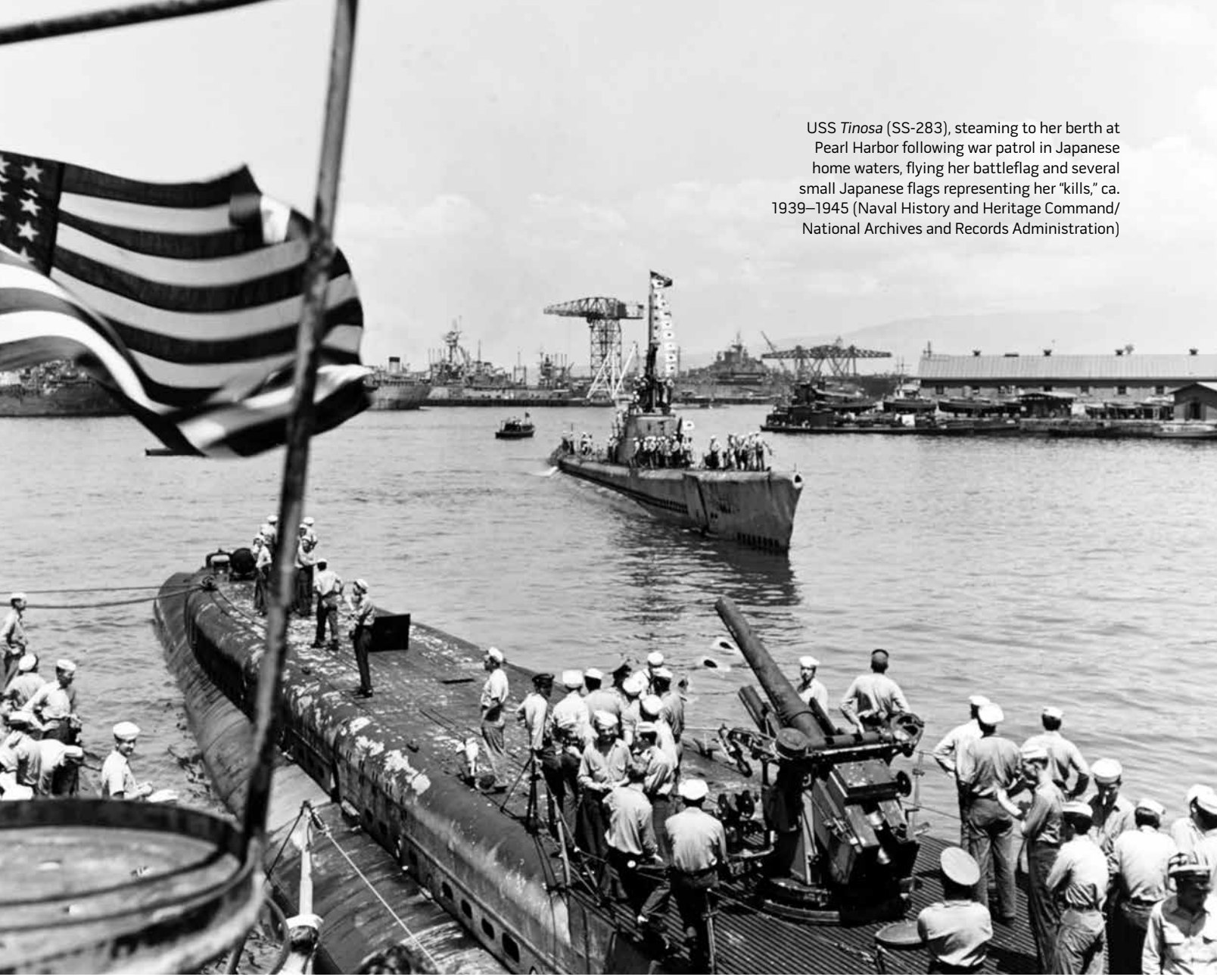

USS *Tinosa* (SS-283), steaming to her berth at Pearl Harbor following war patrol in Japanese home waters, flying her battleflag and several small Japanese flags representing her "kills," ca. 1939–1945 (Naval History and Heritage Command/ National Archives and Records Administration)

Wartime Innovation and Learning

By Frank G. Hoffman

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Wars are the ultimate test for any armed service. They reveal how well military institutions perceived the context of future conflict, how they prepared for war, and how their force design and development processes succeeded in anticipating threats and exploiting emerging technologies. The strategic environment characterized by the 2018 National Defense Strategy is one of significant technological change and diffusion, opening new opportunities for improving U.S. military effectiveness. But the same disruptive advances are also available to potential adversaries.[1] This reality led to then–Secretary of Defense James Mattis's injunction in the National Defense Strategy "to create a culture of experimentation and calculated risk taking" to construct new sources of advantage by combining material, conceptual,

and organizational change to generate innovative warfighting capabilities and sustain our competitive edge.[2]

Pursuant to the strategic direction outlined by the Department of Defense, the Joint Staff evolved its Joint Force Design and Development activities to better enable the joint force to generate and maintain its competitive advantage, improve force posture, and increase the joint force's responsiveness in this dynamic environment.[3]

The Joint Chiefs have operationalized the strategic direction in the National Defense Strategy via the latest vision for joint professional military education (JPME). That vision defines a key learning objective for U.S. military officers, tasking them to "[a]nticipate and lead rapid adaptation and innovation during a dynamic period of acceleration in the rate of change in warfare under the conditions of Great Power competition and disruptive technology."[4] That vision is further reinforced in the latest version of the Officer PME Policy issued in 2020, which defined the requirement to prepare officers to recognize the need for change and to lead transitions as desired educational outcomes.[5] However, these are not just peacetime tasks distinct from warfighting. As recent scholarship demonstrates, the side that is open to self-assessment in wartime—and reacts faster—increases its chances of prevailing in peace and in war.[6]

The following case study details how one leader effectively integrated new operational concepts with a novel technological device to generate a capability in a combat theater. A collection of adaptations produced a new military innovation that was developed and tested incrementally and then applied in wartime. It is a great example of the integration of the research and development community operating forward in time of war to improve a new technology. A few insights regarding leadership and JPME can be drawn from this example. There are no detailed blueprints that we can draw upon for how to best exploit new technologies in every case, but history remains our best source for generating the right questions in the future.

Learning in Action

There is a lot of scholarship that details the enormous value of the U.S. Navy's pre–World War II learning system and how well the Service forecasted the contours of the tough Pacific campaigns. The Navy's interwar development of a campaign strategy known as War Plan Orange, its longstanding plan for responding to Japanese aggression in the Pacific, is well chronicled.[7] More recently, Trent Hone extended this narrative, focusing on the achievements of the Service's surface force before and during World War II.[8]

An appreciation of the development and exploits of the U.S. submarine force in the Pacific campaigns is emerging,[9] and the learning within the "Silent Service" is the focus of this article. Operational leaders recognized that critical challenges limited our submarines against the Japanese empire, and they overcame these with creative plans and rigorous experimentation.[10] These developments culminated in not only a daring operation that could be the Navy's greatest raid but also a model for combat leadership and adaptation in wartime.

The principal actor in this case study is Vice Admiral Charles Lockwood. He was considered among his peers as the chief advocate for the long-range fleet submarine during the interwar period and was called "Mr. Submarine."[11] Postwar reports comment positively on Lockwood's operational leadership. Known for an informal style and for being a gentle critic and dedicated mentor, he defended subordinates and reflected "loyalty down" rather than just demanding compliance.[12] He deferred to his commanders because he understood that they had the best insights, once noting, "I make my decisions based on reports from boat commanders sent through their superiors, not from intuitive estimates or guesses. I rely heavily on the judgments of those in command of the submarines on the spot, and wholeheartedly support their decisions because they are there."[13]

Lockwood was open to new ideas and actively sought out commanders such as the highly successful Commander Dudley "Mush" Morton for personal interviews. He read and commented on the reports written by the boats after each patrol. Lockwood attempted to ensure he had the best information from the fighting units of his command. He would personally meet each boat as it returned to port and would go over reports with the commanders.[14] He also repeatedly sought to get operating time inside the more modern boats being deployed with new technologies such as the Torpedo Data Computer and sonar radar. He collected insights and evidence from many sources and even sought contradictory information. In doing so, this hands-on approach ensured that new concepts for fighting the war came not just from the top down but also from the bottom up and middle out.[15]

His subordinates described him as "not conformist and against rule book thinking."[16] Lockwood was willing to experiment in theater with live ordnance under realistic conditions, whether to fix faulty torpedoes or to adapt new weapons and detection systems. He was also willing to press hard to get necessary changes and confronted Admiral Chester Nimitz and the naval bureaucracy to get the support he needed.[17] Lockwood was persistent in trying to enhance the effectiveness of his force and was open minded about new tactics and new technologies. As a model for wartime adaptation, one is hard pressed to find a better example than Lockwood.

Context

While the contours of War Plan Orange and the Navy's extensive wargaming played out in the early stages of the war, the submarine force had to adjust its doctrine and rectify several material deficiencies.[18] In particular, flaws in their torpedoes marred the forces' performance. This led to a lot of frustration in the fleet, but solutions were found by the middle of 1943 to correct these shortcomings. By the end of 1943, the Submarine Force, U.S. Pacific Fleet (SUBFORPAC), was carrying out an aggressive campaign of attrition on Japan's sea lines of communication.[19]

USS *Sea Dog* (SS 401) on war patrol, May 1945 (Naval History and Heritage Command/National Archives and Records Administration)

Admiral Lockwood, commander of SUBFORPAC since February 1943, realized that the closer the campaign moved toward Japan's home islands, the harder resistance would be. Operations would be conducted in shallow and possibly mined waters, and with far greater exposure to land-based air reconnaissance. Moreover, the Japanese were becoming more effective at antisubmarine warfare. He anticipated his force would need to seek out new methods and capabilities to improve its offensive and defensive tool kit.

The initiation of wolf packs by SUBFORPAC was one of these new methods. They were directed from Washington by Chief of Naval Operations (CNO) Admiral Ernest King in April 1943. The submarine community had been skeptical of Collective Action Groups, as King called them, due to poor ship-to-ship communications and the potential for inadvertent "blue-on-blue" incidents. The community recognized that it had different operational conditions (longer ranges, less maneuver space, and fewer targets) than the German navy faced in the Atlantic. Its problem was not with large convoys; it needed to find small targets in a big ocean. Rather than embrace the German *Kriegsmarine*'s melees at sea, SUBFORPAC staff members evolved their own approach.[20] These tactics overcame Lockwood's skepticism, using improved radios and a training program crafted by combat veterans. These tactics were employed for the first time in October of 1943 and refined well into 1944.

Partly due to better torpedoes, as well as more boats and updated tactics, the results generated by Lockwood's command were much improved in 1944. More submarines, with shorter transit distances from Guam and Saipan, produced intensive patrols in closer contact with Japan's defense. SUBFORPAC reported 520 combat patrols, 50 percent more than 1943, using an increased number of submarines with shorter routes. With torpedoes now both plentiful and functioning, the Navy's submarines surged against their targets. They fired more "fish" in 1944 than in all of 1942 and 1943 combined. They sunk more than 600 ships and put 3 million tons of shipping to the bottom of the Pacific. Japan's imports were slashed by one-third, and its commercial fleet was reduced by half, from 4.1 to 2 million tons. Oil imports dropped sharply, which severely impeded Japan's military operations and training. But the force's aggressive attacks were met by new Japanese interest in antisubmarine capabilities, including patrol planes and better radars. In 1943, the fleet lost 16 boats and their

crews—including the highly regarded Commander Morton and his boat, the famous USS *Wahoo*.[21] The following year, another 19 U.S. boats were lost.[22] Operational success was being achieved, but at a price.

New Opportunities

These losses troubled Lockwood, but they also made him redouble his efforts to enhance the capabilities of his force. For some time, Lockwood had worked to create an innovative plan to unlock the Sea of Japan, a triangle-shaped area covering nearly 400,000 square miles, bordered by Korea, Russia, and the Japanese islands. The seeds of that operation can be traced to a trip Lockwood made to San Diego in April 1943 to visit the shipyards and infrastructure supporting his force. The admiral paid a visit to the University of California's Division of War Research, which was run by Dr. George P. Harnwell, a physicist. Harnwell gave an overview of the various technologies being explored to support the Navy. Lockwood recalled their briefing as a "Wonderland of Ideas," but many were not yet mature or seaworthy.[23] One of these was a new detection sensor they called Frequency Modulated Sonar (FMS), which was still in its infancy. Lockwood admitted later that he did not anticipate how valuable FMS might become at the time.

FMS operated like regular sonar, transmitting a signal that returned to its originating source where the echo produced a visual display on an indicator plot screen. What was unique about FMS is that its signals were silent and did not emit an audible ping that could be detected by the opponent. The system showed an ability to locate subsurface objects, including nets, whales, schools of fish, and rocks/shoals, all of which were displayed in bright green pear-shaped signals on the screen. The system included a speaker that would make a distinctive tone when it identified a hard object. The intensity of the tone and clarity of the green pear display alerted the operator to the presence of submerged objects such as mines. One veteran sonarman stated, "It sounded like a chamber of horrors, it howled something awful."[24] The laboratory at San Diego named the bell tones "Hell's Bells," and the name stuck when FMS was introduced.[25] The initial range of the signal from FMS was limited to a few hundred yards, but the value was evident if all the kinks could be worked out.

Lockwood was impressed enough to begin the bureaucratic maneuvering to ensure that the first available FMS sets would be assigned to his command for testing. The first tests occurred about a year later, with SS-411, *Spadefish*, under the command of Commander Gordon "Coach" Underwood, with a deck-mounted FMS. *Spadefish* tested the device off San Diego against dummy minefields before reporting to Pearl Harbor in June 1944. Lockwood immediately interrogated Underwood on his impressions. He went aboard *Spadefish* and directly observed the new sonar, as Underwood's crew put it through its paces. These trials convinced him that the doors into the Sea of Japan could be unlocked and that "FM Sonar was the magic key that could perform the marvel."[26]

Lockwood was satisfied enough to brief his boss, Admiral Chester Nimitz at Pacific Fleet, who approved efforts to gain additional FMS sets to accelerate their introduction into the Pacific theater.[27] At an arranged meeting during the CNO's visit to Hawaii in July 1944, Lockwood gained King's support for shifting FMS production of 12 sets from minesweepers to his command.

The gears of the Navy's acquisition bureaus ground slowly but surely, and Lockwood got one dozen sonar sets for his force. He continued to invest his personal time and attention in the introduction of sonar and the development of tactics with a series of experiments out of Pearl Harbor. When he could, Lockwood himself observed the experiments. Ultimately, the testing evolved, with one submarine, *Tinosa*, taking FMS on a combat patrol. *Tinosa*, skippered by Commander Richard Latham, patrolled an area off Formosa and the East China Sea where mines were likely to be found.[28] Latham identified 200 mines at range and gave an enthusiastic report on FMS. Other boats testing the system, however, reported discouraging failure rates. Lockwood's faith in sonar was strained by uneven quality largely due to faulty vacuum tubes. The admiral stated that sonar showed "streaks of mulish obstinacy."[29]

But as new boats came in with keel-mounted and increasingly effective FMS sets, Lockwood's confidence grew. He sketched out an operation to penetrate the Sea of Japan to the CNO in December 1944. By striking into the heart of the last sinews of communications and logistics between the Asian mainland and Japan, Lockwood hoped to sever those lines of communication and make Tokyo realize that the war was irrevocably lost. Arguably, the Japanese would be forced to dilute their defenses on the Pacific Ocean side of their country, which was the major target for U.S. air and sea operations. Cutting off Japanese sources of rice, construction materials, ore, and reinforcements from Asia could also materially aid the U.S. war effort. The mission was approved the same month and kicked off the formal planning for a complex raid.

Operational Concept

The raid employed a novel approach. Rather than have a pack of attack boats concentrate on a single target set like a large convoy, the concept of operations had nine boats entering the Sea of Japan and then distributing themselves for simultaneous attacks at a set time. This is essentially the opposite of the German navy wolf pack tactics, which patrolled widely and then aggregated upon slow-moving convoys.

"I want to send all the boats we can muster in at the same time," Lockwood summarized years later, "hit the [Japanese] like a ton of bricks, and pull out before they can properly organize their opposition."[30] This concept would overwhelm the Japanese navy and dilute its counter-responses. Lockwood sought to maximize surprise and destruction with a sudden set of attacks, which would hopefully reduce the ability of the Japanese to quickly react effectively.

Map. Operation *Barney*

Source: Nations Online Project

The plan was devised by Captain William "Barney" Sieglaff, a veteran submariner with 15 vessels sunk to his credit. Somewhat comically, the operational plan was titled Operation *Barney* in honor of its initial designer. The plan was framed around three major events:

- transit through the mine-strewn straits (Fox Day, June 4)
- initial attack time (Mike Day, June 9)
- exit (Sonar Day, June 24).

The entire task force of nine boats would sail from Guam. It was titled the "Hellcats" and divided into three smaller groups under the command of the most senior boat captain. The three groups were called the Hepcats, Polecats, and the Bobcats (see map).

As part of the plan, the Hepcats would sail on May 27, followed by the other groups over the next 2 days. This plan allowed 3 days for the treacherous penetration of the straits, a precarious 16-hour event for each pack. The passage through the mined straits was further complicated by the steady Kuroshio current that would push them along. The intelligence gained from prior patrols identified four belts of mines, 50 to 75 yards apart. Once that barrier was pierced, the task force would maneuver to its attack positions. The task force was given 2 weeks to attack military and commercial shipping before regrouping and exiting via La Pérouse Strait on Sonar Day.

Table. Operation *Barney*: Key Players

Boat	Commander	Results
Hepcats		
Sea Dog SS-401	Earl Hydeman	6 Marus, 7,928 tons
Crevalle SS-291	Everett Steinmetz	3 Marus, 1 frigate, 6,643 tons
Spadefish SS-411	Bill Germershausen	4 Marus, 6,300 tons
Polecats		
Tunny SS-282	George E. Pierce	None
Bonefish SS-223	Lawrence Edge	2 Marus, 12,400 tons
Skate SS-305	R. B. (Ozzie) Lynch	4 Marus and I-122, 6,400 tons
Bobcats		
Flying Fish SS-221	Robert Risser	2 Marus, 4,113 tons
Bowfin SS-287	Alec Tyree	2 Marus, 6,300 tons
Tinosa SS-283	Dick Latham	4 Marus, 6,690 tons

Execution

The three packs carefully made their way through the minefields, with only a few daunting incidents. Without FMS, Fox Day could have been a finale for any of the Hellcats. The Hepcats steamed north into the northeastern part of the Sea of Japan with assigned target areas off Hokkaido. *Crevalle* hunted off Suneko Saki, and *Spadefish* stalked near Otaru, at Ishikari Bay. *Sea Dog* struck first on June 9 against three cargo ships, but a hurried attack failed, and in escaping Commander Earl Hydeman dived too fast and too deep. *Sea Dog* ran aground in a soft seabed and had to slowly back off minus a few sensors. Despite numerous mechanical casualties, Hydeman sunk six small merchants in shallow water. *Spadefish* was almost as successful, eliminating four ships and 6,000 tons. *Crevalle* took on three targets the first 3 days and put them to the bottom of the sea with only five torpedoes. Over the next week, 5 different attacks and 11 "fish" produced no hits. Torpedo failures still plagued the crews. Then on June 22, Commander Everett Steinmetz's firing team successfully attacked the frigate *Kasado*. It was later recovered from the bay but was never operational again.[31]

The east coast of the Korean Peninsula was assigned to the Bobcats. They had a more difficult passage through the treacherous minefields. At one point, the crew described hearing "the squeal of steel on steel" working down port side of *Tinosa*; a mine cable was passing alongside the length of the boat, sounding like fingernails across a blackboard for what seemed like several minutes.[32] Fortunately, they did not activate any mines. After successfully navigating the narrow Tsushima Strait, Commander Richard Latham, commanding *Tinosa*, moved to his sector off the port of Bukuko Ko. With numerous visible targets, he could not contain himself. He launched an attack at exactly 1503 hours, well before sunset on Mike Day, and sunk an unsuspecting freighter.[33] Latham's crew successfully bagged three more during the operation. *Flying Fish* and *Bowfin* proceeded to stand off Seishin and Rahshin harbors until they could begin their attacks.

The Polecats were assigned to cover the west coast of the major island of Honshu. *Tunny* staked out Kyoga Misaki outside the bay of Wakasa Wan. The skipper, Commander George Pierce, found few targets off the coastline, despite his efforts to lean into shallow water. *Skate* fared better. On June 10, it ambushed a submarine, *I-122*, running on the surface and sent it to the bottom. Later, R.B. Lynch's team on *Skate* attacked and claimed four cargo ships. Three were sunk with a spread of six torpedoes Lynch fired from long distance at several cargo vessels hiding in a cove on the west coast of Honshu.

Bonefish was initially ordered to Toyama Bay but found no targets. Subsequently, the captain, Commander Lawrence Edge, requested to move to a more productive area. Edge successfully attacked and sunk the 6,892-ton cargo vessel *Ojikasan Maru* on June 13, 1945. On June 16, 1945, he kept a rendezvous with his Polecat leader, Commander Pierce, and informed him of this sinking. He also asked for permission to conduct a submerged daylight patrol back in Toyoma Wan, which had a depth of 600 fathoms in the mid-part of western Honshu. *Bonefish* successfully attacked and sank a ship, the 5,488-ton cargo vessel *Konzan Maru*, in Toyama Wan on June 18. However, Japanese records show that the next day a Japanese frigate and several corvettes depth-charged a submarine in Toyama Wan, and extensive debris and an oil slick were recorded

by the Japanese. There were no more reports from Commander Edge, and *Bonefish* did not join the rest of the task force at their rendezvous.

After sunset on June 24, Hydeman led the remaining eight boats out of La Pérouse Strait with a high-speed, night-surface dash. They passed through the strait and its strong current into safety. *Tunny* stayed for a few days, hoping that *Bonefish* had been forced to delay its exit due to an engineering problem. The rest of the task force sped home. They arrived July 4 to a hero's welcome at Pearl Harbor. The celebrations were restrained once *Bonefish* was declared as lost.

Overall, two Japanese naval craft, 28 modest-sized cargo ships, and numerous small craft were sent to the deep bottom of the sea—for a total of 65,000 tons. The operational results of each boat in the operation are detailed in the table.

Assessing this mission's results is difficult at the operational and strategic levels. The raid did overwhelm Japan's defense. Regrettably, there were few major targets, and even fewer once the Japanese knew their sanctuary had been compromised. The loss of *Bonefish* and her gallant crew was a calculated risk that offset the gains from the attack. This loss was a gut punch to the small submarine force, but the pending invasion of Japan in Operation *Downfall* posed far more horrific costs.[34] Lockwood hoped to further isolate Japan, materially and psychologically, with this daring raid. Ultimately, the indirect impact on Japanese strategic calculations and morale are unknown, but Lockwood concluded the operation was worth the risk.[35]

Insights

Professor I.B. Holley warns that "it is folly to expect the record of the past to deliver us neat little packages called 'lessons of history' with exacting prescriptive detail. Instead of tidy answers that alleviate inquiry, we explore history to stimulate our thinking and to get better questions to probe the present with."[36] With this caution in mind, some insights can be drawn from Operation *Barney*. These insights include the value of the enduring necessity of rapid wartime learning, the role of leaders and culture that embrace openness, and the importance of technological literacy.

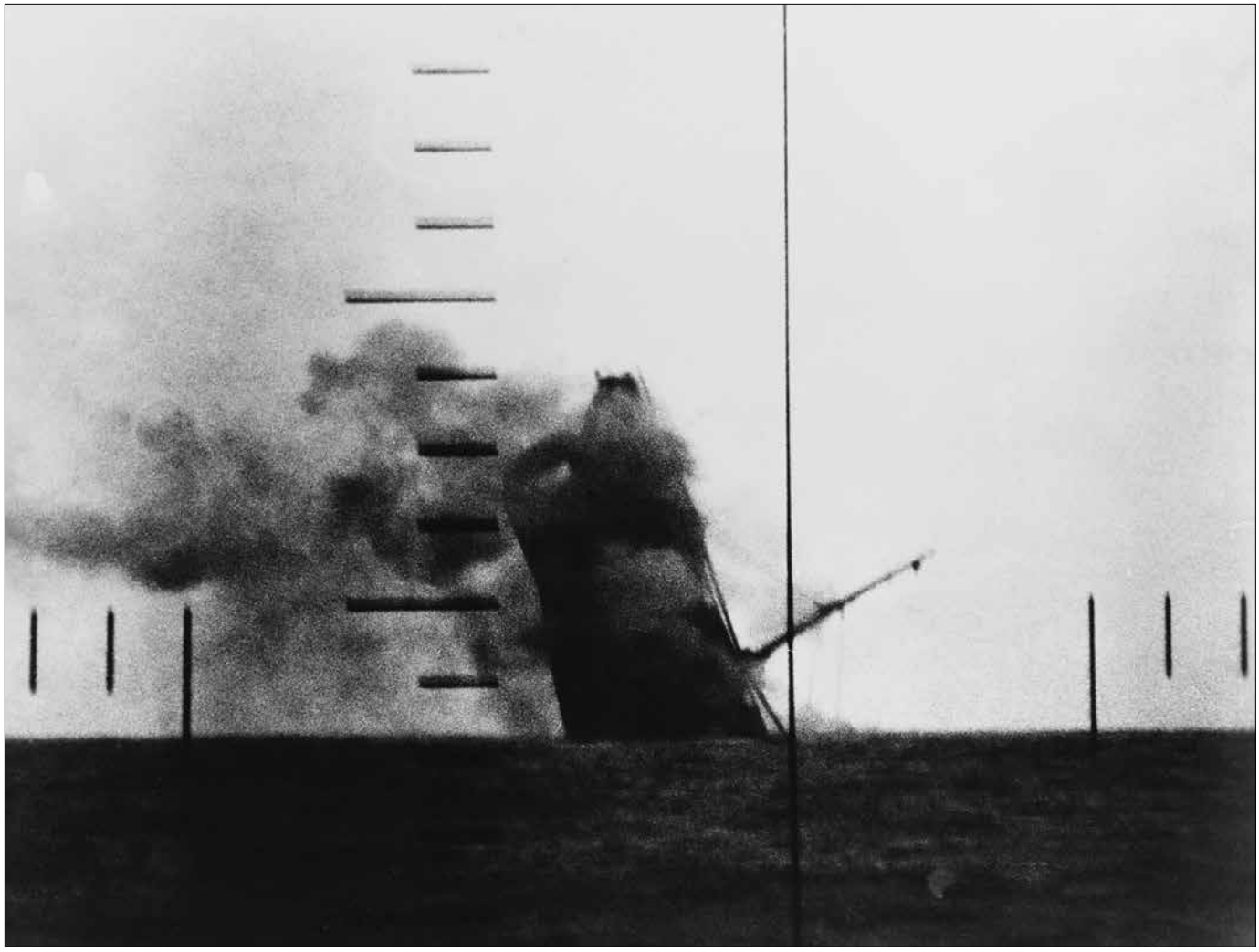
Operational Learning and Adaptation. The Navy's learning system before and during World War II is worthy of study and emulation. The ultimate weapon throughout the Pacific campaign was the Navy's learning culture and mechanisms. The velocity of learning across the Pacific force contributed to a growing overmatch between the respective navies.[37] The Navy systemically gathered operational experience or lessons learned from the fleet in patrol reports and from tests and trials that Lockwood conducted out of Perth, Pearl Harbor, and Guam.[38] As one recent historical account of the early stages of naval warfare in the Pacific notes:

If the navy did one thing right after the debacle of December 7, it was to become collectively obsessed with learning, and improving. Each new encounter with the enemy was mined for all the wisdom and insights it had to offer. Every after-action report included a section of analysis and recommendations, and those nuggets of hard-won knowledge were absorbed into future command decisions, doctrine, planning, and training throughout the Service.[39]

This meant that the Navy's tactical development was thorough and grounded in a realistic understanding of the battlespace, and it was generated from the middle out by operators.[40] In an excellent example of double-loop learning, where operator input makes it all the way to headquarters and is recycled out to the fleet, the SUBFORPAC commander identified key operational challenges and used a campaign of deliberate experimentation by operational commanders to determine the best combination of organizational, tactical, and technological change to resolve its challenges.[41] The concurrent development of both "American wolf pack" tactics and sonar reflects this approach. Such an approach reinforces key insights of wartime and interwar innovation.[42] Lockwood also promoted "horizontal learning" between boats in order to accelerate learning and increase operational effectiveness.[43] The Navy fostered this technique by distributing war patrol reports across the fleet and by having formal endorsements of the conduct of attacks and proposed tactical fixes after each patrol. Historians find both formal and informal mechanisms are necessary to distribute new ways of fighting.

Leadership and Technological Literacy. We operate today in a period often described as an era of disruptive change. Lasers, rail guns, artificial intelligence, and hypervelocity missiles generate new opportunities and threats to the fleet. In World War II, our submarine force operated in a similar era, with radar, tactical data computers, electric homing torpedoes, and various sonar options emerging in a compressed time. Fortunately, our leaders were well trained; they not only knew their seamanship, but they were also well educated in naval engineering. As Wayne Hughes notes, the Navy's best tacticians, from admirals William Sims to Bradley Fiske to Arleigh Burke, knew the benefits and limits of current and prospective technology.[44] Current Navy doctrine notes that "tactics and technology are two sides of the same coin" and enjoins leaders to "inculcate a culture of lifelong learning to foster innovative thinking, adaptability, [and] technical expertise."[45] Like Lockwood, today's leaders must be tech-savvy and understand the potential of emerging technology to be able to adapt it in new ways to solve future problems, even problems for which that technology may not have been originally designed.

With his open learning approach, Lockwood is an outstanding example of a leader of innovation. Current research suggests that openness is invaluable as a leadership attribute. This is manifested in a strong intellectual curiosity, creativity, and a degree of comfort with novelty and variety. Leaders high in openness search for a range of relevant and conflicting perspectives and often spot opportunity earlier than others.[46] Military historians also find this style of leadership as a key variable to promote the requisite critical



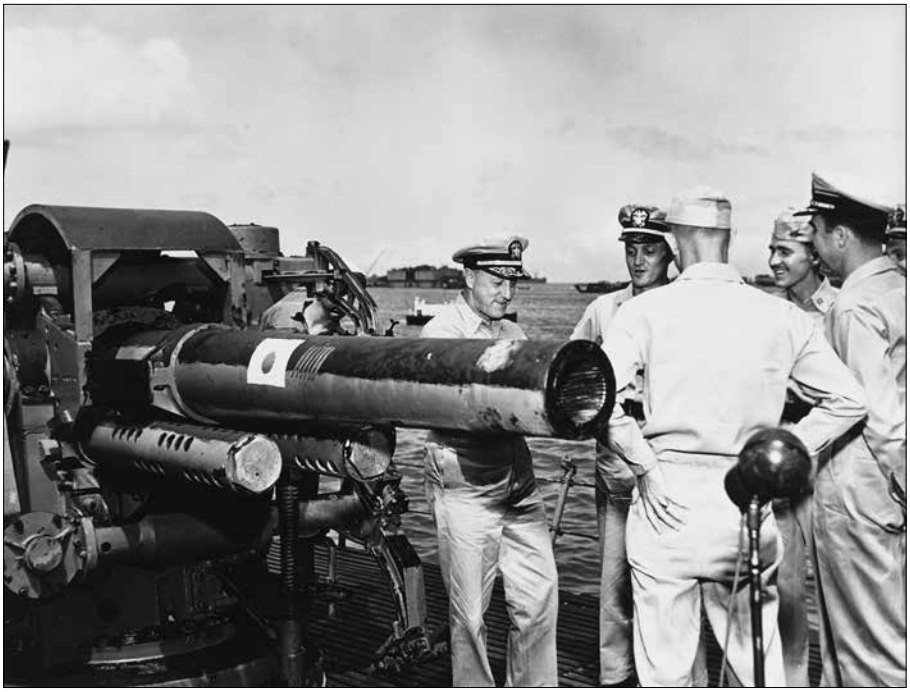
Japanese freighter *Nittsu Maru* sinks in Yellow Sea after being torpedoed by submarine USS *Wahoo*, seen through its periscope, on March 23, 1943 (U.S. Navy/National Archives and Records Administration)

thinking and open debate needed to assess and implement innovation.[47]

Changes in the character of war demand literacy in the implications of ongoing technologies. This is a new objective for our PME institutions, one that should be reflected across the entire system. As noted by Australian Major General Mick Ryan in the pages of this journal, "Over the coming years, at almost every rank level, military personnel will require basic literacy in a spectrum of new and disruptive technologies."[48] Providing this degree of basic literacy to mid-career officers is needed but poses challenges to the Services with near-term readiness demands. Yet the study of innovation and adaptation should be a core component of senior leader education, in addition to introductions to military-relevant emerging technologies.[49] Graduates of top-level schools are going to be leaders in innovation in this era of disruptive change, and their education must reflect that.

The key leaders in this case were also barrier busters and champions for change, willing to overcome slow-moving bureaucrats when needed. Most relevant to today's strategic competition, Lockwood recognized the opportunity presented by the technology as it matured and fought aggressively to get this technology to his operators to exploit it. Not content with isolated development by technicians, he got the San Diego scientists to bring their expertise to Hawaii and other forward bases to merge development and tactics to maximize learning, while also training his people to maintain the new equipment.

Joint Warfighting Culture. This case study does not indicate much appreciation for joint operations. The operation was planned solely as a Navy submarine operation from beginning to end. It could have been a much larger joint operation applying a more integrated approach that would have enhanced the effectiveness of the offensive mission and reduced some of the operational risk. Today, such a mission would be designed as a joint operation, with special operations forces helping distract the adversary, perhaps by attacking a land-based radar site, with U.S. Cyber Command disorienting the Japanese command and control systems, and with the Air Force conducting strikes on Japanese airfields to negate maritime reconnaissance flights over the area being launched. This was a high-risk operation that could



Vice Admiral Charles A. Lockwood, USN, Commander Submarine Force, Pacific Fleet (center), on board USS *Balao* (SS-285), with *Balao*'s Commanding Officer, Lieutenant Commander Robert K.R. Worthington (right of Lockwood, facing camera), welcoming submarine back to port from successful war patrol, ca. early 1945, probably Guam (U.S. Navy/National Archives and Records Administration)

have benefited from a joint combined arms approach.[50]

But 75 years ago, the Services were not always ready to operate as a joint team. Nor was America prepared to operate jointly later in Korea or Vietnam.[51] In the future, globally integrated operations across domains and geographical boundaries are expected to be the norm, mandating increased attention to joint and combined opportunities. Fortunately, we have a much stronger degree of jointness today at the operational level. Yet joint acculturation and education are perishable competitive advantages today and should not be taken for granted.[52]

Conclusion

Admiral Lockwood's vision about Frequency Modulated Sonar and his careful nurturing of the technology offer a valuable case study for today's joint warfighting community in a looming era of potentially disruptive change. The concurrent adaptation of new technology, operational concepts, and organizational change was evident in the submarine force. Operation *Barney* offers a periscope view into the Navy's learning system, from which we can draw some probing insights. Our current conception of operational competence must extend to learning how to innovate in contact with the enemy and deal with new technologies. "Learning under fire" can be a force multiplier if commanders are well educated in historically informed patterns of innovation and adaptation and develop a modest degree of technical literacy.

Overall, this operation exemplifies adapting to the always evolving character of warfare and highlights the application of innovation in combat leadership by senior leaders. It exemplifies how creative solutions to tough operational challenges in the Pacific were pursued and continuous adaptation obtained in a contested environment. We can all learn much from Vice Admiral Lockwood's leadership and the adaptive learning and valor of the Hellcats. **JFQ**

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Notes

[1] On emerging technologies and their likely implications, see T.X. Hammes, *Deglobalization and International Security* (Amherst, NY: Cambria, 2019).

[2] *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Washington, DC: Department of Defense, January 18, 2018), 7.

[3] Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3030.01, *Implementing Joint Force Development and Design* (Washington, DC: The Joint Staff, December 3, 2019).

[4] *Developing Today's Joint Officers for Tomorrow's Ways of War: The Joint Chiefs of Staff Vision and Guidance for Professional Military Education and Talent Management* (Washington, DC: Joint Staff, May 1, 2020), available at <https://www.jcs.mil/Portals/36/Documents/Doctrine/education/jcs_pme_tm_vision.pdf?ver=2020-05-15-103733-103>.

[5] CJCSI 1800.01F, *Officer Professional Military Education Policy* (Washington, DC: The Joint Staff, May 15, 2020). The Officer Professional Military Education Policy defines a desired leadership attribute for officers as being prepared to "respond to surprise and uncertainty" and "recognize change and lead transitions."

[6] David Barno and Nora Bensahel, *Adaptation Under Fire: How Militaries Change in Wartime* (New York: Oxford University Press, 2020).

[7] On War Plan Orange, see Edward S. Miller, *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897–1945* (Annapolis, MD: Naval Institute Press, 1991). On aviation capability developments, see Geoffrey Till, "Adopting the Carrier," in *Military Innovation in the Interwar Period*, ed. Williamson Murray and Allan R. Millett (New York: Cambridge University Press, 1996), 191–225.

[8] Trent Hone, *Learning War: The Evolution of Fighting Doctrine in the U.S. Navy, 1898–1945* (Annapolis, MD: Naval Institute Press, 2018).

[9] See Joel Holwitt, "Unrestricted Submarine Victory: The U.S. Submarine Campaign Against Japan," in *Commerce Raiding: Historical Case Studies, 1755–2009*, Newport Papers 40, ed. Bruce A. Elleman and S.C.M. Paine (Newport, RI: Naval War College, October 2013).

[10] For a more detailed overview of submarine adaptation, see Mick Ryan, "The U.S. Submarine Campaign in the Pacific, 1941–45," *Australian Defence Journal*, no. 90 (March/April 2013), 62–75; Francis G. Hoffman, "Adapt, Innovate, and Adapt Some More," U.S. Naval Institute *Proceedings* 140, no. 3 (March 2014), 30–35.

[11] I.J. Galantin, *Take Her Deep! A Submarine Against Japan in World War II* (Annapolis, MD: Naval Institute Press, 2007), 29.

[12] Ibid.

[13] John G. Mansfield, Jr., *Cruisers for Breakfast: War Patrols of the U.S.S.* Darter *and U.S.S.* Dace (Tacoma, WA: Media Center, 1997), 221.

[14] Charles A. Lockwood, *Sink 'Em All: Submarine Warfare in the Pacific* (New York: Dutton, 1951), 33.

[15] Paul Kennedy, *The Engineers of Victory: The Problem Solvers Who Turned the Tide in the Second World War* (New York: Random House, 2013).

[16] Theodore Roscoe, *United States Submarine Operations in World War II* (Annapolis, MD: Naval Institute Press, 1949), 225.

[17] Brayton Harris, *Admiral Nimitz: The Commander of the Pacific Ocean Theater* (New York: St. Martin's Press, 2012).

[18] On prewar planning, see Joel Ira Holwitt, *"Execute Against Japan": Freedom-of-the-Seas, the U.S. Navy, Fleet Submarines, and the U.S. Decision to Conduct Unrestricted Warfare* (College Station: Texas A&M University Press, 2008).

[19] On the early stages, see Clay Blair, Jr., *Silent Victory: The U.S. Submarine War Against Japan*, vol. 1 (New York: J.B. Lippincott Company, 1975).

[20] The boats out of Brisbane also developed cooperative methods. See Blair, *Silent Victory*, 453–456. Also see Frank G. Hoffman, "The American Wolf Packs: A Case Study in Wartime Adaptation," *Joint Force Quarterly* 82 (2nd Quarter 2016), 34–38.

[21] *Wahoo* was lost in an early attempt at penetrating the Sea of Japan. For more on Commander Dudley "Mush" Morton and the intrepid crew of *Wahoo*, see Richard Kane, *Wahoo: The Patrols of America's Most Famous World War II Submarine* (Novato, CA: Presidio, 1996).

[22] Roscoe, *United States Submarine Operations in World War II*, 432–433; Clay Blair, Jr., *Silent Victory: The U.S. Submarine War Against Japan*, vol. 2 (New York: J.B. Lippincott Company, 1975), 791–799.

[23] Charles A. Lockwood and Hans C. Adamson, *Hellcats of the Sea: Operation Barney and the Mission to the Sea of Japan* (Los Angeles: Bowsprit, 2018), 20.

[24] Cited in Steven Trent Smith, "Payback: Nine American Subs Avenge a Legend's Death," *History.net*, available at <https://www.historynet.com/uss-wahoo-vengeance.htm>.

[25] Peter Sasgen, *Hellcats: The Epic Story of World War II's Most Daring Submarine Raid* (New York: Caliber, 2010), 74–75.

[26] Lockwood and Adamson, *Hellcats of the Sea*, 22.

[27] Western Electric was under contract to produce these initial sets for the Navy's minesweepers.

[28] Commander, USS *Tinosa*, 8th War Patrol Report, dated September 14, 1944. The patrol reports are available at <https://www.hnsa.org/manuals-documents/submarine-war-patrol-reports/>.

[29] Lockwood and Adamson, *Hellcats of the Sea*, 41. These frustrations were based on the commander, USS *Spadefish*, Fourth War Patrol Report, April 14, 1945, which included a special mission report on its efforts to identify mines in the Tsushima Strait with poor performance from Frequency Modulated Sonar.

[30] Lockwood and Adamson, *Hellcats of the Sea*, 53.

[31] Commander, USS *Crevalle*, War Patrol Report #7, July 5, 1945.

[32] Sasgen, *Hellcats*, 185.

[33] Lockwood and Adamson make note of this in *Hellcats of the Sea*, 165.

[34] Operation *Downfall* was the U.S. plan for invading Japan's main islands, and it was projected to be costly in terms of casualties for both sides. See Richard B. Frank, *Downfall: The End of the Imperial Japanese Empire* (New York: Penguin, 2001).

[35] See National Archives and Records Administration, Record Group 38, Records of the Office of the Chief of Naval Operations, Box 358, "Operation Barney," in *Submarine Bulletin* 2, no. 3 (September 1945), 10–16.

[36] I.B. Holley, Jr., *Technology and Military Doctrine: Essays on a Challenging Relationship* (Maxwell Air Force Base, AL: Air University Press, 2004), 113.

[37] Jonathan Parshall and Anthony Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Washington, DC: Potomac Books, 2007), 407.

[38] Ian Toll, *Pacific Crucible: War at Sea in the Pacific, 1941–1942* (New York: Norton, 2011), 375.

[39] Ibid., 375.

[40] Scott H. Swift, "Fleet Problems Offer Opportunities," U.S. Naval Institute *Proceedings* 144, no. 3 (March 2018), 22–26.

[41] Single- and double-loop learning cycles are central to my research in military adaption. See Frank G. Hoffman, *Mars Adapting: Military Change During War* (Annapolis, MD: Naval Institute Press, 2021).

[42] Williamson Murray, *Military Adaptation in War: With Fear of Change* (New York: Cambridge University Press, 2011); see also Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca, NY: Cornell University Press, 1996), 22–38.

[43] Robert Thomas Foley, "A Case Study in Horizontal Military Innovation: The German Army, 1916–1918," *Journal of Strategic Studies* 35, no. 6 (2012), 1–29; Sergio Catignani, "Coping with Knowledge: Organizational Learning in the British Army," *Journal of Strategic Studies* 37, no. 1 (2013), 30–64.

[44] Wayne Hughes and Robert Girrier, *Fleet Tactics and Naval Operations*, 3rd ed. (Annapolis, MD: Naval Institute Press, 2018), 33–34. On Burke, see David Alan Rosenberg, "Admiral Arleigh A. Burke," in *The U.S. Navy: A Complete History*, ed. M. Hill Goodspeed (Washington, DC: Naval Historical Foundation, 2003).

[45] Naval Doctrine Publication 1, *Naval Warfare* (Washington, DC: Headquarters Department of the Navy, April 2020), 55.

[46] Stephen J. Gerras and Leonard Wong, *Changing Minds in the Army: Why It Is So Difficult and What to Do About It* (Carlisle Barracks, PA: Strategic Studies Institute, October 2013), 8.

[47] Williamson Murray, "Innovation, Past and Future," in *Innovation in the Interwar Period*, 311.

[48] Mick Ryan, "The Intellectual Edge: A Competitive Advantage for Future Warfighting and Strategic Competition," *Joint Force Quarterly* 96 (1st Quarter 2020), 9.

[49] A key insight from the Joint Chiefs professional military education vision and echoed in Barno and Bensahel, *Adaptation Under Fire*.

[50] *Description of the National Military Strategy 2018* (Washington, DC: The Joint Staff, 2019), 2, available at <https://www.jcs.mil/Portals/36/Documents/Publications/UNCLASS_2018_National_Military_Strategy_Description.pdf>.

[51] This is particularly true for the Pacific theater in World War II given the divided command structures and strategies of Douglas MacArthur and Chester Nimitz. On Korea, see Conrad C. Crane, *American Airpower Strategy in Korea, 1950–1953* (Lawrence: University Press of Kansas, 2000), 23–55; Price Bingham, "The U.S. Air Force and Army in Korea: How Army Decisions Limited Airpower Effectiveness," *Joint Force Quarterly* 91 (4th Quarter 2018), 47–59. However, one of the largest operations in warfare, Operation *Overlord* into Normandy, reveals good inter-Service relations, as did the air-ground coordination between the U.S. Third Army and Major General Elwood R. "Pete" Quesada's XIX Tactical Air Command during the drive into Germany. See David N. Spires, *Air Power for Patton's Army: The XIX Tactical Air Command in the Second World War* (Washington, DC: U.S. Air Force History and Museum Program, 2002).

[52] Charles Davis and Kristian E. Smith, "The Psychology of Jointness," *Joint Force Quarterly* 98 (3rd Quarter 2020), 68–73.