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FROM INNOVATION TO IMPASSE: THE ANGLO-GERMAN NAVAL ARMS RACE, 1906-1916

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ABSTRACT: *Weapons systems' common compromise of offensive power, defensive protection, and mobility was expressed as a sensational innovation in naval architecture with the completion of HMS Dreadnought in 1906, when Great Power rivalry guaranteed an ensuing arms race. The latter entailed steady improvements of power, protection, and propulsion, all requiring a larger and more costly platform to incorporate even slight advantages. The large dreadnought fleets built by Britain and Germany incorporated few improvements in tactics, command and control. Lengthening big gun ranges exceeded their limits of effectiveness, and hit rates at long range fell to 3 percent or less, yielding probable stalemate other than the destruction of obsolete vessel types and vulnerable hybrids. Advances in destructive power, protection, and speed led inexorably to the increased size and cost of capital ships, climaxed by their inconclusive clash at Jutland in 1916. As a weapon system, the battleship was necessarily modified to cope with air and undersea attack, with imperfect success. Such new vulnerabilities for the battleship echoed the denouement of French armored and mounted knights by English archers and men-at-arms at Agincourt. Perfect weapon symmetry and its related spatial deployment are apt to be transitory phenomena in the practice of modern warfare.*

Keywords: *naval history, arms race*

In Ancient Greece, the Olympic wrestler already represented a long-outdated and intentionally ritualized form of combat, one with no added protection, strength, or range of movement independent of human anatomy. Prehistory had witnessed leather body armor and the protective shield, projectile points, the spear, sling, and bow, and the mounted warrior. The Bronze Age would augment these elements with helmet, breast-plate, cutting edge (sic) weaponry, the chariot, and the ram-fitted oared gallery. In other words, protection, offensive strength, and mobility had evolved in tandem and would continue to do so until the present day.

In any weapons system, 'power' entails a related combination of factors. Between 1500 and 1920, when European States came to hold sway over most of the World, power was vested primarily in sea-power, and the latter found its fullest expression in fleets of line-of-battle, (later simply battle-) ships. This was the Projectile Era for surface navies, spanning both the Age of Sail (1500- c1850) and that of Steam (1850-1920). In both periods, 'power' connoted throw-weight, penetrative strength, likely damage, rate-of-fire, projectile range, and hit-rate. In the Age of Sail, three centuries witnessed surprisingly little change in elements of protection and mobility and their related technologies; indeed, an Elizabethan sailor would have quickly adapted to the tasks necessary on board Nelson's flagship Victory in 1805. Of strikingly similar size, design and armament by the eighteenth century, the largest warships of European navies were hard to catch and even harder to sink, resulting in many stalemate battles involving the Dutch, French, and British navies. That the latter came to dominate the high seas in the Napoleonic Wars reflected Nelson's shift in tactics away from strictly observed parallel lines of battle, and, given the superior training and experience of British seamen, cannon fire that was roughly double that of their adversaries in accuracy and reload time. This differential in power set the stage for the Pax Britannica (1815-1914). The sheer offensive strength of ship-borne cannon can be gauged by comparison of Trafalgar (1805) with Gettysburg (1863). The former concentrated over 5000 heavy guns, moveable at typically six miles per hour, in five dozen ships crewed by less than 40 thousand men. The latter struggled to concentrate less than one tenth as many guns, most of much smaller caliber, dragged at a snail's pace, serving two very large armies.

Not surprisingly, the technology of war at sea was slow to fully adapt to the Industrial Age given the proven advantages of the large sailing ship and its cannon broadside. One well-known landmark event is the clash between the C.S.S. Virginia and the Union's Monitor during the American Civil War. True, both vessels were armored, both represented advances in gunnery, and both dispensed altogether with masts and sails (Brooke, 2002; Simson, 2001). But neither was intended to be ocean-going, and indeed the Monitor's shallow draft, low freeboard, and quirky engine sealed her fate on her second ocean voyage.

The duel of the Virginia and Monitor followed the construction of two antecedent warships – the French Navy's Gloire in 1859 and the Royal Navy's Warrior in 1860. Both were more conventional in appearance than their Civil War successors, retaining square-rigged sails and broadside armament (Hill, 2006; Brown, 2003A). But both were armor-clad, boiler-equipped, screw-propelled, fast, and seaworthy, with the potential global reach essential to British and French interests. The Warrior archetype would gradually lead to a design norm all major navies would adopt, the pre-Dreadnought. That norm would remain a remarkably standard compromise until 1906, when HMS Dreadnought set new standards of power, protection, and propulsion and ignited the Anglo-German naval arms race.

The development of naval gunnery between 1860 and 1892 saw the gradual introduction of larger caliber weapons with greater range, and the related replacement of cannon broadsides with rotating turrets or barbettes. Muzzle-loading gave way to breech-loading guns only when concerns over catastrophic explosions of the latter had been put to rest. Optical range-finding, in its infancy, was adequate at the expected combat range of less than one mile. The 'power' element of the large armored ship eventually settled on four 12" guns in two center-line turrets fore and aft.

At first, protection consisted of iron plate fixed to a wooden hull. By the 1870s wooden ships of the line had disappeared and protection connoted plate armor intended to protect a ship's vital parts and prevent waterline flooding. Armor was certainly effective, but exacted a substantial cost in weight, which in turn exacted a cost in speed, maneuverability, and range of operation.

Propulsion yields speed of course, but also involves factors such as range of operation, reliability of power plant, and ease of operation, reliability of power plant, and access to refueling. The British naval establishment was reluctant at first to relinquish masts and sails because engines were prone to failure and coal stocks were not yet a globally ubiquitous resource. Increments of maximum speed, although a potential tactical advantage in battle, were hard to achieve because greater speed always entails disproportionate increments of energy output, fuel consumption, and fuel stowage. The latter, laterally configured coal bunkers, provided a small degree of added protection to a warship's vital parts. An ideal design for optimal speed combines a long hull and narrow beam, but such a sleek vessel is also the most difficult to protect (Miller, 2001). Thus, like armor protection, propulsion is a Faustian bargain. By 1892 naval architects would settle on a length-to-width ratio of just over 5:1. Later, from 1906 on, the length-to-width ratio of battleships would increase to as much as 7:1. The altar of speed would eventually push these ratios to even higher values (and unprecedented horsepower) for British battle cruisers, eventually reaching 8:1 in HMS Hood (1920) yielding 31 knots speed (Miller, 2001). Hood's fate in action with German battleship Bismarck is well-known. Greater speed entails less protection.

While naval architects could seek an optimal compromise between these three factors, they had essentially no say over matters of Command, Control, and Communication. Thus what was by far the most complete and complex expression of engineering in the Steam Age was largely brainless and clueless (Keegan, 1989; Barnett, 1975). Fleet and squadron subordinates enjoyed no freedom of action, scouting forces routinely failed to pass on key sightings, radio messages were sporadically sent and read, and early aerial reconnaissance, even by 1916, had no means of transmitting real-time information.

"Arms Race' is a portmanteau term which implies more than merely an acceleration in military expenditure to match or exceed that of a probable adversary. The term entails the capacity to build or buy (Miller, 2001; Gardiner, 1979). The builders of large capital ships 1892-1916 were limited to shipyards in Britain, Germany, and-at first- Japan, which became a builder in 1910 (Miller, 2001; Gardiner, 1979), 'Arms Race' also connotes an acceleration of research and development, and the spiraling obsolescence of older weaponry. And it must be based on political policy, resolve, and – where relevant – popular support to be sustained. There is ample evidence that Britain and Germany met all these conditions, increasingly so as the twentieth century dawned (Hurd and Castle, 1913). And, as to popular enthusiasm and support one need point only to symptoms such as Germany's Navy League (ibid. 207-213). By 1912 there were more than one million individual and corporate members of the League, which had been founded in 1898. Its monthly newspaper *Die Flotte* commanded a circulation of over 350 thousand copies (ibid. 207-213). Pride in the Royal Navy was thoroughly embedded in British popular culture and had been for many decades. Among the first sets of cigarettes cards produced by W.D. and H.O. Wills was *Ships and Sailors* in 1895 (www.cigarettes.co.uk). And the cigarettes would likely be lighted with 'England's Glory' matches, featuring a boxtop picture of HMS Devastation.

Although a minor and short-lived Anglo-French arms race followed the completion of the 'Warrior' in 1862, British maritime supremacy remained unchallenged in the three decades which followed. In 1892, Britain settled on a balance of power, protection and propulsion requiring roughly 14 thousand tons displacement, a type retrospectively christened 'pre-dreadnoughts'. Such ships carried four (usually 12') main guns, enjoyed thick belt armor protection, and could manage about 16 knots speed (Pears, 1957). The last pre-dreadnoughts, such as the U.S. Navy's 'Virginia' class (1906-07) were somewhat better armed, with much-improved armor, but were not much faster and only slightly larger (Miller, 2001, 160-161). Rate of fire of the main guns had doubled, as had ranges in gunnery practice which had been a mere 1500 yards in the early 1890s (Brown, 2003A, 155-156), although slow-towed or even stationary smoke-free targets at 5000 yards were still a far cry from the realities of sea-battle.

The 'Dreadnought' of 1906 incorporated perceived 'lessons' of Russo-Japanese naval actions in 1904-05 especially the climactic battle of Tsu Shima (Novikoff-Priboy, 1937; Pleshakov, 2003; Hough, 2001, 17-37). International naval circles drew lessons from the superior speed of the Japanese battle line, the design failings of even the newest Russian-built ships (based on French prototypes) and the damage inflicted by Japanese gunnery (Brown, 2003A, 169-176). The damage was a mélange of upper-deck conflagration from the hail of small-caliber shells at close range, and killing blows of 12" shell hits near the waterline. Expectation that future duels would be fought at long range assigned expert opinion to the ideal of an all-big-gun battleship. Indeed, the naval architect Cuniberti had proposed such a radical design in 1903(Tucker, 2001, 219). Cuniberti's creative thinking owed much to the legacy of Italy's premier naval architect Benedetto Brin, responsible for some of the world's most innovative warships since the 1870s. But the Italian Navy turned down Cuniberti's ambitious design and allowed him to publish it in the 1903 edition of *Jane's Fighting Ships* (ibid. 336-344). In the United States H.C. Poundstone had argued for an all-big-gun battleship as early as 1901 (Tucker, 2001). That Britain took the plunge first rested largely on the influence and mercurial dynamism of the Admiralty's First Sea Lord, John Fisher (Massie, 2001, 219).

The warship which resulted was truly revolutionary. HMS 'Dreadnought' was laid down in October 1905 and completed within twelve months, a record in itself (ibid. 468-497). The ship's main armament was not four but ten 12" guns, with centralized fire control and rangefinding. 'Dreadnought's' Krupp-cemented armor was up to 11" thick and accounted for close to 30 percent of the ship's displacement, a standard adopted in her successors (Brown, 2003B, 47). Steam turbines and quadruple shafts were another innovation, and 'Dreadnought' could manage 21 knots, at least 3 knots faster than any predecessor. These radical improvements did necessitate an 18 thousand ton displacement, close to 30 percent more than a typical pre-dreadnought. Construction cost went up 20 percent (Pears, 1957, 53). In a single stroke Britain had made its own 61 pre-dreadnoughts hopelessly obsolete. It had also created the circumstances for an arms race, a gauntlet only Germany chose to pick up. The 20 capital ships completed for the German Imperial Navy before 1915 fell far short of the British total, 34, but the fact of the race did spur rapid refinement of the 'Dreadnought' archetype with improvements that Japan and the United States could emulate and transcend (Miller, 2001, 120-121). The first American dreadnought, U.S.S. South Carolina, took over four years to build and was completed in 1910. The delay accommodated improvements such as center-line gun turrets, superfiring guns, and a heavier main armament. Japan's lead-time yielded even more impressive results.

As the race proceeded, after the Dreadnought's completion in 1906, "main armament projectiles" got bigger, rising from 12" to 15" on British capital ships. A 15" shell weighed a ton, well over double its 12" counterpart on 'Dreadnought', with commensurate armor punch (ibid., 37). Its 35 thousand yard range was moot given optical rangefinding limited to 20 thousand yards and gunnery practice at just half even that range on stationary or glacially slow targets (ibid., 29). Such unrealistic practice yielded a reassuring 20 percent hit rate.

Belt armor protection on 'Dreadnought's' successors increased by 3 inches thickness, with little attention to deck armor given plunging fire at the longer ranges achievable by 1915. This arrangement was paradoxically 'safe'. At close range hits were likely but probably not mortal; at long range they could be mortal but were extremely unlikely.

There was little improvement in Dreadnought speed at first; Britain hewed to a 21 knot standard, while Germany sacrificed speed somewhat in favor of better protection. The penultimate British dreadnoughts, completed in 1915-16, were the world's first 'fast' battleships (Marshall, 1993). Their 25 knot performance reflected a shift from coal to oil fuel, a switch pressed vigorously led by Winston Churchill (Hough, 1983). Their combination of 15" guns, excellent protection, and high speed required a displacement 10 thousand tons greater than that of Dreadnought. This new modality was soon copied by other Great Powers.

As early as 1904, Lord John Fisher had pressed for a new class of ships that would be large powerful and fast but, necessarily, thinly armored. The prototype 'Invincible' class (1908) led to 17 ships of this type, christened the 'battle-cruiser', completed in Britain and Germany before 1916. The reasonable justification for these ships was that they could overtake and sink weaker opponents and out-run more powerful adversaries. Now and then this worked as planned (Hough, 1983, 111-120). Hough (1983, 111-120) describes the British use of the battle-cruiser HMS Invincible to chase down a weaker German squadron off the Falkland Islands, and SMS Goeben's speed aided her Mediterranean run to Ottoman Turkey. On several occasions the German Navy sent its battle-cruisers on "hit and run" raids on English east coast ports. But the numbers race as the British and German fleets faced off in the North Sea led to the battle-cruisers being pressed into service as the scouting vanguard of the battle line.

The battle line was an anachronism. Although Nelson's victories between 1798 and 1805 had subsumed the sterility of conventional line-of-battle tactics to the rewards of individual initiative by his subordinates, the

Steam Age, poor training, Victorian class hierarchy and decades of peace restored a rigidity of maneuver and near-vacuum of tactics. The core of the British Grand Fleet could either assume a line-ahead formation fully seven miles long, or adopt a line-abreast formation of four-ship squadrons, an arrangement more than five miles wide. The German High Seas Fleet required less sea space only because it was numerically inferior. The real risks of confusion and collision outweighed the possible benefits of concentrated and overwhelming fire. Over such an enormity of sea space few captains could grasp the enemy's location, strength, course, and speed, and even scouting forces generally failed to communicate this information to Flag Officers (Bennett, 1964; Spector, 2001). Radio communication was routinely subordinated to signals conveyed by searchlight or, worse, signal flags. Smoke clouds and poor visibility made matters worse.

The inadequacies of range-finding and gun direction were vividly exposed at Jutland. Of 2626 main-gun rounds fired by British battleships over 96 percent missed (Bennett, 1964, 59-60); their battle-cruisers' gunnery was even worse – a 98.4 percent failure rate. German ships main guns achieved a slightly better hit rate than that of British ships. Gun directors, mechanical analogue computers, needed luck to land a projectile on a moving target at least seven miles away, a target which moved a quarter mile while the shell was in flight. Imagine seeking a bulls-eye in dim light in a smoked-filled bar-room when you and the dart board are in motion, in different directions at a different speed, and the floor is rocking.

But indeed there were 'lucky' shots, and in such instances the dreadnought weapons system proved to be as much a danger to itself as to its adversary. On three occasions at Jutland, all involving thinly armored British battle-cruisers, a turret hit prompted a cordite flash-fire, which reached a magazine, with catastrophic results (ibid, 78-80, 112).

Jutland is generally regarded as a tactical victory for Germany and a strategic success for Britain. Germany, the numerically inferior protagonist, had inflicted greater losses than it had suffered. But the British Grand Fleet continued to possess a considerable numerical advantage, and had forced the High Seas Fleet back to port, where it languished until War's end two years later. In that sense Jutland decided the outcome of the naval arms race. But the battle also demonstrated the inherent shortcomings of a weapons system cumbersome to deploy, nearly ineffectual at long range, and blunted by rudimentary command and control. These handicaps applied despite carefully balanced elements of power, protection and propulsion, all intertwined in a race resulting in a seemingly endless upward curve of scale and cost. Worse, the dreadnought race took little account of the torpedo and mine and their effect on naval warfare (Hough, 1983, 62-63). And after the Great War the prospect of aerial attack on battleships became increasingly apparent (O'Connell, 1989). The lessons of the dreadnought arms race were 'learned' to the extent of post-war disarmament and Naval Treaties (Miller 2001,192-193). When Germany and Japan repudiated treaty constraints battleship building by all major naval powers resumed in the 1930s. Unwieldy fleets at the immense scale of Jutland were no more, but American naval doctrine in the 1930s did contemplate the aging battleships of its Pacific Fleet confronting the Imperial Japanese Fleet's battleships off the Philippines in the event of war. This move, Plan Orange, would most likely have led to a catastrophe greater than Pearl Harbor.

The last battleships built were the United States Navy's Iowa class (1944-) and the Royal Navy's Vanguard (1946). Key wartime refinements of the type had included radar-guided long-range fire, greatly improved deck-armor, a honeycomb of transverse and longitudinal compartments as flooding countermeasures, upperworks bristling with anti-aircraft weaponry, and maximum speeds exceeding 30 knots. Essentially new roles for battleships had included their use as North Atlantic convoy escorts and as supporting fire during amphibious landings.

The United States revised the battle-cruiser type with the Alaska class (1944) and, surprisingly, the Soviet Union's Kirov class battle-cruisers were built as late as the 1980s and conceived as the nucleus of an anti-carrier task force in the North Atlantic. The battleship era can be said to have ended with the completion of the last Kirov. The ship had taken 14 years to build and finally went to sea 7 years after the Soviet Union itself had collapsed (Miller, 2001, 192-193).

Little remains of the Battleship Era, which spanned just over a century. Warrior, the catalyst, has been preserved as a museum ship. Mikasa, Admiral Togo's flagship at Tsu Shima, is moored and open to the public in Yokosuka, near Tokyo. Mikasa is the world's last surviving pre-dreadnought. Likewise, U.S.S. Texas is the only remaining ship of the dreadnought era and is preserved at San Jacinto, Texas. But an impressive total of seven Second World War Era battleships have been preserved in the United States.

The lesson of the Anglo-German naval arms race after 1906 goes beyond the construction expense the protagonists were willing to shoulder to stay ahead (Britain) or try to catch up (Germany). The goal of weapon superiority led to the increasing tonnage necessary to accommodate improvements in power, protection, and propulsion. These three pillars of emphasis were delicately balanced, and any significant departure from them led to potentially fatal vulnerability. Indeed, the neglect of protection in British battle-cruisers proved to be a catastrophic flaw. In the First World War, battleships were a "necessary' weapon only if deployed against enemy battleships, and "sufficient" only if arrayed in large numbers. But in-line deployment exacerbated problems of command, control, and communication, and long-range fire achieved very few hits. In several ways the 'tyranny of distance' almost guaranteed an indecisive encounter.

On land, the closest parallel to the case of the battleship and its three key design criteria is the tank, once it had evolved as a weapon tasked to face enemy tanks. German World War Two tank design in particular entailed a considerable accession of weight to accommodate improved firepower and armor without significant sacrifice of speed. And, like the battleship, the tank too was soon at risk from air attack, mines, and close-range threats it had not been designed to withstand. The fighter aircraft also suggests parallels to dreadnought evolution – symmetry of combatants, and spiraling one-up-manship of firepower, performance, and protection. The Japanese Zero fighter, for example, was unmatched in 1941 but soon became the battle-cruiser of the skies – power and performance without protection.

Few voices on either side of the North Sea opposed the expenditures associated with the Anglo-German naval arms race. Members of the general public could, with pride, name every major warship in their country's navy. Stalemate and impasse were not in their vocabulary. The United States citizen is surely less prone to visceral jingoism (and far less likely to know how defense expenditures are spent). As a result, the kind of debate that might have condemned an arms race (or at least arms expenditures) a century ago seems just as unlikely today. And because military geographers are apt to be as military as they are geographers, holding as a result a vested interest in military expenditure, it is my hope that more mainstream geographers will scrutinize facets of military weapons, their effectiveness, and their associated expenditures by the United States.

REFERENCES

Barnett, C. 1975. *The Swordbearers. Bloomington*: Indiana University Press, 101-190.

Bennett, G. 1964. *The Battle of Jutland*. London: B.T. Batsford.

Brooke, G.M. Jr. 2002. *Ironclads and Big Guns of the Confederacy*. Columbia: University of South Carolina Press.

Brown, D.K. 2003A. *Warrior to Dreadnought*. London: Caxton.

Brown, D.K. 2003B. *The Grand Fleet*. London: Caxton.

Gardiner, R. ed. 1979. *Conway's All the World's Fighting Ships*. New York: Mayflower Books.

Hill, R.H. 2006. *War at Sea in the Ironclad Age*. New York: Harper Collins, 32-34.

Hough, R. 1983. *The Great War at Sea*. New York: Oxford University Press.

Hough, R.2001. *Naval Battles of the 20th Century*. Woodstock: Overlook Press, 17-37.

Hurd, A. and Castle, H. 1913. *German Sea-Power: Its Rise, Progress, and Economic Base*. London: John Murray.

Keegan, J. 1989. *The Price of Admiralty*. London: Viking, 93-150.

Marshall, I. 1933. *Armored Ships*. Charlottesville: Howell Press., 107-111.

Massie, R.K. 1991. *Dreadnought: Britain, Germany, and the Coming of the Great War*. New York: Random House.

Miller, D.V. 2001. *The Illustrated Dictionary of Warships from 1860 to the Present*. London: Salamander.

Novikoff-Priboy A. 1937. *Tsushima*. New York: Alfred A. Knopf.

O'Connell, R. 1989. *Of Arms and Men*. New York: Oxford University Press, 271.

Pears, R. 1957. *British Battleships, 1892-1957*. London: Putnam.

Pleshakov, C. 2003. *The Tsar's Last Armada*. New York: Basic Books.

Simson, J.W. 2001. *Naval Strategies of the Civil War*. Nashville: Cumberland House.

Sondhaus, L. 2004. *Navies in Modern World History*. London: Reaktion Books, 206-213.

Spector, R. 2001. *At War at Sea*. New York: Viking Penguin, 64-102.

Tucker, S.C. 2001. *Handbook of 19th Century Naval Warfare*. Stroud, U.K.: Sutton Publishing, 219.

www.cigarettecards.co.uk