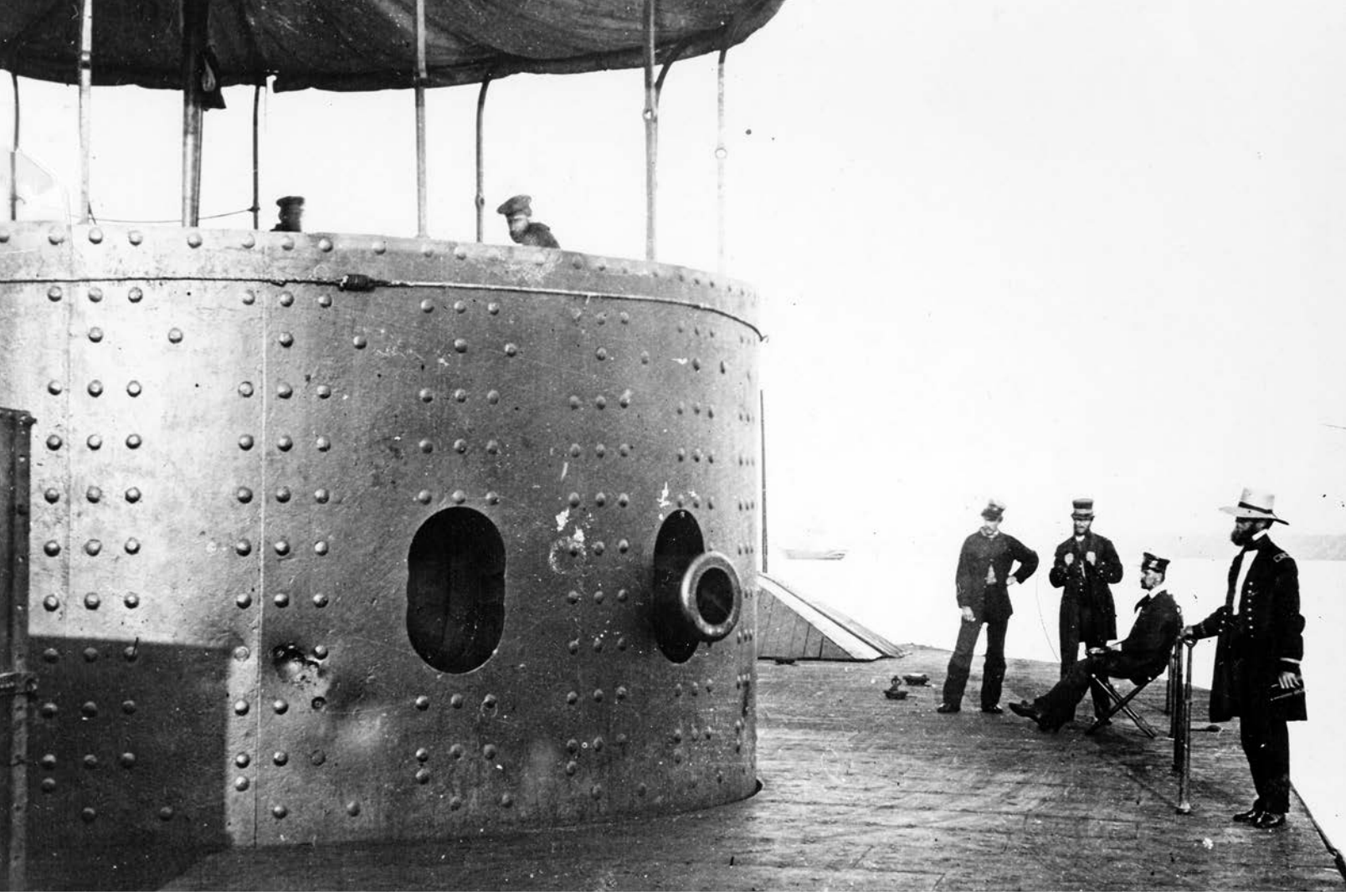

Deck of USS *Monitor*, on James River in Virginia, July 9, 1862; officers at right (left to right): Third Assistant Engineer Robinson W. Hands, Acting Master Louis N. Stodder, Second Assistant Engineer Albert B. Campbell (seated), and Acting Volunteer Lieutenant William Flye (with binoculars) (U.S. Navy/Naval History and Heritage Command)

The Civil War and Revolutions in Naval Affairs

Lessons for Today

By David C. Gompert and Hans Binnendijk

At certain times, the character of naval warfare and the course of naval history undergo rapid, profound, and lasting change. The American Civil War was such a time, and its lessons still resound.

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Because secession swiftly followed Abraham Lincoln's election to the U.S. Presidency, war came before either side was prepared. Both North and South scrambled to assemble available officers, Sailors, and ships. Soon, the inadequacies of off-the-shelf capabilities forced both sides to build better ones. Because the Union's naval strategy was more ambitious, and its technological and

industrial capacities more prodigious, it drove the Civil War's naval revolution. Yet the overmatched Confederacy would improvise tactics and weapons, some of them also revolutionary.

This revolution pivoted on the wholesale replacement of old warships with new ones. Prewar ships-of-the-line were wooden-hulled, wind-driven, and laden with large numbers of ineffective guns.[1] By war's end, warships were clad in metal, propelled by steam and screw, and armed with more accurate guns mounted in rotating turrets. They were more maneuverable, versatile, survivable, and lethal and were indifferent to currents and winds. They could operate on the high seas and in narrow inland waters. Within a year, Northern squadrons were pummeling Southern forts, conducting amphibious landings, transporting troops, and waging riverine warfare.

This revolution, like others, was the product of strategic need and emerging technology. The relationship between strategy and technology is fluid and complex. Strategy called for by looming threats presents demands that can be met by exploiting available or novel technologies. At the same time, exogenous technological change can excite unorthodox thinking about how best to execute strategy. Such "strategy-pull" and "technology-push" phenomena were both at play during the Civil War, as they are today.

An unanticipated danger—Southern secession—gave birth to a Northern strategy that called for new tasks as well as concepts of operations to perform them. These, in turn, demanded better capabilities—for example, steam-driven ironclads, made possible by concurrent technological advances. Northern industrial mobilization forged these new capabilities into a national capacity to fight across thousands of miles of water and shore. Along the way, it took bold and inventive leaders to steer the process and to employ forces in unprecedented ways.

These fundamental dynamics of the Civil War's revolution in naval affairs defined subsequent revolutions, and they pertain today.

The Union's Revolution in Naval Affairs

Union Strategy. The Anaconda Plan, put forward by Lieutenant General Winfield Scott in early 1861, was a strategy to strangle the seceding states by denying them trade through blockading saltwater ports and controlling the Mississippi River.[2] Scott's idea called for naval operations on two fronts. Union warships would blockade about 180 ports along some 3,500 miles of Confederate coastline. On the Mississippi, a force of around 60,000 Union troops, transported in 40 vessels and convoyed by 20 river gunboats, would steam downriver, capturing forts along the way until they reached New Orleans. They would then be reinforced by large army units to hold conquered territory as the flotilla patrolled the river. Should this naval strategy fail to reverse secession, Scott reasoned, Richmond would need to be taken.[3]

Initially, implementation of Anaconda was hampered by lack of suitable warships. It soon became clear that a much larger and better fleet would be needed to stop blockade-runners and thereby establish an "effective" blockade under international law. (An attempted but ineffective blockade could be legally ignored by foreign powers.) Also, the Union would need to seize Southern ports from which runners were operating and establish supply and coaling stations along the South's coasts to reduce steaming distances and time. As a stopgap measure, civilian vessels were hastily converted to warships.

The planned expedition down the Mississippi was deferred while Brigadier General Ulysses S. Grant and Flag Officer Andrew Foote fought their way up the Tennessee and Cumberland rivers for the purpose of controlling Kentucky and subduing Tennessee. Union victories at Fort Henry and Fort Donelson in February 1862 demonstrated the value of joint operations. Foote's flotilla then advanced down the Mississippi to defeat Confederate defenses at Island Number 10. Elements of the flotilla also supported Grant at the Battle of Shiloh, showing how naval fire could advantage land operations.

After Flag Officer David Farragut seized New Orleans in April 1862, Union blue-water ships, both steam and sail, advanced up the Mississippi to meet the riverine flotilla coming down under Foote and, later, Commodore David Porter. But they were both halted beneath the fortress at Vicksburg, Mississippi, where Union ships were exposed to brutal fire. Because Vicksburg's being in Confederate hands prevented control of the Mississippi and encirclement of the South, the city became a Union preoccupation. Attempts to position Union troops to attack it by digging canals and clearing the Yazoo River of torpedoes (later called mines) were to no avail. Eventually, Porter's squadrons ran past Vicksburg's batteries and transported Grant's troops from the Western bank across the river south of the city.

Attacking Southern ports and forts proved far more efficacious than trying to intercept blockade-runners. On the Atlantic coast, Union victories in 1861 and 1862 at Port Royal, Roanoke Island, Hampton Roads, Fort Macon, and Fort Pulaski closed key Confederate harbors, leaving Charleston and Wilmington on the Atlantic and Mobile and Galveston on the Gulf of Mexico for the use of runners. Charleston was closed in 1863, Mobile in 1864, and Wilmington in 1865. Only Galveston remained under Confederate control when the war ended, by which time the Southern economy was moribund.

Emerging Tasks, Concepts of Operation, and Requirements. The tasks and associated concepts of operation required by Union strategy would inspire new uses of technologies to construct the capabilities they demanded.

Intercepting blockade-runners. Confederate blockade-runners initially had decided advantages. Blockaders had to cover the entire Southern coastline with limited numbers of seaworthy ships. Runners could choose opportune times and routes to make the 500- to 1,000-mile runs to the Bahamas, Bermuda, and Cuba. In the war's first year, a mere one out of ten runners was captured.[4] To carry out the Anaconda strategy, the Union required more and faster ships and gunnery with greater range and accuracy to control the ports from which runners operated.

Defeating Confederate ironclads. At first, Confederate ironclads presented serious problems for Union operations in key waters—for example, CSS *Virginia* at Hampton Roads, CSS *Chicora* and CSS *Palmetto State* in Charleston Harbor, and CSS *Arkansas* near Vicksburg. Then, USS *Monitor*'s battle against CSS *Virginia* and subsequent ironclad duels demonstrated the advantages of speed, thick armor, a low profile, armor-piercing shells, accurate guns, rotating turrets, maneuverability, and ramming capability. Eventually, Confederate ironclads were either run aground (CSS *Atlanta*), destroyed in their harbors (CSS *Albemarle*), scuttled by the Confederates themselves to avoid capture (CSS *Tennessee* and CSS *Virginia*), or confined to British shipyards by U.S. diplomatic pressure.

Bombarding forts into submission. With Confederate forts impeding Union passage along the Mississippi and guarding major Southern seaports, the Union faced several new tasks. With steam-powered ships, the Union Navy improvised bombardment tactics whereby its gunships would steam continuously in oval patterns, thus becoming less vulnerable and optimizing firing angles. Also, ironclads could sail close to their targets to get off better shots. The operation against Georgia's Fort Pulaski in April 1862, led by the army, demonstrated for the first time the power of rifled artillery against previously indestructible walls.[5]

Bypassing Confederate forts. When Confederate forts were too hard to attack frontally from the water, Union ships were tasked to "run the gauntlet" through heavy fire to gain a better position from which to attack, as Farragut did at New Orleans. Such runs required speed, covering fire, and armor. Once they were completed, enemy forts often fell to siege and army-navy assault.

Supporting army operations with convoys, amphibious operations, and direct fires. Although there was no such thing as a formal joint army-navy command during the Civil War, victory often took army-navy cooperation.[6] Grant and Foote partnered to take Fort Henry and Fort Donelson. Naval gunfire helped save Grant at Shiloh. Vicksburg finally fell because Grant and Porter collaborated closely. Throughout the war, naval gunboats convoyed transports to bring troops to battle. At North Carolina's Fort Fisher, ships provided covering fire for advancing army troops.[7]

Destroying Confederate raiders. Early in the war, Jefferson Davis commissioned Confederate raiders, which captured and often burned hundreds of Union merchant ships. One of his aims was to force the Union Navy to detach large numbers of ships to go after privateers instead of performing blockade duties. Several fast ships were built for the Confederacy in England, including CSS *Alabama* and CSS *Florida*. Enraged Northern merchants pressured the Union Navy to catch raiders around the globe, which it did, with both sail and stream power.

Clearly, the Anaconda strategy would have failed without new warships. Riverine warfare required the maneuverability, lethality, and survivability that only steam-propelled armored ships could provide. These gunboats gained and kept control of the Mississippi, escorted convoys, and transported troops. During General Ambrose Burnside's Hatteras campaign, gunboats convoyed 12,000 troops in one day to seize the forts guarding New Bern, which fell thanks to bombardment by those same gunboats in support of those troops.[8] Overall, the tasks and operational concepts necessitated by Union strategy transformed naval warfare for good.

Emerging Technology. These challenges summoned Northern inventiveness. There really is such a thing as "Yankee ingenuity." Finding technical solutions to practical problems came naturally in harsh, chilly, rocky New England, the epicenter of the American Industrial Revolution. The region's needs for both agricultural productivity and commercial competitiveness were answered by its inventiveness. Ivy League colleges and the Massachusetts Institute of Technology (founded in 1861) offered unmatched scientific educations. The Northeast gave the Union Navy some of its most creative leaders: Porter, Foote, Rear Admiral John Dahlgren, Navy Secretary Gideon Welles, and Assistant Navy Secretary Gustavus Fox. Technology was already progressing rapidly in the North when the Civil War began, owing to a flurry of inventions. By the mid-19th century, the patent system had established the sanctity of intellectual property, making invention more rewarding than ever. The number of utility patents issued annually increased from 884 in 1850, 4,363 in 1860, and 12,157 in 1870, to 22,065 by 1897.[9]

The most important naval innovation was steam propulsion. In a typical system, fossil fuel (initially coal, later oil) was burned in a boiler to turn water into the pressurized steam needed to drive reciprocating pistons (later turbines) to rotate the ship's shaft and screw, and thus propel the ship.[10] The steam was then converted back to liquid by intake of water, to be boiled again to keep the shaft turning. Screw revolutions per minute—thus ship's speed—were governed by varying steam force on the pistons.

The success of Union strategy also hinged on the use of metal-armored ships. Over millennia, since the Bronze and Iron ages, innovations in mining, extraction of metal from ore, smelting, shaping, and use of coal and coke put in place the means to produce the iron and steel that were used in the Industrial Revolution to make machines and infrastructure. Henry Bessemer is credited with inventing a high-volume steelmaking process 5 years before the American Civil War. Even then, iron was cheaper and easier to make than steel, the latter reserved primarily for small arms. Clad in iron, warships were largely invincible to the weapons of the time.

Innovation also improved gunnery. Technologies in this area advanced rapidly before and during the Civil War. Rifling of gun barrels with spiral grooves was invented centuries earlier, but weapons with this feature were first manufactured on a large scale in the 1850s. Rifling dramatically improved accuracy by spinning and stabilizing projectiles. Around the same time, John Dahlgren invented the "soda-bottle" smooth-bore cannon with a large chamber to increase explosive force and thus range and destructive force. Machined gun sights, percussion

USS *Monitor* crewmembers cooking on deck, on James River in Virginia, July 9, 1862 (U.S. Navy/Courtesy Ronnie Bell)

locks, and new methods for estimating ballistic trajectories improved accuracy, giving ships equipped with the new weapons an edge over shore fortifications.

Union Capabilities. The late Donald Rumsfeld's classic admonishment, "You go to war with the Army you have," describes both Union and Confederate predicaments in 1861. For the Union, "the Navy you have" consisted of a few old warships mostly powered by sail or paddlewheel, which proved unfit for the Anaconda strategy and demanded wholesale replacement.

No warship was more revolutionary than USS *Monitor*. Early on, Navy Secretary Welles commissioned John Ericsson, a renowned Swedish-born inventor, to build a ship capable of defeating any enemy ironclad. Although many technologies in *Monitor* had been experimented with before, they were now assembled in a radically new manner. The ship had just a foot of freeboard, making it hard to target, and a heavily armored, stout, rotating turret with two of the best guns in service. Being nearly impregnable and packing considerable power, *Monitor* became the icon of Union warships.[11] Different monitors were developed for river, harbor, coastal, and seagoing missions, with more than 60 built during the war.

One consequence of the switch from sail to steam, as noted, was the shift of advantage from shore to shipboard gunnery. Steam provided a further edge over shore batteries by increasing ship speed and maneuverability. Striking a moving ship at significant distance was—and still is—extremely difficult. Examples abound of Union steam warships of several types successfully attacking and/or circumventing Confederate forts. Naval bombardment contributed significantly to victory in several cases, including Fort Hatteras and Fort Clark (Hatteras Inlet in August 1861), Fort Henry (Tennessee River in February 1862), Fort Jackson and Fort St. Philip (New Orleans in April 1862), Fort Macon (Beaufort Harbor in April 1862), Fort Wagner (Charleston in April 1863), Fort Morgan (Mobile Bay in August 1864), and Fort Fisher (Wilmington in December 1864).

New warships facilitated joint army-navy operations, starting with Fort Donelson and extending during the war to all Southern coasts and riverbanks.[12] Joint operations encompassed coordinated land and water bombardment, amphibious landings, and softening up fortifications for troops to occupy.

Although the number of gunnery shells made for the Union fleet increased dramatically, rapidity of firing is a better metric of capacity. Breech loading was faster than muzzle loading. The average rate for all Union gunnery was between five and eight rounds per minute per barrel. Magazine elevators enabled nonstop, rapid, withering fire. Porter's fleet contributed 22,000

USS *Onondaga*, on James River in Virginia, ca. 1864–1865, with rowboat in foreground manned by Union Soldiers (Naval History and Heritage Command/Brady & Company)

projectiles to the defeat of Vicksburg.[13] Dahlgren's fleet fired unrelentingly for two months on the Confederate fortifications on Morris Island guarding Charleston Harbor: USS *New Ironsides* alone fired 4,439 projectiles, and the accompanying monitors fired 3,577 more.[14] Coupled with ground assaults, this bombardment eventually forced abandonment of Fort Wagner.

Industrial Mobilization. The Civil War's naval revolution was fed by two other revolutions:[15] the French Revolution, which led to the Napoleonic political phenomenon of national mobilization, and the Industrial Revolution, begun with the advent of the steam engine, which led to the mechanization of warfare on a vast scale. Together, these developments set the stage for unprecedented industrial mobilization in the North during the Civil War, which added heft to innovation.

As the North's ability to wage war grew, the evolving Anaconda strategy, General William Tecumseh Sherman's March to the Sea, and General Philip Sheridan's operations in the Shenandoah Valley combined to destroy the South's ability to wage war. Transportation came to a near halt; the South's railroads were in shambles, its major rivers under Union control. Southern destruction was in proportion to Northern mobilization. The Confederacy got weaker as the Union got stronger.

This eventually yawning gap can be traced back to differences in size and makeup of the two economies. The North's industrial revolution powered huge increases in productivity. Nearly 90 percent of all U.S. industrial production resided in the North. The Union had 11 times the ships and 32 times the number of weapons manufacturers as the South. Meanwhile, the principal "productive" assets of the Southern economy were slaves and land. Because navies are capital-intensive, slavery diverted from the Confederacy's ability to wage war on the water.

Geography also influenced war-making capacity. The Erie Canal, completed in 1825, facilitated economic intercourse between the Northeast and the Northwest. This trade continued to grow as railroads replaced canals. Consequently, the North's capacity to make the machinery of war was integrated both vertically and transregionally. In contrast, the South's addiction to and investment in high-volume, high-margin cotton production, owing to the availability of enslaved labor, crowded out industrialization. Virginia, with relatively little cotton, was the only Confederate state with a modicum of industry, such as Richmond's famous Tredegar Iron Works (which relied in part on slave labor).

The need to accelerate mobilization came from the realization that the war would drag on and expand. The North had ample potential for industrial mobilization, owing to its growing population, agricultural self-sufficiency, preexisting manufacturing base (due to doubling of investment in manufacturing in the 1850s), and financial capacity (based on a growing banking system and revenue from California gold). At war, the North's industrial mobilization expanded as its economy grew by 20 percent from 1862 to 1864. By 1865, the Confederate economy was in ruins, with massive inflation and commerce reduced to bartering.

The bulk of Northern industrial mobilization consisted of the machinery of war: railroads and ships. Although the total number of Northern factories did not ramp up appreciably—the North already had 110,000 factories in 1861—production of iron and steamships did. When the war began, the North was producing 20 times more iron than the South.[16] That and its greater capacity to produce steam engines led to the Union's preponderance of gunboats. When the war began, the Union had 42 commissioned ships, including sailing vessels of doubtful utility. By the end, it had 626 ships, including 84 ironclads carrying 4,610 guns. To 9,000 seamen in 1861, the Union Navy added another 50,000 during the war. By 1865, the Union Navy was the world's largest.[17]

Union Leadership. Senior Union naval officers typically excelled in battle, got the most out of their new capabilities and crews, and left lasting imprints on how war is waged on the water. Many were quick learners and unhesitant innovators, captives of neither tradition nor rigid career expectations. Farragut, Dahlgren, and Foote stood out in all these respects. Not far behind were Porter and Samuel Du Pont. Secretary of the Navy Gideon Welles and Assistant Secretary Gustavus Fox get high marks for vision, political savvy, and commitment to ensure that commanders got the capabilities they needed.

Exceptional leadership was critical during the Civil War for three reasons. First, the new war on water was unlike the previous experiences naval officers Farragut, Porter, and Du Pont had seen in action in the Mexican War, but the opposition they faced there was minimal. Moreover, the capabilities officers were given with which to fight—fast, armored steam warships with advanced gunnery—were unfamiliar. Nonetheless, a good number of senior Union naval officers not only adapted readily to these new capabilities but kept also adapting throughout the war.

Farragut accomplished feats of naval warfare on a scale and at a degree of difficulty never previously attempted.[18] He, along with his fleet of 17 assorted steamships, including "screw sloops," carrying 154 advanced guns, forced the surrender of the Confederacy's largest city and port, New Orleans. He did this by running a squadron past the forts downstream, moving this squadron up the river, and forcing the surrender of the city with the help of 100 of his marines. Farragut took advantage of the exceptional speed of steam propulsion, telling his subordinates, "I believe in celerity."[19] Upon taking New Orleans, Farragut was assigned to gain control of the southern Mississippi, with the goal of extending Anaconda. His planning and conduct of large-scale naval warfare on strategic waterways with exceptional speed and maneuverability were important contributions at the dawn of the revolution in naval affairs. Later, Farragut succeeded as stunningly in bringing Mobile Bay under Union control, despite a formidable array of Confederate torpedoes (mines), which he is said to have loudly "damned" as he sped through them.

While Farragut was opening the southern Mississippi, Andrew Foote, commander of the Union's western gunboat flotilla, teamed with then–Brigadier General Grant to open Tennessee by river to Union control. Foote did this by devising and implementing, with Grant, a level of army-navy collaboration without precedent—a major contribution to the revolution in naval affairs and ultimately the principal American way of war. Grant himself described how Foote was in "perfect agreement" on how to take Fort Henry, on the Tennessee River, and nearby Fort Donelson, on the Cumberland.[20] Bombardment from Foote's fleet deserves primary credit for Fort Henry's capitulation—land forces arrived after the fort succumbed—and he played a supporting role in the subjugation of Fort Donelson 10 days later. With neither officer having authority over the other, Foote and Grant formed a partnership of trust, which has remained vital to jointness ever since.

The Navy Department's leading ordnance expert, Dahlgren, invented the eponymous gun, which excelled during the war. Though muzzle-loaded and smooth-bored, it had a bulbous breech that permitted immense explosive force and, thus, greater distance, accuracy, destructive force, and crew safety than heavy guns to that point. Promoted to rear admiral, Dahlgren was assigned to take or neutralize Charleston, cradle of the Civil War and protected by several forts that had been invincible to previous attempts. He sent monitors within 300 yards of Confederate batteries, while USS *New Ironsides*, a wooden-hulled ironclad with unmatched firepower, bombarded from off the coast. Two months of naval bombardment forced the abandonment of Charleston's forts, effectively ending the city's use by blockade-runners.[21]

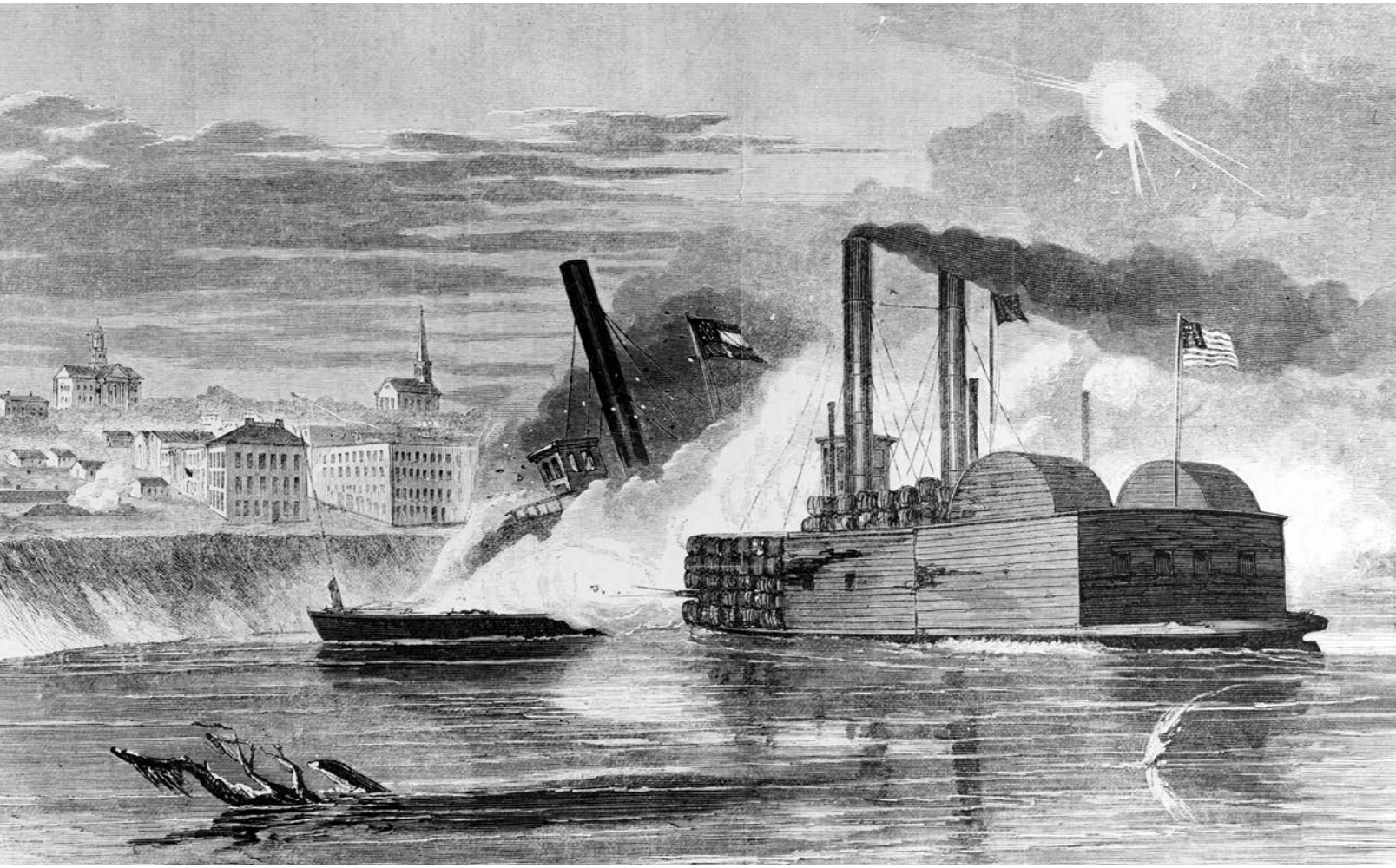
Welles was tapped to be secretary of the Navy because he supported Lincoln in the election of 1860. Assisted ably by Fox, Welles would forge the Union Navy into

a large, modern, and effective fighting force. It was the responsibility of Welles and Fox to create the capabilities, in quality and numbers, to carry out Anaconda, even as it became more challenging in the face of the South's response. USS *Monitor* was constructed at their direction, and the industrial mobilization they managed overpowered Confederate capabilities. Welles rewarded excellence and creativity in his officers, promoting Farragut, Dahlgren, Foote, and Du Pont to the new rank of rear admiral because of their success in leading change.

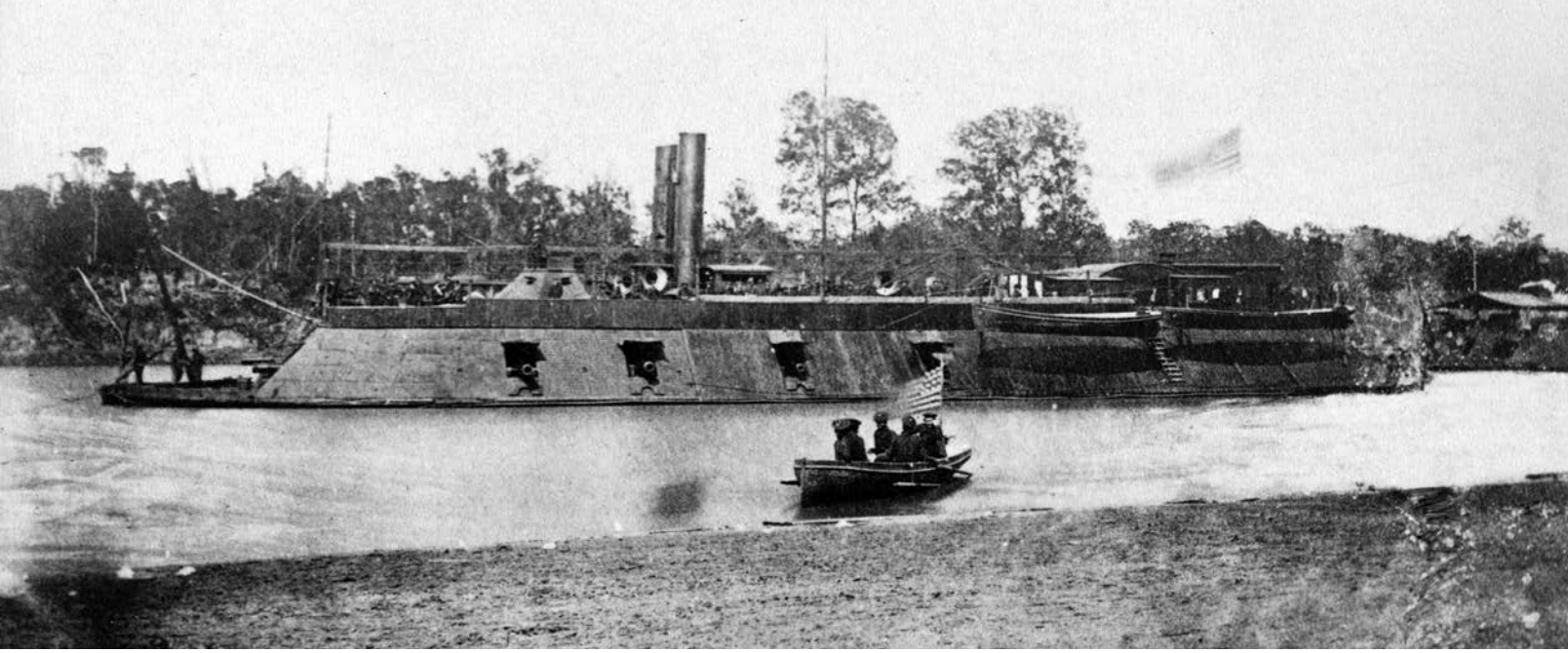
One of the key features of the Civil War's revolution in naval affairs was the feedback loop linking warfighters and those developing capabilities. To illustrate: in July 1864, Navy Secretary Welles sent a report titled *Armored Vessels* to Congress. Here are highlights:

- Rear Admiral Louis Goldsborough praised the rotating turret, recommended that all ironclads be armed with rifled Parrott guns and with rams, noted their vulnerability to plunging fire, and was skeptical about their invulnerability and seaworthiness.
- Rear Admiral John Dahlgren compared the virtues of the *Monitor* class to those of the *Ironsides* class, concluding that the classes had different attributes and were both needed. The monitors were more maneuverable in shallow waters and had better all-around protection, whereas the *Ironsides*-class warships could deliver more ordnance. He noted the beating that the monitors took during two months on station at Charleston and stressed the need for nearby repair facilities.
- Rear Admiral David Porter championed John Ericsson's monitor for its simplicity and effectiveness for both harbor protection and riverine duties. He was pleased that *Monitor*-class ships were being produced in Cincinnati for riverine use. He recommended modest improvements in armor but in general stressed their value as compared with that of the Pook gunboats at his disposal.
- Commodore John Rogers noted the *Ironsides* class's crew comforts and ability to move under sail if needed but stressed the *Monitor* class's thick iron for survivability and its heavy 15-inch guns for lethality.[22]

The Union had an ample supply of naval officers. Some 400 graduates of the U.S. Naval Academy served in the



Engraving published in *Harper's Weekly* in 1863 depicting attack by Federal ram USS *Queen of the West* on Confederate steamer CSS *Vicksburg*, off Vicksburg, Mississippi, February 2, 1863 (Naval History and Heritage Command)



U.S. Navy *City*-class ironclad gunboat USS *Pittsburgh*, on western river, during Civil War (Library of Congress/Naval History and Heritage Command)

Union Navy, compared with 95 in the Confederate Navy. The Union Navy also had a cadre of experienced Sailors. While native-born Whites made up the majority, there were significant percentages of free (or freed) Blacks, plus Irish, British, and German immigrants. These crews were integrated, highly responsive to officers and petty officers, tough, and willing to take on new missions as strategy and leaders required.

Confederate Improvisation

The American naval strategist Alfred Thayer Mahan opined that the Confederacy was doomed for lack of a navy.[23] He theorized that any country with a long coastline and dependence on sea trade ought to have a capable navy, lest it fall victim to an opponent with one. He thought that the Union's Anaconda strategy would have failed had the Confederacy possessed a navy to defend its water frontiers. The South's long coastline and many harbors and inlets would have favored a stronger Confederate navy; given the South's relative weakness, it favored the Union Navy.

Why did the Confederacy not have, or try to build or buy, a navy commensurate with its size, ambition, and reliance on international commerce? As noted, the South, like the North, was unprepared for war on the heels of Lincoln's election. Yet the North proceeded with massive efforts to build a strong modern fleet. If the North's strategy was to flatline the South's economy, why did the South not see the danger and act to prevent it?

There was a decidedly less robust seafaring culture and competency in the South than in the Northeast, which was steeped in maritime tradition and shipbuilding. The Confederacy lacked adequate shipbuilding capacity, and some of its yards were captured. It produced little iron and was unable to build steam engines. Most important, the Confederacy's highest priority by far was to field and sustain land forces. It spent just 10 percent of its wartime budget on naval capabilities, even as the lack of such capabilities was causing severe economic and strategic losses.

Though the Confederacy made do with minimal naval forces, it did have a resourceful naval leader in Secretary Stephen R. Mallory. As a former U.S. senator from Florida and chairman of the Naval Affairs Committee in the 1850s, he had championed U.S. efforts to convert sloops and frigates to steam warships. Because Mallory knew the South could never match the Union Navy, he championed improvisation.

The Confederates became skilled at laying mines to impede Union operations. These were very effective at slowing Grant's move toward Vicksburg. Mines in Charleston's harbor kept Du Pont from taking the city by sea. Defenders at Mobile Bay used mines to channel Farragut's fleet toward Fort Morgan's guns, though to no avail.

Despite metal-making and engineering shortages, the South did acquire some 20 ironclads to defend its ports and rivers. First was CSS *Manassas*, soon to be joined by others, including CSS *Louisiana*, *Mississippi*, *Atlanta*, and *Arkansas.* But it was the converted USS *Merrimack*, CSS *Virginia*, that made history by engaging in the war's first ironclad battle, with USS *Monitor*, in 1862. This fight was well heralded as a "giant step in the revolution in naval warfare."[24] However, as noted, most Confederate ironclads were eventually sunk, captured, or scuttled to avoid seizure. The South's capacity for industrial mobilization was negligible—cotton was king.

On the Mississippi, the Confederacy converted commercial steamboats into rams. Protected by thin armor and cotton bales, each such vessel had only one gun—a ram reinforced with iron—as its main weapon. Rams had existed for millennia, but with steam power, their superior speed made them deadlier. Some Union officers acquired what they called "ram fever," a fear of what the rams could do to gunboats.

The height of Confederate ingenuity was a privately built submarine, CSS *H.L. Hunley*, which was the first submarine ever to sink an enemy ship when it sank USS *Housatonic* in Charleston's outer harbor. The sleek 40-foot vessel, made of iron, had a crew of eight, a hand-crank propeller, ballast tanks, hand pumps, and a torpedo at the end of a 22-foot

spar triggered to detonate at contact. Early efforts to experiment with electric and steam-powered submarines were abandoned. *H.L. Hunley*'s top speed was only 4 knots. In its successful attack on *Housatonic*, its own crew was killed, probably from the concussion of the explosion.

Southern improvisation alone, however, does not qualify as a revolution in naval affairs. Confederate leaders were prepared to experiment because they had little choice. The Confederacy was the first to deploy an ironclad, a submarine, and mines. After the Civil War, many of the innovations made by Mallory and his colleagues would be adopted by the U.S. Navy, thus contributing to the naval revolution that would make the United States the sort of sea power advocated by Mahan.

Subsequent Revolutions in Naval Affairs

The U.S. Navy was the world's largest in 1865, but it was largely mothballed after the Civil War, for lack of an enemy. Yet study of its revolution spread. Foreign powers—Great Britain, France, Russia, Japan, and newly formed Germany and Italy—hurtled into competition for colonies. Strong battle fleets were their main capabilities for both colonizing and competing.[25] These nations began to build large, turreted, oceangoing ironclads. Soon, Great Britain was constructing very large armored warships.[26] British and German battleships, battle cruisers, and destroyers built and sent into World War I were direct descendants of the ships commissioned by the Union for the Civil War. Even the British and German dreadnoughts, improved with steam turbines, onboard electricity, radio communications, and reinforced cladding, were grandchildren to the warships built for the American Civil War some 50 years earlier.

The submarine underwent a less linear development between the Civil War and World War I, from the small, hand-cranked, spar-mine-armed CSS *H.L. Hunley* to the German U-boat of 1914–1918, which was steam-propelled, larger, much faster, and much more dangerous for its adversary with its self-propelled torpedoes. At the same time, amphibious warfare, which figured prominently in the Civil War, was a colossal failure in World War I, when an ill-advised Winston Churchill–inspired British-led attempt to take the Gallipoli Peninsula and gain control of the Turkish Straits ended in an Ottoman victory and a combined loss of half a million lives. Overall, World War I did not bring about a revolution in naval affairs.

Although there have been numerous important naval innovations since the American Civil War, only three genuine naval revolutions conform to the Civil War paradigm of strategy and technology parenting new capabilities, which were then multiplied by industrial mobilization and used effectively by visionary leaders.

The advent of fixed-wing airplanes led to a such revolution starting in the 1920s, which promised greatly increased lethality at far distance. With Europe temporarily at peace, U.S. geostrategic attention shifted to the Pacific, where the rise of Japanese militarism and appetite for East Asian resources spelled danger to U.S. interests. At that time, Army General Billy Mitchell, a proponent of bombing, argued and demonstrated that surface ships, even battleships, could be quickly sunk by air attack.[27] He was court-martialed in 1925 for calling Army and Navy leaders "almost treasonable" for investing in battleships instead of aircraft carriers. Revolutionary leadership often requires courage along with vision.

Despite the merciless reaction to Mitchell's impertinence, the case for carriers prevailed, partly because Japan was showing strong interest in them. Just as the United States commissioned its first carrier, in 1922, so did Japan. At first, the carrier was regarded by U.S. admirals as helpful to extending surveillance hundreds of miles so that battleships could close in for the kill. But then, steam-powered catapults and arresting gear were developed to help heavily armed planes take off, deliver substantial ordnance, return, and land, making the carrier the principal instrument of long-range attack. Despite persistent opposition from the battleship lobby, aircraft carriers would largely decide World War II in the Pacific. Wartime industrial mobilization was breathtaking: the United States built 105 carriers, 40 of them large-deck ones.

In contrast to dreadnought warfare, carrier warfare was "offense-dominant." In the biggest naval engagement of World War I, the Battle of Jutland (1916), neither Great Britain nor Germany lost *any* of the total of 44 dreadnoughts in the fight; essentially, their gunnery was no match for their armor. At the Battle of Midway (1942), of the seven carriers employed by Japan and the United States, five—four Japanese and one American—were sunk, due mainly to air attack. The revolution brought about by naval aviation shifted the advantage at sea from defense to offense—which is just what the United States needed to recover control of the Pacific and take the war to Japan.

After winning World War II, the United States found itself with global responsibilities and threats that demanded sustained presence and patrolling by submarines as well as carriers in distant regions. Nuclear-fission technology offered the answer. Led by Admiral-to-be Hyman Rickover, the United States developed and equipped all of its submarines and some of its carriers with nuclear propulsion. Reactor refueling was needed every decade or so, compared with every month or so for fossil-fueled ships.[28] Superiority in nuclear-powered attack and strategic-missile submarines would make the United States the leading global sea power and give its strategic triad an invulnerable leg.[29] Outfitting the submarine fleet with reactors required mobilization of a specialized new industry. As for Rickover, admirers on Capitol Hill had to keep the Navy from cashiering him for insufficient collegiality.[30]

By the end of the bipolar world, with the Soviet Union's days numbered, the United States found it necessary to project military power to regional contingencies, notably in the Persian Gulf and the Balkans. To gain access for fast intervention with low casualties, the Navy and its sister Services responded by deploying dispersed forces and precision-guided munitions during the 1990s. This required what in Pentagon-speak is considered networked "command, control,

Members of USS *Miami* crew on forecastle, ca. 1864–1865; Frank W. Hackett, former officer of the ship, wrote in 1910: "The officer standing in the background, at the extreme prow of the ship, is W.N. Wells, Executive Officer. The man in the foreground with his arm on the nine-inch gun is White, the gunner. Sergeant of Marines, Stanley, is sitting in the foreground, near the capstan" (Naval History and Heritage Command)

communications, computers, intelligence, surveillance, and reconnaissance." Preceding this development, and mainly outside the government, the skyrocketing commercial demand for distributed processing gave rise to data networking—just what integrated, joint, power-projection operations needed. It took the decade of the 1980s for the digital revolution to transform the military. A dazzling U.S. victory in the Gulf War revealed a new capability: information.

While the leaders of data networking were chiefs of the commercial computer and telecommunications industry, several senior naval officers had the imagination and nerve to promote the idea of networked forces. One was Vice Admiral Arthur K. Cebrowski, an intellectual who ran the Pentagon's Office of Force Transformation in the early 2000s. Another was Vice Admiral Jerry O. Tuttle, who had the more hands-on job of creating a joint network-based operational command and control system. A third was Admiral Bill Owens, an influential Vice Chairman of the Joint Chiefs of Staff, who wrote an important article in *Foreign Affairs*[31] and was a prime mover of the Pentagon's seminal *Joint Vision 2010*. There was also Rear Admiral Wayne E. Meyer, who adopted networking to integrate shipboard missile defense. These officers and their acolytes guided the U.S. Navy to overcome its long-held belief in unit autonomy. Of the many lessons of the digital naval revolution, among the most important is that the U.S. military needs technology designed for civilian use—for example, the Internet.

The Case for Another Revolution

With information technology vital, ubiquitous, and in constant flux, the United States must be poised for a new naval revolution, as part of what is known as joint, all-domain warfare.[32] The U.S. military's highest development priority today is to integrate forces with shared and timely information. Like other revolutions, this one starts with strategy: thwarting China's growing challenge to American power in the Pacific. The magnitude of this challenge dictates learning from prior revolutions—yes, all the way back to the Civil War.

Parallels between then and now are striking. The Union adopted a strategy to strangle the Confederacy, only to discover that its capabilities were inadequate to execute it. Today, U.S. strategy calls for maintaining a superior military presence in the Western Pacific, while new Chinese capabilities are making such a presence untenable. With current U.S. strategy and capabilities, the trend is unfavorable. Unless it is prepared to abandon its influence, alliances, and warfighting edge in that vital region, the United States must embark on a new strategy enabled by new technology.

The Monitor and Merrimac: The First Fight Between Ironclads, chromolithograph of Battle of Hampton Roads, Louis Prang & Company, 1886 (Library of Congress)

Beijing seems determined to retake what it considers historically sovereign territory and seas, stripped from China by imperial powers when it was weak. Doing so would restore Chinese supremacy in East Asia. Perceiving, with good reason, that U.S. military power in the Western Pacific is its principal obstacle, China has developed and deployed quiet attack submarines and maneuverable anti-ship missiles, which would make the Western Pacific a keep-out zone for U.S. forces. Now, as China's race with the United States in advanced information technology heats up, it is putting in place extended-range sensing systems to locate, track, and target U.S. forces at increasing distance from China. Just as the aircraft carrier was crucial in a prior naval revolution—to counter Japan and to project U.S. power—another revolutionary approach is now crucial to dealing with this new challenge.

The concept now coursing through Pentagon corridors is to deploy a joint force that is more dispersed, diverse, elusive, and unmanned than today's, thus confronting China with a very different and harder targeting challenge. The central nervous system of this emerging U.S. force is to be a network to guide and integrate operations across all military Services in all realms: land, water, air, space, and cyberspace.[33] This network will rely mainly on constellations of satellites and surveillance drones. The system's essential capability is information gathered, processed, and distributed seamlessly and fast.

As this strategy forms, the Navy will have a huge role, though it must transition toward smaller and more numerous surface vessels, some of them unmanned, with long-range strike weapons—ballistic, cruise, hypersonic—as well as submarines outfitted with such missiles. While aircraft carriers will remain vital in other regions of U.S. interest, they will become Pacific launch platforms for drones and aircraft with long-range weapons so that they need not steam close to China. The Navy will also need to keep up with constantly improving network software, hardware, and bandwidth that will unify all U.S. forces.

The U.S. strategy demands no less than another revolution in naval affairs, just as other of the Nation's military Services are entering parallel transitions. The requisite technologies are being developed mainly by non-defense innovators, from very large to very small: artificial intelligence (AI), complex autonomous systems, and quantum computing and communications, to name three.

Before assuming that the U.S. Navy and other Services can carry out a revolution to counter China based on civilian technology, certain issues need attention. First, the prospect of unmanned warships run by AI raises concerns about who, or what, controls the use of force. Second, deemphasizing large-deck aircraft carriers in a vital area runs counter to naval, and national, instincts. Third, disincentives for innovative civilian firms to do business with the Pentagon must be demolished, despite political and bureaucratic resistance. Meeting

these challenges will require officers of uncommon ability, willing to joust with forces of tradition and to take risks, including to their own careers.

It is unclear whether the Navy is flexible and imaginative enough to embed its fleet within an integrated all-domain force, where its ships are nonautonomous nodes on a joint network. Recall the Navy's attachment to battleships in the run-up to World War II. Recall the court-martial of Mitchell and ostracism of Rickover for heresy. Recall how Farragut, Dahlgren, Porter, and Welles led the Civil War naval revolution.

The matter of leadership today is complicated by the preeminence of jointness in combat, command and control, force planning, and even technology development. Senior Navy officers, like those of other Services, are increasingly expected to serve in joint assignments. Conversely, leaders of joint organizations from other Services may have as much influence on naval roles and requirements as Navy officers. The notion of a revolution in naval affairs is nowadays hard to disentangle from that of a larger revolution in military affairs. The next Farragut could be in the Army.

One senses that the Chinese threat is motivating senior officers of all Services to exhibit the creativity and verve to guide a new, information-based joint revolution spanning all domains. Less clear is whether they have adequate political top cover from a U.S. Government preoccupied with such other pressing matters as a pandemic, climate change, education, voting rights, and immigration.

Conclusions

The Civil War was the fulcrum of American history: It caused untold violence, destroyed the South's horrific culture and economy of slavery, and gave freedom followed by citizenship to 4 million Americans. It also restored the Union states, which would go on to build unmatched industrial might. Likewise, the Civil War was pivotal in naval history, replacing wind-propelled wooden ships with steam-propelled ironclads. Eventually, the U.S. Navy became an instrument of American power across the globe.

This national and naval narrative began when the Union's Anaconda Plan to cripple the South proved unachievable until old ships, obsolete doctrines, and uninspired officers were replaced. By war's end, mobilized Northern shipyards were rapidly launching ironclads with steam power and accurate guns.

From the top down, Union officers and crews escaped the gravity of tradition. Then and since then, the constant of naval and other military revolutions is the creativity and impatience of leaders. Across several naval revolutions, individuals such as Farragut, Mitchell, Rickover, and Owens brought change by exploiting technology, as Americans are wont to do. Revolutionary champions who emerge today will deserve a place in this pantheon. It behooves today's leaders to study how their forebears did what they did. **JFQ**

Notes

[1] In December 1860, the U.S. Navy had just 7 screw frigates and 10 first-class steam sloops, plus 18 second- and third-class steamers. None were ironclads. See *Register of the Commissioned and Warrant Officers of the Navy of the United States, Including Officers of the Marine Corps, and Others, for the Year 1861* (Washington, DC: Department of the Navy, 1861).

[2] For details on Civil War naval developments, see James M. McPherson, *War on the Waters: The Union and Confederate Navies, 1861–1865* (Chapel Hill: University of North Carolina Press, 2012); and Kevin Dougherty, *Strangling the Confederacy: Coastal Operations in the American Civil War* (Philadelphia: Casemate, 2009).

[3] See Robert McNamara, "Overview of the Anaconda Plan of 1861," *ThoughtCo*, March 7, 2021, http://thoughtco.com/anaconda-plan-definition-1773298; Gary Gallagher, "The Anaconda Plan of the American Civil War," transcript, from the lecture series "American Civil War," *Wondrium Daily*, April 25, 2020, https://www.wondriumdaily.com/the-anaconda-plan-of-the-american-civil-war/; and Ken Stover, "Anaconda Plan," Civil War Academy, https://civilwaracademy.com/anaconda-plan.

[4] McPherson, *War on the Waters*, 32.

[5] Dougherty, *Strangling the Confederacy*, 61–67.

[6] See Dougherty for a detailed history of joint Union Army-Navy operations.

[7] McPherson, *War on the Waters*, 219.

[8] Ibid., 52–53.

[9] "U.S. Patent Activity: Calendar Years 1790 to the Present," U.S. Patent and Trademark Office, 2023, https://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_counts.htm.

[10] The turbine was not used in steam-propulsion plants until 1894.

[11] E.B. Potter and Chester Nimitz, eds., *Sea Power: A Naval History* (New York: Prentice-Hall, 1960), 265.

[12] Dougherty, in *Strangling the Confederacy*, thoroughly examines joint Army-Navy operations in the Civil War.

[13] McPherson, *War on the Waters*, 169.

[14] Ibid., 176.

[15] Williamson Murray and Wayne Wei-siang Hsieh, *A Savage War: A Military History of the Civil War* (Princeton: Princeton University Press, 2016).

[16] Benjamin T. Arrington, "Industry and Economy During the Civil War," National Park Service, https://www.nps.gov/articles/industry-and-economy-during-the-civil-war.htm.

[17] McPherson, *War on the Waters*, 224.

[18] Ibid.

[19] Ibid., 60.

[20] Ulysses S. Grant, *Personal Memoirs of U.S. Grant* (Cambridge: Belknap Press, 2017), 147.

[21] McPherson, *War on the Waters*, 176.

[22] From the library of James Townsend, *Report of the Secretary of the Navy in Relation to Armored Vessels* (Washington, DC: Government Printing Office, 1864), 571–594.

[23] Alfred Thayer Mahan, *The Influence of Sea Power Upon History 1660–1793* (Boston: Little, Brown and Co., 1890), 43–44. Mahan also opined that never had sea power played a more decisive role than in the "conflict which determined the course of world history."

[24] McPherson, *War on the Waters*, 104.

[25] For a cogent explanation of European naval strategies and competition in the run-up to World War I, see Clark G. Reynolds, *Navies in History* (Annapolis, MD: Naval Institute Press, 1998).

[26] Potter and Nimitz, *Sea Power*, 368.

[27] Mitchell persuaded the Navy to let aircraft bomb an ex-German dreadnought after World War I. It promptly sank.

[28] Reactor cores can last as long as 30 years, but standard practice is to replace them more frequently.

[29] Intercontinental ballistic missiles and strategic bombers also played a role.

[30] Theodore Rockwell, *The Rickover Effect: How One Man Made a Difference* (Annapolis, MD: Naval Institute Press, 1992).

[31] Joseph S. Nye, Jr., and William A. Owens, "America's Information Edge," *Foreign Affairs*, March/April 1996.

[32] "All-domain" refers to land, sea, air, cyber, and space.

[33] This network is called Joint All-Domain Command and Control.