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Anglo-American Naval Inventors, 1890–1919: Last of a Breed

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Between 1890 and 1920, a remarkable change occurred in naval engineering. Beginning in an era of self-made mechanics and tinkers, it ended in an era of technical and scientific bureaucracy. In the United States Navy and the Royal Navy, it was possible for imaginative inventors who were also naval officers to experiment and to have considerable effect on technological development. The key to the emergence of a new, much more technocratic navy, which first encouraged such experimenters and then betrayed them, was the emergence of the steel warship and the development of big guns for it. Only after much work had been done on the dreadnoughts and post-dreadnoughts would the naval inventors contribute to the submarine, anti-submarine and aircraft technology. Dominating the inventors of the U.S. Navy during this period was the brilliant and persistent Bradley A. Fiske, who rose to Rear Admiral. His equivalent in the Royal Navy at the same time was Sir Percy Scott, who retired as Admiral. They knew each other and each had coteries of admirers and imitators. Lacking much scientific or engineering background, they resembled the icon of the day: Thomas A. Edison. In common with Edison, they either tried to learn or more usually, depended upon a younger breed of university trained professional engineers to bring their projects to fruition.

It was the last opportunity for the amateur to meddle in high technology. The new German emperor, William II, had a fascination with naval history before he ascended the throne in 1888 and liked to draw warship designs, which he showed to his naval advisors such as Admiral Tirpitz. It was sometimes necessary for the admiral to tactfully suggest that a particular warship, if designed from the emperor's doodles, would sink when launched.[1] The naval inventors in the Royal Navy and the U.S. Navy also spent time in sketching designs and they differed from William II in having a certain amount of technical knowledge and experience.

When the Anglo-American inventors began their experiments, it was in the field of gunnery. The search for more accurate range finding for the shipboard heavy artillery never ceased during the entire period and created increasingly sophisticated firing systems. After the First World War started, however, prewar experiments in submarines and aircraft suddenly became important. The war aroused the Anglo-American inventors and focused their attention on antisubmarine warfare. By the end of the war, however, the great age of amateurs had passed. No longer could a serving officer doodle a design on simple lines and expect it to be translated into a real invention. By 1917, a new generation of university-trained applied scientists and engineers had to make the technological improvements in a naval warfare that had become complex and difficult to understand by the untrained.

The foundations for the new navies were laid by several senior officers and civilians in the Royal Navy and the U.S. Navy by 1890. Providing the strategy for large navies was Alfred Thayer Mahan. Mahan was not particularly interested, however, in the technology of the steel warships. In the U.S., Admiral Stephen B. Luce began the Naval War College and encouraged technological advances in the service. Bradley Fiske, later an imaginative and resourceful admiral, commented on this era.[2]

> Luce, Mahan and others at the war college tried to make us see that the art of war, like any other art, is an art that is practised by men, according to the principles of the art; and that in the military and naval art the guns and other weapons used are tools, just as a hammer and a chisel are tools in the hands of a sculptor or a brush in the hands of a painter.

In the Royal Navy, the dominant figure was Admiral Lord Fisher, First Sea Lord, who undertook a fundamental reorganization of the navy in the first decade of the century. He struck from the list a large number of small and obsolete craft and pushed for the dreadnought battleship and battle cruiser program from 1905 onward. Fisher looked for like-minded juniors and selected Captain John Jellicoe to serve as one of what he called the "Five best brains of the Navy" in a committee charged with design of the *Dreadnought*. Jellicoe devoted much of his time to gunnery problems and was supported by Admiral Sir Percy Scott in the search for range finding improvements.[3]

The innovative generation of naval officers was born after 1850 and reached high rank and influence just prior to the First World War. None of them had good engineering or scientific educations, even by the standards of the third quarter of the nineteenth century. Entering midshipmen had to be at least fourteen and no more than eighteen and had to pass an examination in reading, writing and arithmetic. All of the American naval officers were graduates of Annapolis after 1870 when the curriculum stressed practical seamanship. Physics and chemistry were taught at elementary levels. American Admiral Bradley Fiske did have a scientific and technical grasp superior to the others, however. He published articles and at least one book on chemical problems; he had to provide his own education.[4]

Officer training was even more rudimentary in the Royal Navy. Jellicoe, at age twelve, entered the training ship *Britannia*,[5] a wooden three-decker, in 1872 to undergo "a two year course in seamanship, navigation and a few miscellaneous subjects such as drawing and elementary French," before he was sent to sea. Jellicoe, in common with Fiske, remembered spending a lot of time in the rigging of sailing ships.[6] David Beatty also joined the *Britannia* in 1884. By the latter time future midshipmen had to take entrance examinations and Beatty ranked tenth out of twenty nine. Even at that latter date emphasis was placed on seamanship on sailing ships.[7] Sir Percy Scott entered *Britannia* at age eleven and a half in 1866. In his memoirs, he fails to indicate what he learned in his early years in the Royal Navy except seamanship. In 1898, work started on a shore-based naval establishment at Dartmouth, which would soon replace the antiquated *Britannia*.[8]

To be fair, civilian inventors of this era had rudimentary educations as well. Thomas Edison, and the developer of the gyroscope, Elmer Sperry had little formal education. Arthur Hungerford Pollen received a classical education at Trinity College, Oxford. But even as they began their careers and increasing number of engineers and applied scientists were being produced by American universities including MIT and, in England, by Imperial College, University of London. Engineering, however, still depended upon the apprenticeship system in England especially. The future Director of Naval Construction Tennyson d'Eyncourt, started out in a shipyard learning riveting. Far more important than any formal education for these civilian inventors was their tutelage by master machinists and instrument makers. Craftsmen of the latter type were fundamentally important in the burgeoning industrial revolution by 1900; they were the essential tool and die makers.[9]

Benjamin Franklin Tracy, perhaps the most important of all Secretaries of the Navy up to the First World War, became convinced that the construction of a large and modern line of battle fleet required expertise which the navy did not possess. He ordered six young officers to go to the Ecole d'Application Maritime in Paris and the University of Glasgow to study naval architecture. Four other future Assistant Naval Constructors already studied in Paris and at the Royal Naval College at Greenwich.[10]

Holden Evans, born in 1871, and Academy graduate, determined early to become a Naval Constructor rather than stay in the line. He admitted that the career change "would give me some independence, one in which I can make my living in civil life." Sent to Glasgow, he studied under Archibald Barr, who would later become involved in the development of rangefinders for big guns. He represented the new group of engineers who were trying to achieve recognition in the navy after 1890.[11]

Innovation in ships and weaponry required cooperation of the Bureaus of Construction and Repair, Steam Engineering, and Ordnance. But dominating the whole was the Bureau of Navigation, which made personnel assignments. Rear Admiral Henry Clay Taylor presented to Secretary Long in 1899 a plan for a General Board which would, in effect, assist the necessary cooperation of bureaux and would reinstitute the defunct Policy Board which had been set up during the Spanish American War. But the plan failed[12] and contact with other navies seemed to be limited to periodic visits of Assistant Naval Constructors and the activities of Naval Attachés. Much information could be gleaned in addition from professional journals devoted to engineering, maritime architecture, and the naval profession.

By 1890, important changes began in the Naval Yards as more machinists were hired and the officers commanding them, usually line, deferred to the more technically qualified Naval Constructors. Captain David Taylor, of the Bureau of Engineering, the dean of the naval constructors, and his subordinates worked to increase the production of guns and other equipment by the Naval Yards. Holden Evans claimed that line officers continued to be appointed to engineering posts, ship and shore, without qualifications because of the need to find jobs for high rank line officers. In spite of the rivalry between line and engineering officers, which was not cured when line officer graduates of the Academy were considered engineers, after 1900, the navy became more technical after that date.[13]

Line officers, however, continued to receive the plum assignments and the American naval inventors came from this branch of the officer corps. Between 1898 and 1916 the U.S. Navy was increasingly influenced by the thinking of Rear Admiral Alfred Thayer Mahan, Theodore Roosevelt, future Admiral William S. Sims, and the remarkable Rear Admiral Bradley Fiske. Mahan, of course, had much to do with delineating grand strategy and identified the control of the seas as a dominant factor in warfare, celebrating the Royal Navy for its role in securing this prize over time. More than anyone else, he pushed the navy to imitate the Royal Navy. Sims, at the time of the Spanish American War, was Naval Attaché in Paris, Lisbon and Madrid, and compiled detailed reports on the state of the French, Spanish, and Portuguese navies. Sims was also widely known for his inventive and innovative mind in the service, most evident in his gunnery experiments. Fiske promoted improved gunnery as well and had a great interest in technology. Presiding over these remarkable officers was the indefatigable Theodore Roosevelt, first as Assistant Secretary of the Navy in 1898 and then as President from 1900 to 1908. Motivating all was an abiding belief in Manifest Destiny and an adherence, henceforth, to American imperialism.

When a lieutenant following the Spanish-American War, W. S. Sims returned from a cruise to China where he encountered Captain Sir Percy Scott. Scott, maverick inventor and gunnery crusader in the Royal Navy, remarked in his memoirs that Sims "was a gunnery enthusiast and was trying to impress upon his Naval authorities the necessity of a reform in heavy-gun shooting." He had compared "the very bad shooting of the American Fleet at that time and the records made by H.M.S. *Terrible* in China in 1900 and 1901." Scott believed that Sims prevailed in the U.S. Navy only when he ignored the chain of command and wrote directly to Theodore Roosevelt and, because of the interest of the president, obtained post as his naval Aide-de-Camp.[14] Admiral Bradley Fiske, pleased with the temerity of Sims, claimed that the latter had brought about "an actual revolution in our methods of target practice, and in the matters of the construction of ordnance apparatus as applied to naval gunnery" in the U.S. Navy.[15]

Fiske did not resent the fame, which eventually came to Sims because the navy eventually adopted the "system of gunnery training introduced by Captain Sir Percy

Scott." He believed, however, that aiming by spotting was inferior to the use of a range finder and correctly indicated that the U.S. Navy developed a system of directed firing after 1903, which was a vast improvement over the use of spotters of shellfire alone.[16] Fiske maintained that he had patented a scheme for pointing guns on ships so that the rolling of the hull and the use of a telescope could be correlated. This idea of 1890 led, he asserted, to the Director System "usually credited to Admiral Sir Percy Scott, R.N."[17] In fact, by the winter of 1910 and 1911, while serving on the General Board in Washington, Fiske had patented a scheme for a "combined ranger finder and turret, " and the battleship *New York* was the first to be fitted with this device.[18] His work paralleled that of Arthur Hungerford Pollen and certain officers in the Royal Navy.

In the Royal Navy, efforts had begun to find a range finder after the Ordnance Committee had discovered that Fiske had been conducting experiments in 1889. Fiske had gone to Portsmouth to show officers of the Royal Navy the advantages of his device. While there, he was "disquieted" to discover that a rival machine, cheaper, seemed to be getting good results. Years later he discovered that two young Scottish professors, Barr & Stroud of Glasgow had made substantial improvements to the other machine. Captain John "Jackie" Fisher encouraged development and tests confirmed its utility, and it was adopted by the navy by 1899. Although accurate at short distances the Barr & Stroud range finder was cumbersome to use and inaccurate at the long distances that the new naval gunnery provided. After 1903, further experimentation led to the use of "clock" systems such as that of Vickers, which relied upon a mechanical movement. Eventually the Royal Navy had to choose between a device developed internally and one promoted by an outsider, Arthur Pollen, who had no naval experience. Pollen, in the words of Sumida, "was able to translate his ideas into a practicable system, which not only constituted a major advance in the technique of naval surface gunnery, but also marked a milestone in the development of the modern computer."[19]

The U.S. Navy adopted the Barr & Stroud range finder but Fiske persisted in trying to use it with a spotting system of his own in 1900, which resulted in the creation of the "Turret Range Finder." Fiske, unable to determine how simultaneous firing could be managed of all the turrets of a ship, resorted to a scheme to make range finding accurate for each one separately.[20] Unfortunately for him, the Royal Navy had now progressed beyond that point to concentration on director firing from a central location on board. Arthur Hungerford Pollen perfected such a system by 1913 but the Admiralty refused to adopt it, remembering previous failures of his designs. As a consequence, British warships were not fitted with director firing systems designed by Pollen until after the war. Pollen, in common with Fiske, used the Barr & Stroud range finder[21] as a base point but he went further. A key innovation was the use of a gyroscope such as used in the Whitehead torpedo, which solved the problem of yaw, which had bedevilled Fiske earlier. Pollen, when approached by the U.S. Navy and the German Navy in 1906, refused to allow them access to his plans, preferring to reserve them for the Royal Navy.[22]

According to Elting Morison, Commander, later Rear Admiral William S. Sims, was no inventor but he had the ability to evaluate the ideas of others. Therefore, because of his continued interest in gunnery accuracy he selected an officer who remained in a post near the top of a mast who observed the flight of a salvo, used a range finder, and relayed an estimated range to all the gun sight setters. A “ranging salvo” followed, giving information to the spotter in his fire control aerie who then called corrections.[23] This scheme of 1904 proved useful in gunnery training but was primitive compared to the experiments of Pollen, Barr & Stroud and others.

Sims perfected the training and coordination of gunners on board ship. Fiske devised a series of optical devices, which he intended to use as range finders. Barr & Stroud developed this optical idea but Arthur Pollen achieved the real breakthrough in director control. With the growing naval race after 1906, however, the ideas and inventions of innovators in different navies came to be viewed as important secrets to be guarded carefully. No longer would director control systems benefit from cross-fertilization. But, Bradley Fiske convinced the Bureau of Ordnance of the U.S. Navy to investigate director firing or “fire control” in 1914 when Elmer Sperry developed a system dependent upon his gyrocompass “which provided a reference bearing (true North) in relation to which gun train could be directed” and included an electrically driven machinery for compensation in target bearing. Sperry’s system depended upon the observations of a spotter posted high on the forward mast who relayed information to the conning room below which housed an analog computer used to make compensations for the tracking of fire. This system was vastly improved by a former colleague of Sperry, Hannibal C. Ford, who delivered his range keeper, Mark I, to the navy in 1915. By 1920, Sperry fire control systems had been installed on thirty American capital ships. The Sperry system was used on main armament guns but, after the U.S. entered the war in 1917, “British fire control information became available” and the Vickers system was used for secondary armament only on American ships.[24]

In truth, the evolution of the director control system for warship firing was international in character. The British and American navies worked on similar systems up to the war. Because of the failure to adopt the Pollen system, the British fell behind by 1914 just as the U.S. Navy adopted the Sperry Gyroscope system. In the Battle of Dogger Bank, Captain Ernle Chatfield, Flag Captain to Admiral Beatty, remarked that he asked the control for the range to the German ships on first engagement. “Above 15,000 yards our range-finders were very inaccurate, but they gave a range of about 22,000 yards”[25] using the Dreyer range control apparatus, which many thought was very inferior to the Pollen system. The impetus for technological innovation came from the necessity to improve range-finding capabilities because of the enormous range of the new naval artillery. Lord Chatfield claimed, in an after battle assessment (Dogger Bank), “The failure to keep the range of the enemy at the high speed of the battle-cruisers was the dominating experience.”[26] A different view, stated by Frederick Dreyer, inventor of the rival system to Pollen's which was adopted before the war, supported Jellicoe while Chatfield supported Beatty during the post war debate on Jutland. Dreyer claimed: "The question of fire control was closely examined. We were well satisfied with our Dreyer fire-control tables, but longer base rangefinders were a requirement."[27]

By the middle of the First World War, there was ample evidence to indicate that the gyroscope and analog computer system developed by Sperry and Hannibal Ford was similar to that developed by Arthur Pollen for the Royal Navy. In fact, Sumida maintained that it was probable that Pollen had influenced the development of the Sperry and Ford system.[28] Pollen visited the United States in 1914 and 1917 and had conversations with the U.S. Navy regarding his system but the Sperry system, introduced in the fleet in 1914 seemed to preclude the Pollen system. The U.S. Navy had "learned much from Mr Pollen concerning Fire Control" and looked forward to tests of his system in 1917 but "Apart from the Director System we can learn nothing, in British Fire Control, which is superior to, or even as good as that which we have in the Atlantic Fleet now." The U.S. report went on to claim, "When we are supplied with Ford Clocks, we shall be in better shape than any ship in the British Navy, except the Three or four that have Argo Clocks now." The Argo Clocks had been developed by Pollen's engineers as the computer system in range finding.[29] The evidence seems to lead to the conclusion that the U.S. Navy and the Royal Navy ended with similar director control systems partly as a result of cross-fertilization of ideas.

When the U.S. Navy began to work alongside the Royal Navy after the United States entered the First World War in April 1917, there was surprisingly little friction and much evidence of friendly cooperation. Within each service, traditionalists and modernists argued; the latter placed great reliance on technology. Many of those in high command possessed conservative and change-resistant characteristics. Some such as Admiral Benson, the first Chief of Naval Operations, disliked the Royal Navy and thought that the Naval Act of 1916 had to be carried out as a long-term project not connected to the war itself. The Bureaus of the Navy Department still persisted in their petty rivalries and guarded their territories with gusto. Similarly, within the Admiralty some flag officers continued to oppose technical innovations. In spite of these problems, the two navies cooperated very well indeed. The key to this success can be found in the close and cordial relations of a number of American and English naval officers, civilian engineers, and others who had worked on similar problems before the war and exchanged ideas with one another. These technical innovators were responsible for the development of sophisticated fire control systems on warships and for anti-submarine devices.[30]

Director control was intimately associated with the development of the dreadnought battleships before 1914 because everyone thought that naval supremacy depended upon these warships. Only after the war started would attention shift to the development of anti-submarine plans, ships, and devices.

When the German submarines began to sink both warships such as the old cruisers *Aboukir, Cressy*, and *Hogue* in late 1914 and an increasing number of merchant ships, the Admiralty had to look for ways to counter this new threat. Obviously, warships capable of speed, maneuverability and firepower seemed natural opponents of the submarine. Of these, the destroyer and the torpedo boat were present in substantial numbers at the outbreak of the war. Both types of warships had been developed to fill needs of the fleet with no anticipation of roles in regard to submarines. But the real problem was how to protect merchant shipping. The sheer number of sailings, the variety of ships used as well as their different speeds, seemed to militate against the introduction of a convoy system. Anti-submarine warfare then had to be directed to the search and destroy of U-boats by trying to intercept them coming out of their bases, or, more difficult, to engage them afterward. One efficient means was the laying of mines: Admiral Jellicoe estimated that they accounted for the loss of thirty-five submarines during the war, which equalled the number sunk by depth charges.[31]

The history of the depth charge is still mysterious. Admiral Sir Percy Scott, convinced by the spring of 1914 that " submarines and aircraft had entirely revolutionized naval warfare," created a great controversy when his letter to the *Times* was published. A number of admirals wrote in rebuttal, including Lord Beresford, the old enemy of Admiral "Jacky" Fisher, but Scott eventually was named to head the Anti-Submarine Department of the Admiralty. Upon assuming this position about four months after the war started, he discovered that nothing had been done to meet the danger of submarines. He designed a hydroplane boat, which would attempt to ram submarines, but the model, when tried out in the National Physics Laboratory tank, proved unworkable. Scott designed a bomb that could be dropped on a submarine if it was on or near the surface. The depth bomb was simultaneously conceived by Captain P. H., Colomb and Admiral Sir Charles Madden in October 1914, utilizing a hydrostatic valve that would actuate the charge. These three officers worked independently unaware of one another. Neither Captain Colomb's nor Admiral Madden's schemes were sent to Scott. As a result of the fateful delay, according to Scott due to Admiralty incompetence, the Royal Navy was not provided with depth charges and howitzer throwers of them until 1916. Scott continued to suggest that such charges could be either thrown from ships or dropped by aircraft. In 1915 F. T. Jane, compiler of a handbook on aircraft and famous for his annual volumes on the world's navies, asked Scott to write a statement on aircraft. Scott indicated "the time has arrived when the flying warship is a factor to be seriously reckoned with."[32]

The U.S. Navy had little to do with the problem of anti-submarine warfare until the first crisis of shipping occurred, from late 1914 to the sinking of the *Lusitania* in May 1915. Bradley Fiske, ever interested in inventions, described to Secretary of the Navy Daniels on October 1, 1914, the "diving-shell" invented by Isham, which supposedly would dive into the water close to a target ship instead of ricocheting and might be "a very valuable weapon for fighting destroyers and submarines and even battleships if it could be made to work." Fiske headed a board of investigators that worked on the scheme for a year and a half. The depth charge and thrower emerged as the fruit of this work.[33] Depth charge throwers were introduced by the Royal Navy in July 1917,[34] about the same time as the U.S. Navy started using them. These effective anti-submarine weapons came during the height of the second U-Boat crisis, the spring and summer, 1917.

The Royal Navy Director of Naval Construction, Tennyson d'Eyncourt, prepared a "secret and Personal" memoir in 1916 in which he indicated that a vast increase in the construction of patrol boats, destroyers, and submarines for the Royal Navy had to come. Previously he had placed great emphasis on battleship and battlecruiser construction, following the dictates of the long-time First Sea Lord, Admiral "Jackie" Fisher. But he now claimed: "In view of what we are doing in the direction of very fast ships carrying large caliber guns, also of our present superiority in numbers over the Germans in this type of vessel, the question of Battle Cruisers might be left out of account in connection with the War programme." He did not favor continuing construction of battleships either. Written either at the time of the Battle of Jutland or afterward, this memoir clearly indicated d'Eyncourt's belief that Atlantic shipping and its protection was the key to Britain's survival in the war.

Creativity was a characteristic of the English and American naval officers and engineers in the infant field of aviation as well as in the design of fire control systems. Prior to 1911, the future of aircraft was too problematic to estimate because of the flimsy and experimental nature of the earliest planes.

Captain, later Admiral, David W. Taylor, Chief of the Bureau of Construction and Repair began testing in a special basin constructed in the Washington Navy Yard in 1911, in efforts to design better warship hulls. At the same time, he had built the navy's first wind tunnel in 1912–[35]1914 because he believed that aircraft had a future in naval warfare. In 1914, Admiral Bradley Fiske attempted to take the responsibility for naval aviation from the Bureau of Navigation and place it as an Office of Aeronautics under his Division of Operations. Unfortunately, Fiske had little time before retirement and no influence on the Secretary of the Navy, Josephus Daniels. After Fiske left, the Chief of Naval Operations, Admiral William S. Benson, replaced Fiske's appointee, Captain Mark L Bristol, with a lieutenant junior grade as Officer in Charge. As a consequence, the naval air arm did not prosper until after the entrance of the United States in the war in 1917 and did not develop very far by the armistice.[36]

Admiral Fiske, continuing to be interested in naval aviation, suggested that torpedoes might be launched from aircraft as early as 1911. He conceived the idea of using radio transmission from the aircraft to guide the torpedo but gave this up in favor of just dropping the torpedo so that it would run straight for the potential target. Fiske obtained a patent for the dropping device in July 1912.[37]

If interest in naval aviation was growing in both the Royal Navy and the U.S. Navy the impetus for developing aircraft carriers came from the former. The most interesting aspect of the Royal Navy's role in naval aviation was the development of the aircraft carrier. The Chief of Naval Construction, Tennyson d'Eyncourt, remarked later, "The need for some form of aircraft carrier became apparent pretty soon after our aeroplanes . . . began to take part in the protection of ships, and it was not long before we began work on the production of such vessels." One of two battleships built for the Chilean Navy was finished as the first aircraft carrier: *H.M.S. Eagle*. D'Eyncourt with two assistant designers found that putting a deck the entire length of the hull would enable aircraft to fly off but they had to design arresting gear to stop aircraft in landing. The arresting gear was perfected and, as d'Eyncourt stated, "we were allowed to pass on the details of the invention to the American Navy. In planning the *Eagle,* d'Eyncourt borrowed some pilots of the Royal Flying Corps who spent much time making practice landings at some risk. *Eagle* was launched in 1917 just as the U.S. entered the war and the American ambassador, Walter Hines Page, was invited, with his wife, to perform the ceremony.[38]

Naval aviation owed much to intrepid junior officers such as Lieutenant Ely, aircraft designers such as Glenn Curtiss, and innovative superiors such as d'Eyncourt, Scott, Fiske, and Sims.

The inventors and innovators shared many traits. First, they were outspoken and adept at using the media to further their causes. Second, they did not get along very well with conservative superior officers and sometimes were willing to leapfrog over them to get what they wanted. Third, they were imaginative tinkers. Fourth, they possessed engineering or other technical expertise. Fifth, they were willing to experiment and did not hesitate to abandon some plan if it did not provide practical results. Sixth, they liked to share information and did not think they had a monopoly of knowledge or insight. Seventh, they tended to think they were undervalued and that their superiors constantly tried to impede their careers or stifle their projects.

The last point can be proven by reference to the memoirs of Admiral Sir Percy Scott and Admiral Bradley Fiske. Scott mentioned, for example, that no suitable ammunition had been devised for use against the Zeppelins in spite of submission of a suitable design in 1914: "It was a new idea, so it was turned down." Scott also denounced "red tapism" in the Admiralty, which impeded progress on many occasions. Later he remarked: "I was supposed to be adviser to the Admiralty on gunnery matters, but they did not keep me well enough informed to advise them, and when I gave them advice they did not take it." Fiske likewise had a dim view of the Navy Department and its bureaus. He maintained that "our naval establishment, enormous as it is, and the guardian of the wealth of the wealthiest country in the world, has simply been put together piecemeal, and has never been directed by a policy based on fundamental principles." The most controversial aspect of Fiske's career came in 1916 when he was a key player in the preparedness debate.[39]

Admiral William S. Sims had similar controversies with his superiors and with the Navy Department during his career. His friend and colleague, Albert Lenoir Key, persuaded Sims to write to President Theodore Roosevelt in 1901 a critical letter on the lack of support of the Navy Department for his gunnery-training program. Sims began the letter: "I wish to bring to your attention, namely, the extreme danger of the present very inefficient condition of the Navy, considered as a fighting force."(102–105) In 1906, he pushed for the development of big gun battleships of the *Dreadnought* type and came into conflict with Admiral Mahan who advocated small battleships based upon his analysis of the naval actions of the Russo-Japanese War (164–168). Henry Reuterdahl, a marine artist and American editor of *Jane's Fighting Ships*, formed a friendship with Sims and convinced him to prepare an article in 1907 outlining the faults of the navy. The article, appearing under the name of Reuterdahl claimed, among other things, that officers were promoted by seniority rather than by merit, that the bureau system was inefficient, and that major faults existed in the designs of new warships. President Theodore Roosevelt was much annoyed with his Naval Attaché, Sims, even though he had been hearing these complaints for some years from that officer and others. Sims and other officers interested in reform prevailed in subsequent Senate hearings conducted by an antagonistic Senator Hale but the president put the lid on the controversy by refusing to push for a complete reform of the Navy Department including the abolition of the bureaus and the establishment of a general staff (180–200). Nevertheless, Roosevelt had been responsible for saving Sims' career and for forwarding it through successive promotions.[40]

Perhaps the most intrepid of the naval innovators in both the U.S. Navy and the Royal Navy was Sims. Frustrated with the lack of support and understanding of his superiors, then Commander Sims wrote a critical article on artillery range finding, which appeared in the *U.S. Naval Institute Proceedings* for September 1904. Some of the language he used approached the intemperate and his friend, Bradley Fiske, who had, of course, suffered from opposition in the navy, advised him: "I have heard your most cordial admirers deplore the fact that you often offend people, especially your seniors, by language and a manner that are unnecessarily harsh. They say you are your own worst enemy." Sims, unrepentant, wrote back to Fiske that the opposition was not due to lack of understanding or conservatism but "downright and deliberate dishonesty."[41]

Elting Morison maintained that the climactic episode of the career of Admiral William S. Sims was the Senate Hearing of 1920. Sims accused Admiral Benson, Chief of Naval Operations, and the department of neglect; the navy was not ready for war in April 1917, because it lacked the personnel, material, and war plans necessary for combat. In fact, he argued, outrageously, that it took six months after the United States entered the war before major improvements were made and this lethargy of the Navy Department cost

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2,500,000 tons of shipping, 500,000 lives, and $15,000,000,000. The extreme quality of this assertion cost Sims support. Eventually the Hearings were concluded and the majority report, Republican, agreed that the navy had been unprepared but failed to push for a naval general staff as Sims had argued. Morison argued that the little band of "insurgents" in the navy, which included Luce, Fiske, and Sims had reached the end of their careers. Luce died in 1917, Fiske retired in 1916, and Sims retired in 1922. The navy did not adopt a general staff and the old bureaus continued until Admiral King began important changes in 1942.

In the Royal Navy, other "insurgents" had had their day as well. Sir Percy Scott died in 1924, maintaining a critical role regarding the navy until the last. Tennyson d'Eyncourt, the naval architect who served as Director of Naval Construction, resigned to resume work for Armstrong and Whitworth in the 1920s. D'Eyncourt had also played an important role in the development of the first tanks while Churchill was First Lord of the Admiralty in 1915. Beatty became First Sea Lord after Jellicoe but budgetary restrictions and the disarmament conferences limited Royal Naval reforms after 1920. Most damaging, however, was the loss of the Naval Air Service to the Royal Air Force, which effectively stymied development of naval aircraft until this mistake was rectified in 1937. The interwar period saw real technical innovation in the U.S. Navy and the Japanese Navy in contrast.

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[1] This anecdote can be found in the work of a late friend and historian: Ivo Nicolai Lambi, *The Navy and German Power Politics 1862–1914* (Boston, Allen & Unwin, 1984), 31. Useful sources of information on the naval inventors, aside from their memoirs, include: Peter Karsten, *The Naval Aristocracy* (New York: Free Press, 1972). Arthur Marder, *From the Dreadnought to Scapa Flow*, The Royal Navy in the Fisher Era, vol. 4.

[2] Bradley A. Fiske, *From Midshipman to Rear-Admiral* (New York: Century, 1919), 107. See Paolo E. Coletta, *Admiral Bradley A. Fiske and the American Navy* (Lawrence, KS: Regents Press of Kansas, 1979).

[3] Quote of Fisher in A. Temple Patterson, *Jellicoe*, London, Macmillan, 1969, 39.

[4] Coletta, *Admiral Bradley A. Fiske and the American Navy*, 4–6. Coletta describes this education and then maintains that Annapolis provided "a technical education comparable to that offered by any good engineering school of the day," which seems unwarranted.

[5] Harry Dickinson, "*Britannia* at Portsmouth and Portland," *Mariner's Mirror*, 84:4, 1998, 434–443, discusses the origin of the training ship and its transfer to Portsmouth by 1862.

[6] A. Temple Patterson, *Jellicoe* (London: Macmillan, 1969), 16.

[7] W. S. Chalmers, *The Life and Letters of David Beatty Admiral of the Fleet* (London: Hodder and Stoughton, 1951), 5–6.

[8] Sir Percy Scott, *Fifty Years in the Royal Navy* (London: John Murray, 1919), 4–5.

[9] Thomas Parke Hughes, *Elmer Sperry Inventor and Engineer* (Baltimore: Johns Hopkins, 1971) provides a first class discussion of this generation of inventors. Wyn Wachhorst, *Thomas Alva Edison, An American Myth* (Cambridge, MA: MIT, 1981), 35; Eustace Tennyson d'Eyncourt, *A Shipbuilder's Yarn, The Record of a Naval Constructor* (London, 1950), 1–27; Anthony Pollen, *The Great Gunnery Scandal the Mystery of Jutland* (London: Collins, 1980), 17–18.

[10] Benjamin Franklin Cooling, *Benjamin Franklin Tracy Father of the Modern American Fighting Navy* (Hamden, CT: Archon, 1973), 72–73. 98–99.

[11] Holden A. Evans, *One Man's Fight for a Better Navy* (New York: Dodd, Mead, 1940), 88.

[12] Elting E. Morison, *Admiral Sims and the Modern American Navy* (Boston: Houghton Mifflin, 1942), 69–74.

[13] Evans, *One Man's Fight for a Better Navy*, 162–163.

[14] Scott, Fifty Years in the Royal Navy, 149–151. See also Peter Padfield, Aim Straight a Biography of Sir Percy Scott the father of modern naval gunnery (London: Hodder and Stoughton), 1966.

[15] Bradley A. Fiske, *From Midshipman to Rear-Admiral*, 347.

[16] Ibid., 410–413.

[17] Ibid., 125–126.

[18] Ibid., 481–482.

[19] Jon Tetsuro Sumida, *In Defence of Naval Supremacy* (London: Routledge, 1993), 71–76; Fiske, *From Midshipman to Rear-Admiral*, 151–152.

[20] Bradley A. Fiske, *From Midshipman to Rear-Admiral*, 360–361.

[21] Pollen, *The Great Gunnery Scandal*, 197–200.

[22] Sumida, In Defence of Naval Supremacy, 86–87.

[23] Morison, Admiral Sims and the Modern American Navy, 146–147.

[24] Fiske, *From Midshipman to Rear-Admiral*, 520–521; Prescott Palmer, "World War I Expansion (1914–1921)," Randolph W. King, et al., eds., *Naval Engineering and American Seapower* (Baltimore: Nautical & Aviation Co., 1989), 103–104.

[25] Lord Chatfield, *The Navy and Defence* (London: Heinemann, 1929), 132.

[26] Ibid., 136.

[27] Frederick C. Dreyer, The Sea Heritage A Study of Maritime Warfare (London, 1955), 205.

[28] Jon Tetsuro Sumida, In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy 1889–1914 (London: Routledge, 1989), note 127, 326.

[29] Pollen, *The Great Gunnery Scandal*, 193–194.

[30] Technical innovations have been mentioned in many studies of the U.S. Navy and the Royal Navy but no one has concentrated on the inter-relationships that they shared. See the contributions by Ronald Spector, Richard W. Turk, and David F. Trask in Kenneth J. Hagan, ed., *In Peace and War Interpretations of American Naval History, 1775–1978* (Westport, CT: Greenwood, 1978); Harold and Margaret Sprout, *The Rise of American Naval Power, 1776–1918* (Princeton, NJ: Princeton Univ. Press, 1939). On the Royal Navy, see Arthur J. Marder, *From the Dreadnought to Scapa Flow: The Royal Navy in the Fisher Era, 1904–1919*, 5 vols. (London: Oxford Univ. Press, 1961–70). Jon Tetskuro Sumida, *In Defence of Naval Supremacy: Finance, Technology and British Naval Policy, 1889–1914*, (Boston: Unwin-Hyman, 1989). Paul M. Kennedy, *The Rise and Fall of British Naval Mastery* (New York: Scribner's 1976).

[31] Viscount Jellicoe of Scapa, *The Crisis of the Naval War* (London: Cassell, 1920), 226–227.

[32] Scott, *Fifty Years in the Royal Navy*, 274–288, 318–319; Sir Eustace H. W. Tennyson d'Eyncourt, *A Shipbuilder's Yarn* (London: Hutchinson, 1951), 103.

[33] Fiske, From Midshipman to Rear-Admiral, 551–552.

[34] Viscount Jellicoe of Scapa, *The Crisis of the Naval War*, 87.

[35] Greenwich, d'Eyncourt Papers DEY/18.

[36] Palmer, "World War I Expansion (1914–1921)," King, et al., eds., *Naval Engineering and American Seapower*, 105–106.

[37] Fiske, *From Midshipman to Rear-Admiral*, 503–506.

[38] d'Eyncourt, A Shipbuilder's Yarn,84–86.

[39] Scott, *Fifty Years in the Royal Navy*, 307, 308ff, 325; Fiske, *From Midshipman to Rear-Admiral*, 372, 590ff.

[40] Morison, Admiral Sims and the Modern American Navy, 102–105, 1264–168, 180–200.

[41] Ibid., 142–143.