established colonies in perhaps the larges human migration in recorded history. With colonies spread across the globe, the empires of England, Spain, France, Holland and others required massive naval fleets to transport soldiers to guard their possessions or fight their wars, as well as to protect their trade routes and merchant shipping from raiding by pirates when they were not fighting one another. Opposing fleets would simply string their ships into long lines and sail in opposite directions past one another, delivering devastating broadsides with their cannon as they passed. The line-of-battle remained the predominant naval tactic until the Napoleonic Era, when Admiral Lord Nelson of the British Royal Navy chose to divide his smaller fleet into twin lines led by his flagship the HMS Victory and use them to split the larger battle line of the superior Franco-Spanish forces. The mighty First-Rate warships were some of the largest, grandest, and in the case of vessels such as the British Sovereign of the Seas or the Spanish San Felipe the most ornate sailing ships ever constructed. However, a new age was dawning in the Post-Napoleonic Era, and the arrival of the clipper ships pushed tall ships into the Golden Age of Sail. Long, sleek and fast, the clippers developed in the late 18th century with their three or more masts were long-distance, ocean-going, trans-continental trade ships. Their cargoes included Chinese tea bound for Europe, California gold rounding Cape Horn on its way to the US Eastern Seaboard, salmon from Alaskan fisheries headed to southern markets, and all manner of other goods traveling between major European or American ports and distant locations in the Orient, Australia or South Pacific. With the clipper ships and their later derivatives the iron-hulled windjammers, sailing technology reached its peak in terms of speed, power and performance. However, experiments with steam-powered vessels had begun nearly a century earlier and by the early s regular steamship service had been established along the protected waterways of rivers and lakes. Before long, steam engines became reliable and powerful enough to adapt to ocean-going vessels as well. Although tall ships would linger on in limited service as long-haul cargo vessels and fishing boats for nearly another century, their days were clearly

numbered as the era of the steamship arrived. Morgan learned in , classic tall ships have never truly faded from popular interest. Various races and exhibitions of tall ships remain popular, including the annual Tall Ships Challenge in North America which rotates between Great Lakes, Atlantic and Pacific courses or the intermittent Operation Sail events sponsored by the US Congress to commemorate significant events in American maritime or naval history.

Chapter 6 : Naval tactics in the Age of Steam - Wikipedia

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The age of steam In the 19th century, steam ships were invented. The Britannic was the largest of these three sister ships, and was supposed to be more grand and elegant than the Titanic, but before she set sail on her maiden voyage, WWI broke out and she was stripped of her elegant furniture and elaborate paneling and became a hospital ship. During her term as a hospital ship , she was sunk by either a mine or torpedo, no one knows for sure. Passenger airliners replaced passenger ships for long trips in the late 20th century. Cargo ships became much bigger. The main kinds are container ships for mostly manufactured goods, and bulk carriers including oil tankers. It is being built on Geoje Island, South Korea. It is m long and has the internal capacity greater than the total volume of four large aircraft carriers. What it will do is collect natural gas off the coast of Australia , and liquify it. When liquified, the hydrocarbon takes up times less space than its gas. Smaller tankers will take the liquid gas to its buyers. The ship will do liquifying and temporary storage, which is usually done on land. Shell believes this justifies the cost of the ship. The shipping yard builds all kinds of structures for the oil industry. It employs 30, workers. Some names for parts of a ship Amidships - near the middle of the ship. Bow - the front of the ship. Stern - the back of the ship. Aft - in the direction of the stern. Astern - behind the ship. Starboard - the right side of the ship. Port - the left side of the ship. Bridge - the room in which the ship is controlled. Cabin - a room where a crew member lives. Decks - the floors. Hold - an area inside the ship used to carry goods. Hull - the main body of the ship. Keel - a beam running from stern to bow. Mast - a central pole on which sails are hung. Brig - Prison cells in the ship. Some types of ships Bulk carrier - very large ship used for carrying very heavy cargo. Catamaran - a ship with two hulls. Cruise ship - a large passenger ship that takes people on holiday or vacations. Ferry - a passenger ship which often carries vehicles as well as people. Supertanker - a very large ship usually used for carrying oil. Aircraft carrier - a warship which carries aircraft Battleship - a large warship PT boat - a small warship Submarine - an underwater boat The raft is an early means of water-borne transport. Roman trireme mosaic from Carthage, Bardo Museum, Tunis. Model of a medieval Mogadishan ship. Ferdinand Magellan led the first expedition that circumnavigated the globe in â€” MS Freedom of the Seas under construction in a shipyard in Turku. A ship launching at the Northern Shipyard in Gdansk, Poland Able seaman using a needlegun scaler on a mooring winch. A ship graveyard in France A cargo ship pumps ballast water over the side Exhaust stack on a container ship. Ship breaking near Chittagong , Bangladesh All content from Kiddle encyclopedia articles including the article images and facts can be freely used under Attribution-ShareAlike license, unless stated otherwise.

Chapter 7 : French Navy Ships,

Interestingly enough, the Valmy wasn't the only hold over from the Age of Sail that continued to serve well into the era of steam power. Consider theses other fighting ships. Consider theses other fighting ships.

There was fighting at sea, and there were prolonged blockades , but there were no campaigns between large and well-appointed navies. Steam was applied to warships , at first as an auxiliary force, in the second quarter of the 19th century. The Crimean War gave a great stimulus to the development of the guns. It also brought about the application of iron to ships as armour-plate. Very soon metal was adopted as the material out of which ships were made. The extended use of shells , by immensely increasing the danger of fire, rendered wood so inflammable that it was too dangerous for employment in a warship. Changes so sweeping as these could not take place without affecting all the established ideas as to propulsion, armament and construction. Accidental collisions such as those between the British warships Vanguard and Iron Duke, Victoria and Camperdown showed how fatal a wound could be given by the ram of a steam warship. Between vessels both under full control, a collision was easily avoided where there was space to move. The torpedo may be said therefore to have excluded the pell-mell battle and the use of the ram except on rare occasions. Fewer of the large guns could be carried or mounted, and a wider arc of fire was required to compensate. Since ships would be required to fight "end-on" when attempting to ram or to rush into a pell-mell battle , many ships were designed to give as much fire ahead and sometimes astern as on the broadside. This was usually at the expense of seaworthiness, and in many cases firing directly ahead caused blast damage to superstructure, decks and fittings. This was another factor which made ramming invalid as a tactic. Furthermore, a ship designed to have a ramming capability typically had a tumblehome hull design which would allow the ram to strike below the waterline. This design of hull is inherently slower than almost any other hull design, giving an additional disadvantage to ships employing rams. Development of the torpedo[edit] As the 19th century drew to a close, another element of uncertainty was introduced by the development of the torpedo. A weapon which is a floating and moving mine, capable up to a certain point of being directed on its course, invisible or very hard to trace, and able to deliver its blow beneath the water-line, was so complete a novelty that its action was hard to foresee. The question arose whether the torpedo itself would not become the decisive weapon in naval warfare. It was undoubtedly capable of producing a great effect when its power could be fully exerted. A school arose, having its most convinced partisans in France , which argued that, as a small vessel could destroy a great battleship with a single torpedo, the first would drive the second off the sea. The battleship was to give place to the torpedo boat or torpedo-boat destroyer , which was itself only a torpedo boat of larger size. It could not be used with effect at more than 2, yards. Water resistance rendered its course uncertain and comparatively slow, so that a moving opponent could avoid it, which was comparatively easy given that most early torpedoes left behind a tell-tale trail of bubbles in their wake. Torpedo boats were small and could easily be sunk by gunfire. By night the risk from gunfire was less, but the invention of the searchlight made it possible to keep the waters round a ship under observation all night. The war was a stunning victory for Japan , opening with the blockade and gradual immobilization of the Russian Pacific Fleet at Port Arthur and culminating in the destruction of the Russian Baltic Fleet at the Battle of Tsushima in First use of torpedoes in battle[edit] In the war between Russia and Japan the torpedo was at first used with success, but the injury it produced fell below expectations, even when allowance is made for the fact that the Russian squadron at Port Arthur had the means of repair close at hand. In the sea fights of the war it was of subordinate use, and indeed was not employed except to give the final stroke to, or force the surrender of, an already crippled ship. On April 12, , the Russian flagship Petropavlovsk ran into the minefield off Port Arthur and was sunk, while the battleship Pobieda was badly damaged. The Russians turned the same tactic on the Japanese who lost two of their six battleships, the Yashima and the Hatsuse , in a newly laid Russian minefield off Port Arthur a month later. Sinking ships to block harbours[edit] The Russo-Japanese War and as much may be said for the war between the United States and Spain confirmed an old experience. A resolute attempt was made by the Americans to block the entrance to Santiago de Cuba with a blockship. The Japanese renewed the attempt on a

great scale and with utmost intrepidity, at Port Arthur ; but though a steamship can move with a speed and precision impossible to a sailing ship, and can therefore be sunk more surely at a chosen spot, the experiment failed. Neither Americans nor Japanese succeeded in preventing their enemy from coming out when it wished. The revolutionary Dreadnought of was the first battleship to entirely dispense with smaller guns and used steam turbines for her main propulsion. The Dreadnought rendered all existing battleships obsolete, because she was larger, faster, more powerfully armed and more strongly protected than existing battleships, which came to be known as pre-Dreadnoughts. This sudden levelling of the field led to a naval arms race as Britain and Germany and, to a lesser extent, other powers like the United States , France , Russia , Japan , Italy , Austria-Hungary , Turkey , Brazil , Argentina and Chile all rushed to build or acquire Dreadnoughts. The First World War[edit] The introduction of mines, torpedoes and submarines greatly increased the complexity of naval tactics during the First World War. Even so, the gun remained the principal naval weapon. It could still deliver its blows at the greatest distance in the greatest variety of circumstances. While concentration remained a fundamental objective of tactics, the increased range and field of fire of naval guns meant that admirals now sought to achieve concentration of fire, rather than concentration of ships. By the early 20th century, when gunfire was effective at 7, yards or more, and when guns fired from turrets and barbettes had a far wider sweep, concentration could be effected from a distance. The power to effect it had to be sought by a judicious choice of position. Experiments made during manoeuvres by steam navies, combined with the experience gained in the war of â€”05 in the Far East, showed that no material change had taken place in this respect. It was still as necessary as ever that all the guns should be so placed as to be capable of being brought to bear, and it was still a condition imposed by the physical necessities of the case that this freedom could only be obtained when ships followed one another in a line. Steaming with the enemy off to the side enabled a ship to fire salvoes with both the forward and rear turrets, maximizing the chances for a hit. When in pursuit or flight, or when steaming on the look-out for a still unseen enemy, a fleet may be arranged in the "line abreast". A pursuing fleet would have to run the risk of being struck by torpedoes dropped by a retreating enemy. But it would have the advantage of being able to bring all its guns which can fire ahead to bear on the rear ship of the enemy. When an opponent was prepared to give battle, and turns his broadside so as to bring the maximum of his gunfire to bear, he must be answered by a similar display of force â€” in other words, the line ahead must be formed to meet the line ahead. This was accomplished by painting striking designs along the ship, with long, bold lines frequently cutting across the hull and thus rendering the bow of the ship indistinct, which in turn prevented submarines from determining the heading or speed of the ships. This innovation was short-lived, however, as the stark lines intended to confuse submarines only made ships into more visible targets for aircraft. The final evolution of camouflage was into the now prevalent gray shades which almost all warships since WWII have been painted. Individually, submarines were only capable of sinking a small number of ships because of their limited supply of torpedoes and shells. Anti-submarine tactics were in their infancy at the outbreak of the First World War. Surface warships lacked the means to detect submerged submarines or the weapons to attack them. Surface warships were reduced to hoping to sight the periscope of a submerged submarine or the wake of its torpedoes. Other than gunfire, the only way to sink a submarine was by ramming. Defensive anti-submarine tactics largely consisted of turning ships end-on to the submarine, to reduce the size of the target, by turning towards a submarine sighted off the bows and away from a submarine sighted off the stern. By the end of , German cruisers had largely been cleared from the oceans and the main threat to shipping came from U-boats. The British Admiralty was slow to respond to the change. Losses to U-boats dropped to a fraction of their former level. Development of aircraft[edit] The British carrier Furious in , after she had been fitted with a landing-on deck aft, but still clearly showing her cruiser origins. Note the large crash barrier rigged behind her funnel and her dazzle camouflage. During WWI, the German forces occasionally employed Zeppelins to attack enemy shipping, but this never inflicted serious losses. Towards the end of the war, the British began to develop the first aircraft carriers by adding flying off and then landing decks to the large light cruiser Furious. The interwar years[edit] Fearing another naval arms race, the big naval powers agreed to the Washington Naval Treaty and scrapped some of their battleships and cruisers while still on the slipways. In addition to this, the Washington Naval Treaty established limits on the total tonnage of

the fleets of America, Japan and Britain. It was decided in negotiations that a ratio of power would be established of 5: This meant that the Japanese fleet would only be allowed a fraction of the power that was given to the American and British fleets, a fact which lead directly to the Japanese construction of super battleships. Although this treaty was extremely explicit in its governance of battleship and cruiser tonnage, it was lax in the area of carriers, a fact which all of the participants failed to take advantage of. The growing tensions of the s and the rise of aggressive nationalist governments in Japan, Italy and Germany restarted the building programs, with even larger ships than before; Yamato , the largest battleship ever, displaced 72, tons, and mounted Emergence of the aircraft carrier[edit] Shortly after the end of the war, the first aircraft carriers designed from the keel up were completed: Both ships were too small to be satisfactory. Under the terms of the Washington Treaty, Britain, America and Japan were allowed to convert two ships that were due to scrap under the treaty into aircraft carriers. By luck as much as planning, the Americans and Japanese both developed large carriers that were capable of handling up to 90 aircraft, based on the hulls of battlecruisers due to be scrapped under the Washington Treaty. Both navies gradually began to develop new tactics for employing aircraft carriers in battle, although these tactics did not come into full fruition until the middle of the Pacific Campaign of WWII. Development of new weapons[edit] The Magnetic mine was a German development that allowed naval mines to become more deadly than ever; by detecting the magnetic charge of a large ship a mine could detonate without ever having to make contact with the craft, and it would be completely harmless to smaller ships, whose lack of a strong magnetic field allowed them to pass safely, saving the mine for more valuable targets. The oxygen Long lance torpedo , which used pure oxygen instead of air for the oxidizer, was developed by the Japanese just prior to their full involvement in WWII. Despite having more than twice the effective range of the best Allied torpedoes and lacking the tell-tale torpedo wake, the oxygen torpedo was not used to its fullest capacity by the Japanese Imperial Navy, mostly because of inefficient submarine deployment. The Second World War[edit] During the Second World War tactical developments became even more closely tied to the development of new weapons and technologies. In the North Sea and Atlantic, Germany lacked the strength to challenge the Allies for command of the sea. Instead, German naval strategy relied on commerce raiding using capital ships, armed merchant cruisers, submarines and aircraft. The Allies immediately introduced a convoy system for the protection of trade that gradually extended out from the British Isles, eventually reaching as far as Panama, Bombay and Singapore. In the Mediterranean, Britain and Italy fought a conventional naval war for command of the sea. The need to provide capital ships with the anti-submarine protection of a destroyer screen and air cover from an aircraft carrier led to the increasing use of ad hoc task forces , composed of whichever ships were available for a particular operation. Later in the war however, anti-submarine warfare was perfected to a large degree by the Allies, meaning that much more specialized ships and equipment were deployed in convoys with the express purpose of detecting and destroying German and later Japanese submarines. Impact of aircraft on tactics[edit] The development of air power led to further tactical changes, including the emergence of aircraft carriers and the development of naval air fleets. The employment of land-based and carrier-based aircraft during the Second World War showed that command of the seas rested in great part on control of the air above it. Off Norway in the spring of and in the English Channel in the summer of that year, the German Luftwaffe demonstrated that the British could not maintain command of the sea in daytime without command of the air. In the following year, the arrival of Luftwaffe squadrons in the Mediterranean reversed the British ascendancy in the theatre by neutralizing the British dominance at sea. Development of the wolf pack[edit] With the immediate introduction of convoy by the Allies at the start of the Second World War , the German submarines known as U-boats operating against Allied trade in the Atlantic were driven to adopt new tactics. Until the last year of the war, almost all U-boats were diesel -powered, relying on electric motors for propulsion while underwater. This design had important tactical implications. The electric motors were far less powerful than the diesel engines and had a short battery life. When submerged, most submarines were capable of about 10 knots, little more than the slowest merchantman. So a submerged submarine was not only much slower than when on the surface, but also unable to proceed at its maximum submerged speed for any length of time. Submarines of the Second World War were more submersibles than true submarines.

Chapter 8 : Ship Facts for Kids

The development of the steam ironclad firing explosive shells in the mid 19th century rendered sailing ship tactics obsolete. New tactics were developed for the big-gun Dreadnought battleships.

From early times, the substantial carrying capacity of the warship made it an indispensable element in its own logistic support, particularly in the era before steam power eliminated the problem of covering long distances between ports. Tactical science is an orderly description of these activities, and tactical art is the skill required to carry them out in combat. The search for constants It should be said that, in order to achieve victory, willpower and courage must always accompany tactical art and science and often dominate the outcome of battle. These qualities are not tactics, but they are related to tactics in the way a sound decision is related to the resolution with which it is implemented. There is no finer example than Horatio Nelson. In a similar manner, new technology is not tactics, but it may have a decisive effect in both altering the face of battle and affecting its outcome. Navies put special emphasis on warships and aircraft. It is well said that on the ground men are served by their weapons while at sea weapons are served by men. He pointed out that in the American Civil War the Confederate ironclad Virginia, with 10 guns, handily defeated the Union sloops-of-war Congress and Cumberland, which carried a total of 74 guns. Courage and resolve were powerless against progress and armour. Tacticians, on the other hand, are conscious of tactical constants as well, especially the following: The study of trends Naval officers also study history for its trends, because trends are the only clue as to how tactics are changing and are the best check against the fatal sin of preparing to fight the last war. The trend that has influenced all else in the conduct of naval battle is the increasing range and lethality of naval weapons. Paradoxically, greater lethality has not led a trend toward greater loss of life. The first reason is that, unlike ground combat, the principal aim at sea is to put the fighting machine, not the fighting man, out of action, and modern machines are thus far sensitive to damage. Second, it is a long-standing constant that naval battles, once joined, are fast-moving and decisive. To sketch how the range of weapons has affected naval tactics, a simple structure that describes the processes of combat must be established. First is firepower delivery itself. Second is the scouting process, which gathers information by reconnaissance, surveillance, cryptanalysis, and other means and delivers it to the tactical commander. Third is command itselfâ€”or command and control C2 in modern parlanceâ€”which assimilates the information, decides which actions are called for, and directs forces to act accordingly. Combat being the activities of force against force, there is a natural antithesis to all three processes described above. Second, when scouting was accomplished by ships or aircraft flung out ahead of a formation, information denial was accomplished by screeningâ€”that is, by flinging out an opposing line of ships and aircraft. Third, enemy C2 can be confused by deceptive signals or decoy forces. It can also be crippled or delayed by electronically jamming enemy communications. The six processes described aboveâ€”namely, firepower delivery, scouting, C2, and the three countermeasures against themâ€”as well as maneuver, are the raw materials of naval tactics. To achieve success, they are synthesized into a harmonious blend of action and counteraction. For example, a modern naval screen of ships or aircraft defends a formation both by destroying enemy aircraft or missiles and by denying tactical information. The screen itself may even be so central in importance that it becomes the focus of enemy attack, with destruction of the screen being tantamount to destruction of the force. Thus, the study of naval tactics has become more than the study of formations, firepower, and maneuvers. Tactics in the modern era The study of tactics has always emphasized actions between fleets that gain or challenge control of the sea lines of communications. That traditional emphasis is retained here, but in the 20th century three other types of combat at sea have demanded greater attention. War from land to sea and from sea to land While navies have always had as their ultimate objective an influence over events on land, aircraft and missiles have extended the range and amplified the influence. Likewise, land-based systems have made their growing influence felt on warships and sea-lanes alike. Putting ground forces ashore from the sea by amphibious landing is an operation that has neither gained nor lost importance since the earliest galley warfare , but modern combined-arms tactics are quite different and require separate attention. A by-product of the extended range of modern weapons is the greater complexity of joint

operations. The reorganization of many armed forces has been in large measure a response to the demand for well-coordinated operations. Nuclear weapons The United States , the Soviet Union , the United Kingdom, France , and China keep a considerable strategic deterrent force at sea in the form of submarine-launched ballistic missiles. The safeguarding or threatening of nuclear submarines has inspired a set of tactics unique in history. This does not mean that such tactics, if ever used, will prove unsound. During the great transition from sail to steam and big gun, keen study by naval tacticians throughout the world developed the sound tactics that were finally practiced in World War I. Raiding War against trade is the war of an inferior navy that cannot compete for command of the sea but that, instead, dispatches raiders to deny the enemy its free use. These tactics of sea denial are those of predator and prey, of hunter and evader, and are as unique from the force-on-force tactics of major sea battles as are guerrilla war tactics from those of decisive land battle. With the maturity of submarines, these tactics have become so important that a separate section is devoted to them see below Guerrilla war at sea: Historical development In the following examination of the history of naval tactics, a shift in importance between elements of combat will be apparent. In galley warfare, sheer power dominated the outcome, and maneuver of numerous small ships, much as on land, contributed to its concentration. In warfare under sail, great firepower could be concentrated in individual ships, and doctrine, formations, and signal flags were means of controlling the slow-moving, wind-constrained formations. With battleships, steam power gave freedom to maneuver in any direction, and the range of the big guns allowed a concentration of fire from the whole formation. The defensive element came to prominence, symbolized by armour. Tactical decisions had to be made before the enemy was in sight, so that scouting became more evident as a tactical ingredient. Control had to be exercised over much greater distances, which expanded the possibilities of exploiting the means of control, notably through radio direction finding and code breaking. The growth in the tactical influence of scouting, anti-scouting, command and control, and countermeasures against command and control continued through the era of the aircraft carrier and into the era of the guided missile. These elements have become as important to tactical success at sea as firepower, consuming comparable thought and resources. The age of galley warfare Galleys being relatively unseaworthy, war at sea among the ancients was always near land. Pictures of billowing sails notwithstanding, masts and canvas were stowed for battle, and oars were the means of propulsion. The most destructive weapon was a ram in the bow, which dictated a line abreast as the tactical formation. In the line abreast, two lines of opposing galleys approached each other head on, with the ram of each vessel unobstructed by the ships on either side. Multiple banks of oars afforded speed, and the geometry of their arrangement fascinated naval architect-historians of later eras. Major battles comprised hundreds of ships on a side. Battles occurred because of the threat of invasion, so that many armed men were present. These participated as archers or boarders. Rome developed grappling hooks and the corvus a long boarding plank spiked at the end to secure the victim ship while disciplined legionnaires fought their way on board. Scouting the enemy formation was a subordinate issue, although contemporary descriptions indicated that formations and maneuvers, showing ingenuity and cunning, played a large part in the outcomes. Since battles were nearly impossible in foul weather, good visibility permitted the deployment of the lines abreast, often in two echelons, much as the commander intended. Descriptions of the battles and the period was rich in them were usually couched in the terms of land warfareâ€”such as the routing of a flank, or an attempt to crush by encirclement. Galley tactics were so similar to land tactics that a reserve was actually held backâ€”a practice that ever afterward was regarded in navies as a mistake. An inference cannot be drawn that a commander had tight control of his ships in action, however, and the correct image of a galley battle would be that of a wild melee, with oars smashed, hulls crushed, armour-clad soldiers drowned, losses enormous, and battles decisive with lasting consequences. The ultimate battle under oar was at Lepanto on October 7, By this time, three to five guns were fitted in the bows of galleys, and harquebuses were fired by Spanish soldiers. But, as was usual in galley warfare, the outcome was decided by boarding and hand-to-hand fighting with sword and pike. The Christian fleet under Don John of Austria prevailed in a bitterly contested donnybrook; losses to the Turks were placed at 30, killed, against 8, among the victors. The age of fighting sail By the middle of the 17th century guns arrayed along the sides of fighting ships were the decisive weapon. Thus, the shift to sail was a victory of fighting strength over maneuver. The column, or line ahead , became

the logical tactical formation for bringing the most guns to bear. With all the ships of a battle line following one another, their guns could face the enemy line without obstruction. The three Anglo-Dutch Wars of â€”74 saw the first closely studied battles of sail and gun. In them the column was as much a means for command and control as it was for concentration of fighting force, for as long as a fleet maintained station in line ahead, each ship separated by a scant or yards, cohesion was assured, maneuvers were coordinated, and any malingering by reluctant captains was obvious. The line was not a formation that permitted the concentration of fire, however, for naval guns in a rolling platform were effectively accurate at only about one-quarter of a mile, and the range for penetrability of shot was even less. In effect, engagements were decided within pistol shot, a battle line being a thin ribbon of death, miles long but scarcely yards wide. When the English fought the Dutch in the 17th century, this was not considered a problem, because the tactics of both sides called for closing with the other aggressively. But in the 18th century their French opponents felt that their strategic interests lay in avoiding battle at close quarters, and in the Anglo-French wars the Royal Navy endured a long period of indecisive actions handicapped by a tactical doctrine so rigidly interpreted by courts-martial as to have become tactical dogma. These Fighting Instructions, though soundly conceived when first issued in , were unsuited to this new opponent, for the implementing system of signals was unimaginative and constraining. Toward the end of the 18th century, the British admiral Richard Kempenfelt began to unshackle the Royal Navy with a better system of signaling. The new freedom of maneuver came finally and forever to be embodied in the tactical genius and personal inspiration of Horatio Nelson , whose matchless victories at the battles of the Nile , Copenhagen April 2, , and Trafalgar October 21, drew the enduring admiration of naval tacticians. Tactical study during this era concentrated on maneuver. Popular aims were raking firing a broadside the length of an enemy ship from across the bow or stern or doubling concentrating force by putting ships on both sides of the enemy line. The most reliable way to concentrate gunfire was to build it into ships vertically by stacking gun decks one over the other. Later tacticians demonstrated analytically what every fighting seaman of the seafaring era knew instinctively: The age of steam and big gun Tactics and technology complement each other, and there is no better period in history for studying their interrelationship than the shift from sail to steam in the 19th century. The shell gun raised to naval attention during the Crimean War by the Battle of Sinope, November 30, compelled navies to adopt the iron sheathing of hulls. This pointed the way to all-metal hulls iron, then steel , which in turn both permitted and demanded as a response the installation of rifled, breech-loaded guns of major calibre. Concurrently, iron boilers and screw propellers made steam propulsion practical and gave great new freedom of maneuver. Navies were unfettered tactically from the wind, but only at the strategic price of having to remain within steaming range of coaling stations. The sweeping consequences of these and other technological innovations lacked the crucible of war in which to test them, for it was an era of Pax Britannica, with the maritime peace kept by the Royal Navy. The Monitor and the Virginia at the battle of Hampton Roads , March , marked the short-lived ascendancy of armour and the defense. This led to a brief revival of the ram and to some very speculative tactical concepts that looked outrageous in later days. But the superiority of defense at sea did not last long. The tacticalâ€”technical turning point came from the observation of a few battles in East Asia around the turn of the century and from an often overlooked bit of military technology. By World War I the tactical issues were settled. First, big guns would dominate, a burly battleship firing a battery of them in broadside.

Chapter 9 : The â€˜Golden Ageâ€™ of steam ships | Turbomachinery Magazine

The age of fighting sail By the middle of the 17th century guns arrayed along the sides of fighting ships were the decisive weapon. Heavy guns required a gun deck and a short, sturdy hull, which were at odds with the galley's requirements of lightness and length.

Bring fact-checked results to the top of your browser search. The age of steam and iron As the Industrial Revolution unfolded in the 19th century, the age of wooden-hulled sailing ships gave way to that of steam-powered iron ships. Phenomenal changes took place in nearly every aspect of warship design, operation, and tactics. These changes ended the reign of the majestic ship of the line by the mids, but another half century elapsed before it was clear what form its replacement as the backbone of fleets would take. Toward the ironclad The change from wood to iron came slowly, in considerable part because the introduction of steam power required new techniques and experience in shipbuilding. The general use of iron for warships awaited the full realization of the value of the shell gun and the resulting need for armour, which were first demonstrated in the employment of armoured batteries in the Crimean War and in the battle between the Monitor and Merrimack in the American Civil War. The changes may be summarized under three headings: Propulsion Steam for propulsion of vessels was tried with varying success in several countries during the late 18th century. Engines and supporting machinery were at first not adequate for this fundamental advance in ship capability, but useful steam craft appeared in the early s, suitable for operation on inland and coastal water-ways. The earliest steam warship was the Demologos of the U. Navy renamed Fulton after its designer, Robert Fulton. Built in the War of , this well-gunned, double-hulled, low-powered ship, propelled by a single paddle wheel located amidships between the twin hulls, cruised briefly in the New York Harbor area before the war ended and later was destroyed by an accidental fire. The floating gun battery, renamed the Fulton in honour of its designer, engineer Robert Fulton, was the first steam-powered warship of the U. Courtesy of President Franklin D. Naval Historical Center Photograph The earliest steam warships in action were small paddle wheelers used by British and American navies against pirates and other weak foes. As engines gradually improved, navies experimented with them in standard warships, first as auxiliaries to sail, which was then essential for endurance. The paddle wheels were particularly vulnerable to enemy fire. Navy; from a lithograph by Nathaniel Currier, By the mids, boilers, engines, and machinery had improved to the point that thereafter practically all of the new warships had steam propulsion, though they also still carried sails. Among the advances of this period were two other milestones. In Samuel Hall of England patented a type of steam condenser that made it possible to use fresh instead of corrosive salt water for boilers. In James Peter Allaire of the United States invented the compound-expansion steam engine , in which the steam was used in a second cylinder at a lower pressure after it had done its work in the first. Eventually it was made practical by progress in metallurgy and engineering; in John Elder , shipbuilder on the River Clyde , installed a successful two-stage engine in the merchant steamer Brandon. The higher efficiency was of great importance for ocean-keeping navies. Armament The basic changes in armament that were to take place in the 19th and 20th centuries had begun in the 18th century. Flintlocks pulled by a lanyard, instead of match, fired the guns. In the early s navies began to employ mercury fulminate in percussion caps to initiate firing. Efficient percussion locks came into use within a few years. Smoothbore guns were still inaccurate, and successful efforts were made to bring back the rifled barrels, as well as the breech loading , of early guns, thus increasing their speed and accuracy of fire. The bore of a rifled gun barrel had spiral grooves cut into it that caused a projectile fired from it to spin in flight; if this projectile was shaped in the form of a cylinder with a cone-shaped forward tip, spin enabled it to fly through the air with its pointed end forward at all times. This improved aerodynamics gave the shell a more accurate course of flight and a longer range. Because a projectile could not be rammed down the muzzle of a rifled barrel, the use of rifling had to await the design of an efficient breech-loading mechanism. In the s, Italian and Austrian inventors brought out sliding-wedge breechblocks. Later the French developed an interrupted screw system, originally an American invention. A British firm produced a rifled breech-loading gun that the Royal Navy used until , when a number of accidents brought a temporary reversion to

muzzle-loaders. But defects were eventually remedied, and breech loading brought phenomenal increases in rates of fire. They helped impress all of the navies with the need for rifling. Slower-burning powder was also badly needed. Black powder had gradually been improved during years of use in firearms, but it still retained its primary defect, too-rapid burning and hence the creation of gas pressures so high that they could burst a gun barrel upon firing. The use of rapid-burning powder required keeping the size of the charge down and therefore the range to prevent the bursting of even the best guns. Just before the American Civil War the U. Army developed large, perforated, dense grains of black powder that burned more slowly and thus were a start toward the controlled burning ultimately achieved with smokeless powder. A development equal in importance to the rifling of naval guns was the replacement of solid iron cannonballs with large shells that exploded upon impact. A principal architect in bringing big shell guns to sea was Henri-Joseph Paixhans, a general of French artillery. The new guns began to come into use afloat in the s, a French squadron firing them in the bombardment of Vera Cruz, Mexico. Navy began installation of the new guns, including 16 eight-inch cm shell guns in the three-decker Pennsylvania , along with pounder solid-shot guns. The British made similar installations. There was good reason for navies to proceed cautiously, as the production of shell guns at first encountered many manufacturing problems. Indeed, in a gala demonstration of the inch shell guns on the USS Princeton for President John Tyler , one of the guns blew up, killing the secretary of the navy and several others. In the event, improvements in metallurgy, gun construction, and fire controlâ€”along with the maneuverability of steam warshipsâ€”at last led to the important extension of range that the big gun had promised from the beginning. England, the United States, and others built big steam frigates as they were misleadingly called with big shell guns. Their great striking power and maneuverability under steam made them the capital ships of the day, superseding the ship of the line for a brief time before the ironclads took over. Larger guns, increased powder charges, and greater tube pressures were made possible by the replacement of cast iron by built-up wrought-iron guns later, cast steel and, eventually, forged steel were used. Hoops were shrunk on over the powder chamber and breech end of the tube to give the strength required for the greater internal pressures sustained by these guns upon firing. Armour The use of larger guns with more penetrating power and explosive shells made armour plating imperative. Among early experiments were floating armoured batteries built for the Crimean War. Heavy wrought-iron plates over a thick wooden backing gave these flat-bottomed vessels outstanding protection as they carried large-shell guns close inshore. Other developments followed swiftly. The British soon built the first iron-hulled floating batteries. The French followed in with the Gloire , the first seagoing armoured warship, protected throughout her entire length by a wrought-iron belt of 4. Displacing 5, tons, she mounted 36 large shell guns and could steam at Gloire was the first of a series of ironclads laid down by Napoleon III; 13 similar ships soon followed, then two-decker armoured rams. In Great Britain countered with the Warrior , the first iron-hulled, seagoing, armoured man-of-war. Much larger than the Gloire, she displaced 9, tons, mounted 28 seven-inch cm shell guns, had slightly lighter armour, carried sails, and was one knot faster. French ironclad Gloire, engraving by Smythe after a painting by A. Weedon Courtesy of the trustees of the British Museum; photograph, J. Naval Historical Center Photograph These first ironclads were commissioned on the eve of the American Civil War , in which ironclads were destined to take a decisive part. The war itself produced several spectacular developments, including pioneer submarines, the first aircraft carriers to handle balloons for observation , and the torpedo boat , one of several means the Confederates explored in trying to break the blockade. These little craft had weak steam engines and mounted a torpedo lashed to a spar projecting from the bow. Called Davids, they were weak but definite forerunners of the torpedo boat and the versatile destroyer. River and coastal ironclads ultimately, mostly monitors dominated the war against the South in attacks from the sea and in decisive support of land operations from the Mississippi system to the Chesapeake Bay and James River. Most memorable of the combats was the duel between the Monitor and Virginia better known as the Merrimack. When the Federal forces lost Norfolk Naval Shipyard in Portsmouth, Virginia, in April , they burned several warships, including the heavy steam frigate Merrimack. The Confederates raised the Merrimack, installed a ram and slanting casemates made from railroad track over thick wooden backing, as had been done in the Gloire, and renamed it Virginia. Mounting 10 guns, including four rifled ones, the Virginia, with yard

workmen still on board finishing up, sailed on March 8, , for its trial run. Displacing fewer than 1, tons, less than one-third of the Virginia, the Monitor had a boxlike iron hull supporting an iron-plated wooden raft on which revolved the turret. The foot- metre- long vessel had little freeboard except for the thickly armoured rotating turret within which were mounted two inch cm smoothbores. Not really a seagoing warship, it had nearly sunk on its voyage down from New York and did sink on its next sea voyage. Yet it proved the equal of its rival in their duel on March 9. The battle ended in a draw with neither ship seriously injured, but the repercussions of this first duel between completely ironclad warships swept the world. On April 4, scarcely more time than required for a ship to cross the Atlantic, Great Britain ordered the gun ship of the line, the Royal Sovereign, to be cut down, armoured, and fitted with turrets. The Union Navy ordered 66 coastal and river monitors; these were low freeboard ships that were unsuitable for high-seas action and rarely suitable for long voyages. Many were not completed in time for war service. Besides the Virginia, the Confederates began a number of other ironclads. Several of these rendered valuable service and probably lengthened the war, but most had to be destroyed before completion. Out of a combination of characteristics of the Monitor and Virginia types evolved the battleship, which was next to rule the sea. Toward the battleship The later 19th century continued to be a time of great flux in warship design. European nations tried numerous arrangements of guns and armour, such as centreline turrets, a central armoured citadel with large guns on turntables at each corner, lightly armoured big guns topside in barbettes open-top breastworks , torpedoes in even the largest vessels, and substitution of high speed for armour. Launched in , it mounted four ton, inch muzzle-loading guns in two hydraulically powered turrets. For greater stability, the engines and powder magazines were gathered toward the centre of the ship and protected by up to 24 inches of iron. The masts were removed in the s. When the Austrians won the Battle of Lissa from the Italians in by ramming, its value for the future seemed confirmed. Hence for years most large ships carried rams, which proved to be more dangerous to friend than foe when ships were sunk in peacetime collisions. This period also saw a fundamental advance in underwater weaponry with the invention of the locomotive torpedo. The Whitehead torpedo, as it was quickly adapted by the European navies, was about 16 inches 41 cm in diameter and had a range of about 1, yards metres at approximately seven knots. Engines for all the types of warships steadily improved as stronger metals made possible higher steam pressures and weight reduction. In the s a third cylinder was added onto the two-stage compound steam engine to make the triple expansion engine, and in the s a fourth cylinder was added. These improvements on the traditional reciprocating steam engine provided a marked increase in speed that was surpassed only by the radical innovation of the steam turbine at the end of the century. Ships A trend toward the centreline-turret, big-gun battleship finally became clear.