THE EVOLUTION OF NAVAL ORDNANCE: 1820-1866

by John V. Quarstein

The Age of Sail was quickly coming to its end during the Napoleonic Wars. Little had changed during this prior two-hundred-year span of time. Ships and artillery had remained virtually the same, while battlefield techniques only made significant changes during the era's final drama. The introduction of Admiral Horatio Nelson's tactics of annihilation at the birth of the 19th century made it essential that equally destructive weapons be introduced into combat (Figure 1). Consequently, the Industrial Age welcomed new ordnance and motive power technologies which caused a major revolution in ship design concepts, construction and composition. While seamen would feel relatively at home in ships of either the seventeenth or eighteenth centuries, sailors from Admiral Sir Edward Hawke's *Royal George* would have been overwhelmed by the new vessels and the firepower of the late 19th century.

Figure 1. *The Battle of Trafalgar, 21 October 1805* by Clarkson Frederick Stanfield

The Napoleonic Wars prompted the development of new types of artillery. Heavier guns with greater impact or projectiles with more destructive power were sought to gain battlefield superiority. Rockets, explosive shells and columbiads were all introduced; however, naval warfare remained the same. Wooden sailing ships had ruled the waves for centuries, and admirals seemed satisfied to fight sea battles in the traditional manner. Notwithstanding the new Nelsonian concepts of penetration and envelopment of an enemy's line, technology limited combat to cannonballs and musket fire. New tactics of annihilation required equally destructive weaponry. Accordingly, old techniques of warfare ended when Brigadier General Henri-Joseph Paixhans published two books, *Nouvelle Force Maritime et Artillerie* [1] in 1822, and *Experiences Faites Sur Une Arme Nouvelle* [2] in 1825, in which he advocated a system of naval gunnery based on standardization of caliber and the use of shell guns. European armies had been using explosive shells for howitzers, mortars and coastal defense guns as early as the 1760s, Paixhans acknowledges that his concepts were not new; nevertheless, his thoughts unified a series of ideas which proved to be extremely revolutionary. In 1824, Paixhans tested an 80-pounder shell gun against an old 80-gun ship of the line, *Le Pacificate,* at Brest, France. The battleship was virtually demolished by only 16 shells. Besides demonstrating the tremendous destructive power of explosive shells, Paixhans argued that modern warships should be steam-powered, iron-plated and armed with like-caliber shell guns.[3]

Shells were far superior to solid shot in terms of wooden warship combat. Whereas a solid shot strove to penetrate (yet often did not) the wooden sides of warships. Shells were detonated upon a ship's sides, leaving an irregular hole which was difficult to repair and could easily sink a wooden vessel. Sparks from the explosion could ignite fires on the damaged warship. Furthermore, the resulting wooden splinters and iron shell fragments had nasty anti-personnel properties which could decimate a crew. Initially, the lower velocity required to propel shells against a target meant that the shell guns could be lighter. This allowed more powerful guns to be mounted in a ships' battery, thereby increasing the weight of a warship's broadside.

Other ordnance improvements followed Paixhans' work. Harvard professor Daniel Treadwell introduced cast iron smoothbore guns which were strengthened with wrought iron cylinders in 1835. These guns proved to be too expensive to produce.[4] Other gun designers worked to solve the problems of cast iron's weakness. The objective was to increase projectile weight advantage. The 1844 USS *Princeton* disaster near the Washington Navy Yard involved an XIII-inch shell gun that exploded on the deck of a new steam screw frigate, killing and wounding numerous American politicians and naval officials (Figure 2). This clearly demonstrated the problem with large wrought-iron guns. The welding of bands and the inherent weakness of wrought iron due to long exposure to intense heat made gun designers look for other solutions.[5]

Figure 2. Explosion of an XIII-inch shell gun on the deck of the USS *Princeton* near the Washington Navy Yard in 1844.

Lieutenant John A. B. Dahlgren believed that "*inferiority in overall number of ships might be offset by superior ordnance*." [6] Dahlgren was an advocate of the U.S. Navy transferring entirely to shell guns. Dahlgren later noted that:

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Paixhans had so far satisfied Naval men of the power of shell guns to obtain their admission on shipboard; but by unduly developing the explosive element, he had sacrificed accuracy and range. … The difference between the system of Paixhans and my own was simply that Paixhans guns were strictly shell guns, and were not designed for shot, nor for great penetration or accuracy at long ranges. They were, therefore auxiliary to, or associates of, the shot guns. This made for a mixed armament, was objectionable as such … My idea was to have a gun that should generally throw shells far and accurately, with the capacity to fire solid shot as needed. Also, to compose the entire battery of such guns. [7]

In 1854, the six Merrimack-class of steam screw frigates were equipped with IX-inch Dahlgren shell guns. By 1856, the Dahlgren gun had become the standard armament of the U.S. Navy. Dahlgren smooth bores were extraordinarily reliable. One captain wrote that the IX-inchers were "*the best … ever made*." He added that their crews handled them "*with as much confidence as they drank their grog*." [8] Unlike Paixhans, whose ordnance could only serve as shell guns, Dahlgren designed his guns to fire both shell and solid shot, as well as to fire for greater penetration and accuracy.

Figure 3. A IX-inch Dahlgren shell gun.

His design gave greater metal at the breech, equalizing strain/pressure from expanding propellant gasses. Dahlgren would produce guns in various sizes from VIII-to-XX-inch (Figures 3 and 4). This smooth bore exterior and the curved lines of a Dahlgren prompted some observers to call them "*soda bottle guns*." [9] Despite the ability of these guns to safely fire (without bursting), the shot's velocity was rather slow.

Navies and armies still sought to produce a more accurate and reliable weapon and the answer was found, in part, through the development of rifled cannon. Sardinian army officer Major Giovanni Cavalli introduced the first effective rifled gun in 1845. Cavalli's gun featured a two-grooved, rifled barrel with a ribbed cylindrical shell. An explosive shell could now be hurled at a target with greater velocity, accuracy and penetrating power than that of smooth bore guns. Unfortunately, when tested by the British Army the Cavilli rifle became unserviceable after only four rounds.[10] Soon, other designers, such as Sir William Armstrong, Sir Joseph Whitmore, Robert Parker Parrott (Figure 5) and John Mercer Brooke created a variety of rather reliable muzzle-loading rifled guns.[11] Robert Parker Parrott, West Point 1820, joined the West Point Foundry Association in 1836. He devised and patented a process to forge weld spiral-coiled wrought iron cylinders over the cast iron tube. Parrott derived the proportional thickness for the wrought iron band to surround the seat of the charge in brittle cast iron guns. [12]

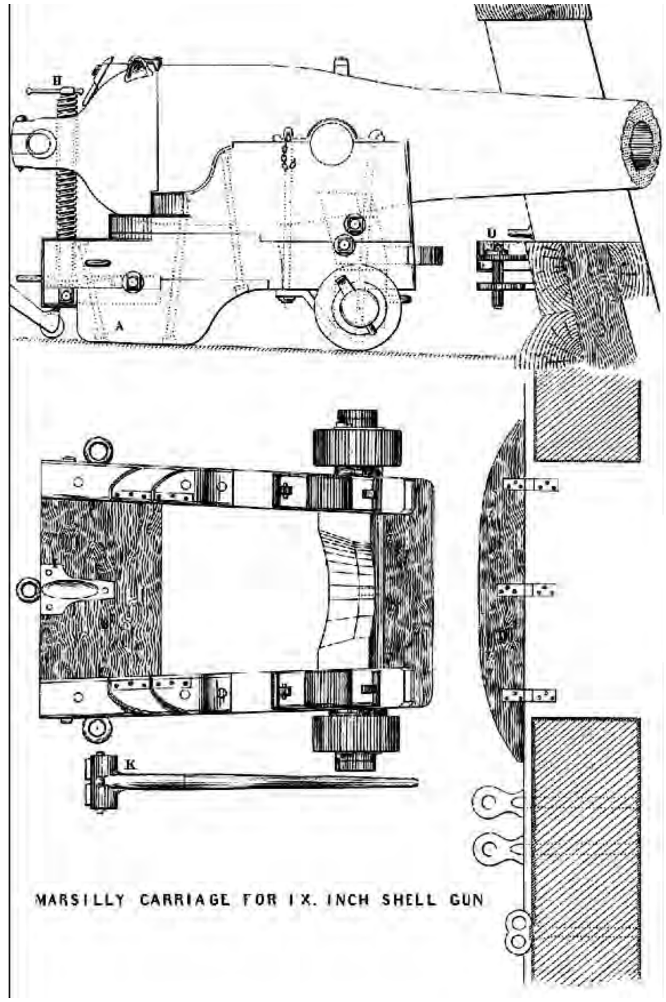

Figure 4. A Marsilly carriage for a IX-inch Dahlgren shell gun.

Figure 5. A 100-pounder Parrott rifle.

The Industrial Age introduced new ordnance and motive power technologies which caused a major revolution in ship design concepts, construction and composition. The shellgun developed into a death knell for wooden warships. USS *Fulton (*USS *Demologos*) was the first functioning steam power warship; navies immediately recognized the power of steam over sail.[13] Accordingly, the transition to steam was rapid and quickened even more for military purposes by the invention of the side propeller. Side-paddle wheels took up the space where mounted guns would otherwise have been (Figure 6). Likewise, the paddles themselves and their engines mounted on deck were very vulnerable to artillery fire. The screw propeller enabled engine systems to be installed below the waterline, making screw warships motive systems virtually shot proof.[14]

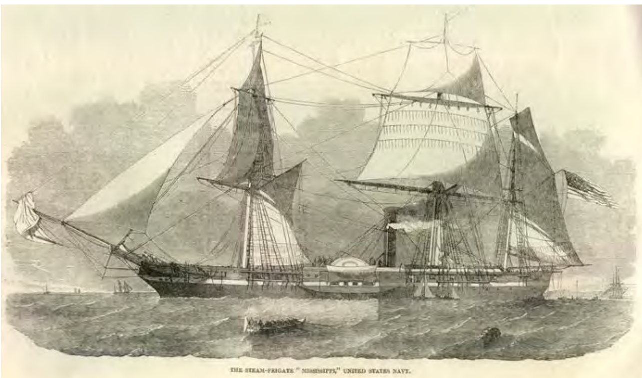

Figure 6. Steam frigate USS *Mississippi.*

The combination of shell and steam power would be fully introduced to naval warfare during the Crimean and American Civil wars. Although steam power proved itself during the American-Mexican War, the power of explosive shells would prompt great changes to warship construction during the Crimean War. The stunning Russian naval victory at Sinope on 30 November 1853, proved the superiority of the new shellguns. Admiral Pavel Stepanovich Nakhimov's squadron totally destroyed a Turkish fleet. Thereafter, the Allied navies refused to engage the Russian batteries defending Sevastopol, fearing the impact of Russian shells on their ships. The French, and later, the British, responded with the construction of floating iron-cased batteries. Three of these, *Devastation, Lave* and *Etonnante,* were towed into the Black Sea and used in an Allied assault at Kinburn on 17 October 1855. The Russian forts were shelled into submission. Kinburn proved the value of armored vessels against shells and fixed fortifications.[15]

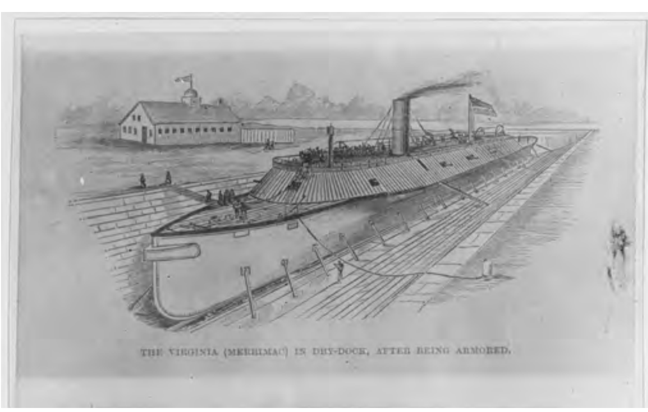

Figure 7. Sketch of the CSS *Virginia* in Drydock.

By 1860, naval warfare had evolved more in the 45 years since the end of the Napoleonic Wars than during any previous era in history. Technology now ruled the waves and when the American Civil War erupted, North and South alike looked to interpret new machines of war into their war efforts. The South was first to react as the new Confederacy needed the support of France and Great Britain; the trade of cotton for cannons was crucial to the independence of the Southern states. The Union immediately instituted a blockade of the 3,500 miles of Southern coastline. Fortunately, the Confederates had captured the largest naval yard in the United States, Gosport Navy Yard in Virginia, and used those facilities to transform the scuttled steam screw wooden frigate USS *Merrimack* into the powerful ironclad ram, the CSS *Virginia* (Figure 7).

All the technical knowledge was absorbed from the Crimean War and used in *Virginia's* construction. The ironclad featured sloped armor to deflect shot, four rifled guns (2 x 7-inch, 2 x 6.4-inch), six IX-inch Dahlgren shell guns (two of which fitted to fire hot shot), and a 1,500 pound cast iron ram at its bow. On 8 March 1862, the *Virginia* attacked the elements of the Union's North Atlantic Blocking Squadron in Hampton Roads, Virginia, scoring one of the most dramatic naval victories of the American Civil War. In one afternoon, the Confederate ironclad ram sank two Union capital ships and damaged two others, sank two transports and captured another, and damaged one gun boat. That evening, the CSS *Virginia* appeared to be the most powerful ship in the world; however, the USS *Monitor* arrived that evening. The next day, 9 March 1862, the *Monitor* fought the *Virginia* to a standstill during the first battle between ironclads.[16]

Figure 8. Currier and Ives print of the USS *Cumberland* sinking after ramming by the CSS *Virginia.*

The CSS *Virginia* proved the power of iron over wood with rifles and shell guns, as well as by the dramatic ramming of the USS *Cumberland* (Figure 8). The world immediately recognized that ironclads were the key to naval supremacy. Both nations re-doubled their efforts to produce ironclads: the South would place 23 in the water, and the North 67 (of which 43 were monitors). The first question then arose: how to penetrate the armor of an enemy's armor-clad? Lieutenant John Mercer Brooke, the inventor of the Brooke gun, and the CSS *Virginia* prototype for subsequent Confederate ironclads, developed the armor-piercing Brooke bolt. These bolts were solid cylindrical projectives with a blunt or flat nose to reduce the chance of a ricochet. This shot had devastating effects on the USS *Galena* at Drewry's Bluff, outside of Richmond, Virginia, on 15 May 1862; and on Rear Admiral S.F. DuPont's fleet of monitors during the 7 April 1863 attack on Fort Sumter, Charleston Harbor, South Carolina.[17]

Nevertheless, the Federals countered with larger Dahlgren smooth bores. During the Battle of Hampton Roads the assistant secretary of the Navy, Gustavus Vasa Fox, who had observed the engagement, recognized that new monitor classes needed a more powerful gun to smash the Confederate ironclad casemates. He witnessed the power of the XV-inch Rodman gun (known as the Lincoln gun) at Fort Monroe, Virginia and so he challenged Dahlgren to design a similar gun for use in the new *Passaic*-monitors. This larger ordnance poised several problems, especially when casting such a big gun.

Dahlgren, then chief of the Naval Bureau of Ordnance, decided to use the Rodman method of casting. West Point graduate Thomas Jackson Rodman developed a patented 'core-barrel' process. The gun would be cast hollow and cooled inside by air or water. "*The concept was to freeze molten metal from its bore outward, pushing impurities to the exterior.*" He envisioned " '*the casting' as an outward succession of concentric rings, that in turn, while cooling, would solidify and then shrink. Their shrinkage would compress those already cooler within, producing compression stresses to oppose firing pressures*." [18] The XV-inch solid shot had a terrible impact upon the CSS *Atlanta* and the CSS *Tennessee* during combat. Each of these Confederate ironclads had their casemates blown apart by close-ranged XV-inch solid shots.[19]

Besides new projectiles, both navies had to introduce other ordnance designs to achieve victory. The torpedo was introduced which witnessed the development of various delivery systems. Mathew Fontaine Maury, the "Pathfinder of the Seas", experimented with contact and hydrostatic torpedoes (mines). Minefields were placed at the entrance to most Confederate ports and these explosive devices sank several Union warships, including the shocking destruction of the monitor USS *Tecumseh* at the entrance to Mobile Bay, Alabama. Torpedo boats and submarines were designed to place spar torpedoes underneath an enemy vessel, equally dangerous and destructive to the hunter and the prey such as the case of CSS *Hunley* and USS *Housatonic.*[20]

Few facets of the American Civil War more closely support the technology and attrition theme than does the war on the water. The war witnessed an overnight change to naval tactics. "Fighting instructions'' became totally archaic and forgotten due to steam power, shellguns, ironclads, rams (Figure 9), revolving turrets, torpedoes and rifled cannons. These tools left an incredible mark on future ordnance and ship design. The ordinance of 1862 dictated how new warships must be built as it was the shot and shell, hurled by mammoth shell guns and powerful rifles, that could destroy or debilitate a pre-war wooden vessel with a single hit.

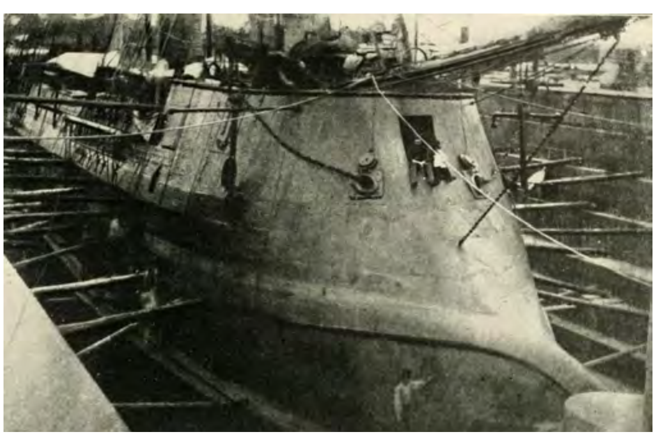

Figure 9. Bow ram of the CSS *Stonewall* in dry dock.

Whereas the post-war American naval establishment seemed content, the European navies were driven to construct improved ocean-going ironclads to ensure their control of ocean routes to overseas resources. The lessons learned during the American conflict were immediately employed by the Europeans. "*Like a bayonet charge of infantry,*" Stephen Russell Mallory called the impact of ramming during a naval battle.[21]

The Battle of Lissa on 20 July 1866 was the most decisive naval engagement of the Seven Weeks' War between the Austrian and Italian fleets for control of the Adriatic Sea. The Italian fleet, commanded by Admiral Count Carlo Pellion di Persano, which consisted of 11 armored ships, steamed against the Austrian-controlled island of Lissa. The Austrian fleet, commanded by the dynamic Rear Admiral Wilhelm von Tegetthoff, moved to stop the Italian strike force (Figure 10). Tegetthoff's command contained only seven armored ships and as his vessels did not possess heavy modern shell guns, he believed in the power of the ram. The Austrians, in three divisions, formed within three arrowhead lines. Tegetthoff's flagship, *Erghergog Ferdinand Max*, rammed and sank the *Re d'Italia*. Two other Italian ironclads would also be sunk that day. Lissa was the first sea battle between ironclad warships.[22]

Figure 10. *Rear Admiral Wilhelm von Tegetthoff at the Battle of Lissa* by Anton Romako, 1880.

Since naval artillery did not seem as effective against ironclads as the ram, this combat tactic would influence ship design over the next 30 years. These designers recognized that improved ordnance – bigger guns with more powerful projectiles – were required. The new ordnance developed after 1870 would heavily impact ship design, protection and propulsion, and in 40 years would witness the height of battleship design, the HMS *Dreadnought.* This evolution all began in 1822 with the publishing of Henri Paixhans' far-reaching book and the subsequent development of ordnance that dictated ship design.

Endnotes

[1] Paixhans, Henri-Joseph, *Nouvelle Force Maritime, et Application De Cette Force a Quelques Parties Du Service De L'armee De Terre*. Bachelier, Librairie, Quai Des Augustins, Paris, 1822

[2] Paixhans, Henri-Joseph, *Experiences Faites par la Marine Française, sur une Arme Nouvelle*, Bachelier, Librairie, Quai Des Augustins, Paris, 1825

[3] Hogg, Ian V., *A History of Artillery*, London: Hamlyn Publishing Group, 974, p. 72-73. and Spencer Tucker, *Handbook of 19th century Naval Warfare*, Annapolis, MD: Naval Institute Press, 2000, p. 78-79.

[4] Olmstead, Elmer, Stark, Wayne E. and Tucker, Spencer C. *The Big Guns: Civil War Siege, Seacoast and Naval Cannon*, Alexandria Bay, New York: Museum Restoration Service, 1997, p. 111.

[5] Quarstein, John V. *The Monitor Boys: The Crew of the Union's First Ironclad*, Charleston, SC. The History Press, 2001, p. 18-23.

[6] Dahlgren, Madeleine Vinton. *Memoir of John A. Dahlgren, Rear Admiral United States Navy*, New York: J.R. Osgood and Co., 1882, p. 226.

[7] Scheller, Robert, Jr., *Quest for Glory: A Biography of Rear Admiral John A. Dahlgren*, Annapolis, Md: Naval Institute Press, 1995.

[8] Tucker, Spencer C. *Handbook of the 19th Century Naval Warfare*. Naval Institute Press, Annapolis, MD. 2000, p. 85

[9] Ripley, Warren *Artillery and Ammunition of the Civil War*, New York: Promontory Press, 1970, p. 91.

[10] Tucker,2000. *Op. cit.* p. 87

[11] Ibid.. p. 86-93.

[12] Olmstead, Stark, and Tucker, 1997, *Op. cit.*, pp. 111-113.

[13] Cannery, Donald . *The Old Steam Navy: Frigates, Sloops and Gunboats, 1815-1885*, Annapolis, MD: Naval Institute Press, 1990, p.3.

[14] Quarstein, 2001. *Op. cit.* p. 16.

[15] Quarstein, John V. *CSS Virginia: Sink Before Surrender*, Charleston, SC: 2012, p. 54-56.

[16] Ibid, p. 57-58, 117-135, 167-169.

[17] Quarstein John V. *A History Of Ironclads: The Power of Iron Over Wood*, Charleston, SC: The History Press, 2006, p. 134, 165-167.

[18] Olmstead, Stark and Tucker, 1997. *Op. cit.* 1997, p 75.

[19] Quarstein, 2006. *Op. cit.*, pp. 134, 165-167.

[20] Ibid, p. 182, 200.

[21] Quarstein, 2012. *Op. cit.* p. 73

[22] Tucker. *Op. cit.* p. 131-133.