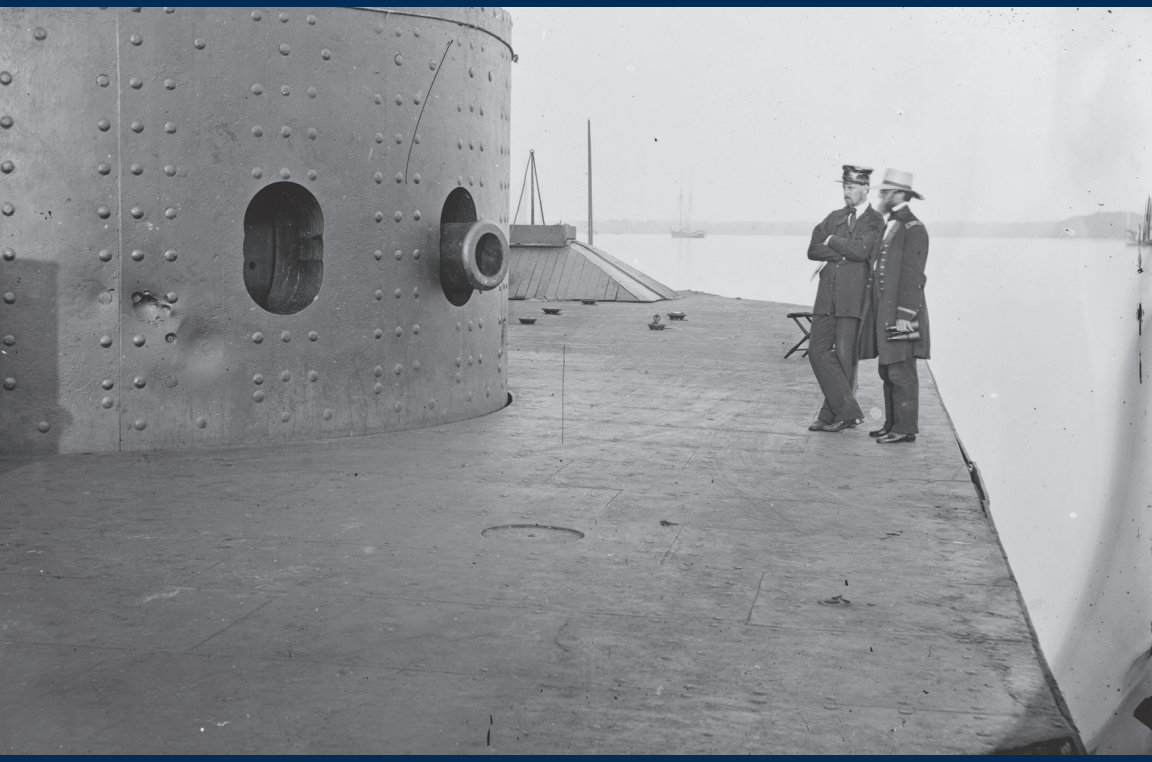

The Civil War and Revolutions in Naval Affairs

Lessons for Today

David C. Gompert and Hans Binnendijk

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Cover: Photograph shows light damage caused to turret of ironclad USS *Monitor* during its fight with Confederate ironclad CSS *Virginia*, March 9, 1862, at Battle of Hampton Roads—the first battle of two ironclad warships. James F. Gibson, photographer. James River, Virginia, July 9, 1862. Photo available at <https://www.loc.gov/item/2018666817/>.

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Introduction

At certain times, owing to new strategy, new technology, or the vagaries of war, the character of naval warfare and course of naval history undergo rapid, profound, and lasting change. Our thesis is that the American Civil War was one such time. It was the seminal revolution in naval affairs in the history of the United States. With its existence at stake, the Union doubled down on its plan to blockade the Confederacy even as the demands of doing so became clear. What followed was an American revolution in naval affairs with worldwide implications for the 19th, 20th, and 21st centuries.

The war began suddenly, with South Carolina's secession coming a mere month after Abraham Lincoln's election. Hostilities commenced before North or South was prepared for what would come. As strategies took shape and requirements became clear, both sides scrambled to assemble experienced officers, recruits, and ships. Within a year, the inadequacies of these off-the-shelf capabilities forced leaders of both sides to find new ways of operating, new technologies offering better capabilities, and stellar leaders, all at once. Because the Union's naval strategy was the more ambitious, and its technological and industrial capacities the more prodigious, it drove the Civil War's naval revolution. Yet the Confederacy was so overmatched on water that it had to improvise tactics and weapons, some of them also revolutionary.

At the center of this revolution was the dramatic transition from old warships to new ones. Standard prewar "ships-of-the-line" were wooden-hulled, largely wind-dependent, and laden with large numbers of inaccurate broadside guns.[1] By the war's end and after, warships were sheathed in metal, propelled by steam-driven propellers, and equipped with fewer but much better guns mounted in movable turrets. In contrast with old ships, new ones were more maneuverable, versatile, survivable, lethal, and immune to currents and winds. They could operate in narrow and shallow inland waters, as their missions required. Soon, the sails that had replaced oars a millennium earlier were relegated to history.

The Civil War's naval revolution began because the Union's strategy was adopted before the capabilities needed to execute it were fully understood, much less at hand. Yet, before long Northern squadrons would be pummeling shore batteries to destroy Southern forts, control Southern harbors, and close Southern ports. Union gunboats would conduct amphibious landings, convoy troop ships, and wage riverine warfare. More accurate guns fired faster and caused greater destruction of intended targets.

As guns improved, the possession of ironclads became urgent, whereupon the difficulty of disabling ironclads prompted further improvements in guns. When the Confederacy deployed ironclads, the Union answered with more and better ones, which the Confederacy answered with the first combat submarine. As the efficacy of new capabilities became plain, the Union scaled up production at an unprecedented clip. This was possible because the Industrial Revolution was sweeping the North, while the South was preoccupied with growing cotton and using enslaved people to pick it.

In the era that followed the Civil War, its revolution in naval affairs would influence other navies, not least the British Royal Navy and Imperial German fleets that fought the Battle of Jutland in 1916. For its part, the United States, after recovering from the Civil War and stretching to continental width, would combine innovations made by both sides and aspire realistically to become a global sea power, as advocated by Alfred Thayer Mahan in *The Influence of Sea Power upon History, 1660–1783*.[2] American industry repeatedly rose to the task: the Union mobilization of 1861–1865 previewed that of 1917–1918.

Three other significant naval revolutions would follow, notably those brought about by the aircraft carrier following World War I, nuclear propulsion following World War II, and digital information networking in support of joint power projection, dramatized by the Gulf War. As this monograph is being written, the table is set for a fifth major naval revolution, as part of a revolution in joint all-domain warfare, necessitated by China's growing military strength in the vital Asia-Pacific region.

There is no better time than now to learn lessons from examination of the Civil War's naval revolution and those that followed. And no lesson is more urgent than the leverage of leadership. Even with clear strategy and requirements, promising technology, and commitment of industry, a would-be revolution headed up by risk-averse leaders, entrapped by bureaucracy and unwilling to slay politically sacred calves and buck Service tradition, will end up on the shoals. Sustaining America's naval and military superiority today will take inventiveness and fortitude akin to what Union leaders displayed to preserve the Nation.

Our purpose is not to explain why naval superiority helped the Union win the war—historians James McPherson, Kevin Dougherty, and others have done that well.[3] Nonetheless, it is useful for our purpose to examine how well the revolutionary capabilities of the Civil War performed relative to the demands of the battles and campaigns of the times. As we will see, they performed immeasurably better than those they replaced could have.

The Civil War revolution in naval affairs involved six distinct but related elements:

◆ Fighting an unanticipated war required a new strategy.

◆ That strategy in turn created new operational tasks and concepts of operation to execute those tasks.

◆ New emerging technologies had to be identified and harnessed to meet these requirements.

◆ These technologies then needed to be forged into useful capabilities, and operational concepts were further adjusted as those capabilities emerged.

◆ Industrial mobilization was needed to turn new capabilities into a larger capacity to act across thousands of miles of water and shore.

◆ Innovative leadership was required to encourage and support this entire process.

The relationship between strategy and technology is as fluid as it is complex. Sometimes, new strategy demanded by changing geopolitical realities presents demands that can only be met by developing new or exploiting existing technologies in revolutionary ways. Alternatively, exogenous technological change can excite thinking about capabilities to improve strategy. Often, both strategy-pull and technology-push are at work, which was evident in the Civil War and is so again today. At the nexus of strategy and technology are operating concepts—ways of using force—which are necessitated by strategic change and enabled by technological change. These, in turn, inform plans and programs to improve or replace capabilities. This innovation system is scaled up by mobilizing industry and driven by empowering bold leaders.

This formula for a revolution in naval affairs remains valid to this day.

The Union's Revolution in Naval Affairs

Union Strategy: Anaconda

The Anaconda Plan, designed by Lieutenant General Winfield Scott from March through May 1861, was a strategy to defeat the seceding Confederate states by denying them trade with other nations through a blockade of saltwater ports and by controlling the Mississippi River, thus dividing and blocking east-west trade in the South. Scott's strangulation proposal called for naval operations on two fronts. On the Mississippi, under Scott's plan a spearhead force of some 60,000 Union troops transported in 40 vessels and convoyed by a flotilla of some 20 river gunboats would sail south, capturing forts along the way until it reached New Orleans. It would be reinforced later by larger army units that would hold conquered territory as the flotilla patrolled the river. On the second front, Union seagoing vessels would conduct a blockade of some 180 ports and inlets along some 3,500 miles of Confederate coastline. Should this two-part naval strategy fail to reverse secession, Scott's backup plan was a land attack on Richmond.[4]

The fact that an Army veteran of the War of 1812 and the hero of the Mexican-American War designed a predominantly naval strategy to bring the South to its knees was no accident. Scott had seen the power of naval blockades in action in both of those wars, conducted amphibious operations himself against the British in the War of 1812, and orchestrated the amphibious assault and Army-Navy siege of Veracruz in 1847. He was a Virginia Unionist, and he understood the massive casualties both sides would suffer in a protracted land war. He sought a more humane way to win.

Abolitionist critics derisively named Scott's plan "Anaconda" after the constricting snake—a name that stuck. Initially, Lincoln withheld full support because the plan was thought to be too slow. Scott was also unable to override the objections of George McClellan and other generals, who wanted instead to march on Richmond. After the first move toward Richmond failed at First Bull Run, however, the essence of Scott's plan was adopted and combined with the Army's land strategies. In failing health, Scott retired in November 1861.

Implementation of the Anaconda Plan was initially slow because of a lack of warships. (See appendix A for a list of selected Civil War naval battles.) Many civilian vessels were quickly converted for military purposes. The Navy initially focused on the saltwater blockade; it was the Army that commanded riverine gunboats at first.[5] It soon became clear that a larger fleet was needed to stop blockade-runners and thereby establish an "effective" blockade under international law, which could otherwise be ignored by foreign powers. Also, the Union would have to seize Southern ports from which runners were operating and establish supply and coaling stations along the South's coasts to reduce steaming distance and time.

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 driving Confederate forces out of Kentucky and Tennessee. Union victories at Forts Henry and Donelson in February 1862 demonstrated the value of joint operations. By March, most of Foote's flotilla had advanced down the Missis-

sippi to defeat Confederate defenses at Island Number 10. Elements of the flotilla also supported Grant at Shiloh and demonstrated how naval fire could affect land battles.

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

On the Atlantic coast, Union victories at Port Royal in November 1861, Roanoke Island in February 1862, Hampton Roads in March 1862, Fort Macon in March 1862, and Fort Pulaski in April 1862 closed key Confederate ports, leaving Charleston and Wilmington on the Atlantic and Mobile and Galveston on the Gulf as the only big ports from which blockade-runners could operate.

Consistent with the Anaconda Plan, Union naval control of most of the navigable segment of Virginia's James River in June 1864 was crucial to Grant's ability to use City Point as a base of operations for the siege of Petersburg. It bottled up Confederate naval vessels in Richmond and allowed rapid movement of Union troops by ship in preparation for the final push to Richmond. Most of the remaining Confederate ports were eventually closed: Charleston in late 1863, Mobile Bay in August 1864, Plymouth in October 1864, and Wilmington in January 1865. Only Galveston remained under Confederate control until the end of the war. At the same time, Anaconda's goals of dividing and starving the Confederacy were consistent with Union land operations under Major General William Tecumseh Sherman in

his March to the Sea and under Major General Philip H. Sheridan in the Shenandoah Valley.

New Tasks and Requirements

From this narrative, we can derive the operational tasks that flowed from the evolving implementation of the Anaconda strategy. These tasks would define requirements and inspire use of new technologies to build the capabilities to fulfill them. The most important of these tasks follow.

Intercepting Blockade-Runners

On April 27, 1861, Lincoln declared all Confederate states subject to a naval blockade. Confederate blockade-runners initially had considerable advantages. The blockaders had to cover the entire Southern coastline with limited numbers of seaworthy ships to cover the escape routes. The Union Blockade Strategy Board had to stretch Union assets to their limit. Several squadrons were organized by geographic region to implement the blockade. Runners were able to choose an opportune time and route. They operated with fast ships able to make the 500- to 1,000-mile runs quickly to such destinations as the Bahamas, Bermuda, and Cuba. In the war's first year, a mere 1 out of 10 runners was captured.[6] To compensate and make the blockade effective under international law, the Union Navy required more and faster ships, gunnery with greater range and accuracy, coaling stations, and the capability to control the ports from which the runners were operating.

Defeating Enemy Ironclads

At first, Confederate ironclads presented serious problems for Union operations in key waters: CSS *Virginia* at Hampton Roads, CSS *Chicora* and CSS *Palmetto State* in Charleston Harbor, and CSS *Arkansas* near Vicksburg, for example. Then, USS *Monitor*'s battle against CSS *Virginia* and subsequent ironclad duels demonstrated the importance of speed, thick armor, a very low profile, armor-piercing shells, accurate guns, rotating turrets, maneuverability, and ramming capability. In due course, Confederate ironclads

were either run aground, such as CSS *Atlanta*; destroyed in their harbors, such as CSS *Albemarle*; scuttled by the Confederates themselves to avoid capture, such as CSS *Tennessee* and CSS *Virginia*; or kept in British shipbuilding facilities by diplomatic pressure.

Forcing Surrender of Forts by Bombardment

With Confederate forts impeding Union passage along the Mississippi and guarding major Confederate ports, the Union took on several naval tasks. With its steam-powered ships, the Union Navy improvised new bombardment tactics, against Forts Hatteras and Clark and again against Forts Walker and Beauregard, in which squadrons of gunships would cycle continuously in oval patterns, making them less vulnerable than if stationary and optimizing firing angles. Ironclads would sail close to the target to get off better shots, with the more vulnerable ships carrying long-range Dahlgren guns keeping their distance in tighter circles. In conjunction with the Army, the Navy demonstrated for the first time, in its operation against Fort Pulaski in April 1862, the power of rifled artillery against previously impenetrable walls.[7] On the Mississippi, mortars on rafts and schooners provided massive long-range firing against targets, for example at Island Number 10. By the end of the war the Union could bring to bear massive naval firepower, such as it used on Fort Fisher.

Running Past Confederate Forts When Direct Attack Is Impractical

When particular Confederate forts were too difficult to attack frontally from the water, Union ships were tasked to "run the gantlet" through heavy fire to gain a better position from which to attack the forts or the ports the forts were protecting. Farragut successfully brought his oceangoing steam schooners and sloops upstream at night past the chains, forts, and batteries protecting New Orleans. At Vicksburg, as noted, Porter got much of his flotilla below the town, to enable ferrying Grant's army across the Mississippi. At Mobile Bay, Farragut lashed wooden ships to ironclads for protection

against fires from Fort Morgan. These gantlet runs required not just speed, covering fire, and the protection of armor, but innovations such as strapping coal ships alongside to absorb shot or protecting transport ships by means of cotton bales or metal chains. Once the fleet was in a stronger location, the fort often fell to a joint siege or ground 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 came when the services were tasked to cooperate.[8] Grant and Foote partnered to take Forts Henry and Donelson. Naval gunfire helped save Grant at Shiloh. Vicksburg finally fell because Grant and Porter commanded their respective forces to collaborate closely. Throughout the war, naval gunboats convoyed transports to bring troops to battle. At Fort Fisher, ships provided covering fire for advancing Army troops.[9]

Maintaining Control Over the Mississippi and Surrendered Ports

Once Vicksburg and key Confederate seaports fell, a remaining naval task was to maintain control over ports and rivers until the South surrendered. Some cities, such as Mobile, Charleston, Savannah, and Richmond, did not capitulate immediately upon loss of their forts and waterways. Union ironclads and other gunboats remained in Southern bays and harbors as land forces occupied surrendered forts. Control over the Mississippi area proved to be equally difficult. Confederate guerrilla fighters in groups of up to 100 constantly harassed Union patrols and convoys. To counter this effort, the Navy dispatched Marines to chase and fight these Confederate fighters. The Navy was also tasked with patrols to prevent Southern trade across the Mississippi.

Finding and Destroying Confederate Raiders

Early in the war, Confederate President Jefferson Davis granted letters of marque to Confederate raiders, who captured and often burned hundreds of Union merchant ships and whalers. Several fast ships were built surreptitiously

for the Confederacy in England and fitted elsewhere, including *CSS Alabama* and CSS *Florida*. Outraged Northern merchants pressured the Navy to assign ships to run down raiders around the globe. In fact, one of Davis's aims was to force the Union Navy to detach large numbers of ships to go after privateers instead of performing blockade duties. The Union refitted and constructed several well-armed vessels with sail and stream power to provide both the speed and the sustainability to catch these raiders. The *Alabama* was finally sunk off France and the *Florida* was captured in Brazil.

To implement these Union naval tasks, a series of specific requirements had to be met quickly. For the Union Navy these included:

- innovative leaders unafraid of professional or political risks.
- creation and maintenance of two fleets, for riverine and oceanic operations.
- large numbers of ships, to chase blockade-runners and raiders, take and hold ports, and control the Mississippi.

For individual warships, Union requirements included:

- speed, to catch runners, reduce vulnerability from Confederate artillery, and ram with force.
- maneuverability, to operate in river currents and outmaneuver enemy gunboats.
- armor, to withstand attacks and close in on targets.
- low silhouette, to present a small target.
- slanted profile, to deflect incoming projectiles.
- shallow draft, to navigate in shallow river waters, over barriers outside ports, and through minefields and other such obstacles.
- long-range high-velocity weaponry, to improve accuracy.
- iron- and masonry-piercing shells, to attack enemy ironclads and forts.

In sum, the Union ships and the fleet required greater survivability, lethality, connectivity, sustainability, and versatility. (We will return to these key attributes in a later section.)

In considering how the Anaconda strategy spawned a revolution in naval affairs, it must be stressed that Union requirements grew as the difficulty of strangling the South became apparent and as the Confederates innovated to avoid strangulation. Fortuitously for the Union, the Industrial Revolution offered technological advances and advantages that helped the Union win the Civil War and powered the revolution in naval affairs.

Emerging Technology

Historically, war has been a propellant of technological innovation. In his masterly history of the world, *The Rise of the West*, William H. McNeill explained why the medieval "West," originally Europe, excelled at developing technology compared with the Chinese and Arab civilizations of the day, which were superior in science and mathematics.[10] Being divided into principalities and fiefdoms, Medieval Europe was internally competitive and disposed toward conflict. This made the West ambitious in practical uses of science—technology—whereas other civilizations viewed science as hierarchical, serving emperor or Allah. Also, because Europeans had continual contact with one another, hostile and not, inventions spread quickly and widely. Though not all wars beget technology, and not all technology is begotten by wars, the correlation is strong. This was much in evidence on the Union side during the Civil War.

There really is such a thing as "Yankee ingenuity." Finding technical solutions to practical problems came naturally in harsh, chilly, rocky New England. It was 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 was arguably as innovative as northern England and Saxon Germany. Its states gave the Union Navy some of

its most creative leaders, including John Dahlgren, David Porter, Andrew Foote, Samuel Du Pont, Navy Secretary Gideon Welles, and Assistant Navy Secretary Gustavus Fox. Technology was progressing rapidly in the North as the Civil War began, and it helped ignite the naval revolution.

More broadly, technology played a role in both the cause and the conduct of the American Civil War. The invention of the cotton gin in the late 18th century enabled the South to corner the world market in cotton, thanks to forced labor—giving it a reason to secede rather than face a ban on slavery's expansion to new states, which Lincoln intended. Steam power progressed in strides from the 1790s on. The war itself was waged and decided by a flurry of 19th-century inventions. As historians Wayne Hsieh and Williamson Murray have highlighted, the Civil War marked the confluence of the Napoleonic nation-at-war ideology and the Industrial Revolution.[11] The latter was begun and sustained by a burst of human creativity. By the mid-19th century, the patent system had established the concept of intellectual property, making invention more rewarding than ever. The number of patents issued annually grew from about 900 in 1850 to 5,000 in 1860 to 13,000 in 1870 to 26,000 by 1897. Even Lincoln held a patent on a naval invention.[12]

The most important factor in the Civil War's naval revolution was steam propulsion coupled with the screw propeller. It is easy to explain steam propulsion, but it is hard to engineer and operate steam-propelled vessels safely. In a typical system, fossil fuel—then coal, now oil—is burned in a boiler to turn water into pressurized steam, which drives reciprocating pistons or turbines, which rotate the ship's propeller shaft and screw, which propel the ship.[13] Steam from the pistons is then cooled by intake of sea or river water and converted to liquid water, to be recycled and boiled again to keep the shaft turning. Screw revolutions per minute, and thus ship speed, are governed by adjusting force on the pistons. Wind and current have minor effects on steam propulsion, easily offset by turbine force and ship's steerage. The first steamship to be driven by a screw propeller was the British SS *Archimedes*, which was built in 1838. Screw propellers were refined over the next

several decades, but they could outperform the paddle-wheel ships used by the United States in the Mexican-American War.

If Anaconda would have been impossible without steam, its ultimate success hinged on the use of metal-clad ships. Metallurgy defined the Bronze and Iron Ages. Over the millennia, innovations in mining, extraction of metal from ore, smelting, shaping, and use of coal and coke furnished the Industrial Revolution with the iron and steel with which to make machines and infrastructure. New techniques were developed to roll the iron more effectively in factories, such as those in Troy, New York. Henry Bessemer is credited with inventing a high-volume steelmaking process five years before the American Civil War. Even then, iron was cheaper and easier to make than steel, which was favored primarily for small arms. Clad in iron, warships were largely invincible to the weapons of the time. This changed the way warships were used, then and since.

Innovation also improved gunnery. The technologies associated with weapon effectiveness advanced rapidly before and during the Civil War. Rifling of gun barrels with spiral groves was invented centuries earlier but first implemented on a large scale in the 1850s. Rifling dramatically improved accuracy by spinning and stabilizing projectiles. At the same time, Dahlgren, a Union officer who would later distinguish himself by obliterating the forts that defended Charleston, invented the "soda-bottle" smoothbore cannon with a large chamber to contain increased explosive force and thus boost range and destruction of targets.

These innovations improved gunnery to the advantage of moving gunboats against fixed, fortified batteries. Machined gun sights, percussion locks, and new methods to estimate ballistic trajectories added to force and accuracy. Just as enhancements in naval gunnery made ironclads more important, ironclads made it important to continue improving gunnery.

Accompanying improvements in gunnery was the development of rotating turrets. Such turrets were first used by the British in the Crimean War and were further developed in the United States by John Ericsson. His turret could turn every 22.5 seconds, and incoming projectiles tended to glance

off its round shape. Ericsson's turret was originally designed to hold two smoothbore Dahlgren guns. It was reconfigured over time to avoid leakage and a blind spot where the pilot house was located.

The telegraph is widely regarded as one of the most consequential new technologies used extensively during the Civil War, along with steam propulsion, railroads, accurate weaponry, and iron cladding for warships. But ships at sea had to rely on such ancient communications practices as arm-waving semaphore and flag signaling; the radio revolution in naval communications followed the Civil War. Yet coordination of army and naval forces, which produced victory in many battles, made interservice communications vital, especially because unified joint commands had yet to be evolved.

Such technologies enabled a revolution in naval affairs, as well as Union victory, by providing decidedly better capabilities to meet the requirements of strategy. The clearer the strategy, the better defined were the requirements of its tasks, and the intent of Anaconda was clear enough even as its demands grew. The Union came to see that blockading the Confederacy would require more than interdicting blockade-runners: it would require conducting accurate and close-in shore bombardment; running past shore batteries; implementing riverine operations to project force, counter guerrilla operations, and control river commerce; and waging joint warfare, such as amphibious landings and seizing forts and ports. In sum, by being turned into capabilities, technology would offer solutions to the problems associated with the tasks of the strategy.

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. Recall how abruptly the Civil War began, with Lincoln's election triggering a run of secessions and the formation of the Confederacy. Perhaps both sides could have seen this coming and prepared accordingly in the 1850s, but they did not. Consequently, both had to improvise from the outset. For their armies, this meant increasing troop numbers and force structure

while taking advantage of telegraph and rail systems. For the Union, "the navy you have" consisted of a small number of old warships mostly under sail or paddle-wheel power, which were patently unfit for the Anaconda strategy and demanded wholesale replacement. Yet all the North could do quickly was to convert paddle wheelers into gunboats. Fortunately for the Union, the technologies that Anaconda would require were either available—somewhere—or under development

An examination such as this of how the Civil War gave rise to a naval revolution requires assessing whether capabilities developed for and during the war had the potential to alter not just the course of that conflict but also the character of naval warfare. The place to begin, though, is with how well these capabilities met the challenges of the day.

The fulcrum of the Civil War's revolution in naval affairs was the steam-propelled ironclad warship: fast, easy to maneuver and to turn for best target angle, survivable, and defiant of wind direction and velocity. New warships came in numerous types: As noted, some early on were unarmored converted riverboats, with paddle wheels abeam or astern. In time, most had centerline shafts and screws, the better to change direction and speed. There were wooden-hulled "screw sloops"—steam-propelled with the option to sail at sea, such as USS *Hartford*, Farragut's beloved flagship. As the war went on, most new warships were clad in wrought iron, from the compact USS *Monitor* to the imposing USS *New Ironsides.* But there were also "timberclads" and "tinclads," as well as appropriately named "turtlebacks," with arched structures over the deck to withstand heavy seas.

Early in the war, Navy Secretary Welles commissioned Ericsson, a renowned Swedish-born inventor, to build a ship capable of defeating any in the Confederate fleet. USS *Monitor* was "perhaps the most original design in the history of naval architecture. . . . Nearly everything about the ship was radically new and untried." The *Monitor*'s chief engineer estimated that it contained at least 40 patentable innovations. It had just a foot of freeboard, making it a hard target, and a heavily armored turret with two of the largest

guns in service. Being nearly impregnable and packing considerable power, the *Monitor* became the icon of Union warships.[14]

The original *Monitor* had two 11-inch guns, and its turret was covered with 8 inches of armor. Different monitors were developed for river, harbor, coastal, and seagoing missions. They developed into the several types of ships, including the *Neosho*-, *Marietta*-, *Casco*-, *Passaic*-, *Canonicus*-, and *Milwaukee*-class monitors, with more than 60 built during the war. One example of innovators in riverine warship construction is naval inventor James B. Eads, who first transformed many of his Mississippi vessels into iron-protected river gunboats and later constructed new flat-bottomed, wide-beamed paddle wheelers with iron-sheathed slanted encasements called "Pook's Turtles."[15] Another example is civil engineer Charles Ellet, Jr., who used the speed associated with steam power to construct several rams painted black for the Army, which acted independently but helped the Navy clear Confederate vessels from the Mississippi.[16]

Civil War gunnery progressed as rapidly as propulsion and armor. Rifled (Parrott) guns offered a major advance in accuracy, and new smoothbore Dahlgren guns fired explosive shells instead of cannonballs to multiply destructive force. Rotating turrets provided near-omnidirectional fire, thus augmenting the turning advantage of steam-propelled warships. Percussion locks permitted breeches to be closed and add force. Improved gunsights made new guns even more accurate.

Although the number of gunnery shells made for the Union fleet exceeded requirements, 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 5 and 8 rounds per minute per barrel. Magazine elevators enabled nonstop, rapid, withering fire. Porter's fleet contributed 22,000 shells of various sorts to the defeat of Vicksburg.[17] The Union fleet under Dahlgren 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.[18] Coupled with ground assaults, such as the famous one of the 54th Massachusetts, this

bombardment finally forced the abandonment of Fort Wagner and the rest of Morris Island.

Industrial Mobilization

The Civil War's revolution in naval affairs was enabled by two other revolutions.[19] The French Revolution led to the Napoleonic phenomenon of national mobilization for war. At the same time, the Industrial Revolution, begun with the advent of the steam engine, would lead to the mechanization of warfare on a vast scale. These developments set the stage for unprecedented national industrial mobilization in the North during the Civil War, which added mass to the revolution in naval affairs.

As the North's ability to wage large-scale war grew, the Anaconda strategy, Sherman's March to the Sea, and Sheridan's operations the Shenandoah Valley all combined to destroy the South's ability to wage war. The totality of Southern destruction was in proportion to Northern mobilization. The Union got stronger as the Confederacy got weaker. These trends enabled Grant to defeat Lee on land; they also explain Northern naval supremacy.

The gap between the regions' fighting power can be traced back to differences in size and makeup of the two economies. The North's own industrial revolution powered huge increases in productivity and production. Nearly 90 percent of all U.S. industrial production resided in the North. The Union had 11 times as many ships and 32 times the number of firearms manufacturers as the South. The principal productive assets of the Southern economy were enslaved people. Because navies are capital-intensive, slavery effectively crippled the Confederacy's ability to wage war on the water.

Geography also influenced the North's capacity for war-making. The Union's Northwestern region had considerable iron-mining and iron-making capacity, but it needed a trading relationship with other regions of the country. The Erie Canal connected the North's western and eastern halves in a way that facilitated economic and political linkages between them. The alternative was for Michigan, Wisconsin, Illinois, Indiana, and Minnesota to depend on north-south trade routes, notably the Mississippi; but this had

been relatively unimportant before the war. East-west trade continued to grow as railroads replaced canals. This mattered because 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 cost-free labor, crowded out industrialization. Virginia, with relatively little cotton, was the only Confederate state with a modicum of industry, such as Richmond's Tredegar Iron Works (which relied in part on slave labor).

The requirement for massive mobilization arose from the fact that the North, not to mention the South, was woefully unprepared to wage war. The need to accelerate mobilization came from the growing realization that the war would expand and drag on. The North had ample potential for industrial mobilization, owing to its large population, swollen by immigration; agricultural self-sufficiency, despite having just 40 percent of its land in farming; a preexisting manufacturing base, thanks to the doubling of investment in manufacturing in the 1850s; and financial capacity, based on a growing banking system and revenue from Californian 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 exchanges reduced to barter trade.

The bulk of Northern industrial mobilization consisted of the machinery of war: railroads and ships. While the total number of Northern factories did not ramp up appreciably—it 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.[20] That and the increased capacity to produce steam engines led to the Union's preponderance of gunboats and other modern warships.

The demand for gunboats to meet Anaconda's call for control of the Mississippi was at first met by conversion of paddle wheelers. It was Grant's need for modern gunboats to wage riverine and joint army-navy war in the West that led to a major increase in modern shipbuilding in 1862. Of the 84

ironclads the North would build before the war's end, 64 were of the turreted *Monitor* type.

A growing money supply contributed to Northern mobilization. The Legal Tender Act of 1861 contributed $500 million in fiat currency—"greenbacks"—that businesses were required to accept. In addition, a progressive (3 percent to 10 percent) income tax generated substantial revenue. Industrial Age capitalism flourished in the North during the Civil War, rapidly growing production of warfare's machinery.[21]

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. From 9,000 seamen in 1861, the Union Navy added another 50,000 during the war, becoming the world's largest navy.[22]

To summarize to this point: The Union had a strategy but discovered before long that it lacked the capabilities to execute it. Therefore, it capitalized on emerging technologies to build new and better capabilities in numbers that could carry out the tasks the strategy demanded. As the war went on, the Union drew upon a growing cadre of leaders with the skill and nerve to put these capabilities to best use. It also mobilized its industrial bases to build forces that could and did overwhelm those of the Confederacy.

New Operational Concepts

New requirements and capabilities led to a series of operational concepts, such as firing at forts while on the move, running gantlets to circumvent forts, maximizing speed and maneuverability to defeat other ironclads, establishing convoys and other joint operations, developing coaling stations to expedite blockades, and creating special operations to deal with guerrillas.

One of the consequences of the switch from sail to steam was the shift of advantage from shore batteries to warships—that is, from land to water. Because the Union relied on naval forces to implement Anaconda, while the Confederacy had to defend its seacoasts and river shores from fixed positions, this shift was of strategic importance. Steam gave naval gunnery a fur-

ther edge over shore batteries by increasing ship speed and maneuverability. Hitting a moving ship with ordnance at significant distance was extremely difficult (and, for that matter, still is). Moreover, as noted, steam-propelled warships could turn quickly to get a good target angle. Picture graceful warships under sail seeking the wind's cooperation to tack for broadside salvos: this would have been hopeless against shore batteries.

Examples abound of Union steam warships of several types successfully attacking and/or circumventing Confederate forts by using this new lethality. Naval bombardment contributed significantly to victory in several cases, including Forts Hatteras and Clark (Hatteras Inlet in August 1861), Fort Henry (Tennessee River in February 1862), Forts Jackson and 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). The capability and capacity to outgun land-based batteries did more to impose Anaconda than did all efforts to interdict Confederate blockade-runners.

Union ironclads and other steam-propelled warships excelled in carrying out many tasks that Anaconda would require: riverine warfare required the speed, maneuverability, and lethality that only steam-propelled ships could provide, and iron cladding obviously helped. These gunboats gained and kept control of the Mississippi—completely, with the fall of Vicksburg—to enable Union transit and constrict Confederate replenishment across the river. They escorted convoys, transported troops, and protected vulnerable troop transports. Numbers speak: during General Burnside's Hatteras campaign, gunboats convoyed the transport of 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 the ground force.[23]

These vessels facilitated joint army-navy operations, starting with Fort Donelson and extending to all coasts and riverbanks of the Confederacy and throughout the war.[24] Joint operations encompassed coordinated land and water bombardment, amphibious landings, and softening up fortifications

for troops to occupy. The capability to perform such operations became crucial as the difficulty of stopping blockade-runners grew.

Union Leadership

Union naval officers typically excelled in battle; got the most out of their new ships, new guns, and crews; and left lasting imprints on the practice of waging war on the water. Generally speaking, these leaders were quick learners and unhesitant innovators, captives of neither tradition nor the status quo. As senior commanders, Farragut, Dahlgren, and Foote stood out in all these respects. Not far behind, in our view, were Porter and Du Pont. Secretary of the Navy Gideon Welles and his assistant secretary, Gustavus Fox, deserve high marks for vision, political savvy, and commitment to ensure commanders got the capabilities they needed.

Competent leadership is a generic naval warfighting capability; it was critical during the Civil War, for three specific reasons. First, the war on water was a far cry from the previous experiences of these senior naval officers. Farragut, Porter, and Du Pont had seen action in the Mexican-American War, during which the U.S. Navy performed many of the missions it did during the Civil War; however, the opposition they had faced in the earlier conflict was minimal. Moreover, the technologies and capabilities these officers were given to operate during the Civil War—especially fast, armored steam warships with advanced gunnery—were relatively new to naval officers. Nonetheless, a significant number of senior Union naval officers not only adapted quickly to these new capabilities but kept adapting throughout the war.

Farragut accomplished feats of naval warfare on a scale and with a degree of difficulty never previously attempted much less accomplished.[25] He used his fleet of 17 assorted steamships, including screw sloops, carrying 154 advanced guns to force the surrender of the Confederacy's largest city and port, New Orleans, as previously noted. He did so by running a squadron past the forts downstream of the city, moving this squadron up the river, and forcing the city's surrender with the help of 100 of his marines. Farragut took advantage of the exceptional speed of steam propulsion, telling his sub-

ordinates: "I believe in celerity."[26] 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 with exceptional speed and maneuverability on strategic waterways were important contributions at the dawn of the revolution in naval affairs. Later in the war, he succeeded no less 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 knifed through them at full speed.

While Farragut was defeating Confederate forts and fleets in the Southern Mississippi, Andrew Foote, Commander of the Union's Western Gunboat Flotilla, teamed with then–Brigadier General Ulysses Grant to open Tennessee by river to Union control. Foote did so by devising and implementing, with Grant, a level of army-navy "joint" collaboration without precedent—a major and long-lasting contribution to the revolution in naval affairs and ultimately the principal American way of war. No less an authority than Grant himself, in his *Personal Memoirs*, praised Foote for his collaboration in crafting and executing plans to take Fort Henry on the Tennessee River and nearby Fort Donelson on the Cumberland.[27] Bombardment from Foote's fleet deserves primary credit for Fort Henry's capitulation—land forces arrived after the fort succumbed—whereas 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 the kind of partnership of trust that has remained a vital quality of jointness ever since. Foote also showed that a force of steam-propelled armored gunboats with effective gunnery could fight and win warfare on and from inland waters that wooden sailing ships, regardless of firepower, could not.[28]

The Navy Department's leading ordnance expert, Commander John Dahlgren, invented the eponymous gun, which saw extensive and invaluable use during the war. Though it was muzzle-loaded and smooth-bored, its bulbous breech permitted immense explosive force and, thus, greater distance, accuracy, destructiveness, and crew safety than heavy guns before that point. Along with rifled shipboard gunnery, the Dahlgren gave naval firepower an

advantage over fortification firepower, as noted earlier. 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 on previous attempts. He sent his monitors within 300 yards of Confederate batteries, while USS *New Ironsides*, a wooden-hulled ironclad with unmatched firepower, bombarded from off the South Carolina coast. After two months of naval bombardment, Dahlgren forced the abandonment of Charleston's forts, effectively ending the city's use by blockade-runners.[29] If Farragut's main contribution was to take New Orleans and Mobile Bay from the water, and Foote's was to join with Grant to take Forts Henry and Donelson, Dahlgren's was to improve naval capability to demolish Charleston's defenses.

Welles was tapped to be secretary of the Navy largely because he had supported fellow Republican Lincoln in the election of 1860. Assisted ably by the remarkable Fox, Welles would turn the Union Navy into a large, modern, and effective fighting force. Fox in particular championed development of the *Monitor*-class ironclads. It was the responsibility of Welles and Fox to create the capabilities, in quality and quantity, 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 they engineered the phenomenal industrial mobilization that 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 based on their success and ability to lead in the face of uncertainty and change. Indeed, what distinguished the leaders mentioned here is the combination of creativity and fortitude, against both the enemy and the status quo.

One of the most important features of the Civil War's revolution in naval affairs was the feedback loop involving warfighters and those developing capabilities. To illustrate: in July of 1864, Secretary of the Navy Welles sent a report titled *Armored Vessels* to Congress. The report stated that operating commanders interacted with the Navy Department to critique the Union's ironclads and prompt improvements for future ones. Here are some 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 the *Ironsides*-class, concluding that they had different attributes and were both needed. The monitors were more maneuverable in shallow waters and had better all-around protection, while 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–class* monitors for their 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 to 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.[30]

Such timely back and forth between operators and developers is essential for a revolution to happen during hostilities—and highly desirable in any case. It also underscores the importance of objectivity and honesty among leaders so that capabilities can be critiqued and reworked as conditions require and technology allows. Even the self-assured Royal Navy scrutinized Welles's report on armored vessels.[31]

Union leadership innovations also included the establishment of several boards to oversee elements of what became the revolution in naval affairs. A Blockade Strategy Board, chaired by Du Pont, was established to set priorities, organize the Navy for these missions, and suggest new operational

concepts.[32] A separate Board of Ironclad Vessels was established to guide modifications in those ships.

In this conflict, excellence in leadership trickled down, as most senior officers were seen routinely on deck, in harm's way, by junior officers and sailors. David Farragut even climbed a mast amid battle, the better to direct his fleet. In turn, cohorts of junior officers and seamen of the Union Navy by and large stepped up to new capabilities and their fiercely opposed missions.

The Union had a large supply of naval officers. By the end of the war, 400 graduates of the U.S. Naval Academy served in the Union Navy, compared with 95 in the Confederate Navy. (In contrast, 217 West Point graduates became Union general officers, and 146 became Confederate general officers.) As the Union was developing and deploying superior warships to those of the Confederacy, it was doing so in vastly greater numbers.[33]

The Union Navy also had a cadre of experienced sailors, who happened to be strikingly diverse. While native-born whites made up the majority, there were significant percentages of free (or, later, freed) Blacks and Irish, British, and German immigrants. While diversity in and of itself does not guarantee quality, in the case of the Union Navy these crews were integrated, highly responsive to officers and petty officers, tough, and willing to take on new missions as strategy and leaders required. By 1865, the Union Navy had over 50,000 sailors serving.

Confederate Innovation (But No Revolution in Naval Affairs)

The American naval strategist Alfred Thayer Mahan opined that the Confederacy was doomed for lack of a navy.[34] In his general theory of sea power, any country with a long coastline and dependence on trade ought to have a capable navy, lest it fall victim to a foe with one. He further argued that the Union's Anaconda strategy would have failed had the Confederacy possessed a navy to defend its water frontiers. Indeed, the South's long coastline

and many harbors and inlets would have favored a Confederate navy; because the South did not have one, it favored the Union Navy.

Whether or not one buys Mahan's theory of sea power's influence on history, it must be asked why the Confederacy did not have or try to build or buy a force commensurate with its size, ambition, and reliance on seaborne trade. As noted earlier, the South, like the North, was unprepared for war on the heels of Lincoln's election. Yet as the North proceeded with a massive effort to convert, then build, a strong fleet, the South did not. If the North aimed to snuff out the South's economy, why did the South not see the danger and act to prevent it?

For one thing, there was a stronger seafaring culture and higher competence in the Northeast then in the South. This seems to have made Union leaders more aware than their rivals of the crucial role sea power could and would play. The Middle Atlantic and Lower New England states were steeped in maritime pursuits and shipbuilding, whereas European buyers did most of the shipping of the South's cotton exports. The Confederacy had only modest shipbuilding capacity, and some of its yards were captured. It had not nearly enough iron, and it was unable to build steam engines.

Whether Confederate leaders made a definite decision to deprive their navy in favor of funding their armies, this was the effect of their policies. The Confederacy spent no more than 10 percent of its wartime budget on naval capabilities, even as the lack of such capabilities was causing severe economic and strategic losses. In contrast, Union naval funding increased tenfold during the war. Because the Union built a major fleet and the Confederacy did not, the latter had to be, and was, resourceful and ingenious, though in the end unsuccessful.

One last word on Mahan: Although he did not address the question of naval revolutions as such, one of his main propositions about sea power and history was that countries with long coastlines, sizeable populations, and dependence on international commerce would invest vigorously in superior naval forces or suffer at the hands of those that did. Of course, he had the United States of 1890 in mind, and it followed his advice to become a great

sea power. The combination of the Civil War naval revolution and the writings of Mahan set the stage for U.S. global power.

While the Confederacy, by choice or neglect, had to make do with minimal naval forces, it at least had in charge a resourceful and innovative leader. Confederate Secretary of the Navy Stephen R. Mallory was the force behind the Southern navy. As a U.S. senator from Florida and chairman of the Committee on Naval Affairs, in the 1850s he had championed the U.S. Navy's efforts to convert sloops and frigates to steam power. Mallory understood that the South could never match the Union Navy. Although the Confederacy had many privately owned shipyards at the beginning of the war and enough sawmills, it lacked adequate iron to armor most of its ships. Given the total number of vessels converted, built, or purchased overseas throughout the war, the Union Navy outnumbered his more than 5 to 1. Mallory fostered improvisation to compensate for lack of numbers. The South's broad strategy was to counter Anaconda both at sea and on the rivers. Its leaders needed to play for time and to keep the Southern economy going long enough for the North to tire of the cost of war or until European powers intervened. Confederate innovation was designed to defend, delay, and survive.

A major part of Confederate strategy was to strengthen forts that could defend saltwater harbors or block Union passages along the Mississippi and other rivers. Those forts were continually equipped with better artillery and reinforced with such supplementary capabilities as floating batteries and obstructions. There were early Confederate defeats, including Forts Henry and Donelson. But strongpoints such as Island Number 10, Port Hudson, and Vicksburg on the Mississippi and the forts protecting Charleston, Wilmington, and Mobile Bay created greater difficulties for Union fleets. Fire from an elevated Confederate battery at Drewry's Bluff, on a bend of the James River, kept Union gunboats from reaching and attacking Richmond. Forts on commanding heights, such as Vicksburg, had to be taken by land forces. Some, such as Fort Pulaski with its thick masonry, capitulated only after tremendous bombardment by Army rifled artillery supplemented by the Navy. Others, such as Fort Moultrie, used sand to absorb Union shot.

Forts alone were inadequate. The Confederates became skilled at laying torpedoes (mines) that at least retarded Union operations. They experimented with these devices early in the war, and despite problems with damp powder, the devices' numbers and sophistication grew as the war continued. Mines along the Yazoo River were particularly effective at slowing Grant's move against 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 within close range of Fort Morgan's guns, though to no avail. James McPherson concludes that mines were the Confederate's most deadly naval weapon, sinking or damaging 43 ships.[35]

Despite iron and engineering shortages, the South did acquire some 20 ironclads to defend its ports and rivers. The war's first ironclad was CSS *Manassas*, soon to be joined by others including CSS *Louisiana*, CSS *Mississippi*, CSS *Atlanta*, and CSS *Arkansas.* But it was the converted USS *Merrimack*, CSS *Virginia*, that was championed by Mallory and made history by engaging in the war's first ironclad battle with USS *Monitor* on March 9, 1862. This battle was highly visible and heralded a "giant step in the revolution in naval warfare."[36] Most of these slow Confederate ironclads, though largely impervious to most shells, were eventually sunk, captured, or destroyed by the Confederates themselves to prevent their capture. One of the last to surrender was CSS *Tennessee*, in Mobile Bay.[37] They were vulnerable not only to Union ironclads but also to Union armies that threatened their harbors.

Mallory turned to British shipyards for new warships, in surreptitious violation of British neutrality. First, specially designed sleek ships with low visibility, low draft, smokeless coal power, telescoping smokestacks, and special steam escape valves were used for running the blockade.[38] As a result of these and other blockade-running measures, some 8,000 successful trips were made circumventing the Union Anaconda. Second, two formidable ships with both sails and steam-driven propellers, CSS *Alabama* and CSS *Florida*, were launched in 1862 and became commercial raiders. During the last year of the war, CSS *Shenandoah* became one of the most feared com-

mercial raiders; it fought on until November 1865, firing the last shot of the war. Some 252 Union merchant ships or whalers were ransomed or burned during the war by these Confederate raiders.[39] The purpose of commercial raiders was to interdict Union trade (much as the blockade interdicted Confederate trade) and to force the Union Navy to chase the raiders, thus diverting Union attention away from the blockade.

These efforts, owing to British shipbuilding, were successful for the first few years of the war. As Union efforts progressed to close ports rather than just chase blockade-runners, fewer ports were available from which Confederate ships could stage. Eventually, CSS *Alabama* was sunk off the French coast by USS *Kearsarge*, and CSS *Florida* was captured in Brazil. Even so, Southern naval efforts succeeded in extending the Confederacy's survival and thus its chance to win the war by other means.

On the Mississippi, the Confederacy converted commercial steamboats into rams, creating the River Defense Fleet. Protected by thin armor and cotton bails, they had only one gun each but used a ram reinforced with iron as their main weapon. Rams had existed for millennia, but with steam power their superior speed made them deadly. Some Union officers developed what they called "ram fever," a fear of what the rams could do to gunboats. The rams were put into service at Fort Pillow under Flag Officer James F. Montgomery and demonstrated their effectiveness by sinking the ironclad USS *Cincinnati* and grounding USS *Mound City.* [40]

Also on the Mississippi, guerrilla operations continually harassed Union shipping from the shore, forcing Union gunships to convoy river traffic. Semi-submersible craft, which exposed only their conning powers and smokestacks, had a poor history of success. The most prominent, the 50-foot steam-powered *David*, was armed with spar torpedoes. The stealthy craft attacked but failed to sink several warships in Charleston Harbor, including USS *New Ironsides.*

The height of Confederate creativity was a privately built submarine, CSS *Hunley*, which was the first submarine ever to sink an enemy ship, namely, USS *Housatonic*, which went down in Charleston's outer harbor. The 40-

foot sleek vessel was made of iron and 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. The *Hunley's* top speed was 4 knots. In its successful attack on the *Housatonic*, the Hunley's own crew was killed, probably from the concussion of the explosion.

The South's innovations alone do not qualify as a revolution in naval affairs, if only because it lacked the means to apply those innovations on a large scale. But Confederate leaders were by and large not afraid to take risks—they had little choice. The Confederacy was the first to deploy an ironclad, a submarine, and mines. After the Civil War ended, many of the innovations made by Mallory and his colleagues would be adopted by the U.S. Navy and thus contribute to the naval revolution that eventually made the United States a sea power, as advocated by Mahan.

Subsequent Revolutions in Naval Affairs

Even as the U.S. Navy shrank after the Civil War, study of its revolution in naval affairs bloomed around the world. Foreign powers—Great Britain, France, Russia, Japan, and the newly formed Germany and Italy—plunged headlong into competition for colonies, and strong battle fleets were their principal instruments for both colonialization and competition.[41] These nations began to build large, turreted, oceangoing monitors, such as those of the Union Navy. Soon, Great Britain, the world's supreme sea power, was constructing very large ironclad warships.[42] The 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.

To illustrate, consider the 4,190-ton, 250-foot long, steam-propelled USS *New Ironsides*, with its crew of 450, 20 rifled guns, partial wrought-iron armor, and four boilers. USS *Illinois* (BB-7), commissioned 40 years later, circumnavigated the globe with the Great White Fleet, was 370 feet long and had 40 guns, steel armor, and eight boilers—bigger and better than the

New Ironsides, but not fundamentally different. The U.S. ships that fought in the Spanish-American War were, loosely speaking, halfway between the *New Ironsides* and the *Illinois*. The most significant enhancement in warships from the Civil War to the Great War was speed, with the rate rising roughly from 6 knots to 16 knots. Even the formidable British and German dreadnoughts, improved with steam turbines, onboard electricity, radio communications, and reinforced metal sheathing, were essentially linear follow-ons to warships built for the American Civil War some 50 years earlier.

The submarine underwent a more impressive, nonlinear evolution between the Civil War and World War I, from the small, hand-cranked, spar-mine-armed CSS *Hunley* to the typical 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 itself did not bring about a genuine revolution in naval affairs.

There have been a few important innovations in naval capabilities since those of the Civil War. For instance, self-propelled ("automotive") torpedoes were invented and used to enable smaller boats of lesser powers—for example, Austria—to hold enemy battleships at bay; German submarines attacked shipping in both world wars; and U.S. missile-bearing submarines have been crucial to deterrence during and since the Cold War. Yet we find only three naval revolutions that measure up to the Civil War criteria of strategy and technology yielding new capabilities that are used effectively by great leaders and multiplied by industrial mobilization. They were, in chronological order, the aircraft carrier in the interwar years, the nuclear propulsion of the 1950s, and the force networking of the 1990s.

The advent of fixed-wing airplanes led to a revolution in naval affairs, starting in the 1920s, which focused on increased lethality at great distance.

With Europe temporarily peaceful, U.S. geopolitical attention shifted to the Pacific, where Japan was seeing a rise in militarism and had a goal of seizing East Asian resources to feed its industrial appetite. At the same time, Army General Billy Mitchell, a proponent of bombing, argued and demonstrated that surface ships, even battleships, could be quickly sunk by air attack.[43] He was court-martialed in 1925 for calling Army and Navy leaders "almost treasonable" for investing in battleships instead of aircraft carriers. Revolutionary leadership may require courage as well as vision.

Despite the harsh reaction to Mitchell's impertinence, the case for carriers prevailed, in part because Japan was showing strong interest in them. Just as the United States commissioned its first carrier, in 1922, so did Japan. The American strategy of containing Japanese power would require naval aviation to provide long-range surveillance and weapon delivery. Indeed, the carrier was regarded by naval leaders as a useful innovation to extend 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 and land, making the carrier the principal instrument of long-range naval, and often land, attack. Despite stubborn opposition from the battleship lobby, aircraft carriers would largely decide World War II in the Pacific, starting at Midway. Industrial mobilization was breathtaking: the United States went on to build 105 carriers, 40 of them large-deck ones, during the war. As had happened with the steamship of the mid-19th century, it took a major war to revolutionize warships.

In contrast to dreadnaught 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 45 dreadnaughts in the fight, because 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 of them Japanese—were sunk, thanks mainly to the effectiveness of attack aircraft. Thus, the revolution brought about by naval aviation shifted the advantage from defense to offense—which is just what

the United States needed to recover control of the Pacific and take the war to Japan.

The carrier went on to be the visible symbol of U.S. naval supremacy during the Cold War. By the 1950s, though, the United States found itself with global responsibilities and threats that demanded sustained presence and patrolling of submarines. Nuclear-fission technology offered the answer. Led by Admiral-to-be Hyman Rickover, the United States developed and equipped all its submarines and some of its carriers with nuclear propulsion. Refueling of reactor-equipped ships was needed every decade or so, compared with every month or so for fossil-fueled ships.[44] Superiority in nuclear-powered attack and strategic-missile submarines made the United States the leading global sea power and gave its strategic triad an invulnerable leg.[45] 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.[46]

Toward the end of the Cold War, with the Soviet Union's days numbered, the United States found it necessary to "project power" to regional contingencies, notably in the Persian Gulf and the Balkans. For the sake of gaining access for fast intervention with low casualties, the Navy and other services responded by forming joint, integrated, dispersed forces and employing precision-guided munitions during the 1990s. This required what in Pentagon-speak is called "command, control, communications, computation, intelligence, surveillance, and reconnaissance." Preceding this development, and mainly outside the government, the skyrocketing commercial demand for distributed processing gave rise to data networking. This was more or less exactly what integrated, joint, power-projection operations needed. It took the 1980s for the digital revolution to transition to and transform the military. A dazzling U.S. victory in the Gulf War revealed a new capability: information.

Whereas 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 a important article in *Foreign Affairs*[47] 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 must acquire technology designed for civilian use, such as, notably, the Internet.

Naval Revolutions and Attributes of Ships and Fleets

We can find lasting lessons from the first naval revolution of the Civil War and in those that followed, the better to understand and act on the one in front of us. One such lesson concerns certain crucial attributes of ships and fleets. The foremost attribute of a warship is survivability, without which nothing else matters. Survivability has been the aim of metal armor since the Civil War. At the same time, the need for survivability against improved ordnance inspired submarines, which have grown steadily in importance since their cameo appearance in the Civil War. Survivability has also been enhanced by speed and agility, owing to the transition from sails to shafts and screws driven by steam from boilers or nuclear plants. Last, dispersing ships can reduce the vulnerability of each one—which becomes increasingly important as surface ships become more easily targeted.

This leads us to the second necessary attribute of ships, especially combatants: lethality, owing to weapon range, precision, and destructiveness. These were all greatly improved by new gunnery during the Civil War. Starting in the 1920s, carrier-based attack aircraft provided weapon delivery at distances

of hundreds of miles. In the 1980s, standoff precision-strike missiles invented for joint power projection added still more to range, accuracy, and destructive effect. Of late, the use of drones for global surveillance, reconnaissance, and strikes offers another way of improving range and accuracy, not to mention sparing the lives of pilots.

Third is a ship's ability to connect with other ships and superior commands. The Civil War was stuck with quaint semaphore and signal flags, slow and impossible beyond telescope range. But joint Army-Navy operations enhanced the Navy's connectivity with land warfare. By World War I, radio technology was available, though not with the power needed for the reliable ship-to-ship-to-shore communications that came in World War II. Advances in connectivity, via data via satellites, virtually defined the naval revolution that was part of the larger revolution in military affairs of the 1990s.

In addition to essential attributes of ships are those of fleets as a whole, of which two stand out. Sustainability is needed for naval forces insofar as their campaigns demand it, as they often do. Patrolling, enforcing a blockade, waging prolonged bombardment, and maintaining sea and river control were all elements of the Union fleet's sustainably requirement. In each naval revolution, and for each type of warship—ironclad, aircraft carrier, nuclear submarine—campaigns were if anything more important than battles. In a subsequent naval revolution, nuclear power significantly enhanced the sustainability of the fleet.

The other attribute of a naval force that commanders regard as having transcending value is versatility. Commonly, fleets need to be prepared for multiple missions, including unanticipated ones, yet they cannot be altered at sea. Ironclads were called on to bottle up harbors, bombard fortifications, and escort troop transports, depending on the course of a campaign or battle. Aircraft carriers may launch strikes one day, defend themselves from enemy strikes the next, and turn into anti-submarine-warfare hubs if needs arise. Nuclear submarines may be asked to hunt for surface ships or enemy submarines, or even to collect intelligence. Networked forces may be asked to perform numerous naval or joint tasks.

In sum, naval leaders want survivable warships that can inflict lethal effects and connect with other ships and commands, as part of naval forces that are sustainable enough for protracted operations and versatile enough to take on multiple assignments, planned or unplanned. We are about to see that survivability, lethality, connectivity, sustainability, and versatility are as important today as they were in the American Civil War.

In U.S. naval history since 1861, achieving and maintaining these attributes as strategies and conditions change depends above all on technology. The American aptitude for technological innovation has been a defining and distinguishing strength since the Civil War. It produced the ironclad to provide survivability in harm's war, the aircraft carrier to multiply the range of lethality, nuclear propulsion to enable submarines to patrol for months on end, and data networking to connect forces in joint power projection.

The Eve of Another Revolution

With information technology vital, ubiquitous, and in constant flux, the United States must be poised for a new naval revolution, in support of what the Pentagon calls "joint, all-domain" warfare.[48] The U.S. military's highest development priority today is to integrate all operating forces and commands with shared and timely information. As in other revolutions, this one begins with strategy, to wit: thwarting China's challenge to American power in the Pacific. The magnitude of this challenge dictates dusting off and taking to heart lessons from prior revolutions, starting with that of the Civil War.

The parallels are chilling. The Union adopted a strategy to strangle the Confederacy, only to discover that its existing capabilities were woefully insufficient for the task. Today, U.S. strategy calls for maintaining a superior military presence in the Western Pacific, though Chinese antiaccess/area-denial capabilities are steadily making such a presence untenably vulnerable. Unless it is prepared to abandon its influence, alliances, and war-fighting edge in that vital region, the United States must design a new posture enabled by new technology.

This looming revolution in naval affairs will require improvements in all five transcending qualities of American ships and fleets—survivability, lethality, connectivity, sustainability, and versatility—just as was the case during and since the Civil War. To achieve those improvements—as we have seen from our Civil War example—will require new strategy, technologies, and capabilities, as well as a mobilization and strong leadership.

The Chinese state is determined to retake historically sovereign territory and seas stripped from China when it was weak, and in so doing to restore Chinese supremacy in East Asia. Chinese party and military leaders believe China is now ready to go after those goals. Perceiving, not without reason, that U.S. military power in the Western Pacific is the principal obstacle in its way, China has developed and deployed quiet attack submarines and maneuverable anti-ship missiles to make the Western Pacific a keep-out zone for American forces, especially aircraft carriers. 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. U.S. aircraft carriers within strike distance of China are increasingly targetable and vulnerable.

To parry China's drive for military superiority in the vital East Asian region, the strategy coursing through Pentagon corridors is to counter with a joint force that is more dispersed, diverse, elusive, and unmanned than those of today, thus confronting China with a very different and more difficult targeting challenge. The central nervous system of this emerging U.S. force will be a network to guide and integrate operations across all military services and realms: land, water, air, space, and cyberspace.[49] This network will rely mainly on constellations of satellites and surveillance drones, with guidance for maneuverable weapons also coming from space. The system's essential capability is information gathered, processed, and distributed with unprecedented connectivity and speed.

The Navy will have a huge role in this new strategy and system, though it must evolve toward smaller and more numerous surface vessels ("platforms," in Pentagon jargon), some of them unmanned, with long-range strike weap-

ons—ballistic, cruise, and/or hypersonic—as well as submarines outfitted with such missiles. While aircraft carriers will remain important in other regions of U.S. interest, they will become Pacific launch platforms for drones and aircraft with long-range weapons that need not be stationed in harm's way near China. The Navy will also need to keep up with constantly improving network software, hardware, and bandwidth that will unify all U.S. forces. This will include the ability to wage cyberwar.

This emerging U.S. strategy and its requirements demand no less than another revolution in naval affairs, just as other military services are entering parallel transitions. The requisite technologies are being developed by non-defense companies, from very large to very small, for purposes of meeting fast-changing commercial and societal demand: artificial intelligence (AI), complex autonomous systems, and quantum computing and communications, to name three.

Before asserting that the U.S. Navy and its sister services can carry out a revolution by adapting civilian technology to prevent Chinese control of East Asia, there are some issues in need of attention. First, the notion of unmanned ships run by AI is highly controversial, as is demoting large-deck aircraft carriers in the very ocean where they fought and defeated Japan. Second, barriers and disincentives for innovative civilian firms to do business with the defense establishment must be circumvented, short-circuited, and eventually demolished—industrial mobilization by another name.

Third, naval and other leaders will have to be extraordinarily imaginative, willing to tilt at the fortress of tradition and to take calculated risks. An unanswered question is whether the Navy is too "anchor-dragging" and short-sighted to embed the very concept of a fleet within that of an integrated joint force and to regard its ships as "nodes" on a joint all-domain network. Recall the Navy's attachment to battleships before World War II, even as aircraft carriers had demonstrable advantages. Recall the court martial of Mitchell and ostracism of Rickover. Recall how Farragut, Dahlgren, Porter, Welles, and others led the first revolution in naval affairs.

The authors sense that the Chinese threat is motivating senior officers to show the imagination and drive it will take to maintain superior sea power as a major component of a new, information-based U.S. joint, all-domain power. Even so, will they have the political air cover they need from a U.S. Government preoccupied with such other pressing matters as pandemic, climate change, education, voting rights, and immigration? Will they be able to collaborate across Service lines, putting Service jealousies aside?

Conclusions

The Civil War was the pivotal event in the history of the United States. It caused horrendous violence, destroyed the South's economy and "peculiar institution" 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 starve the South's economy proved unrealistic until old ships, obsolete doctrines, and unimaginative officers were replaced. Union leaders, including new admirals, remedied this situation with imagination and vigor. They exploited technology to create capabilities to meet the requirements of their strategy. By war's end, mobilized Northern shipyards were rapidly launching ironclads with rotating turrets and accurate guns.

This narrative did not end with Union victory, for other sea powers transformed their own fleets based on lessons from the American experience. Two of them, Great Britain and Germany, went on to compete for naval superiority in the run-up to war in 1914. Another, Japan, challenged the United States for control of the Pacific. The ships they built had more in common with those the Union built for the Civil War than those Union ships had in common with the legacy ships of 1860. The ships that fought the Civil War were

radically more survivable, and better able to deliver ordnance at greater range and with greater accuracy, than their predecessors. Greater connectivity would come later. The Union fleet proved sustainable for lengthy assignments and versatile enough to cope with the twists and bends of the war, like those of the Mississippi.

From the top down, Union officers and crews escaped the gravitational pull 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, Foote, Dahlgren, Welles, Mitchell, Rickover, and Owens brought change by exploiting technology, as Americans are wont to do. It behooves today's busy naval leaders to study how their predecessors achieved what they did. Revolutionary champions who emerge today will deserve a place in this pantheon.

Appendix. Implementing Anaconda: Selected Naval and Riverine Operations

Aquia Creek (first use of Confederate torpedoes in combat): May 1861

Hatteras Inlet (Forts Clark and Hatteras fall; Stringham's circular attack): August 1861

Head of Passes (first use of ironclad ram): October 1861

Ship Island (staging area for Gulf operations; seized easily): November 1861

Port Royal (first major naval battle, Du Pont uses elliptical attack): November 1861

Fernandina, Jacksonville, St. Augustine (Fort Marion; all taken easily): March 1862

Lucas Bend (first use of Union ironclad): January 1862

Fort Henry (Tennessee River; Foote's main attack by water; successful): February 1862

Fort Donelson (Foote supports Grant's main attack by land; successful): February 1862

Roanoke Island (Forts Blanchard, Huger, Bartow fall; amphibious operations): February 1862

New Bern (Fort Thompson falls; staging area for Atlantic coast): March 1862

Fort Macon and Beaufort Harbor (siege and bombardment): March 1862

Hampton Roads (USS *Monitor* vs. CSS *Virginia*): March 1862

Island No. 10 (Six forts on Mississippi River; Foote runs gantlet): February–April 1862

Shiloh (critical naval support on Tennessee River for Grant): April 1862

New Orleans (Forts Jackson and St. Philip; Farragut runs gantlet, seizes by land): April 1862

Savannah (Fort Pulaski; destroyed by rifled artillery with naval support): April 1862

Fort Pillow and Memphis (on Mississippi River; ram battle): May–June 1862

Plum Point Bend (first Union ironclad sunk): May 1862

Drewry's Bluff on James River (plunging fire from Fort Darling stops Union): May 1862

Galveston (fell October 1862; recaptured by Confederates in January 1863)

Memphis (victory for Union rams and ironclads): June 1862

Vicksburg (Grant and Porter joint operations; successful siege): June 1862–July 1863

Charleston (Union attacks on Forts Wagner and Sumter fail): April–September 1863

Port Hudson (Farragut runs gantlet March 1863; Hudson falls after Vicksburg): July 1863

USS *Ironsides* (attacked by Confederate torpedo boat, ship saved): October 1863

USS *Housatonic* (first sinking of warship by Confederate sub *Hunley*): February 1964

Red River Campaign (Porter's ironclads barely escape): March–May 1864

Albemarle Sound (naval battle including Confederate ironclad): May 1864

James River stalemate (provides Grant freedom for Petersburg siege): May–June 1864

Mobile Bay (Farragut runs gantlet by Forts Morgan and Gaines): August 1864

Plymouth (commando attack sinks *CSS Albemarle,* Plymouth falls): October 1864

Fort Fisher (Terry and Porter amphibious assault succeeds): January 1865

Trent's Reach (Confederate effort to attack City Point by river fails): January 1865

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] Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660–1793* (Boston: Little, Brown and Co., 1890).

[3] 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). In preparing this article, we have drawn heavily on these works for examples to support our thesis.

[4] See Robert McNamara, "Overview of the Anaconda Plan of 1861," *ThoughtCo*, March 7, 2021, available at <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, available at <https://www.wondriumdaily.com/the-anaconda-plan-of-the-american-civil-war/>; and Ken Stover, "Anaconda Plan," *Civil War Academy*, available at <https://www.civilwaracademy.com/anaconda-plan>.

[5] McPherson, *War on the Water*, 131.

[6] Ibid., 32.

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

[8] See ibid for a detailed history of joint Union Army-Navy operations.

[9] McPherson, *War on the Water*, 219.

[10] William H. McNeill, *The Rise of the West: A History of the Human Community* (Chicago: University of Chicago Press, 1963).

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

[12] Ian de Silva, "Evaluating Lincoln's Patented Invention," *Journal of the Abraham Lincoln Association* 39, no. 2 (Summer 2018), 1–28.

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

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

[15] McPherson, *War on the Water*, 71.

[16] Ibid., 87.

[17] Ibid., 169.

[18] Ibid., 176.

[19] This is a main theme of Murray and Hsieh, *A Savage War*.

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

[21] *The Civil War Remembered: Official National Park Service Handbook* (Virginia Beach, VA: Donning Co., 2011).

[22] McPherson, *War on the Water*, 224.

[23] Ibid., 52–53.

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

[25] Noted in McPherson, *War on the Water*.

[26] Ibid.

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

[28] U.S. Naval Academy professor and Civil War historian Wayne Hsieh points out that jointness was a glass half-full/half-empty during the Civil War. As we explain, the institutions, command chains, and decision protocols of jointness came after, not during, the Civil War. Although primitive forms of jointness showed promise, think of how effective Union forces especially would have been if true jointness had been in effect and how many opportunities were missed for lack of true jointness. Indeed, with a superior Union Navy and a large and increasingly capable Union Army, the war might have been won more quickly and with less loss if jointness had been in place.

[29] McPherson, *War on the Water*, 176.

[30] 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.

[31] Townsend's copy of this report came from the British Navy and was heavily marked up.

[32] Dougherty, *Strangling the Confederacy*, 31–38.

[33] These numbers are compiled from Potter and Nimitz, *Sea Power*; and McPherson, *War on the Water*.

[34] Mahan, *The Influence of Sea Power upon History*, 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."

[35] McPherson, *War on the Water*, 5.

[36] Ibid., 104.

[37] Dougherty, *Strangling the Confederacy*, 161.

[38] McPherson, *War on the Water*, 119.

[39] Ibid., 4.

[40] Ibid., 82–85.

[41] 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).

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

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

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

[45] ICBMs and strategic bombers also played a role.

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

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

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

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

About the Authors

David C. Gompert is on the faculty of the U.S. Naval Academy and a senior advisor to Ultratech Capital Partners. He was Principal Deputy Director and Acting Director of National Intelligence in 2009 and 2010.

Hans Binnendijk is a Distinguished Fellow at the Atlantic Council. He was previously the National Security Council's Senior Director for Defense Policy, Principal Deputy Director of the State Department Policy Planning Staff, and Director of the National Defense University's Institute for National Strategic Studies.

Both authors are on the Board of Directors of the American Civil War Museum.


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