TECHNOLOGICAL CHANGE AND BRITISH NAVAL POLICY (1904 - 1914)

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The historical relationship between technology and naval power has, of course, been a very long one. It has been argued that technological developments have been decisive in naval battles as far back in history as the Battle of Mylae in 260 B.C., when the Roman introduction and use of the *corvus* resulted in the defeat of a great Carthaginian fleet with the destruction of almost half of the latter's vessels.[1] It has, however, been in our modern era that the link between scientific progress and naval affairs has been the strongest.

The marriage between science and naval technology during the modern era, however, has not always had "smooth sailing." This situation was particularly the case at the turn of our century and in the British Navy. Observers of the naval scene in Britain at that time, indeed, sometimes had sound reasons for doubting that those responsible for the Royal Navy knew much about science or anything about basic principles of physics. When the battleship H.M.S. *Albion* was launched on June 21, 1898, for example, her "wash" when she went into the water came back up the slipway, wrecked the stands erected for the spectators and drowned thrity-four people, mostly women and children.[2] Another unfortunate "launching accident" occurred when the Admiralty built a new Royal Yacht for Queen Victoria. When the yacht was first floated on January 3, 1900, it promptly took a heavy list to port and sank to the floor of the dry dock in which it had been built. An official inquiry into the incident found that the vessel was top-heavy and would have to be altered to become seaworthy.[3]

Such errors and miscalculations were more common in the Royal Navy than most Englishmen realized and even, alas, occurred in the most famous warship of the prewar decade, H.M.S. *Dreadnought*. This was the battleship which the Admiralty claimed made all others totally obsolete. It was designed for a speed of twenty-one knots and was equipped with a uniform "all big gun" armament of 12-inch guns. It also had numerous technological faults which soon became apparent to its officers and crew. While carrying out its trials, for example, it was discovered that one of its three main shafts was developing twice the maximum horse-power that it was designed to withstand. This meant that the vessel could not sustain its nominal top speed for very long. It was also discovered that if the ship were given more than ten degrees of helm when going over fifteen knots, the steering engine was not powerful enough to bring the rudder central again and that the ship would thus run in circles until the speed dropped below fifteen knots.[4] If, on the other hand, the vessel went less than ten knots and the helm was put over hard the *Dreadnought* would spin like a saucer.[5]

The numerous mistakes and miscalculations made in the application of science and technology to naval construction, however, were only a part of the problem that confronted the Admiralty during the prewar decade. More important, in fact, was the rapidity with which scientific and technological change was taking place. Such change presented both opportunities and new difficulties for the British Admiralty. Its effect upon British naval policy, therefore, was inevitable.

Naval historians have often observed that until the nineteenth century changes in naval technology were neither rapid nor very radical. When innovations of a technological nature were made, moreover, they could often be simply incorporated into existing vessels. This meant that warships could remain in service for many decades and those built for one war were often used in another conflict a generation later. The most famous example of such warship longevity, perhaps, was Lord Nelson's flagship at the Battle of Trafalgar. The H.M.S. Victory had been launched some forty years before the crucial battle was fought. The Victory, however, was not unusual in that respect. Some of the British warships which fought in the American Revolution had been no less than eighty years of age and had been able to fight on almost equal terms with vessels of more recent construction.[6]

The time when a forty year old warship could effectively compete with a new one rapidly came to an end during the last half of the nineteenth century. The development of the steam engine, the screw propeller and the shell gun, along with the use of iron and steel in the construction of warships, substantially reduced their effective lifetime. New vessels usually had superior speed, better protective armor and more powerful guns than their immediate predecessor class thus making the latter obsolete. Indeed, by the last quarter of the century new inventions and improvements in ship design were developed with such rapidity that a given warship could be virtually obsolete even before it had been launched. In addition, the new ships were dependent upon mechanical devices which tended to wear out and decrease in efficiency with use. The cost of maintaining a warship in commission, therefore, steadily increased while its value as a fighting unit actually decreased.

This was, by and large, a trend which the British Admiralty found undesirable. If new innovations made the existing ships of the Royal Navy obsolete, then they would have to be sent to the scrap-heap and replaced by new vessels. Britain would lose her superiority in existing ships and, in effect, would have to start its competition with foreign navies anew. The alternative was to try to bring the old ships "up to date" by incorporating new innovations into them and, in practice, that was what often happened during the late nineteenth century. The H.M.S. Alexandra, for example, was launched in 1875 and was not finally scrapped until 1908, even though the ship was virtually obsolete before it set sail for the first time. It began its service with both sails and steam engines and was equipped with muzzle loading guns. In 1889 the vessel underwent a partial conversion during which the sails were abandoned, new engines installed and the old muzzle loaders in the main battery replaced by breech loading guns. These modifications were completed in 1891 and just six years later the ship was again in dockyard hands for some additional changes in its armament and machinery.[7]

By the beginning of the twentieth century, however, it was quite apparent to many British naval officers that new guns, new boilers and additional armor plating simply could not make an old warship able to compete with a new one. Admiral Sir John Fisher, First Sea Lord from 1904 to 1910, shared that view. A few days before becoming First Sea Lord he wrote to his superior, Lord Selborne, arguing that "no mistake is greater or more wasteful than putting new wine into old bottles! Nothing can possibly bring an 'OUT OF DATE' ship 'UP

TO DATE'! You simply can't do it! It has been exemplified by hideous waste ever since the Ark!" From that it naturally followed that the time which His Majesty's Ships could be retained on the effective list would have to be reduced. Fisher thus continued, "As fighting vessels become obsolete in 14 years it's nonsense building them to last 40 years."[8]

A shorter effective lifetime for warships was the inevitable result of the obsolescence resulting from rapid scientific and technological developments. During the 1890s, for example, the armor plating used in the construction of warships was improved to the extent that it gave twice the protection afforded by the armor used during the first half of the decade. This meant, in turn, that a new battleship could achieve greater protection against enemy shells with a smaller percentage of its total displacement devoted to armor. Thus the Majestic class battleships laid down by Britain in 1894-95 had an average displacement of about 14,900 tons, of which 4,535 tons were in armor. The King Edward class built less than a decade later had an average displacement of 16,350 tons, of which 4,175 tons were in protective armor. With less of their tonnage in armor, of course, the King Edwards could have increased speed and armament. Thus while the Majestics had a nominal speed of 16 knots and carried four 12-inch guns and twelve 6-inch guns, the King Edwards had a speed of 18.5 knots and carried an armament of four 12-inch, four 9.2-inch and ten 6-inch guns. The heavy guns on the King Edwards were also of a larger caliber and, with the consequent greater muzzle velocity achieved, had a greater ability to penetrate armor than did the 12-inch guns of the earlier Majestics.[9]

While the King Edwards were still under construction, however, further technological developments occurred which tended to reduce the likely effectiveness of the ships even before they came into service in the fleet. Foremost among these developments was that of the introduction of the "capped artillery shell" which greatly decreased the amount of protection afforded by even the most recent type of armor plating. The King Edwards were thus made vulnerable to enemy shells at a much greater distance than had been the case when the ships had been designed.[10]

The rapid pace of technological development had inevitable effects on both shipbuilding design and Admiralty policies concerning the number of ships to be built and the speed with which they should be built. Recognizing the necessities imposed by science and technology, Admiral Sir John Fisher expounded his shipbuilding policy with the simple motto:

"BUILD FEW -- BUILD FAST
EACH IMPROVING ON THE LAST"[11]

Unless battleships were built rapidly, argued the Admiral, they would be made obsolete by improved technology and design before they could even join the fleet. A large number of battleships of the same type would simply mean that more vessels would have to be dropped from the list of effective ships at the same time. The obvious solution was thus to build ships as fast as possible so that they would become available quickly and give the maximum number of years of service. Fewer ships of each class should be built so that improvements resulting from scientific research and technological developments could be adopted quickly and the number of vessels made totally obsolete by change reduced to a minimum. That was the policy adopted by the Admiralty after Admiral Fisher became

First Sea Lord. Whereas, for example, eight ships of the King Edward class were built between March 1902 and January 1907, the Bellerophon class of Dreadnoughts consisted of only three ships. The first of this type was laid down in December 1906 and the last was completed in May 1909.

In addition to the technological improvements which directly affected the fighting power of warships themselves, of course, there were also developments which affected the very nature of naval warfare. An excellent example of this was the adoption during the late 1890s of the water-tube boiler. The latter represented an enormous improvement over the older cylindrical or "tank-type" boiler because it made it possible for a warship to raise steam and get underway very quickly. Admiral Sir Reginald Bacon summed up the advantage:

> Steam could be raised from cold water in one-quarter of the time that was possible with the old pattern boilers; this not only affected the time in which steam could be raised in harbour, but rendered it possible to supply a sudden call for steam when at sea with much greater rapidity than hitherto had been the case.[12]

The introduction of the water-tube boiler was quite controversial, largely because the British firms which made the old cylindrical type boilers would lose their substantial investment in plants. Most Englishmen, however, favored the change and did not realize that the adoption of the new type of boiler not only reduced drastically the value of all battleships equipped with cylindrical boilers but, more importantly, made "instant war" a possibility. In March 1905, the Director of Naval Intelligence, C. L. Ottley, pointed out the larger strategic implications in a memorandum for Admiral Fisher. Captain Ottley wrote:

> Already, some years ago and while the power of that terribly potent engine of naval offense, the water-tube boiler, was still in inception, the statement was made at the Berlin Congress that, while the first great and decisive land-battle cannot take place until thirteen days after mobilization, a great fleet action may easily take place at sea within thirteen hours.
>
> Landsmen are apt to forget that what the water-tube boiler has done has been to give to warships a dreadful and restless mobility which will shorten up the period of preparation from thirteen hours to seven or less. Vessels equipped with these boilers may be lying in the basins of our dockyards, or at their moorings in the stream, with fires out and water cold, and 30 minutes later may be under way, with steam up for full speed, ready to fight an action.[13]

Another revolutionary technological change that would have both tactical and strategic implications was the adoption of steam turbine engines in place of the old reciprocating engines which had been in use in the Royal Navy. The latter type of engine was notorious for its unreliability and inherent defects. It had moving parts many tons in weight which threshed up and down more than a hundred and eighty times a minute at a velocity of thirty feet per second. The inevitable damage done to the engine when such energy was absorbed made it impossible for a fleet to steam at full speed for long without loosing two or three ships to breakdowns. In November 1905, for example, Britain's Second Cruiser Squadron had attempted to cross the Atlantic from New York to Gibraltar at high speed. Three of the six cruisers had to drop out because of engine defects and the whole squadron was out of action for a month after the cruise while repairs were made to the engines.[14]

The new steam turbine engines, of course, did not have such problems and the improvement was quite apparent when the Dreadnought, the first battleship with turbine engines, took its initial cruise. The ship steamed from England to Trinidad and back at a speed of seventeen knots and arrived home in England with no defects in its main engines. The reliability of the steam turbine engines meant that the Admiralty could count upon its fleets reaching their assigned stations on schedule and at their nominal strength.

A third technological change of revolutionary significance was the introduction of the use of oil instead of coal as the fuel for British battleships. Although the first such battleship to be "oil-fired" was the H.M.S. Queen Elizabeth laid down in 1912, the actual transition to oil from coal was a gradual process in the Royal Navy. Oil had already been used as a supplementary fuel for some years. The Lord Nelsons and the Dreadnought, for example, carried over a thousand tons of oil in addition to their primary fuel of coal. The British had also adopted oil as the sole fuel for smaller vessels such as destroyers and submarines. By the end of 1911, in fact, the Admiralty had already built or was building fifty-six destroyers and seventy-four submarines powered solely by oil.

The advantages of oil over coal were enormous. Sir Winston Churchill, the First Lord when the change to oil was made, summed up the advantages:

> In equal ships oil gave a large excess of speed over coal. It enabled that speed to be attained with far greater rapidity. It gave forty per cent greater radius of action for the same weight of coal. It enabled a fleet to refuel at sea with great facility. An oil-burning fleet can, if need be and in calm weather, keep its station at sea, nourishing itself from tankers without having to send a quarter of its strength continually into harbour to coal, wasting fuel on the homeward and outward journey....The use of oil made it possible in every type of vessel to have more gun-power and more speed for less size or less cost....All these advantages were obtained simply by burning oil instead of coal under the boilers.[15]

At the same time that improvements in armaments, armor and propulsion systems were increasing the power of British battleships, however, there were other technological developments which created new problems for the large ships and tended to reduce their dominance in naval warfare. One such development was the self-propelling torpedo. First invented by Robert Whitehead in 1869, the torpedo had gradually improved from a device with a range of only a few hundred yards and a speed of 6 or 7 knots to one which, by 1914, had a range of over 11,000 yards and a speed of over 30 knots. During the same period the size of the explosive charge carried increased from only 60 pounds of guncotton to the point where a single torpedo could sink even the largest and latest battleship afloat. The importance of this development is indicated by the fact that when the First World War began in 1914 the navies engaged in it together had a total estimated 80,000 torpedoes on hand.[16]

The strategic implications of the development of the torpedo were substantial. When equipped to launch torpedoes the smallest and least expensive vessels could now sink or disable the most powerful battleship or cruiser afloat. Whether the torpedo-boats could carry out a successful attack depended, moreover, upon such things as weather conditions or the time of day. In a memorandum on the possibility of invasion, British Prime Minister Arthur J. Balfour took note of the impact which the development of the torpedo could have upon the outcome of naval engagements when conditions might favor the small and fast torpedo-boats. The Prime Minister wrote:

> There is no standard by which to compare the fighting efficiency of a first-class battleship and a torpedo-boat. Light or darkness, heavy seas or calm waters, distance from or nearness to the base, may make the torpedo-boat either the feeblest or the most formidable of antagonists -- a negligible quantity or a governing strategical and tactical consideration.[17]

Superiority in battleships and cruisers, consequently, could no longer insure that Britain would have command of the sea in those areas in which enemy torpedo-boats could operate. Indeed, the risks inherent in sending the large ships into waters where they might be attacked and sunk by torpedo-boats were simply too great to allow such a venture. Close blockade of enemy ports thus became impossible because of the new danger to the ships assigned to blockade duty. Even more important was the possibility that an enemy might be able to close an entire sea route to British merchantmen during wartime if the sea lanes passed through waters within the cruising radius of its torpedo-boats. As early as 1902 Admiral Sir John Fisher was convinced that British trade through the Mediterranean would have to be diverted around the Cape of Good Hope in wartime because of the threat from torpedo-boat attack. In 1905 he predicted that within a few years any navigation in the western basin of the Mediterranean during wartime would be extremely dangerous.[18]

What convinced Fisher and others that the torpedo would pose a great danger in the future was, most of all, the concurrent development of the submarine. Fisher believed that submarines would be very effective in the next war and when he retired as First Sea Lord in January 1910, the Royal Navy had

61 submarines ready for service with another 13 building or on order.[19] Other navies were, of course, also building submarines and when war came in 1914 the European nations together possessed 291 submarines and had approximately another hundred under construction. From the outset of the war there were 264 submarines involving over 20,000 men engaged in the combined war efforts of both sides. The Royal Navy, which had no submarines in 1901, had 65 in service in 1914. The German Navy, interestingly, had only 27 submarines available in 1914.[20]

The large number of submarines built during the period, however, was less an indication of faith in the new weapon than it was a consequence of technological change. Most naval officers, in fact, did not believe that submarines would play a significant role in the next war. But the period from 1902 to 1912 was, in Admiral Jameson's words, "The Decade of Development" for submarines and improvements were made with such rapidity that a high rate of construction was needed just to keep pace with technological progress. Within this brief period the displacement of submarines increased from 120 tons to 313 tons. Surface speed doubled from 8 to 16 knots while cruising radius increased from 1,000 to 2,000 nautical miles.[21] Such rapid development meant an equally rapid rate of obsolescence for submarines already built.

The technological progress made with respect to submarines, torpedo-boats and the torpedo itself created both dangers and advantages for the Royal Navy. The Admiralty's constant nightmare now became that the British Fleet might be caught unawares by, in Churchill's words, "a surprise torpedo attack before or simultaneous with the declaration of war."[22] Flotillas of enemy torpedo-boats and submarines could easily be towed secretly into the vicinity of the British Battle Fleet's home ports and, in one swift blow, the Royal Navy's costly superiority in battleships and cruisers might be wiped out. That, rather than the possibility of not being able to send any British warships into the waters where enemy torpedo-boats could operate, was the real danger against which the Admiralty felt it had to be prepared.

The dangers of a sneak attack were, however, partly balanced by additional protection against the threat of invasion. Even if the Royal Navy temporarily lost command of the sea in home waters as the result of a battle fleet disaster or the temporary absence of the Home Fleet, British torpedo-boats and submarines would still be able to make conditions unfavorable for any invasion attempt. The Admiralty thus took the position that the concentration and retention of a large number of battleships and cruisers in home waters were not really essential for protection against invasion. The Royal Navy's torpedo craft, wrote Driector of Naval Intelligence Prince Louis of Battenberg in 1903, would "always be on the spot as a standing and most serious menace to an invading fleet of transports."[23] If the enemy chose to use battleships and cruisers to escort the invading force, then these large ships would also come under attack from torpedo-boats and submarines. This view was also taken by Prime Minister Balfour in his 1903 memorandum on the possibility of invasion.

> The deductions from these considerations with which we are here concerned are that, even if our battle fleet were absent from the channel

> or beaten, and the enemy's battle fleet swept it like Van Tromp's, from end to end, this might hamper, but could not drive into port our superior force of cruisers, and would affect our torpedo-boats and submarines chiefly by supplying them with additional objects of attack.[24]

Technological progress had also provided another danger which the Royal Navy could now pose before any enemy fleet attempting an invasion of Britain, namely, that of being sunk by automatic submarine mines. Because the Royal Navy did not have the sixty thousand mines deemed necessary for an effective mine-laying operation in the North Sea when war began in 1914, doubts have often been expressed about whether the British Admiralty had taken the submarine mine seriously before the war. One historian has even written that the Royal Navy never regarded the mine as a formidable weapon and that such devices were "looked upon as rather expensive luxuries in an unimportant branch of naval warfare."[25] Although it is certainly true that the British Admiralty deemed submarine mines to be less important than battleships, cruisers, destroyers and submarines, this attitude did not mean that it considered mines to be ineffective during the prewar period.

Any doubts about the efficacy of mines, in fact, were removed by the Russo-Japanese War. During the first months of that conflict nine battleships and cruisers plus numerous smaller vessels were sunk and at least three battleships damaged by submarine mines. While the war was still in progress, consequently, the Admiralty produced and circulated a memorandum on what it termed "these objectionable devices." The memorandum began:

> The startling success achieved by automatic mines during the present war inculcates a lesson which is likely to be only too readily accepted by foreign naval Powers.
>
> The comparative cheapness of these contrivances and the ease, secrecy, and rapidity with which they can be sown broadcast in an enemy's waters at night, have long been known to other nations....But, until a few months ago, Europe had had no opportunity of gaining a knowledge as to how far the automatic mine, admittedly a lethal weapon enough in the mimic operations of peace manoeuvres, was in reality dangerous in war.[26]

As any uncertainty about the value of submarine automatic mines had now been "routed" by "the logic of recent events," there was only one conclusion to be drawn:

> The Board of Admiralty believe that automatic mining will inevitably form part of operations of any future naval war, and they are therefore preparing for this contingency.[27]

It was also apparent to the Admiralty, of course, that the widespread use of submarine mines would not be in Britain's interests. She had by far the largest merchant fleet and would, therefore, run the greatest risk of losing ships to mines. The Admiralty thus proposed that the British Government should seek to make an agreement with other Powers which would, at least, restrict the manner in which submarine mines could be used in future wars.[28] As there was very little prospect that such an agreement would be obtained, however, the Admiralty also proposed that the Royal Navy should at once begin to build and maintain an inventory of no less than ten thousand mines for use in future wars. The project would be carried out in secret with the orders for the various parts of the devices to be distributed among many firms so as to "avoid foreign countries ascertaining that we have placed orders for a large number of mines."[29]

The fact that the Royal Navy had only four thousand inefficient mines on hand when war came in 1914, consequently, did not mean that the Admiralty had failed to appreciate the formidable character of the mine itself or the dangers and opportunities which it represented. Nor did the Hague Convention of 1907 limiting the laying of mines to territorial waters or remarks by the Chief German delegate to the conference disavowing the use of mines lead the British, as one historian has argued, into a false sense of security and complacency.[30] The Germans only accepted the Hague Convention limitation on the use of mines with reservation and that convinced most British naval officers that the Germans intended to use mines very extensively in any future wars.[31] The British shortage of mines in 1914 was, rather, the result of an earlier shortage of funds. There were simply too many technological innovations to be funded and it was felt that mines could be obtained quickly after war came while the vessels to lay and to sweep them could be improvised. Such was not the case with two other new inventions of the period, the radio and the airplane.

The invention of the "wireless telegraph" or radio, of course, was no less revolutionary in its impact upon naval affairs than had been the water-tube boiler, the torpedo, or the submarine. Until the invention of radio, communication between the Admiralty and the fleets at sea or on distant stations was slow and, at best, uncertain. Once the wireless had been installed in His Majesty's ships and atop the Admiralty in London, communication between the Sea Lords and the Admirals afloat became instantaneous and assured. Fleets on distant stations or at sea on maneuvers could be quickly recalled or moved to their war stations upon the outbreak of war. As the ships could now communicate among themselves over great distances, once the enemy fleet had been sighted its location could be promptly reported and the British battle fleet would take appropriate action. In an era when "suddenness in naval operations" and the "instant initiative," as the Admiralty termed a sneak attack, were thought to be the chief characteristics of naval warfare, the development of radio was of immense significance. The Admiralty in London could now provide the Commanders-in-Chief afloat with the latest intelligence and, to a far greater extent than ever before, the Sea Lords themselves would be able to direct the naval war from London.

The invention and development of the airplane during the pre-war decade was also of major significance. Although the Admiralty at first rejected the airplane as being "of no particular value," the possibility of its use for reconnaisance purposes was soon apparent. The Royal Naval Air Service was thus established and, when war came in 1914, the Royal Navy had fifty-two seaplanes and thirty-nine airplanes to serve as scouts for the British Fleet or to attack the German Zepplins sent over to serve the same purpose for the German High Seas Fleet.[32]

The decade prior to the First World War was a period of rapid technological change for navies throughout the world. For the British Admiralty which had to respond to such rapid change, alas, it was also a period of bitter controversy and much criticism. When the Admiralty spent scarce funds on such things as the wireless, construction of submarines, and the purchase of airplanes, it was accused of wasting valuable resources on the new and the untried to the neglect of the old and the proven. On the other hand, if it failed to make such expenditures, it faced the charge of not keeping abreast of the latest scientific and technological developments and of courting defeat in the next war. The truth of the matter was, of course, that no one knew for certain what would be most needed when battle came. What should be most expected in the next war, argued Admiral Fisher in 1905, is that the totally unexpected would happen.[33]

Fisher was right, of course, and the totally unexpected did happen in the war at sea. The British were prepared for a repeat of the Battle of Trafalgar, which never came, and unprepared for the submarine crisis which almost brought their defeat. Because Germany also prepared for the wrong type of war at sea, however, the heavy price which the British paid for their mistake did not include their defeat and humiliation. At the end of the war it was the German Battle Fleet that rested on the bottom in Scapa Flow and not the Grand Fleet. Although some would argue that the superior ships were on the bottom, the British victory is itself testimony to the fact that the British Admiralty had managed to keep the Royal Navy abreast of technological change during the prewar period.

NOTES

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