

## THE SUBMARINE, 1776–1918

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*Frank Uhlig, Jr.*

When, on 11 April 1900, the U.S. Navy bought the *Holland*, named for its designer, that little submarine joined a fleet consisting of two armored cruisers, six monitors, seven first and second-class battleships, and seventeen each of protected cruisers, gunboats, and torpedo boats. At sixty-four tons the

*Holland* was not the smallest vessel then possessed by the Navy, but at fifty-four feet it was the shortest.

Though many of the ships in the not-very-old and not-very-large U.S. fleet of 1900 would last for years afterward (the *Holland* would not be among them), all would be obsolete when the “Great War” broke out only fourteen years later. So would all those ships still being built in 1900, and all those yet only concepts—and not only in the U.S. Navy but in all navies. Technology was moving swiftly.

Among those types of warship that made up the American fleet at the beginning of the twentieth century, the submarine alone would survive until the beginning of the twenty-first century. In what size, shape, or any other particular the submarine will make it into the second half of this century, we cannot know, but we can be confident that survive it will.

The submarine would prove itself to be a revolutionary instrument of naval war. But the submarine was not the only such instrument of war to appear at

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*Using both the spoken and written word, he has participated in the never-ending debate about the future and past of navies, especially those of the U.S. Navy, including a recent article “Fighting at and from the Sea: A Second Opinion,” in the Spring 2003 issue of the Naval War College Review, as well as classroom and conference discussions.*

*The author is indebted to Rear Admiral W. J. Holland, Jr., USN (Ret.), for rediscovering a manuscript both he and the admiral had forgotten.*

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that time. Within less than five years two other instruments of similar import to those concerned with the struggle for mastery of the sea would make their appearance. In 1899 the Italian inventor Guglielmo Marconi demonstrated, first to the British and then to the U.S. Navy, the practicality of wireless radio communications both between ships at sea and between ships and shore. No one needed to tell the navies the value of this. In the U.S. Navy alone, by the end of 1904 there were fifty-nine radio sets in use afloat and ashore. During the Russo-Japanese War, which began that year, both sides used radio; in addition, the Russians engaged in communications intelligence.<sup>1</sup>

Meanwhile, in December 1903 two Ohio bicycle manufacturers, Wilbur and Orville Wright, were to show the world that manned, powered, controlled flight in a craft heavier than air was another practical thing. The first use of such a practical thing in war took place in Libya in 1911 during an Italian war against the Ottoman Empire. The first naval use was by the Americans at Vera Cruz, Mexico, in April 1914.<sup>2</sup>

Both electrical communications over a distance and manned flight had had long histories before Marconi and the Wright Brothers demonstrated their achievements. It was in 1844 that Samuel F. B. Morse began to communicate via telegraph between Washington and Baltimore. By then men had been flying—in

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balloons—for years. The first manned flight, by the Montgolfier brothers, over Paris, took place in 1783. Manned flight it was, but it was barely controlled by those on board, for they were lifted by hot

air and driven by the wind. Submarines also underwent a long history of development before John Holland could demonstrate to the U.S. Navy that he had a reliable warship, able at its captain's command to move, steer, shoot, submerge, and surface.

For more than a century before the *Holland's* time, inventors, not often with naval help, had been trying to develop a practical submarine. One of the earliest such was David Bushnell of Connecticut, who in 1776, before there was a United States, built a balloon-shaped undersea craft, the *Turtle*, which was driven by a hand-cranked propeller. The craft's one-man volunteer crew, Sergeant Ezra Lee, attacked HMS *Eagle*, a sixty-four-gun ship of the line then at anchor in New York Harbor. The weapon was a time bomb that Lee was to screw into the ship's bottom. Unfortunately for both Bushnell and Lee, the latter found it impossible to fasten his weapon to the *Eagle's* bottom. Both the *Eagle* and the *Turtle* survived their brief encounter unharmed.

Eighty-eight years later, in 1864, eight Southern volunteers, commanded by a Confederate army officer, all of whom were trying hard to put an end to the United States, used another hand-cranked undersea craft, the cigar-shaped *Hunley*, to attack the wooden screw sloop USS *Housatonic*, anchored on blockade duty off Charleston, South Carolina. Their weapon was a spar torpedo, a ninety-pound charge at the end of a long pole jutting forward from the *Hunley*'s bow. Unlike Lee, not only did they sink their intended victim but they sank with it, perishing to a man.

By the end of the nineteenth century several countries, including Spain and France, had built some marginally successful submarines. The designers' chief advances had been to abandon reliance on propulsion by quickly exhausted men in favor of machine-driven propellers, and to replace time bombs and spar torpedoes with the newly developed "fish" torpedo. This weapon was developed by Robert Whitehead, an English inventor working in Trieste, the main seaport of the Austro-Hungarian Empire. After being expelled from a tube the torpedo would swim under its own power toward its intended victim, which, upon being struck, presumably would sink.

In the nineteenth century both commercial vessels and warships left sail behind as soon as possible, replacing it with coal-fired boilers and reciprocating engines. The first machine-powered submarines were among those steamships. But steam, with its need for air intakes and smokestacks, among other characteristics, was useful for submarines only when they were surfaced. Though it could deliver not much speed and less endurance, the newly developed electric storage battery was the only practical means of propelling the submarine when submerged.

Half a century and more would pass before anyone would develop a better solution to the problem of submerged propulsion, but for surface work the gasoline engine, another late-nineteenth-century invention, had clear advantages over steam, for it needed neither boiler nor smokestack, and its fuel supply could be kept in tanks. It was gasoline that propelled the *Holland* and many another of the early-twentieth-century submarines. Gasoline carried with it mortal dangers, for its vapors were both poisonous and subject to sudden explosions. Still, it permitted the submarine to dive much more swiftly than the steam engine did, thus potentially saving the crew in wartime from death by gunfire or ramming.<sup>3</sup>

Probably John Holland's biggest step ahead of other submarine designers was that he provided his craft with diving planes so that, for the first time, a submarine's officers and men had positive control over their craft's vertical movements. It was this quality that put Holland's boat and its new owner, the U.S. Navy, in the van of submarine development. As a British submarine officer, Vice

Admiral Sir Arthur Hezlet, was to write in 1967, America was “the true home of the submarine.”<sup>4</sup>

Nearly a century before the *Holland*'s arrival on the scene, Sir John Jervis, Lord St. Vincent and First Lord of the Admiralty, opposed in 1804 the support given by the prime minister, William Pitt the Younger, to a proposal by an American inventor, Robert Fulton, to build a submarine for Britain to use in its seemingly endless war against the French Revolution and then Napoleon. Pitt, he said, “was the greatest fool that ever existed to encourage a mode of war which those who commanded the sea did not want, and which, if successful, would deprive them of it.”<sup>5</sup>

St. Vincent's view prevailed over that of the prime minister. Robert Fulton was out of luck. But St. Vincent, already recognized as a superb combat commander and commander in chief, showed himself in this moment—though not in this moment alone—a fine strategic thinker. He also showed himself a man with a clear sense of the potential course of a nascent technology. Britain's decision to do nothing to encourage the development of the submarine was sound policy, and, with some wavering in the 1880s, it remained in effect for ninety-six years.

By 1900 the time to replace that policy had come. In 1898 Britain, the world's greatest naval power, and France, the world's second such power, had nearly gone to war after a lapse of nearly a century, this time over clashing colonial ambitions in Africa. French naval maneuvers that year had shown that despite their many imperfections, submarines might indeed deprive Britain of its command of the seas, at least off the enemy's coast. Thus, in order to learn all it could about submarines, in 1900 the Admiralty ordered five for its own fleet—113-tonners, to be almost identical to the seven A-class boats (SS 2 through SS 8) John Holland had designed for the U.S. Navy.<sup>6</sup>

Political changes in the first fourteen years of the twentieth century were as radical as those in technology. Though many individuals were involved, their chief instigator was the German emperor Wilhelm II. Largely owing to that unsuitable ruler's words and actions, and those of the men he chose to hold high office under him, Germany, once Britain's friend, had become not only its rival for commercial and naval supremacy at sea but its potential enemy ashore. As a consequence, Britain began to extend the hand of friendship to its old foe, France, the revenge-seeking enemy of Germany. It even accepted France's alliance with imperial Russia, a loathed tyranny that for long had been Britain's opponent in an often obscure struggle for influence in Central Asia. But France and Russia, the second and third naval powers in 1900, had by 1914 fallen to fifth and seventh place respectively. The Germans had risen to second place, the Americans to third, and the Japanese to fourth. Italy and Austria-Hungary were sixth and eighth.

France's need above all for a strong army was the main reason its navy had fallen so badly; the Russian navy had fallen because in war against Japan (1904–

1905) it had been beaten soundly. In any case, neither France nor Russia was likely to have kept its place in the face of the ambitious German (and, for a few years, the American) building program. Still, the world's second and third navies together would not quite have matched the British numerically, for in modern, battle-worthy ships—that is, in general, those built after the commissioning of HMS *Dreadnought* in 1906—by 1914 the German fleet was about 60 percent as large as the British, and the American fleet about half the size of the German.<sup>7</sup>

By 1914 all those navies had submarines, and none more than the British. According to Paul G. Halpern's *A Naval History of World War I*, Britain had seventy-three. Its allies, France and Russia, had fifty-five and twenty-two respectively. Germany had twenty-eight.<sup>8</sup> The distant, and neutral, United States had thirty. The newest submarines in all navies (except the French, where some of the latest boats were still surface steamers) were driven when on the surface by the complex but comparatively safe internal combustion engine invented by the German engineer Rudolph Diesel, for whom the engine was named. British manufacturers seemed able to produce a diesel equal to the German originals. Other countries did less well. American manufacturers were to produce disappointment after disappointment until just before the Second World War. When it worked, the diesel provided submarines with enormous endurance at sea. For submerged propulsion, the electric battery, which provided power for only the briefest time before it needed recharging, was still the only way to go. Whatever their power plants, in 1914 the main weapon of almost all submarines was the torpedo, though some submarines carried mines instead. Most of the new submarines also carried a small deck gun, three inches or so in caliber, but soon to grow.

Originally, British submarines had been intended to replace controlled mines for the defense of harbors and to protect the coast from prowlers and invaders. In war they were to prove unsuccessful in those roles, but by then they had gone well beyond them. Now the submarines were to advance several hundred miles from their bases and ambush German warships in waters the Germans thought of as their own. They did these things and, despite often-ineffective torpedoes and poorly designed mines, did them well. They did them in the North Sea, in the Baltic (where no other British warships could go), and they did them in the Dardanelles and Sea of Marmara during the otherwise unsuccessful Allied attack on the Turkish Straits in 1915. German submarines, or "U-boats," were active in the same way against the British fleet, with similar results. Throughout the war submarines on both sides were to sink many more large warships than surface warships managed to sink; unlike those sunk by surface warships, however, all the submarines' victims among large ships were obsolete pre-dreadnoughts and armored cruisers.<sup>9</sup>

In a third task, that of serving as distant scouts for the fleet, the submarines of both fleets were to fail repeatedly. That failure stemmed mainly from their low speed compared to the rest of the fleet and from the necessity to submerge when in the presence, or anticipated presence, of enemy fighting ships. They could neither transmit nor receive radio signals while in that state; they had to surface first and then rig cumbersome aerials before they could use their radios (and then unrig them before diving). The result was that for any combined operation they had to sail long before the rest of the fleet and, as soon as they entered hostile waters, dive or be ready to dive, thus falling effectively out of touch with their commander in chief.<sup>10</sup>

The big thing German submariners learned was that they need not focus on the powerful British Grand Fleet, a fleet of many types of fighting ship centered on an all-new battle line of dreadnought battleships. Though that fleet existed mainly to ensure Britain's ability to snuff out German overseas trade—about which the German submarines could do nothing—and to ensure Britain's ability to protect Allied and other friendly shipping from German raiders, it soon proved itself ineffective against, even fearful of, German submarines.<sup>11</sup>

Shipping was almost exclusively owned privately and manned by civilians. It included everything afloat that was not part of the fighting fleet—passenger liners (some of them, eventually almost all of them, converted during the war into troop transports), cargo ships, oil tankers, colliers, and the rest. Those were the ships that moved Allied armies across both broad oceans and the narrow seas, that kept those armies (and the fighting fleets too) supplied and resupplied; that, inbound, carried the raw materials from which factories fashioned arms and ammunition and, even more important, the food that every Briton, soldier,

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sailor, and civilian alike, ate; and that, outbound, carried the mined and manufactured goods that did so much to pay for the essential imports and the other costs of

war. In contrast to Britain, France was able to feed its own people, but in other respects it shared Britain's dependence on imports from abroad.

However, we should not underestimate the influence of the Grand Fleet. First, under its protection, except in the unreachable Baltic, Britain's blockading cruisers ended all of Germany's enormous seaborne international trade. During the first year or so of this blockade the cruisers captured more merchant ships from the Germans than the British lost to the U-boats. Those captured ships went into British employment, with the result that despite early U-boat successes, the size of the British merchant marine actually increased in the first year of the war. Moreover, the cruisers detained over seven hundred neutral

merchant ships filled with cargoes bound for Germany. The British took those cargoes for their own use.<sup>12</sup> Second, the Grand Fleet provided the cover behind which the small warships assigned to protect British shipping could do their work. Without the distant presence of that fleet, those small warships would likely soon have perished under the guns of German cruisers.

By the middle of 1915 the British windfall of captured German ships and seized cargoes had come to an end. But the blockade of Germany did not end; neither did the cover under which the antisubmarine forces worked.

Effectively for the first two years of the war Britain itself was under no blockade. Self-satisfied, the Admiralty cut back severely the construction of new merchant ships in favor of new warships and delayed endlessly the repair of existing merchant ships in favor of repairs to warships. In so doing, the Admiralty squandered the work of its blockading cruisers. It did so for it had not anticipated the disaster at sea about to befall Britain and its allies.<sup>13</sup>

Meanwhile, the U-boats came to cruise independently in the approaches to British and French ports, the places all Allied merchant ships had to sail from and return to; others trespassed even closer and stealthily laid mines in the fairways. To employ a useful term only recently created, from the beginning the U-boat captains had information dominance over their victims, for the latter knew nothing of any U-boat's whereabouts until a submarine's skipper chose to make his presence known by means of a challenge, a shell, or a torpedo. The submarine captain would likely attack with his deck gun, or board and sink his victim with a bomb placed deep inside. If a merchantman were armed, he would submerge and attack it with a torpedo. The U-boats' numbers were small at first—only thirty in February 1915 but fifty-two in March 1916, and more were on the way.<sup>14</sup>

The British responded to what before long would become an assault on their very existence by building dozens, then scores, eventually hundreds, of minesweepers, sloops (that day's equivalent of a modern frigate), and destroyers. Their purposes were to open the channels and keep them open, and to patrol the seaward approaches to the ports (out to four or five hundred miles) in order to find and sink the U-boats before the latter could find and sink the merchant ships. But men in small ships with no sensors except their eyes, hunting for other small ships that wished not to be found except on their own terms, could not often succeed. The U-boats had information dominance over them too. They were small ships—few of the U-boats in that war displaced as much as a thousand tons surfaced; the best of their opponents, the war-built sloops and destroyers, were not much bigger than that.

Haltingly—eagerly on the part of the kaiser's admirals and generals, reluctantly on the part of his politicians and statesmen—Germany edged toward ordering its submarine captains to torpedo without warning any ship, regardless of flag or



nature, that came within their sight. That is, they were to engage in “unrestricted submarine warfare.” When unsought consequences developed, chiefly in the form of anger expressed by the American government, Germany edged back.<sup>15</sup>

After two years of intense, seemingly unending warfare on two enormous fronts that were across the Continent from each other (one in Russia, the other in France) and of the ever-worsening effects of the British blockade, against which they were helpless, by the summer of 1916 the major figures in the German government, civilians included, could see no hope of victory except by means of an unrestricted submarine assault against British, other Allied, and neutral shipping. (The neutrals were included because they carried about 30 percent of Britain’s imports.) In October, with ninety-six submarines, the German government moved forward again. In February 1917 they went all the way.<sup>16</sup>

Appalled by the destruction of many civilian lives in sunken passenger ships—notably the Cunard liner *Lusitania*, attacked in May 1915 with a loss of 1,200 lives, 128 of them U.S. citizens—the Americans had already made clear their opposition to any unrestricted submarine attacks. But the Germans were desperate, and they believed that even if the Americans entered the war, they could not be effective enough soon enough to save the Allies. The Americans declared war on 6 April 1917.

Perhaps because they believed in the maxim that “the best defense is a good offense” (strategic and operational thought in those days seems not often to have risen above the level of appealing maxims), the Royal Navy preferred patrolling (hunting) for U-boats, which they saw as being on the offensive, over gathering merchant ships into convoys escorted by sloops and destroyers, which they interpreted as being on the defensive. Undeterred by the patrols, the U-boats kept on sinking ships. By the spring of 1917 one merchant ship in four that cleared a British port would fail to return;<sup>17</sup> the Germans calculated that the end of the war at sea was nigh. Gloomily, the British reached the same conclusion.<sup>18</sup> When that end came, the Allied position on the eastern front (disintegrating), on the western front (shaky), everywhere, would collapse. The war would end in German victory.

In the nick of time the British and their new associates, the Americans, adopted the escorted convoy. The most authoritative comment on this is Grand Admiral Karl Doenitz’s succinct observation in his memoirs that “the German submarine campaign was wrecked by the introduction of the convoy system.”<sup>19</sup> In another passage Doenitz tells us that when the convoys went into effect

the oceans at once became bare and empty; for long periods at a time the U-boats, operating individually, would see nothing at all; and then suddenly up would loom a huge concourse of ships, thirty or fifty or more of them, surrounded by a strong escort of warships of all types. The solitary U-boat, which most probably had sighted the convoy purely by chance, would then attack, thrusting again and again and

persisting, if the commander had strong nerves, for perhaps several days and nights, until the physical exhaustion of both commander and crew called a halt. The lone U-boat might well sink one or two of the ships, or even several; but that was but a poor percentage of the whole. The convoy would steam on. In most cases no other German U-boat would catch sight of it, and it would reach Britain, bringing a rich cargo of foodstuffs and raw materials safely to port.<sup>20</sup>

In October 1918 Doenitz himself, commanding the five-hundred-ton *UB-68* in the Mediterranean, lost his submarine while he was attempting to attack a convoy, and he spent the last bit of the war in a British prison camp. Later he would put to good use both his experience and that of the U-boats in general when opposed by convoys.

The convoy system had not deprived the submarines of their information dominance. It had just made that dominance nearly irrelevant, for it had reduced the number of potential targets from many single ships to a few groups of ships; if the submarine's captain, "by chance," as Doenitz says, found such a group, he found it accompanied by an armed escort bent on frustrating, and if possible destroying, him. Because of the escorts he had to avoid closing on the surface. Compared to most merchantmen a submarine's speed on the surface was high; submerged, its speed was low. Therefore, unless from the first moment the U-boat was ahead of the convoy, it was not likely ever to get into a firing position. Even if the escorts never knew that a submarine had been nearby, they still would have frustrated its attack.

Admiral Hezlet gives us an example of this effect, from May 1918:

Eight U-boats were on patrol in the south-western approaches to the British Isles, deployed to intercept convoys. In operations that lasted about a fortnight, thirty-six convoys passed through the area, but the U-boats made contact with only five of them. All five were attacked and three merchant ships were sunk. Two independent ships were also sunk in this area. In a similar period a year before against unescorted shipping, this number of U-boats would probably have sunk a hundred ships or more.

The convoy escorts, Admiral Hezlet adds, sank none of the U-boats.<sup>21</sup>

The first American contribution to the war was with destroyers, of which on 9 April 1917 the U.S. Navy had sixty-eight—some in the Pacific, some on the Asiatic station, but most in the Atlantic. Six arrived at the British naval base at Queenstown, Ireland, early in May 1917. Early in July half the entire force was in European waters, and more would follow.<sup>22</sup> Their task was to take part in the protection of shipping. They were particularly called on to escort the transports with which the United States advanced its army three thousand miles across the Atlantic to France. This the destroyers did without losing a single transport to U-boat attack on the outbound voyage. (They did lose three largely empty

transports on the return voyage.) Many of those transports were former German passenger liners interned by their owners in American harbors in order to avoid capture by blockading British cruisers.

Eventually there were two million American soldiers in Europe. They never became as skilled as were the experienced French, British, and German soldiers, but through their weight of numbers and their vigor they helped defeat the Germans on the western front. The defeat in France, and other military failures in Italy, the Balkans, and southwestern Asia, combined with the “total demoralization of an underfed nation” caused by the blockade, led to revolution in the German, Hapsburg, and Ottoman empires, the flight of old rulers to exile, and a call from Field Marshal Paul von Hindenburg for an armistice.<sup>23</sup> So ended the war, on 11 November 1918.

That “total demoralization of an underfed nation” was among the objectives the desperate Germans had hoped their U-boats would achieve against Britain. The U-boats came close, but then, as we have seen, their effort was “wrecked by the convoy system.”

In fact, the “convoy system” was the naval share of a great civil-naval effort beginning in Britain in 1917 aimed at overcoming the U-boats. Civilian leaders drove the Admiralty to repair damaged and worn-out merchant ships and to build new ones; they also centralized and made orderly the hitherto helter-skelter scheduling of ships’ sailings, made ports and railways more efficient, and established a system of food rationing throughout the kingdom, so that despite the U-boats, everyone had enough—just enough—to eat.<sup>24</sup> Theirs was a great achievement.

Still, with only a few thousand officers and men (about a thousand to start with, five thousand lost, and thirteen thousand serving at the end), manning from beginning to end only about 350 small ships (of which half had been lost by war’s end in November 1918), the Imperial German Navy’s U-boat arm had nearly overcome an alliance that eventually included almost the entire world outside of Germany and its principal allies, the decrepit Austro-Hungarian and Ottoman empires.<sup>25</sup>

That was an impressive performance by a very small number of people at a time when navies measured their manpower in the hundreds of thousands and armies measured theirs in the millions. In four years that small number of officers and men sank five thousand ships. No submarine campaign since then has matched that number. The average size of that vast, unfortunate armada of sunken ships was 2,400 gross tons—not large, but collectively they came to twelve million gross registered tons, and that is a lot.<sup>26</sup> The most successful submarine commander in any navy, any war, was Lothar von Arnauld de la Periere, who, in the Mediterranean with his 685-ton *U-35*, sank more than 435,000 gross tons of shipping—put another way, 194 ships. Many of those ships went down as a result of fire from Arnauld’s single 4.1-inch gun.<sup>27</sup> Clearly, in reaching those

numbers Arnauld had no convoy escorts with which to contend. Also, plainly, most of his victims were small ships engaged in the coastal and short-sea trades. Nowadays a single tanker, or perhaps two together, might measure 435,000 tons.

There was still another impressive performance: This simple, practical instrument of war, employed directly upon shipping—the object around which naval war revolves—achieved its effect in the most brutal fashion. Because all too often they dared do it no other way, submarines torpedoed merchant ships, including passenger liners, without warning. Then, because they had no way of rescuing those who had survived the blast, they left them to the mercy of chance. Chance is not often merciful.

It was the brutality associated with the sinking of ships by submarines that was a primary cause, perhaps the primary cause, of the U.S. declaration of war on Germany and Austria-Hungary in 1917. Without the participation of the Americans, probably there would have been no allied victory—at best, after the Royal Navy's defeat of the U-boats, a standoff on the western front followed by a

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negotiated peace motivated by exhaustion on both sides as well as, in Germany's case, the urgent need to end the blockade. So, doing it the only way they could, the

submarines nearly brought victory to their side. But by doing it the only way they could, they brought their own side down to defeat. For them it was a situation without solution.<sup>28</sup>

What about the other two revolutionary instruments that revealed themselves at about the same time as the submarine, the wireless radio and the heavier-than-air craft? By the summer of 1914 both had managed to show themselves as practical instruments of war. It was not until the autumn of that year that the submarine managed to show that it too was a practical instrument of war. In the "Great War," radio communications and one of its offspring, communications intelligence, were to play major roles in the deployment of forces strategically, operationally, and tactically, especially for the Allies, but not so effectively as the Allies might have hoped in their struggle against the U-boats, for the latter were always better informed about their enemies than their enemies were about them. The submarine's impact on the war, then, was greater than that of radio and its derivatives. As for aircraft, though in the war of 1914–18 they were built and used by the hundreds of thousands, they had little influence on the course of events, either afloat or ashore.<sup>29</sup> Both radio (and its derivatives) and the aircraft, however, would have enormous impact on events yet to come—in this writer's view, even greater than that of the submarine.

## NOTES

1. Vice Admiral Sir Arthur Hezlet, *Electronics and Sea Power* (New York: Stein and Day, 1975), pp. 32–34; John D. Alden, *The American Steel Navy* (Annapolis, Md.: Naval Institute Press, 1972), p. 234.
2. David Brown et al., *The Guinness History of Air Warfare* (Enfield, Middlesex, U.K.: Guinness Superlatives, 1976), pp. 6–7; Archibald D. Turnbull and Clifford L. Lord, *History of United States Naval Aviation* (New Haven, Conn.: Yale Univ. Press, 1949), pp. 41–42; Jack Sweetman, *The Landing at Veracruz: 1914* (Annapolis, Md.: Naval Institute Press, 1968), pp. 146, 148–52.
3. Hezlet, *Electronics and Sea Power*, pp. 1–15.
4. *Ibid.*, p. 12.
5. *Ibid.*, p. 3.
6. For an excellent discussion of these matters, see Nicholas A. Lambert, *Sir John Fisher's Naval Revolution* (Columbia: Univ. of South Carolina Press, 1999).
7. In August 1914 the Royal Navy had twenty full-sized dreadnought battleships and nine battle cruisers, the Imperial German Navy had thirteen and four, and the U.S. Navy eight and zero. For full coverage of the fleets of that time see Robert Gardiner, ed. dir., *Conway's All the World's Fighting Ships 1906–1921* (London: Conway Maritime, 1985).
8. For the British, see Paul Halpern, *A Naval History of World War I* (Annapolis, Md.: Naval Institute Press, 1994), p. 8. Other figures derived from *Conway's*.
9. Hezlet, *The Submarine and Sea Power*, pp. 19–42. For sinkings of major warships by submarines, see H. W. Wilson, *Battleships in Action* (London: Sampson Low, Marston, n.d. but probably 1926), vol. 2, pp. 341–43.
10. Hezlet, *The Submarine and Sea Power*, pp. 40–42.
11. Admiral of the Fleet Sir John Jellicoe, *The Grand Fleet 1914–1916: Its Creation, Development, and Work* (London: Cassel, 1919), pp. 141–58; Hezlet, *The Submarine and Sea Power*, pp. 29–30; V. E. Tarrant, *The U-Boat Offensive, 1914–1945* (Annapolis, Md.: Naval Institute Press, 1989), p. 11.
12. Tarrant, *The U-Boat Offensive*, pp. 21, 25.
13. Hezlet, *The Submarine and Sea Power*, pp. 104–106; Tarrant, *The U-Boat Offensive*, p. 21; John Tetsuro Sumida, “Forging the Trident: British Naval Industrial Logistics, 1914–1918,” in *Feeding Mars: Logistics in Western Warfare from the Middle Ages to the Present*, ed. John A. Lynn (Boulder, Colo.: Westview, 1991), pp. 223–31 and table 10.8, p. 248.
14. Tarrant, *The U-Boat Offensive*, pp. 15, 26.
15. Hezlet, *The Submarine and Sea Power*, pp. 85–92; Tarrant, *The U-Boat Offensive*, pp. 25–30; Halpern, *A Naval History of World War I*, pp. 291–310, 333–34.
16. Hezlet, *The Submarine and Sea Power*, pp. 85–92; Tarrant, *The U-Boat Offensive*, pp. 31–46; Halpern, *A Naval History of World War I*, pp. 335–39.
17. “One merchant ship in four”: Hezlet, *The Submarine and Sea Power*, p. 88; Halpern, *A Naval History of World War I*, p. 340.
18. Tarrant, *The U-Boat Offensive*, pp. 44–45; Elting E. Morison, *Admiral Sims and the Modern American Navy* (Boston: Houghton Mifflin, 1942), p. 342 (conversation between the First Sea Lord, Admiral Sir John Jellicoe, RN, and Rear Admiral W. S. Sims, USN, 10 April 1917), and pp. 348–49 (opinion of Prime Minister David Lloyd George, 22 April).
19. Grand Admiral Karl Doenitz, *Memoirs: Ten Years and Twenty Days*, trans. R. H. Stevens with David Woodward (Annapolis, Md.: Naval Institute Press, 1990; New York: Da Capo, 1997), p. 19.
20. *Ibid.*, p. 4.
21. Hezlet, *The Submarine and Sea Power*, p. 98.
22. Rear Admiral William Sowden Sims, U.S. Navy, in collaboration with Burton J. Hendrick, *The Victory at Sea* (London: John Murray, 1921), p. 63; James C. Fahey, “Our World War Destroyers,” *Our Navy* (mid-November 1938), pp. 4–9, 53. Sims says that on 5 July 1917 there were thirty-four U.S. destroyers in the war zone. Fahey, giving ships’ names and dates, says thirty-five were in, or operating from, Queenstown by 2 July.
23. “Total demoralization”—Louis Guichard [Lt., French Navy], *The Naval Blockade 1914–*

- 1918, trans. Christopher R. Turner (London: Philip Allan, 1930), p. 310.
24. Hezlet, *The Submarine and Sea Power*, pp. 104–105; Tarrant, *The U-Boat Offensive*, pp. 50–51; Sumida, “Forging the Trident: British Naval Industrial Logistics,” table 10.6, p. 247. For the contributions of those in civilian fields of endeavor, such as in improving British seaport and railroad productivity, and in the limiting and fair distribution of Britain’s imports of food from overseas, see C. Ernest Fayle, *Seaborne Trade*, vol. 3, *The Period of Unrestricted Submarine Warfare* (London: John Murray, 1930). Fayle covers all aspects of the attack on, defense of, and use of seaborne trade by all participants in the war.
25. The figure of one thousand is the author’s estimate. Other figures are from Hezlet, pp. 101–102.
26. Tarrant, *The U-Boat Offensive*, p. 153.
27. *Ibid.*, pp. 36, 146.
28. See R. H. Gibson and Maurice Prendergast, *The German Submarine War 1914–1918* (London: Constable, 1931), p. 330, quoted in Tarrant, *The U-Boat Offensive*, pp. 73–74.
29. Brown et al., *History of Air Warfare*, p. 55.