Technology, Behavior, and Effectiveness in Naval Warfare

The Battles of Savo Island and Cape Saint George

John Severini and Stephen Biddle

Military effectiveness has attracted a large and growing literature in political science.[1] To date, however, most of this work focuses on land warfare. With the rise of China, attention is shifting to maritime conflict, given its salience for the Sino-American competition in the Western Pacific. A host of important but understudied questions emerge from this shift. What explains victory and defeat at sea?[2] In particular, what is the relative contribution of material variables, such as technology or numerical superiority, and nonmaterial behavioral variables, such as skill, motivation, or leadership,[3] and what does this mean for a potential war between the United States and China in the Western Pacific?

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1. For reviews of military effectiveness, see: Stephen Biddle, "Military Effectiveness," in Robert A. Denemark and Renée Marlin-Bennett, eds., *The International Studies Encyclopedia* (Hoboken, NJ: Wiley-Blackwell, 2010); Risa A. Brooks, "Introduction: The Impact of Culture, Society, Institutions, and International Forces on Military Effectiveness," in Risa A. Brooks and Elizabeth A. Stanley, eds., *Creating Military Power: The Sources of Military Effectiveness* (Stanford, CA: Stanford University Press, 2007), pp. 1–26; Caitlin Talmadge, *The Dictator's Army: Battlefield Effectiveness in Authoritarian Regimes* (Ithaca, NY: Cornell University Press, 2015), pp. 4–8; Jasen J. Castillo, *Endurance and War: The National Sources of Military Cohesion* (Stanford, CA: Stanford University Press, 2014), pp. 8–12.
2. See, for instance: Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660–1783* (Boston: Little, Brown, 1890); Julian S. Corbett, *Some Principles of Maritime Strategy* (London: Longmans, Green, 1918); Raoul Castex, *Strategic Theories*, translated by Eugenia C. Kiesling (Annapolis, MD: Naval Institute Press, 1993); Philip H. Colomb, *Naval Warfare: Its Ruling Principles and Practice Historically Treated* (London: W. H. Allen, 1891).
3. Historians, naval officers, and analysts have all studied the determinants of naval outcomes. But the topic has received much less attention in the political science literature. The most influential contributions include: Henry E. Eccles, *Military Concepts and Philosophy* (New Brunswick, NJ: Rutgers University Press, 1965); Joseph C. Wylie, *Military Strategy: A General Theory*

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U.S.-China competition is likely to feature a progressive shift in material power resources as China's gross domestic product grows. If so, this will enable China to invest greater resources in its military and to build a larger and more sophisticated navy with important potential material advantages over the U.S. Navy (USN).[4] By contrast, the People's Liberation Army Navy (PLAN) has much less combat experience than the USN, and its crews and officers are likely to be less proficient.[5] The political systems, social structures, cultures, and civil-military relationships from which each navy derives its nonmaterial skills may be less likely to change over time as China's economy grows. The nonmaterial behavioral dimensions of military power that are shaped by such considerations may thus be more stable over time. The relative military contribution of China's growing material wherewithal and its possibly more stable nonmaterial makeup have especially important implications for the long-term trajectory of U.S.-China competition and the military balance in the Western Pacific.

In our large-*N* analysis comparing maritime and land combat outcomes, we find that "naval outcomes [are] more sensitive to materiel, quicker, and more one-sided," but that matériel per se does not explain all the variance.[6] Available datasets are too coarse, however, to shed much light on the causal mechanisms at work or on how material and nonmaterial factors produce combat outcomes at sea. This article helps overcome this shortcoming via a focused comparison of two World War II naval battles with unusual leverage for testing ideas about the relative influence of these contributors to effectiveness at sea: Savo Island and Cape Saint George.

Savo Island, fought at nighttime on August 8–9, 1942, was a surface engagement between an Imperial Japanese Navy (IJN) squadron and a combined force of U.S. and Australian warships in waters off the island of Guadalcanal

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of Power Control (Annapolis, MD: Naval Institute Press, 1967); Bernard Brodie, *A Guide to Naval Strategy*, rev. ed. (New York: Praeger, 1965); Wayne P. Hughes, *Fleet Tactics and Coastal Combat*, 2nd ed. (Annapolis, MD: Naval Institute Press, 2000). Our discussion below draws on this literature but seeks to present a more formal, structured comparison of material and nonmaterial variables per se.

4. Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, CRS RL33153 (Washington, DC: Congressional Research Service, 2025), https://www.congress.gov/crs-product/RL33153; Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, CRS RL32665 (Washington, DC: Congressional Research Service, 2025), https://www.congress.gov/crs-product/RL32665; Stephen Biddle and Eric Labs, "Does America Face a 'Ship Gap' with China?," *Foreign Affairs*, March 19, 2025, https://www.foreignaffairs.com/united-states/does-america-face-ship-gap-china.

5. Biddle and Labs, "Does America Face a 'Ship Gap' with China?"

6. Stephen Biddle and John Severini, "Military Effectiveness and Naval Warfare," *Security Studies*, Vol. 33, No. 3 (August 2024), pp. 1–23, https://doi.org/10.1080/09636412.2024.2363533.

in the Solomons chain. Cape Saint George, fought in the early hours of November 25, 1943, was waged about 500 miles northwest of Guadalcanal near Bougainville. In both actions, the Japanese had superior torpedoes but were outnumbered, outgunned, and lacked the critical technology of radar for search and fire direction. In both battles, U.S. and Allied forces were numerically superior and had radar.

In material terms, both actions should have been U.S. victories—especially at Savo Island, where the Allies had almost twice as much tonnage as the Japanese. The outcomes, however, were radically different. Savo Island was a decisive victory for Japan, which sank four Allied heavy cruisers and damaged another Allied cruiser and two destroyers.[7] Japan lost none of its own ships and suffered only moderate damage to two heavy cruisers and one light cruiser. In fact, historians describe Savo Island as the USN's second-greatest defeat in its history, second only to the Japanese attack on Pearl Harbor.[8] Cape Saint George, by contrast, was a decisive victory for the United States, which sank three of five Japanese destroyers and damaged another. The USN did not lose any ships, even though its material balance was less advantageous than in the U.S. defeat at Savo Island.

These radically divergent results correlate poorly with the material balance of forces. Instead, we argue that the critical difference between these two battles was that the commanders in the respective squadrons made a series of different nonmaterial choices. These outcomes rested on leadership decision-making, organization, and crew proficiency.

At Savo Island, the Allied fleet was unable to exploit its material advantages because of a splintered Allied chain of command, training deficiencies in nighttime operations, and tactical decisions to divide Allied ships into detachments that were too far apart to support one another. Crews and commanders were unable to exploit radar's crucial technological advantages because they lacked the skills to use the new equipment to its theoretical potential. The materially inferior Japanese, by contrast, had a unified chain

7. Denis Ashton Warner, Peggy Warner, and Sadao Seno, *Disaster in the Pacific: New Light on the Battle of Savo Island* (Annapolis, MD: Naval Institute Press, 1992), p. 3.
8. Paul S. Dull, *A Battle History of the Imperial Japanese Navy, 1941–1945*, rev. ed. (Annapolis, MD: Naval Institute Press, 2007), p. 192; Samuel J. Cox, "H-011-1 Guadalcanal: Victory at Cape Esperance (Sort of), 11/12 October 1942," Naval History and Heritage Command, October 2017, https://www.history.navy.mil/about-us/leadership/director/directors-corner/h-grams/h-gram-011/h-011-1.html; Jonathan Parshall, "How Can They Be That Good? Japan, 1922–1942," in Vincent P. O'Hara and Trent Hone, eds., *Fighting in the Dark: Naval Combat at Night, 1904–1944* (Annapolis, MD: Naval Institute Press, 2023), p. 168.

of command and extensive training in nighttime surface battle, which enabled them to use the equipment at their disposal to overwhelm a materially superior foe.

At Cape Saint George, by contrast, a retrained and reorganized U.S. squadron made systematically different choices, maintaining concentration, coordinating fires, and maneuvering to maximize the firepower available to them. And radar technology that had failed in practice at Savo Island was now used effectively by crews and leaders who made the most of its potential. Systematically different behavior with less advantageous matériel created a vastly different and far more successful result.

We do not suggest that material advantage is irrelevant at sea; of course it is not. But material factors are nevertheless insufficient for understanding naval outcomes, and to ignore them is to risk serious error. There is a growing political science scholarship that considers the security dynamics of the maritime domain and the unique effects stemming from military power at sea.[9] While these efforts fruitfully distinguish naval warfare's role in international relations, the literature focuses entirely on material variables when calculating aggregate measures of naval power.[10] A much more systematic treatment of naval power's nonmaterial dimension will contribute to this

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9. See, for instance: Jack S. Levy and William R. Thompson, "Balancing on Land and at Sea: Do States Ally Against the Leading Global Power?," *International Security*, Vol. 35, No. 1 (Summer 2010), pp. 7–43, https://doi.org/10.1162/ISEC_a_00001; Jonathan N. Markowitz and Christopher J. Fariss, "Power, Proximity, and Democracy: Geopolitical Competition in the International System," *Journal of Peace Research*, Vol. 55, No. 1 (2018), pp. 78–93, https://doi.org/10.1177/0022343317727328; Jonathan D. Caverley and Peter Dombrowski, "Too Important to Be Left to the Admirals: The Need to Study Maritime Great-Power Competition," *Security Studies*, Vol. 29, No. 4 (2020), pp. 579–600, https://doi.org/10.1080/09636412.2020.1811448; Erik Gartzke and Jon R. Lindsay, "The Influence of Sea Power on Politics: Domain- and Platform-Specific Attributes of Material Capabilities," *Security Studies*, Vol. 29, No. 4 (2020), pp. 601–636, https://doi.org/10.1080/09636412.2020.1811450; Sara McLaughlin Mitchell, "Clashes at Sea: Explaining the Onset, Militarization, and Resolution of Diplomatic Maritime Claims," *Security Studies*, Vol. 29, No. 4 (2020), pp. 637–670, https://doi.org/10.1080/09636412.2020.1811458; Nizan Feldman and Mark Shipton, "Naval Power, Merchant Fleets, and the Impact of Conflict on Trade," *Security Studies*, Vol. 31, No. 5 (2022), pp. 857–884, https://doi.org/10.1080/09636412.2022.2153732.

10. Examples include: J. Andrés Gannon, "Planes, Trains, and Armored Mobiles: Introducing a Dataset of the Global Distribution of Military Capabilities," *International Studies Quarterly*, Vol. 67, No. 4 (2023), pp. 1–12, https://doi.org/10.1093/isq/sqad081; Mark Souva, "Material Military Power: A Country-Year Measure of Military Power, 1865–2019," *Journal of Peace Research*, Vol. 60, No. 6 (2023), pp. 1002–1009, https://doi.org/10.1177/00223433221112970; Michael Beckley, "The Power of Nations: Measuring What Matters," *International Security*, Vol. 43, No. 2 (Fall 2018), pp. 7–44, https://doi.org/10.1162/isec_a_00328; Brian Benjamin Crisher and Mark Souva, "Power at Sea: A Naval Power Dataset, 1865–2011," *International Interactions*, Vol. 40, No. 4 (2014), pp. 602–629, https://doi.org/10.1080/03050629.2014.918039.

literature and to more sound policy prescriptions based on robust assessments of the U.S.-China military balance.

Nonmaterial behavior has varied greatly historically, and this variance is likely to continue in future naval combat. Relative to land warfare, naval combat has been rare since 1945. Navies thus cannot observe the effects of changing technology in actual warfare. As a result, isomorphic pressure on behavior may be less for war at sea than for land warfare.[11] Despite naval warfare being more materially determined, all things being equal, variations in the use of that material could lead to outsized differences in military effectiveness when the next major war at sea comes about, and especially so in its early battles.[12]

There is also risk in overemphasizing the potential advantages of new technology. Radar was critical to the eventual Allied victory in World War II, but it took years of trial and error in combat to learn its potential.[13] Mastering this complex new technology required corresponding innovations in training, organization, and doctrine that emerged much more slowly than did the new equipment. The equipment alone radically underperformed at Savo Island; only with the associated nonmaterial innovations could the United States exploit new technology at Cape Saint George.

Before technology can be properly used, it must first be invented, procured, and deployed.[14] The military then needs to train the commanders who rely on the technology and the personnel who operate it. Insufficient training

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11. There are, of course, numerous other variables underlying the type of competitive isomorphism that scholars such as Kenneth Waltz describe. Kenneth N. Waltz, *Theory of International Politics* (Reading, MA: Addison-Wesley, 1979), p. 127. But the general trend of competition inducing similarity among militaries does seem to hold. See, for instance: Theo Farrell, "World Culture and Military Power," *Security Studies*, Vol. 14, No. 3 (2005), pp. 448–488, https://doi.org/10.1080/09636410500323187; Emily O. Goldman, "International Competition and Military Effectiveness: Naval Air Power, 1919–1945," in Brooks and Stanley, *Creating Military Power*, pp. 158–185; Michael C. Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010); Morgan MacInnes, Ben Garfinkel, and Allan Dafoe, "Anarchy as Architect: Competitive Pressure, Technology, and the Internal Structure of States," *International Studies Quarterly*, Vol. 68, No. 4 (December 2024), https://doi.org/10.1093/isq/sqae111.
12. Biddle and Severini, "Military Effectiveness and Naval Warfare"; Vincent P. O'Hara and Leonard R. Heinz, *Innovating Victory: Naval Technology in Three Wars* (Annapolis, MD: Naval Institute Press, 2022), pp. 7–14. On the changing relationship between material and nonmaterial variables over time in long wars, see, for example, Biddle and Labs, "Does America Face a 'Ship Gap' with China?"
13. O'Hara and Heinz, *Innovating Victory*, chap. 5.
14. For a similar perspective dealing with military innovation more generally, see Michael C. Horowitz and Shira Pindyck, "What Is a Military Innovation and Why It Matters," *Journal of Strategic Studies*, Vol. 46, No. 1 (2023), pp. 85–114, https://doi.org/10.1080/01402390.2022.2038572.

and understanding can lead to mistaken expectations about technology's benefits, which in turn may result in outcomes worse than if the technology had not been deployed in the first place.[15] It is possible to craft peacetime doctrine that anticipates the proper use of a technology, but best practices often stem from use in combat.[16] Given the lack of battles between major navies in the last several decades, it is highly likely that the newest technology deployed in a naval conflict between the United States and China will take time to learn and integrate properly. Understanding the learning process and minimizing its costs will therefore be critical to finding success in war at sea.

These findings have implications for both policy and scholarship. For policy, our analysis offers an empirical basis to be more optimistic about the U.S.-China naval balance than material counts of ships or tonnage would suggest—but only if the U.S. government continues to commit resources to recruit, train, and retain highly skilled officers, and only if the USN can preserve its skill advantage in a potentially long war. For scholars, we highlight the importance of treating the study of naval warfare as a social science undertaking. Engineering and physics are important for war at sea, but failing to account for the role of nonmaterial human behavior risks serious error and an impoverished understanding of this critical topic.

We present our findings in eight steps. First, we justify our choice of Savo Island and Cape Saint George as cases. Second, we present brief summaries of the key events of the two battles. Third, we discuss the material makeup of the respective fleets, and we make the case that the United States had superior tonnage in both battles, and that the U.S. advantage in sensor technology offset the Japanese advantage in torpedo design. Fourth, we trace the prewar institutional history of the two navies and highlight key features of each that would in turn influence behavior before, during, and between the battles. In the fifth and sixth sections, we characterize the two squadrons' nonmaterial training, preparation, and organization that occurred before and between each battle and describe the results of these differences. Section seven presents the findings of a counterfactual analysis in which we remediate a series of Allied errors at Savo Island and project the likely losses on the two sides. We conclude with a summary of our key findings and their implications for scholarship and policy.

15. See Kendrick Kuo, "Dangerous Changes: When Military Innovation Harms Combat Effectiveness," *International Security*, Vol. 47, No. 2 (Fall 2022), pp. 48–87, https://doi.org/10.1162/isec_a_00446.
16. O'Hara and Heinz, *Innovating Victory*, pp. 1–8.

Why Study Savo Island and Cape Saint George?

Nonmaterial military variables are hard to study with statistical methods, as most of the available datasets focus on easier-to-quantify material measures. The case study method is thus essential for exploring factors such as organization, leadership, or combat dispositions. This method also allows detailed process tracing to help distinguish causation from mere coincidence.[17] But selection bias is an inherent risk of the case study method: Case selection is important for validity because an argument's success (or failure) in a small sample of cases might stem from choosing misleading or unrepresentative examples.[18] Savo Island and Cape Saint George possess several features that help to mitigate selection bias.

First, these cases offer an unusual degree of control for external factors that might otherwise confound causal inference: (1) Both were nighttime surface actions fought in the same Solomon Islands theater of World War II; (2) both pitted the IJN against Allied opposition dominated by the USN; (3) both involved Japanese attempts to reach a disputed island to defend its ground forces against a U.S. invasion; (4) technology varied little between the two battles; (5) in both cases, Japanese squadrons were outnumbered and outgunned, and they had superior torpedoes but otherwise inferior equipment (e.g., inferior sensors for nighttime engagement). The cases differ, however, in the choices and behaviors of the respective commanders, especially on the Allied side. Perfect control is impossible in the case study method, but because these battles' material circumstances were so similar, we were able to conduct an unusually controlled examination of the effects of varying behavior.

These cases also present extreme outcomes that are unlikely to be products of chance alone. The Japanese victory at Savo Island was remarkably one-sided. Not only was it the second-most-severe defeat in the history of the USN, the battle was more one-sided than almost 90 percent of all battle outcomes by all states in the history of naval warfare since the dawn of the age of sail in the seventeenth century.[19] And the Cape Saint George outcome was

17. David Collier, "Understanding Process Tracing," *Political Science & Politics*, Vol. 44, No. 4 (2011), pp. 823–830, https://doi.org/10.1017/S1049096511001429; Andrew Bennett and Jeffrey T. Checkel, eds., *Process Tracing: From Metaphor to Analytic Tool* (Cambridge: Cambridge University Press, 2014).
18. Jack S. Levy, "Case Studies: Types, Designs, and Logics of Inference," *Conflict Management and Peace Science*, Vol. 25, No. 1 (2008), pp. 1–18, https://doi.org/10.1080/07388940701860318.
19. Values are derived from the Columbia University NAVBATTLE dataset, John Severini,

even more one-sided: Its casualty-exchange ratio is the thirteenth-most-lopsided result in the last 375 years of naval history.[20] A difference this extreme is unlikely to be a mere artifact of random chance; for two cases whose material variables were this similar to produce results this different suggests a systematic causal effect for nonmaterial behavior.

Key Events of the Battles of Savo Island and Cape Saint George

BATTLE OF SAVO ISLAND, 1942

The Battle of Savo Island was the first major naval engagement of the Guadalcanal Campaign of the Pacific War, known to the Allies as Operation Watchtower.[21] Eager to exploit its strategic momentum after the Battle of Midway, the USN's goals for Watchtower were to halt Japan's southward expansion toward Australia, curtail the IJN's operational maneuverability in the area, and establish a forward air base on Guadalcanal that would serve as a springboard for subsequent counteroffensives.[22] U.S. Vice Admiral Frank Jack Fletcher was the overall commander of Allied forces and the direct commander of the carrier task groups providing air cover.[23] U.S. Rear Admiral Richmond K. Turner directed the amphibious fleet delivering Allied troops to Guadalcanal and Tulagi.[24] Under him was the United Kingdom's Rear

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"Replication Data for: 'Military Effectiveness and Naval Warfare,'" V2, 2018, Harvard Dataverse, https://doi.org/10.7910/DVN/HGZGCY. For a detailed description of the dataset, see Biddle and Severini, "Military Effectiveness and Naval Warfare."

20. Severini, "Replication Data for: 'Military Effectiveness and Naval Warfare.'" With zero U.S. casualties, the casualty-exchange ratio (computed as the losses of the higher-loss side to the losses of the lower-loss side) at Cape Saint George was infinite; of the 91 battles in NAVBATTLE for which a single side has zero casualties, Cape Saint George ranks 13th in total casualty differential.

21. Narrative for the Battle of Savo Island primarily comes from: Richard W. Bates, *The Battle of Savo Island August 9th, 1942. Strategical and Tactical Analysis. Part I* (Newport, RI: U. S. Naval War College, 1950), https://apps.dtic.mil/sti/tr/pdf/ADA003037.pdf; Warner, Warner, and Seno, *Disaster in the Pacific*; Bruce Loxton and Chris D. Coulthard-Clark, *The Shame of Savo: Anatomy of a Naval Disaster* (Annapolis, MD: Naval Institute Press, 1997); Richard F. Newcomb, *The Battle of Savo Island* (New York: Henry Holt, 2002); Samuel Eliot Morison, *History of United States Naval Operations in World War II*, Vol. 6, *Breaking the Bismarck Barrier, 22 July 1942–May 1944* (1950; repr. Castle Books, 2001); James D. Hornfischer, *Neptune's Inferno: The U.S. Navy at Guadalcanal* (New York: Bantam Books, 2011).

22. Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 40–42; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 5–12; Ronald H. Spector, *Eagle Against the Sun: The American War with Japan* (New York: Simon and Schuster, 2012), pp. 144–146, 185–187.

23. Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 41; John B. Lundstrom, *Black Shoe Carrier Admiral: Frank Jack Fletcher at Coral Sea, Midway, and Guadalcanal* (Annapolis, MD: Naval Institute Press, 2013).

24. Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 41–43.

Admiral Victor Crutchley, who was given tactical command over a primarily U.S. force of eight cruisers and nine destroyers.[25] This screening group was tasked with protecting the amphibious landing ships and providing direct fire support for the landings themselves.[26]

After failing to anticipate the Allied landings on August 7, 1942, the IJN responded to the relatively unopposed landings by immediately launching air strikes from Rabaul and organizing a nighttime counterattack using surface forces.[27] Vice Admiral Gunichi Mikawa, commander of the recently created Eighth Fleet, hastily arranged the seven cruisers and one destroyer he had available and immediately set off southward toward Savo Sound, reaching Allied forces just after midnight on August 9.[28]

Crutchley had divided his forces into three groups, each protecting one entrance to Savo Sound.[29] In the southern group were the cruisers USS *Chicago*, HMAS *Canberra*, and his flag, HMAS *Australia*. To the north were the cruisers USS *Vincennes*, USS *Quincy*, and USS *Astoria*. And in the east nearest the transports were the cruisers USS *San Juan* and HMAS *Hobart*. Two destroyers escorted each group. Just to the northwest of Savo Island, Crutchley placed as picket screens two radar-equipped U.S. destroyers meant to provide early warning of any approaching Japanese ships.

Just before 2100 hours on August 8, Crutchley removed himself and his ship, *Australia*, from the southern group to attend a conference with Admiral Turner.[30] At about 0100 hours, Mikawa's single-file battle line silently slipped past the Allied picket screens and entered the sound undetected. At 0136 hours, they spotted the southern group of two cruisers and two destroyers, launched torpedoes, and—still undetected—opened fire seven minutes later at close range. The two Allied cruisers received devastating 8- and 5-inch gunfire from enemy ships that they had immense difficulty locating or identifying. *Chicago* erroneously turned away from the battle and survived the night, while *Canberra* received so much fire that within minutes the Japanese ships had killed *Canberra*'s captain, destroyed its guns, and knocked out its power.

Immediately turning north, Mikawa directed his now-split line toward the northern group of three cruisers and two destroyers, none of which had

25. Ibid., pp. 43–46.
26. Ibid.
27. Ibid., pp. 79–82.
28. Ibid., pp. 82–89.
29. For details in this paragraph, see ibid., pp. 74–75.
30. For details in this paragraph, see ibid., pp. 98–101, 114–140.

been made aware of the combat to their immediate south.[31] The Japanese launched torpedoes at 0144 hours and opened fire at 0150 hours.[32] The Allies returned fire several minutes later, but by that point the Japanese had already fired on all three Allied cruisers at close range, igniting flammable material and search planes on their decks.[33] The flaming Allied ships burned so brightly that the Japanese cruisers could turn off their searchlights when firing.[34] The Japanese ships received only minor hits in return and continued to fire until 0216 hours, when Mikawa ordered firing to cease as his two columns had begun to move out of range, north of Savo Island.[35] He briefly deliberated whether to turn back and destroy the Allied transports off the coast of Tulagi and Guadalcanal, but—erroneously believing Allied carrier forces to be present—he decided the risk of daylight exposure was too great and ordered his ships to return home.[36]

BATTLE OF CAPE SAINT GEORGE, 1943

The Battle of Cape Saint George took place a little over a year later.[37] In November 1943, the Allies had invaded Bougainville in the northwest Solomons with the goal of establishing a foothold to create future airfields.[38] As part of the famous "Tokyo Express," the IJN had been running army reinforcements from Rabaul to both Bougainville and the smaller island of Buka immediately to its north.[39] The Japanese Army believed that the Allies planned to target the major military base on Buka.[40] On November 24, five Japanese destroyers landed 920 soldiers on Buka, embarked 700 aviation personnel, and began

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31. Ibid., pp. 141–147.
32. Ibid., pp. 146–147.
33. Ibid., pp. 147–148.
34. Ibid.
35. Ibid., pp. 166–169.
36. Ibid., pp. 258–259.
37. Narrative for the Battle of Cape Saint George primarily comes from Vincent P. O'Hara, *The U.S. Navy Against the Axis: Surface Combat, 1941–1945* (Annapolis, MD: Naval Institute Press, 2007); Vincent P. O'Hara, "Battle of Cape St. George: November 25, 1943," accessed August 21, 2023, http://www.microworks.net/pacific/battles/cape_stgeorge.htm; E. B. Potter, *Admiral Arleigh Burke* (Annapolis, MD: Naval Institute Press, 2005); Morison, *History of United States Naval Operations in World War II*; Ken Jones, *Destroyer Squadron 23: Combat Exploits of Arleigh Burke's Gallant Force* (Annapolis, MD: Naval Institute Press, 2012); Trent Hone, *Learning War: The Evolution of Fighting Doctrine in the U.S. Navy, 1898–1945* (Annapolis, MD: Naval Institute Press, 2018).
38. Morison, *History of United States Naval Operations in World War II*, pp. 337–349; Spector, *Eagle Against the Sun*, pp. 242–248.
39. Morison, *History of United States Naval Operations in World War II*, pp. 352–353; Richard B. Frank, *Guadalcanal: The Definitive Account of the Landmark Battle* (New York: Penguin Books, 1992), pp. 205–213.
40. Morison, *History of United States Naval Operations in World War II*, pp. 352–353.

the return to Rabaul at about 0045 hours on November 25.[41] Captain Kiyoto Kagawa commanded a screening force of two destroyers that traveled in front of three other destroyers; Captain Katsumori Yamashiro commanded these three destroyers, which transported the aviators.[42]

Unbeknownst to the Japanese, the USN had positioned Destroyer Squadron 23, with five destroyers of its own under Captain Arleigh Burke, along the expected route to Rabaul.[43] The USN had also positively identified the Japanese destroyer group late on November 24.[44] Burke divided his ships into two columns: Destroyer Division (DesDiv) 45 in the lead, and DesDiv 46 in support under Commander Bernard Austin.[45] At 0141 hours, the destroyer USS *Dyson* of DesDiv 45 made radar contact with the Japanese screen to the west and began approaching.[46] At 0156 hours, DesDiv 45 launched 15 torpedoes at a range just under 6,000 yards and subsequently turned 90 degrees south along with DesDiv 46 to avoid any Japanese retaliation.[47] At 0200 hours, Kagawa's flagship, IJN *Onami*, spotted the U.S. destroyers but failed to react. A few moments later, several U.S. torpedoes hit the ships of the Japanese screen; *Onami* erupted into a massive fireball, quickly killing everyone on board. The second leading ship, IJN *Makinami*, was hit seconds later and became completely disabled.

Leaving DesDiv 46 to finish off *Makinami*, Burke pursued the fleeing Japanese transport group to the north.[48] DesDiv 45 successfully dodged several torpedoes fired from the remaining Japanese ships and by 0222 hours had closed in enough to force them to separate and head in three different directions.[49] One of the fleeing Japanese destroyers was hit by a dud torpedo, but another, IJN *Yugiri*, received repeated hits and sank by 0328 hours.[50] The two U.S. divisions rejoined at 0345 hours, unsuccessfully attempted to

41. Ibid., p. 353; O'Hara, "Battle of Cape St. George."
42. Ibid.
43. Morison, *History of United States Naval Operations in World War II*, pp. 353–354; O'Hara, "Battle of Cape St. George."
44. Ibid.
45. Ibid.
46. Morison, *History of United States Naval Operations in World War II*, p. 355; O'Hara, "Battle of Cape St. George."
47. For details in the rest of this paragraph, see: Morison, *History of United States Naval Operations in World War II*, pp. 355–356; O'Hara, "Battle of Cape St. George."
48. Morison, *History of United States Naval Operations in World War II*, p. 356; O'Hara, "Battle of Cape St. George."
49. Morison, *History of United States Naval Operations in World War II*, pp. 356–357; O'Hara, "Battle of Cape St. George."
50. Morison, *History of United States Naval Operations in World War II*, p. 357; O'Hara, "Battle of Cape St. George."

track down the remaining two Japanese destroyers, and eventually returned home without any damage.[51]

The Material Balance at Savo Island and at Cape Saint George

THE MATERIAL BALANCE AT THE BATTLE OF SAVO ISLAND

Despite Japan achieving an overwhelming victory at the Battle of Savo Island, its squadron was outmatched on paper. Mikawa led a smaller, more lightly armored fleet of older ships with fewer guns against a larger, more heavily armored fleet of newer ships with more guns. He did so while attacking at night in a highly defensible, restricted inlet whose geography forced any attack to funnel through one of three narrow entrances.

The Allied squadron outnumbered the Japanese squadron by 17 ships to 8.[52] Crutchley commanded a total of 6 heavy cruisers, 2 light cruisers, and 9 destroyers to Mikawa's 5 heavy cruisers, 2 light cruisers, and 1 destroyer. Many of the Allied ships were destroyers, but the squadron still had more cruisers than Japan's squadron and outweighed the Japanese ships overall by more than 85 percent in aggregate displacement. Select material details for both Japanese and Allied ships at Savo Island are in table 1.

LAUNCH YEAR. The Allied fleet's ships were on average ten years newer than the Japanese ships; Mikawa's newest ship was his flag, IJN *Chokai*, which had been launched in 1931, and his oldest was the light cruiser IJN *Tenryu*, launched in 1918. By contrast, the Allies' newest ship was the light cruiser *San Juan*, launched in 1941; their oldest was *Australia*, launched in 1927.

DISPLACEMENT. Ship categories can be deceiving. The Allies and the Japanese used different categorizations for "heavy" and "light" cruisers. The Japanese heavy cruiser *Chokai*, displacing 9,850 tons and mounting ten 8-inch guns, was similar to the Allied heavy cruisers. But the four other Japanese heavy cruisers (*Aoba*, *Furutaka*, *Kako*, and *Kinugasa*) displaced only 7,100 tons and carried only six 8-inch guns each. By comparison, the six Allied heavy cruisers (*Astoria*, *Australia*, *Canberra*, *Chicago, Quincy*, and *Vincennes*) displaced 9,646 tons and carried nine 8-inch guns on average. Additionally, the Allied light cruisers (*Hobart* and *San Juan*) had an

51. Morison, *History of United States Naval Operations in World War II*, pp. 358–359; O'Hara, "Battle of Cape St. George."

52. For details in this paragraph, see: Loxton and Coulthard-Clark, *The Shame of Savo*, appendix 1; Newcomb, *The Battle of Savo Island*, appendixes D, E. Note that Newcomb does not list the U.S. destroyer *Jarvis*, which was present at the battle.

Table 1. Select Material Variables for the Imperial Japanese Navy (IJN) and the Allies at the Battle of Savo Island

Ship	Launch year	Displacement (long tons at standard load)	8-inch guns	Beltline armor (inches)	Turret armor (inches)	Search radar	Fire control radar	Torpedo tubes
Chokai	1931	9,850	10	3.9	1	none	none	8
Aoba	1926	7,100	6	3	1	none	none	8
Furutaka	1925	7,100	6	3	1	none	none	8
Kako	1925	7,100	6	3	1	none	none	8
Kinugasa	1926	7,100	6	3	1	none	none	8
Tenryu	1918	3,230	0	2	0	none	none	6
Yubari	1923	2,890	0	2.3	1	none	none	4
Yunagi	1924	1,270	0	0	0	none	none	6
IJN totals		45,640	34					56
Australia	1927	10,000	8	4.5	2	none	none	0
Astoria	1933	9,950	9	4	6	none	FC	0
Canberra	1927	9,850	8	4.5	2	271	A290	0
Vincennes	1936	9,400	9	4	6	SC	FC	0
Quincy	1935	9,375	9	4	6	none	FC	0
Chicago	1930	9,300	9	3	2.5	CXAM	FC	0
Hobart	1934	7,105	0	3	1	none	none	8
San Juan	1941	6,000	0	3.75	1.25	SG	FC	8
Buchanan	1941	1,700	0	0	0	SC	FD	10
Monssen	1940	1,630	0	0	0	SC	FD	5
Bagley	1936	1,500	0	0	0	SC	FD	16
Blue	1937	1,500	0	0	0	SC	FD	16
Helm	1937	1,500	0	0	0	SC	FD	16
Jarvis	1937	1,500	0	0	0	SC	FD	16
Patterson	1937	1,500	0	0	0	SC	FD	16
Ralph Talbot	1936	1,500	0	0	0	SC	FD	16
Wilson	1939	1,500	0	0	0	SC	FD	16
Allied totals		84,810	52					143

SOURCES: For the displacement, 8-inch guns, and torpedo tube values, see: Loxton and Coulthard-Clark, *The Shame of Savo*, appendix 1; Newcomb, *The Battle of Savo Island*, appendixes D, E. For the launch year and armor values, see: Robert Gardiner and Randal Gray, *Conway's All the World's Fighting Ships, 1906–1921* (Annapolis, MD: Naval Institute Press, 1985); Roger Chesneau, ed., *Conway's All the World's Fighting Ships, 1922–1946* (London: Conway Maritime Press, 1980). For radar values, see R. W. Madsen, "Radar in the South and Southwest Pacific as at Savo Island in August 1942," *Naval Historical Review*, September 2019, pp. 3–4, http://phwl.org/assets/images/2021/11/Madsen17.%20Radar%20at%20Savo%201942.pdf. For standard displacement, see Chesneau, *Conway's All the World's Fighting Ships*, p. 2.

NOTE: Long tons, also known as imperial tons, are equivalent to 2,240 pounds. Standard displacement refers to the displacement of a ship when it has no fuel or reserve water but has full ammunition stores.

average displacement of 6,553 tons, more than double that of the Japanese light cruisers (*Tenryu* and *Yubari*). In aggregate, the Allied fleet had twice as many total inches of gun caliber as the Japanese fleet, including over 50 percent more of the largest-caliber guns (i.e., 8-inch guns) that either squadron had available.

PROTECTION. The Allied ships were also better protected. Whereas the Japanese cruisers averaged 2.9 inches of armor along their beltlines and 1.3 inches along their decks, Allied cruisers had an average of 3.8 inches of belt armor and 1.9 inches of deck armor.[53] The disparity was even greater for turret armor. The Japanese lightly armored their ships' turrets with only 1 inch of protection, whereas on average Allied cruisers had 3.3 inches of turret armor—and the cruisers *Astoria*, *Quincy*, and *Vincennes* of the ill-fated northern group had 6 inches of turret armor each. This difference mattered. Although *Astoria* had received up to 63 hits, was beginning to sink, and had lost the entirety of its fire control, two of its three 8-inch turrets remained operable even as the Japanese fleet was leaving the sound.[54] A single hit from *Astoria*, by contrast, disabled one of *Chokai*'s five 8-inch turrets, removing 20 percent of its 8-inch gun firepower.[55]

DETECTION. Fifteen of the seventeen Allied ships at Savo were equipped with radar—and the only two that were not (the cruisers *Australia* and *Hobart*) played little role in the battle. Allied radars at Savo Island included the CXAM, SC-1, SG-1, Type 271, Type A290, FC, and FD sets. The CXAM, SC, and SG were combined air and surface search radar sets. The British Type 271 was dedicated to surface search only, whereas the British A290 was an air search radar with a secondary fire control feature. The FC and FD sets were dedicated fire control radars for U.S. cruisers and destroyers, respectively. Air and surface search radar sets were usually located at the highest point on a ship; they had longer wavelengths and emitted wider beams while rotating in a 360-degree azimuth panorama to enable early warning and detection. Fire control radar sets, by contrast, were usually located lower, near a ship's guns; they had shorter wavelengths and emitted narrower beams at higher intensities. On balance, the trade-off was shorter detection range for better resolution and more accurate tracking. Table 2 lists the technical details of each radar set that the Allies used at Savo and at Cape Saint George.

53. Deck armor values are not in table 1 because of space limitations. For deck armor values, see: Gardiner and Gray, *Conway's All the World's Fighting Ships*; Chesneau, *Conway's All the World's Fighting Ships*.
54. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 231–232.
55. Ibid.

Table 2. Technical Specifications for Radars Used by Allies at Savo Island and at Cape Saint George

Radar set	Function	Peak power (kilowatt)	Beamwidth (azimuth° x elevation°)	Wavelength (meters)
CXAM	air/surface search	15	14 x 70	1.5
SC-1	air/surface search	100	30 x 40	1.36
SG-1	air/surface search	50	5.6 x 15	0.1
Type 271	surface search	7–90	6.5 x 65	0.1
Type A290	air search/fire control	50	n/a x 27	1.5
FC	fire control	20	12 x 12 or 6 x 30	0.4
FD	fire control	20	12 x 12	0.4

SOURCES: Norman Friedman, *Naval Radar* (London: Conway Maritime Press, 1981), pp. 145 (CXAM), 146 (SC-1), 147–148 (SG-1), 172 (FC and FD), 192 (Type 271), 196 (A290); F. A. Kingsley, ed., *The Development of Radar Equipments for the Royal Navy, 1935–45* (Basingstoke, UK: Macmillan Press, 1995), pp. 195–203, 220, 271, 355, 372–373 (Type 271), 172–175, 182, 356, 367–368 (Type A290); Madsen, "Radar in the South and Southwest Pacific," pp. 3–4.

For skilled operators, the height of the antenna and the physical horizon determined radar detection ranges for major warships (destroyers and larger). *Chicago*'s CXAM had the highest antenna, at about 130 feet above the waterline, implying a detection range of about 25,000 yards to the horizon. The shorter masts on Allied destroyers would have been able to detect Mikawa's warships at a shorter, but still substantial, range of about 19,300 yards.[56]

By comparison, the IJN had not yet developed any ship-mounted radar by August 1942. As a result, Mikawa's squadron relied on human spotters to detect Allied ships. Although the Japanese did not have radar, they had developed sophisticated optics for nighttime fighting, including 150-millimeter Nikon binoculars that could collect up to 980 times as much light as the naked eye.[57] Still, like radar, these lenses were limited by the physical horizon. Given its shorter height, the lead ship, *Chokai*, had a potential detection range

56. These range estimates are based on the authors' approximation of mast height from official drawings. See United States Office of Naval Intelligence, *ONI 222-US, United States Naval Vessels—Official United States Navy Reference Manual Prepared by the Division of Naval Intelligence, June 1945* (Washington, DC: Division of Naval Intelligence, September 1, 1945), pp. 65, 99; Madsen, "Radar in the South and Southwest Pacific," pp. 3–4.
57. Madsen, "Radar in the South and Southwest Pacific," p. 10; Parshall, "How Can They Be That Good?," p. 145.

of about 19,500 yards.[58] Thus, even if *Chokai* had steamed directly at *Chicago* at its maximum speed of 35 knots, and even if both ships had detected each other at their maximum possible physical horizons, the gap between *Chicago* detecting *Chokai* and *Chokai* detecting *Chicago* would have been about five minutes.[59] By the end of the war, U.S. radar regularly detected targets at or near the physical horizon, but there are no known examples of a Japanese spotter detecting an enemy ship at the physical horizon at night during the war.[60]

TORPEDOES. The Japanese did have one important technological advantage: the Type 93 "Long Lance" torpedo. Its advanced design included a compressed oxygen propulsion system that enabled a maximum range of 22,000 yards at 50 knots or 44,000 yards at 36 knots.[61] By comparison, the 1942 U.S. Mark 15 torpedo had serious design flaws that caused frequent depth errors and failures to explode on contact; even when functioning correctly, its maximum range was only 6,000 yards at 46 knots or 15,000 yards at 26 knots.[62] On paper, the Type 93 was faster, more reliable, and had a maximum firing range that was almost three times longer than that of the Mark 15.[63]

Even though *Chicago*, *Quincy*, and *Vincennes* were all hit by torpedoes, it was surface gunfire that sank all four of the Allied cruisers. Indeed, *Canberra* had lost its power and had begun to take on water before it was hit by a

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58. These range estimates are based on the authors' approximation of mast height from official drawings. See United States Office of Naval Intelligence, *ONI 222-J, The Japanese Navy—Official United States Navy Reference Manual Prepared by the Division of Naval Intelligence* (Washington, DC: Division of Naval Intelligence, June 1945), p. 35; Eric Lacroix and Linton Wells, *Japanese Cruisers of the Pacific War* (Annapolis, MD: Naval Institute Press, 1997), pp. 137–139.
59. Of course, both ships would have been looking for each other's superstructures, which stood substantially above the horizon. Five minutes is thus conservative with respect to the difference in detection time. If the two superstructures are included, the maximum possible detection range is 44,900 yards. Because only radar was capable of detection at such a range, the detection gap could be upward of 20 minutes, implying an even greater U.S. technical advantage in target acquisition potential.
60. Indeed, *Chokai*'s 18,000-yard sighting of *Vincennes* at Savo might be one of the longest-range sightings on record for the Imperial Japanese Navy. See Bates, *The Battle of Savo Island*, p. 115; Parshall, "How Can They Be That Good?," p. 167.
61. David C. Evans and Mark R. Peattie, *Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887–1941* (Annapolis, MD: Naval Institute Press, 2012), p. 270; O'Hara and Heinz, *Innovating Victory*, pp. 73–74.
62. Frederick J. Milford, "The Great Torpedo Scandal, 1941–1943," *Submarine Review*, October 1996, pp. 81–94, https://www.geocities.ws/pentagon/1592/ustorp2.htm; David F. Matthews, *Mark XIV Torpedo Case Study*, Acquisition Research Case Series (Monterey, CA: Naval Postgraduate School, 2011), https://apps.dtic.mil/sti/pdfs/ADA550699.pdf. Note that the Mark 15 torpedo was the larger, heavier, destroyer-launched variant of the submarine-launched Mark 14 torpedo. Both had similar design flaws.
63. Evans and Peattie, *Kaigun*, pp. 267–272; O'Hara and Heinz, *Innovating Victory*, pp. 67–68; Parshall, "How Can They Be That Good?," pp. 148–152.

friendly Mark 15 torpedo launched by the destroyer USS *Bagley*,[64] and *Astoria* sank without being hit by any torpedoes whatsoever.[65] Two torpedoes hit *Chicago* (one of which did not explode) at the opening moments of the battle; while it did need to return home for repairs afterward, the ship and most of its crew survived.[66]

THE MATERIAL BALANCE AT CAPE SAINT GEORGE

At Cape Saint George, by contrast, the material balance—though still favoring the United States—was much closer to even. Both sides at Cape Saint George deployed five ships.[67] Burke's squadron had about 26 percent greater aggregate displacement at full load than the Japanese squadron;[68] at Savo Island, the Allied advantage was more than 85 percent. Burke's ships were also on average eight years newer than his opponent's ships—a smaller disparity than the ten-year age difference at Savo.[69] Unlike the cruisers at Savo, moreover, U.S. destroyers at Cape Saint George did not have meaningfully better protection—that is, neither side's destroyers were armored. Destroyers are built for speed, and Burke's five Fletcher-class ships (USS *Charles Ausburne*, USS *Claxton*, USS *Dyson*, USS *Converse*, and USS *Spence*) were rated for 38 knots, about 4 knots faster on paper than the Japanese.[70] It is likely, however, that maintenance issues reduced their top speed to about the same as that of the newer Japanese ships.[71]

Both sides primarily used torpedoes at Cape Saint George. Although the United States deployed more torpedo tubes (50, as opposed to Japan's 38), Japan's torpedoes were still technologically superior.[72] In 1942–1943, the USN investigated the Mark 15's major problems, most notably

64. Bates, *The Battle of Savo Island*, pp. 127–129; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 183–190, 198.
65. Newcomb, *The Battle of Savo Island*, appendix E.
66. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 211–214.
67. Morison, *History of United States Naval Operations in World War II*, pp. 353–354; O'Hara, "Battle of Cape St. George."
68. O'Hara, *The U.S. Navy Against the Axis*, p. 217. In contrast to standard displacement, full load displacement refers to the displacement of a vessel at its greatest allowable draft—in effect with full ammunition, stores, and fuel. Navy Department, "Nomenclature of Naval Vessels," United States Navy, June 1942, https://www.history.navy.mil/content/history/nhhc/research/library/online-reading-room/title-list-alphabetically/n/nomenclature-naval-vessels.html#displacement.
69. The average launch year for the Japanese destroyers was 1933.6. All U.S. destroyers were launched in 1942. See O'Hara, *The U.S. Navy Against the Axis*, p. 217.
70. O'Hara, "Battle of Cape St. George"; O'Hara, *The U.S. Navy Against the Axis*, p. 217.
71. O'Hara, "Battle of Cape St. George."
72. O'Hara, *The U.S. Navy Against the Axis*, p. 217.

its faulty detonator and depth gauge.[73] By November 1943, it is likely that Burke's destroyers were equipped with upgraded Mark 15s with better detonators.[74] Nonetheless, while the USN at least partially addressed the reliability of the Mark 15, it was still significantly less capable than the Type 93 in speed and range.[75]

Cape Saint George was fought on the open sea, primarily at ranges exceeding 10,000 yards. On paper, this significantly favored the Japanese. Both sides used gunfire to slow, defend against, and sink enemy ships, but torpedoes were the battle's decisive weapon. A single torpedo could cripple a destroyer, and at such a long range, the Type 93 was still decidedly superior to even the upgraded Mark 15.[76]

The sensor technologies at Cape Saint George were not much different from those at Savo Island. Burke's Fletcher-class destroyers were outfitted with the SG search radar that had been used by the cruiser *San Juan* at Savo.[77] But given their shorter masts, these destroyers had a shorter detection range compared with the cruisers in the earlier battle. Similarly, the Japanese had not developed more advanced night optics since Savo Island, and they still used large night binoculars for nighttime scouting. The Allied advantage in potential detection range was thus greater at Savo Island than at Cape Saint George.

Nonmaterial Variables: Prewar Strategic and Institutional Influences

JAPAN

As early as 1907, Japanese naval strategists viewed the United States as Japan's most likely future opponent, and their plans thus increasingly focused on defeating a numerically superior USN.[78] Achieving a decisive battle against an industrially dominant United States seemed for some fundamentally unattainable because of U.S. manufacturing advantages.[79] This disparity was exacer-

73. Milford, "The Great Torpedo Scandal, 1941–1943," pp. 83–90; Matthews, *Mark XIV Torpedo Case Study*, pp. 26–34.
74. The problems that had plagued the Mark 15 were corrected by October 1943, just one month before the Battle of Cape Saint George. Matthews, *Mark XIV Torpedo Case Study*, p. 34.
75. Parshall, "How Can They Be That Good?," pp. 148–152.
76. Ibid.
77. The older SC-1 radar was not equipped with a Plan Position Indicator display, which indicated contacts using the now well-known sweeping radar map. Friedman, *Naval Radar*, pp. 26–27, 146.
78. Evans and Peattie, *Kaigun*, pp. 148–150; Parshall, "How Can They Be That Good?," pp. 143–144.
79. Dull, *A Battle History of the Imperial Japanese Navy, 1941–1945*, pp. 1–7.

bated by several interwar treaties that imposed limits on the size of the great powers' navies.[80] The Washington Naval Conference of 1922 limited Japan's naval power compared with that of the United Kingdom and the United States, cementing a capital ship ratio of 3:5:5 and capping the total size of each country's fleet.[81] Both the United States and Japan estimated that in the event of war in the Pacific, the U.S. fleet would attrit to approximately 70 percent of its original strength before reaching Japanese territory. To ensure a U.S. advantage in a future naval conflict, U.S. negotiators thus insisted that Japan's aggregate displacement of capital ships should not exceed 60 percent of the U.S. total.[82] Japan perceived this imbalance as humiliating, and Japanese leadership was motivated to find alternative means for success in a decisive battle, despite Japan's material inferiority.[83]

One of the keys to overcoming this obstacle was to master nighttime combat. The natural limitations of nighttime combat, Japan hoped, could enable a smaller, better trained force to weaken a larger, inadequately trained foe before engaging in a subsequent decisive battle in daylight. Japan heavily invested in searchlights, illuminating shells, torpedoes, and night optics, and radically shifted its training focus toward night combat. Concurrently, overall naval doctrine was also evolving. With the decisive battle now prefigured as being at least a day-long affair, Japan began to focus its initial night phase on using cruisers and destroyers, whose high speed and plentiful torpedoes would prove especially effective in low-visibility combat.[84] Moreover, this night phase was premised on rapid offensive maneuvers against a surprised enemy; lightning speed, close range, and immediate, overwhelming firepower were expected to be the primary keys to victory. By the late 1930s, the IJN started to view success during nighttime engagement as being critical to overall success in war against the United States.[85]

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80. For more on the limits that this treaty imposed, see John Jordan, *Warships After Washington: The Development of the Five Major Fleets, 1922–1930*, rev. ed. (Annapolis, MD: Naval Institute Press, 2015).
81. Sadao Asada, *From Mahan to Pearl Harbor: The Imperial Japanese Navy and the United States* (Annapolis, MD: Naval Institute Press, 2006), chap. 4.
82. H. P. Willmott, *Empires in the Balance: Japanese and Allied Pacific Strategies to April 1942* (Annapolis, MD: Naval Institute Press, 1982), p. 37; Parshall, "How Can They Be That Good?," pp. 143–144.
83. Sadao Asada, "The Revolt Against the Washington Treaty: The Imperial Japanese Navy and Naval Limitation, 1921–1927," *Naval War College Review*, Vol. 46, No. 3 (Summer 1993), pp. 82–97, https://www.jstor.org/stable/44637473.
84. Evans and Peattie, *Kaigun*, pp. 205–207.
85. Parshall, "How Can They Be That Good?," pp. 157–162.

But naval combat at night is difficult, especially when coordinating a rapidly moving squadron of ships against a materially preponderant foe. The IJN regularly practiced arduous nighttime scenarios, even during inclement weather such as typhoons. Japan viewed accidental collisions and sinkings as acceptable costs for ensuring fleet-wide proficiency in maneuvering at night. The IJN conducted complicated exercises—some drills were so complex that they bordered on impracticality.[86] To help simplify this complicated process, night doctrine called for a single night-battle commander to control the entire squadron. Japanese ships were well-equipped with radio to enable the communications required for such a setup; by the start of the war, one cruiser flagship could have more than fifty radio sets.[87] And though Japan was several years behind Germany and the Allies in radar development, its rigorous selection process for spotters and strict and continuous training maximized the value of its advanced night optics. As a result, until mid-war, Japanese spotters could visually detect ships at night at ranges comparable to that of their opponents' radar.[88]

UNITED STATES AND ALLIES

Like Japan, the United States had long planned for a naval war against its eventual opponent across the Pacific Ocean.[89] Anticipating a strike at the Philippines, the United States expected that it would have to collect its strength in the Pacific, make the long journey across the ocean to Japanese territory, defeat the IJN, and then achieve sea control while blockading the Japanese home islands.[90] In a series of war plans known as War Plan Orange, the United States developed this strategy in the interwar period and implemented much of it during the war itself.[91]

Another similarity with Japan was that the United States focused its plan on an expected decisive battle between surface fleets; U.S. prewar training and doctrine thus focused on preparing for such a battle. While Japan concentrated on a single engagement type—nighttime surface action—the United

86. Evans and Peattie, *Kaigun*, pp. 276–286; ibid., pp. 146–147.
87. Parshall, "How Can They Be That Good?," pp. 146–147.
88. Ronald H. Spector, *At War, at Sea: Sailors and Naval Combat in the Twentieth Century* (New York: Penguin Books, 2002), pp. 155–156; Parshall, "How Can They Be That Good?," pp. 144–145.
89. Louis Morton, "War Plan *ORANGE*: Evolution of a Strategy," *World Politics*, Vol. 11, No. 2 (January 1959), pp. 221–250, https://doi.org/10.2307/2009529.
90. Hone, *Learning War*, pp. 96–98, 106–107.
91. Edward S. Miller, *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897–1945* (Annapolis, MD: Naval Institute Press, 2007).

States divided its attention among multiple kinds of actions.[92] This strategic flexibility led the USN to experiment with different methods for achieving victory at sea even before entering World War I. Captains were expected to base their decisions on a broad set of heuristic principles, working out their choices alongside a predetermined battle plan informed by available information. This institutional mentality produced two major trade-offs. First, it created an expectation that captains would be self-sufficient and tactically adaptable. But this adaptability was not always possible in particularly disorienting moments of combat, especially when captains had to unexpectedly delegate down the chain of command. Second, it allowed the USN to learn from its mistakes and figure out the most efficient path for future doctrine. But this emphasis on learning came at the cost of preparedness for early encounters with a determined adversary.

By the beginning of the Pacific War, the USN was a highly robust institution with commanders who had internalized the credo of perpetual adaptation.[93] Yet the same institutional mentality that championed flexibility and learning also produced a navy that never trained toward a singular mission with the same zeal as did the IJN for night combat operations. Whereas Japanese training involved a variety of realistic (even dangerous) nighttime scenarios and battle conditions, U.S. prewar training was more stylized. In particular, U.S. planning focused on a major fleet action between opposing battleships in which destroyers and cruisers would play a narrowly defined supporting role. At night, the smaller ships were intended to locate the enemy, penetrate the Japanese cruiser and destroyer screen, and enable a short-range torpedo attack against slow-moving hostile battleships. These nighttime operations intended to weaken the hostile fleet before the decisive battleship engagement at dawn. But the assumed scenario conditions shaped the nighttime fighting in a way that encouraged simplified training exercises. The night action was expected to start with U.S. cruisers using gunfire to blow a hole in the Japanese screen that U.S. destroyers could penetrate to reach the close ranges needed for U.S. torpedoes to be effective. U.S. destroyer captains could target the Japanese battleships by identifying the muzzle flashes of their return fire. In U.S. night training exercises, U.S. destroyers thus practiced charging a line of target ships that carried flashing

92. George W. Baer, "U.S. Naval Strategy 1890–1945," *Naval War College Review*, Vol. 44, No. 1 (Winter 1991), pp. 6–33, https://www.jstor.org/stable/44637144; Hone, *Learning War*, pp. 95–96.
93. Hone, *Learning War*, pp. 160–162.

lights to simulate gunfire. Such a straightforward scenario decreased the risk of collision during complex nighttime maneuvers.[94]

In principle, using radar was an effective technological solution to the inherent confusion expected during nighttime combat. Although the USN had developed and deployed radar on its ships, it had not yet learned how to properly use the complicated technology by the time of Savo Island. Search radars and fire control radars both provided quick, accurate, and reliable information to ship crews that was beyond the capacity of any human spotter. But in 1942–1943, operators and commanders had to perform a complex inferential process in order to use the radar systems properly.[95] Radar operators had to read continuous variations in signal strength on an oscilloscope, decipher this information using contextual estimates, and relay their judgments up the chain of command. To understand the unfolding battle, commanders then had to integrate this new information with their own recollections of the battle so far and their mental picture of the locations and movements of friendly and enemy ships. This was a slow and complex process with many moving parts and many potential points of failure, both mechanical and human. It would take time, blood, and a lot of learning before systems could be put into place that took full advantage of radar's potential.[96]

Nonmaterial Variables: Choices and Behaviors at Savo Island

The Battle of Savo Island was an early test for these contrasting approaches to prewar preparation for nighttime surface action. Its strategic context posed further challenges for Allied commanders. Operation Watchtower was a multinational effort that straddled two major Allied commands' areas of operation: the South Pacific Area, commanded by Admiral Robert Ghormley, and the South West Pacific Area, commanded by General Douglas MacArthur.[97] The two commands, separated at least in part to provide MacArthur with a command commensurate with his political prominence, struggled to share information quickly.[98] As a result, Turner and Crutchley received late and fragmentary intelligence about both the IJN's

94. Trent Hone, "'Give Them Hell': The US Navy's Night Combat Doctrine and the Campaign for Guadalcanal," *War in History*, Vol. 13, No. 2 (2006), pp. 171–199, https://doi.org/10.1191/0968344506wh335oa.
95. O'Hara and Heinz, *Innovating Victory*, pp. 126–136.
96. Ibid., pp. 136–143; Hone, *Learning War*, p. 209.
97. Bates, *The Battle of Savo Island*, pp. 15–21.
98. Spector, *Eagle Against the Sun*, pp. 144–146, 186–187.

whereabouts and the composition of its nearby fleet. They concluded that the enemy's most likely intention was to attack on the morning of August 9, not during the night, and they relayed this expectation to their subordinates.[99] Key assumptions reinforced these expectations. There was limited intelligence on the doctrinal importance that Japan had placed on night combat. Reports during the interwar period failed to recognize the extent of Japan's focus on nighttime action using destroyers and cruisers.[100] Moreover, accounts from the Battle of the Java Sea in February erroneously claimed that mines or submarines had caused the main Dutch losses at night. In fact, Japan's destroyer and cruiser torpedoes sank the Royal Netherlands Navy's cruisers and destroyers.[101]

The entire Allied chain of command believed that submarines, not surface ships, posed the largest threat to the operation.[102] Nimitz openly stated as much while organizing Watchtower.[103] Fletcher feared that the longer his carrier task forces stayed in the area the greater the existential risk.[104] His decision to move away after two days led Turner to call a meeting that pulled Crutchley away from the southern group.[105] Crutchley himself had spent his last two years in the Atlantic primarily dealing with German U-boats, and his experiences there may have colored his expectations for the Japanese naval threat.[106] His eventual decision to separate the surface fleet into three groups to protect Savo Sound's entry points was heavily motivated by the desire to ensure complete anti-submarine coverage during the night, and both Fletcher and Turner seemed to agree with his reasoning.[107] Unbeknownst to them, the nearest Japanese submarine was hundreds of miles away.[108]

Both Turner and Crutchley believed that if a Japanese surface fleet did emerge, the three groups could quickly and effectively carry out a coordinated

99. Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 228–243; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 151–164.
100. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 42–48.
101. Ibid., pp. 45–46.
102. Bates, *The Battle of Savo Island*, pp. 54, 151; Warner, Warner, and Seno, *Disaster in the Pacific*, p. 219; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 42–43.
103. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 134–135.
104. Bates, *The Battle of Savo Island*, pp. 91–95; Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 71–78; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 70–72, 104–118.
105. Bates, *The Battle of Savo Island*, pp. 87–88; Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 98–109; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 108–112.
106. Loxton and Coulthard-Clark, *The Shame of Savo*, p. 30.
107. Bates, *The Battle of Savo Island*, pp. 54–61; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 42–43, 73–82.
108. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 126–127, 287n20.

defense.[109] Their assumption was predicated on an inflated confidence in their fleet's practical radar capabilities.[110] Two picket destroyers had been placed outside the sound, USS *Blue* and USS *Ralph Talbot*, and they were expected to detect any approaching surface ships at their SC radars' maximum possible range. The two ships' radar crews had identified planes at distances exceeding 20,000 yards, even at night, a fact that may have influenced Turner and Crutchley.[111] But *Blue* and *Ralph Talbot* were unable to interpret more difficult surface radar signals when the time came.[112] Had they used their radar optimally, both ships would have been technically capable of achieving at least forty-five minutes advanced warning. But given the area's geographic complexity and the crews' insufficient training with their radar equipment, neither ship located the enemy.[113]

This tripartite fleet separation also complicated an already complex tactical command structure. Fletcher, who was nominally in charge of the operation, was directly commanding three carrier task forces over a hundred miles away on the other side of Guadalcanal.[114] Turner was primarily occupied with the landing operations and stationed his headquarters on a troop transport near the Guadalcanal coast.[115] Crutchley was a British commander representing the Australian navy and put in charge of the surface fleet in the sound itself. This was his first time commanding USN subordinates, but he neither conferred with them in advance nor issued a pre-engagement battle plan, as was common practice in the USN. Instead, he intended to follow Royal Navy doctrine by issuing orders directly as the battle unfolded.[116] When Crutchley left to attend Turner's meeting that night, he delegated temporary command to *Chicago*'s Captain, Howard Bode, but without informing *Vincennes*'s Captain, Lois Riefkohl, who was expecting orders from Crutchley in the event of contact.[117]

In addition to a broken command structure, Allied combat readiness was also problematic. By the night of August 9, the operation had been underway

109. Bates, *The Battle of Savo Island*, pp. 56–57; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 73–76.
110. Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 241–242.
111. Bates, *The Battle of Savo Island*, p. 90; Loxton and Coulthard-Clark, *The Shame of Savo*, p. 81; Madsen, "Radar in the South and Southwest Pacific," pp. 7–10.
112. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 260–261.
113. Ibid., pp. 171–177.
114. Ibid., pp. 69–71.
115. Ibid., pp. 73–76.
116. Ibid.
117. Bates, *The Battle of Savo Island*, p. 60; Loxton and Coulthard-Clark, *The Shame of Savo*, p. 112.

for two days. Sailors were exhausted after almost forty-eight hours of fending off Japanese planes, keeping watch for submarines, and assisting the amphibious landing with barrages and air scouting missions. They were also still acclimating to fatiguing heat and humidity.[118] Turner and Crutchley thus chose to put all ships at readiness level two, which meant that important stations such as turrets, engine rooms, and radar posts were all manned at half-strength.[119] Crutchley was absent, and key personnel (such as the captain of the cruiser *Chicago*) were asleep in their beds.[120] No battle plan had been issued, and enemy surface forces were not expected until the next day at the earliest.[121] Had Mikawa attacked the following morning as expected, Turner and Crutchley's decision to reduce nighttime readiness would likely have been a prudent measure to ensure a higher readiness for the subsequent battle. As it happened, however, the Allied squadron was at a reduced level of readiness when struck by an aggressive enemy keen to exploit the element of surprise.

When Mikawa learned that the Allies had invaded Guadalcanal and Tulagi on August 7, he rushed to organize a relief force,[122] which he arranged as a single battle line that he led from the front.[123] This greatly facilitated surprise. At 0053 hours, *Chokai* unexpectedly sighted the picket ship, *Blue*, but did not fire on it, as doing so would have revealed the cruiser's location. The rest of the Japanese squadron, following *Chokai*'s lead, passed silently by the U.S. picket.[124] The Japanese crew performed very proficiently. Despite the night being moonless and peppered with squalls around Savo Island, the spotters on *Chokai* identified *Blue* at 10,900 yards, *Canberra* and *Chicago* at 12,500 yards, and *Vincennes* at an extraordinary 18,000 yards just before the squadron engaged with the Allied southern group.[125] Additionally, nighttime combat training paid dividends for the Japanese, who used human

118. Bates, *The Battle of Savo Island*, pp. 107, 111, 126, 141; Warner, Warner, and Seno, *Disaster in the Pacific*, p. 216; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 171, 221.
119. Bates, *The Battle of Savo Island*, pp. 125–127, 138–139; Warner, Warner, and Seno, *Disaster in the Pacific*, p. 160; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 84–85, 180, 260.
120. Bates, *The Battle of Savo Island*, pp. 125, 139, 187; Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 120–121, 171, 179; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 180, 210, 218.
121. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 73–80.
122. Bates, *The Battle of Savo Island*, pp. 6–8, 44; Warner, Warner, and Seno, *Disaster in the Pacific*, p. 3; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 125–126.
123. Bates, *The Battle of Savo Island*, p. 48; Warner, Warner, and Seno, *Disaster in the Pacific*, p. 89; Loxton and Coulthard-Clark, *The Shame of Savo*, p. 131, 170.
124. Bates, *The Battle of Savo Island*, p. 107; Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 113–116; Loxton and Coulthard-Clark, *The Shame of Savo*, p. 131, 171–175.
125. Bates, *The Battle of Savo Island*, p. 107 (*Blue*), p. 115 (*Canberra* and *Vincennes*); Warner, Warner,

spotters, searchlights, star shells (which released illuminating flares into the sky), and plane-launched flares to hit their targets well before receiving any return fire. Overall, Japanese gunners achieved a hit rate of 8–12 percent, and they were able to score their initial hits within the first few salvos.[126] At such a close range, the heavy 8-inch guns caused tremendous damage to the Allied cruisers.

The Allies' low readiness might not have mattered if their picket destroyers had detected the Japanese approach. The picket ships were positioned more than ten miles northwest of the southern group of Allied cruisers.[127] *Chokai* spotted *Blue* at 0053 hours and reached torpedo range of the southern group at 0138 hours.[128] If *Blue*'s radar operators had performed even as well as *Chokai*'s visual spotters, and if *Blue*'s commander had issued an alert after detecting *Chokai*, doing so would have given the southern group at least forty-five minutes warning. A well-trained crew could reach general quarters in three to six minutes at night; in principle, there was ample time for the Allied cruisers to reach full readiness if alerted as soon as Mikawa reached the pickets.[129] But neither U.S. destroyer detected the Japanese.

Used properly, the SC radars on both destroyers should have been able to detect the Japanese. Mounted on masts about 80 feet above the waterline, these radars had a physical horizon of about 19,300 yards.[130] Both *Blue* and *Ralph Talbot* followed patrol routes that offered clear lines of sight directly down the long, open slot that the Japanese squadron had to traverse to reach the sound. *Chokai* passed by *Blue* and spotted it, using only optics, at a range of 10,900 yards, and *Blue* eventually passed within 5,000 yards of the Japanese line. Yet *Blue* did not detect *Chokai*, or any of Mikawa's other ships.[131] The radar equipment was not faulty: At about 1130 hours, *Blue* identified Japanese bombers at 27,000 yards, while *Ralph Talbot* picked up a

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and Seno, *Disaster in the Pacific*, p. 104 (*Blue*), p. 117 (*Canberra* and *Vincennes*); Parshall, "How Can They Be That Good?," p. 167.
126. Bates, *The Battle of Savo Island*, pp. 356–357; Newcomb, *The Battle of Savo Island*, appendixes D, E.
127. Bates, *The Battle of Savo Island*, pp. 54–56; Loxton and Coulthard-Clark, *The Shame of Savo*, p. 81.
128. Bates, *The Battle of Savo Island*, pp. 107, 110, 116.
129. Ibid., p. 145; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 167–168.
130. This range estimate is based on the authors' approximation of mast height from official drawings. See United States Office of Naval Intelligence, *ONI 222-US, United States Naval Vessels*, pp. 65, 99.
131. Bates, *The Battle of Savo Island*, pp. 106–111, 146–147; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 171–177.

single scout plane just before combat began at about 2345 hours at a range of over 14,000 yards.[132] Finding radar contacts in the air is a simpler process because the sky has far fewer complexities. But the radar crews were exhausted from two days of watching the skies and inexperienced in searching for surface contacts. Islands, reefs, shoals, small noncombatant ships, and Allied vessels were all physical objects that might show as radar contacts. Radar crews needed to continuously process all this data during active SC searches. U.S. radar equipment was in principle sufficient to provide ample warning. But the crews did not use the equipment in a way that realized its technical potential.

The Allied cruisers were thus caught unaware and at low readiness when the Japanese opened fire. This had several important consequences. First, Allied ships were delayed in their response as surprised crews and officers came to general quarters. Movement to battle stations, moreover, often involved multiple stairways and narrow passages; early damage to these compartments could block sailors from their destinations, leaving gun turrets or other critical assets without their crews and degrading ships' fighting capacity beyond the apparent damage itself.[133] The Japanese squadron thus had several invaluable minutes of unopposed fire, which gave them the opportunity to inflict disproportionate early damage. In fact, the cruiser *Canberra* sank before it could fire a single shot; the cruiser *Chicago* suffered so much damage so quickly that it was withdrawn before firing a shot from its main guns.[134]

Second, the Allied cruisers were unnecessarily vulnerable to this fire. U.S. cruisers of this era embarked scout aircraft that were launched from catapults and recovered by shipboard cranes after water landings. When fueled and shipboard, these aircraft could be fire hazards; when battle was expected, the aircraft were normally either launched or drained of fuel. *Quincy*, however, had left its scout planes fueled and on their launch rails. When hit by unanticipated Japanese 8-inch gunfire, this fuel ignited, causing massive fires that not only threatened the ship but illuminated other nearby Allied warships, simplifying Japanese targeting.[135]

132. Bates, *The Battle of Savo Island*, p. 90; Madsen, "Radar in the South and Southwest Pacific," p. 10; John E. Fahey, "Blue I (DD-387), 1937–1942," *Dictionary of American Fighting Ships*, October 31, 2022, https://www.history.navy.mil/research/histories/ship-histories/danfs/b/blue-i.html.
133. Bates, *The Battle of Savo Island*, pp. 180–181, 349–350, 361–362.
134. Ibid., pp. 180–181; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 178–190, 211–216.
135. Bates, *The Battle of Savo Island*, p. 183; Newcomb, *The Battle of Savo Island*, pp. 146–147.

Third, the confusion and chaos of unexpected battle degraded Allied officers' situation awareness. As previously mentioned, some key officers, such as Captain Bode of the *Chicago*, were asleep when the Japanese opened fire.[136] Suddenly awakened, they had to orient themselves even as unseen assailants damaged their ships and killed or injured their crews. Many Allied officers, moreover, distrusted the new radar technology; this distrust, combined with their radar operators' inexperience, limited their ability to use the radar's sensor to find the Japanese.[137] Perhaps more important, their lack of orientation made it difficult to identify the ships that the radars (and human spotters) detected.[138] Was a ship in the night a Japanese assailant, or an Allied cruiser or destroyer? The result was additional critical minutes of lost time. Even after being illuminated by Japanese searchlights and fired upon by Japanese cruisers, some Allied captains declined to return fire for fear of inadvertently engaging other Allied ships. Their concern was not misplaced: The destroyer *Bagley* mistook the *Canberra* for a Japanese warship and launched a salvo of torpedoes that struck the damaged cruiser, sealing its fate.[139] *Astoria*'s gunnery officer ordered the ship to return fire when fired upon, but he was overruled by the ship's captain, who was confused about the locations of friendly ships and was loath to cause fratricide.[140] This order was eventually rescinded, but not before more time had been lost.

The complex positioning of Allied ships and the absence of the Allied squadron commander, Crutchley, exacerbated this disorientation. Separated into multiple detachments in different locations, Allied captains found it especially difficult to distinguish between friends and foes as they interpreted sightings from unexpected directions. Crutchley had not notified the other captains of his absence, or that he had designated Captain Bode of *Chicago* to command in his place; Bode, in turn, failed to issue orders to the other ships when the battle began or even to alert them to the attack.[141] Awakened from his slumber with the battle already raging, he turned to the immediate problem of figuring out the confusing situation and maneuvering his own ship

136. Bates, *The Battle of Savo Island*, pp. 125, 139, 187; Warner, Warner, and Seno, *Disaster in the Pacific*, pp. 120–121, 171, 179; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 180, 210, 218.
137. Bates, *The Battle of Savo Island*, p. 350; Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 264–265; Thomas McCool, *Battle of Savo Island: Lessons Learned and Future Implications* (Carlisle Barracks, PA: U.S. Army War College, 2002), p. 17, https://apps.dtic.mil/sti/tr/pdf/ADA404261.pdf.
138. Bates, *The Battle of Savo Island*, pp. 363–364.
139. Loxton and Coulthard-Clark, *The Shame of Savo*, pp. 191–205.
140. Ibid., pp. 226–227.
141. Ibid., pp. 111–112, 213–214.

amid the hail of incoming fire. Bode never did assert meaningful control: After a Japanese torpedo and gunfire damaged *Chicago*, Bode instead took the damaged ship, and himself, out of the battle.[142]

The net result was a major difference in realized firepower. Though the Allies had sixty-four more 8-inch and 5-inch guns, the Japanese fired almost four times as many rounds during the battle's thirty-three minutes (a total of 1,867 versus 471). The balance of realized firepower was even more one-sided for the cruisers' 8-inch main batteries: The thirty-two Japanese 8-inch guns at Savo Island fired 1,020 rounds, while the forty-four Allied 8-inch guns fired only 107, about a tenfold difference.[143]

Nonmaterial Variables: Choices and Behaviors at Cape Saint George

The costly loss at Savo led to changes in U.S. doctrine and practice at Cape Saint George. Among the most important was the development of the "Combat Information Center," or CIC. The CIC's purpose was to overcome the confusion and poor situational awareness of U.S. forces in previous nighttime surface actions. Each ship created a central communication hub that integrated continuous input from radio messages, radar contacts, and sonar contacts. CIC officers communicated what they knew to other ships, received data on what other ships knew, continuously updated charts with a real-time picture of the battlespace, and made this information available to the ship's captain. This process allowed the captain to focus on the developing action without having to interpret vast quantities of continuously inflowing sensor data.[144]

The CIC not only increased captains' situational awareness but also enabled new tactics. By late 1942, Arleigh Burke and other officers in the theater had begun to experiment with different formations to maximize a destroyer squadron's firepower using the new CIC organization. In Burke's system, destroyer squadrons were separated into two divisions that maneuvered independently but remained coordinated with each other. The first division would close in for a torpedo attack on the target while the second division would remain at a distance. When the first received fire, the second would surprise the enemy by unexpectedly engaging from a different direction. When the enemy turned to the second division, the first would swing

142. Ibid., pp. 212–214.
143. Newcomb, *The Battle of Savo Island*, appendixes D, E.
144. Hone, *Learning War*, chap. 6.

back and launch another salvo.[145] This setup required every ship commander to maintain constant awareness of both friendly and enemy locations. At night, doing so meant relying on radar. Executing these plans required not only advanced training but also trust. Commanders had to trust that the information from their own CIC and that of their fellow ship commanders was accurate, and that all would act on that information quickly as combat evolved.[146]

This organizational innovation encouraged different nonmaterial U.S. behavior at Cape Saint George. By November 1943, Burke's destroyers all had functioning CICs and had practiced using them.[147] This practice included effective radar operation. The USN had substantially improved its ability to recognize surface targets at night and to integrate radar with other information to build more comprehensive pictures of the battlespace. And U.S. ship commanders had gained confidence in the results and became willing to act on them. This in turn enabled Burke to design tactics that required flexible use of multiple, independently maneuvering detachments at night.

Burke also adopted a streamlined command structure. In contrast with the Allies' fragmented chain of command and lack of prebattle operation orders at Savo Island, at Cape Saint George, Burke was in overall command and had distributed explicit orders to his subordinates before the battle. Burke had rehearsed such orders repeatedly with his ships before the action, and thus each subordinate ship commander understood them clearly.[148]

The result was a very different battle. The USN was now able to use its radar technology advantage to surprise the Japanese. The United States, not Japan, fired the first shot against an unwitting target.[149] The IJN, not the USN, was confused as to the location of its assailants. U.S. fire was coordinated and concentrated. The Japanese technological advantage of superior torpedo range was negated by Japanese commanders' inability to detect their opponent's ships until the USN's own inferior torpedoes were well within range of the Japanese.[150] Unopposed early, massed, effective U.S. fires crippled their opponent before the Japanese could react.

Japan had few options. The surprise U.S. strike had sunk or disabled

145. Jones, *Destroyer Squadron 23*, pp. 22, 27–33.
146. Hone, *Learning War*, pp. 225–229.
147. Ibid., pp. 243–247.
148. Ibid., pp. 243–244; Trent Hone, "Mastering the Masters: The U.S. Navy, 1942–1944," in Hone and O'Hara, *Fighting in the Dark*, pp. 206–209.
149. Morison, *History of United States Naval Operations in World War II*, pp. 355–356.
150. Ibid., pp. 356–357.

40 percent of the entire Japanese squadron before Japan knew that the United States was there. When Yamashiro realized he was under attack, the material balance had shifted dramatically against him. Astute, tightly coordinated Japanese countermaneuvers might have enabled a more effective reply: With a sharp turn to starboard, if not matched by Burke, the Japanese transport group might have been able to cross Burke's T. Doing so would have involved sailing across the front of the U.S. battle line, allowing the Japanese to use all guns against U.S. ships entering effective range one at a time. (U.S. ships could respond only with their forward-facing turrets.) These maneuvers would have required an exceptional grasp of a rapidly changing situation combined with an uncharacteristically slow U.S. counter-response. Yamashiro chose instead to flee.

Perhaps the most consequential difference in Japanese behavior was how the sensor crews aboard Kagawa's destroyers performed. At Savo Island, Mikawa's squadron had detected Allied ships on a moonless night at ranges of up to 18,000 yards. But Kagawa's squadron failed to detect Burke on a similarly moonless night until the USN had closed within 5,000 yards.[151] Had they detected U.S. ships in time, the range advantage of the Japanese destroyers' Type 93 "Long Lance" torpedoes could have given them an important edge at Cape Saint George. Even if U.S. radar had seen the Japanese first, the United States' limited weapon range meant that Kagawa's squadron could still have fired first if it had detected Burke's ships soon enough. In the actual battle the Japanese did not detect the ships, but this had less to do with their equipment than with their crews' proficiency in using it.

Counterfactual: Better Allied Choices at Savo Island

Another way to shed light on the relative contribution of material and nonmaterial variables in these battles is to consider the effects of different behavior with the same matériel. The online appendix presents such a counterfactual analysis for Savo Island—both sides have the same matériel as in the historical case, but we remediate several Allied errors. In particular, the counterfactual assumes that Crutchley does not divide his squadron, that he distributes orders to his ship captains in advance of the battle and does not depart the scene beforehand, and that Allied radar operators use their equipment to its

151. Ibid., pp. 355–356; Bates, *The Battle of Savo Island*, p. 115; Parshall, "How Can They Be That Good?," p. 167; Hone, "Mastering the Masters," p. 207.

full technical potential. Crutchley and Turner had received intelligence on August 8 that identified Mikawa's force heading south. They discounted this report, but in the counterfactual we assume that they accepted its implications and thus concentrated their squadron in a single line of battle south of Savo Island.[152] We further assume that Crutchley positions his radar picket destroyers between Russell and Santa Isabel Islands, where they can detect the approaching threat in time to notify the concentrated battle line to their east.

The projected results are dramatically different. In the historical battle, the Allies were decisively defeated: Four heavy cruisers sank and one was damaged, and two destroyers were also damaged. In comparison, only three Japanese cruisers were moderately damaged. In the counterfactual, by contrast, the Japanese force is annihilated (i.e., all its ships sink), and the Allied loss rate drops by half (two cruisers sink and one is damaged). With Crutchley's errors remediated, the Allied squadron sees the Japanese first and maneuvers to cross the Japanese T. Superior Japanese torpedoes still inflict losses, but Mikawa is unable to escape before losing his entire squadron in less than fifteen minutes. The difference cannot be attributed to matériel, which was the same in the historical case and the counterfactual—the difference is the result of plausible changes to choices and behaviors alone.

Conclusion

The balance of material and nonmaterial variables for naval outcomes is increasingly important as China's material power grows. Can nonmaterial Western political, social, and institutional features compensate for expected growth in the PLAN's size and sophistication? No analysis of a handful of cases can answer such a question definitively. But the particular similarities and differences in the battles of Savo Island and Cape Saint George show how underlying nonmaterial variables can shape potentially important downstream consequences.

These battles suggest that matériel alone is at best an incomplete predictor of battle outcomes at sea. The material balance favored the USN in both battles. An assessment based only on the numbers and types of ships and equipment would thus predict that the USN would be victorious in both battles.

152. Warner, Warner, and Seno, *Disaster in the Pacific*, chap. 16; but see also Loxton and Coulthard-Clark, *The Shame of Savo*, chap. 15. The intelligence report was made, but it remains contentious whether Victor Crutchley and Richmond Turner received it but did not believe it, or whether the report failed to make it to their headquarters for some reason.

Yet this is not what happened. Savo Island was a decisive U.S. defeat—in fact, it was arguably the second-worst defeat in the history of the USN.[153] Cape Saint George, by contrast, was a decisive U.S. victory—in fact, it was among the most one-sided victories in naval history. The difference was not the matériel in use, which was actually more favorable to the USN in its defeat at Savo Island than in its victory at Cape Saint George. The difference was in the role played by nonmaterial variables, and in particular, the major differences in leadership decision-making, organization, and crew proficiency in the two battles. When we varied these behaviors in our counterfactual analysis while holding the matériel on the two sides constant, the Japanese losses at Savo Island were much greater because the Allies made better choices.

These findings have implications for both policy and scholarship. For policymakers, our analysis offers an empirical basis to be more optimistic about the U.S.-China naval balance than material counts of ships or tonnage would suggest. The USN has far more combat and operational experience than the PLAN does, and it is possible that these nonmaterial advantages could compensate for the PLAN's growing size and material sophistication.[154] Our findings suggest that superior skill and leadership can, in fact, enable even materially inferior squadrons to prevail decisively under the right conditions: It has happened in the past.

Optimism, however, needs to be carefully conditioned. Superior matériel clearly matters in naval warfare, and material advantages have historically been more consequential at sea than on land.[155] Chinese shipbuilding capability is now so great that China could overwhelm even a better-skilled opponent in a long war.[156] If the USN-PLAN material balance continues to worsen for the United States, it can eventually outweigh the effects of superior USN skills. If the IJN ships at Savo Island had had 50 percent greater displacement, the IJN would have prevailed against even the skilled Allied squadron in our counterfactual.

Skills are also expensive to maintain and can erode without practice. Navies like the USN, which operates regularly at sea, benefit from ongoing training operations. But many kinds of training activities are costly. Military education and training ashore improve skills but increase personnel requirements

153. Dull, *A Battle History of the Imperial Japanese Navy, 1941–1945*, p. 192; Cox, "H-011-1 Guadalcanal"; Parshall, "How Can They Be That Good?," p. 168.
154. See O'Rourke, *China Naval Modernization*, pp. 4–6.
155. See especially Biddle and Severini, "Military Effectiveness and Naval Warfare."
156. Biddle and Labs, "Does America Face a 'Ship Gap' with China?"

without increasing ship numbers—that is, officers in school ashore cannot sail ships at sea, requiring additional officers to maintain the same naval activity afloat. Personnel retention is important for building experience but requires substantial pay and benefits, both of which compete with matériel for scarce funds. Selective recruitment improves training results but requires higher pay to compete successfully for talented people. The USN can sustain its skill advantages only if the U.S. government continues to fund efforts to recruit, train, and retain personnel. Yet it is easier to quantify the payoff for building more ships or modernizing equipment, which elected officials often support because the benefit to their constituencies is more visible. At the margin, nonmaterial investment is thus easy to undervalue. But our analysis shows that without the skills that such expenditures underwrite, navies can fail to exploit the apparent benefits of the matériel that the shipbuilding and modernization budgets provide.[157]

The balance of skill can also change during a long war—peacetime skill advantages do not tell the whole story. The USN at Savo Island did not use its material resources effectively, and it lost to a materially inferior foe. But a year of astute wartime reforms in training, organization, and leadership produced radically different behavior at Cape Saint George, where a U.S. squadron crushed a weaker foe. The debate over the U.S.-China balance in the Western Pacific tends to focus on a prospective war's opening battles, but adaptation during a long war can change skills dramatically. Just as combat experience during Savo Island helped the USN improve its skills before the battle at Cape Saint George, Chinese skills could similarly improve if the PLAN gains combat experience. If it does, it is possible that the PLAN's higher ship count and trained personnel could overwhelm the USN. Wartime

157. There are important interactions between material investment and nonmaterial human performance. For example, just as underinvesting in training or personnel can reduce performance and retention, so too can an undersized fleet that must operate at a tempo that exhausts its crew. There may be grounds for concern that current U.S. Navy operating tempos exceed what crews can sustain, as suggested, for example, by the high accident rate for U.S. Pacific Fleet surface combatants in recent years and the role of human error in those incidents. See: Department of the Navy, Office of the Chief of Naval Operations, "Memorandum for Distribution: (1) Report on the Collision Between USS *Fitzgerald* (DDG 62) and Motor Vessel ACX *Crystal*; (2) Report on the Collision Between USS *John S McCain* (DDG 56) and Motor Vessel *Alnic* MC," October 23, 2017, https://www.documentcloud.org/documents/4165421-USS-Fitzgerald-and-USS-John-S-McCain-Collision; Eric Schmitt, Thomas Gibbons-Neff, and Helene Cooper, "Navy Collisions That Killed 17 Sailors Were 'Avoidable,' Official Inquiry Says," *New York Times*, November 1, 2017, https://www.nytimes.com/2017/11/01/us/politics/navy-collisions-avoidable.html; David Larter, "Navy Crews at Fault in Fatal Collisions, Investigations Find," *Defense News*, November 1, 2017, https://www.defensenews.com/breaking-news/2017/11/01/navy-crews-at-fault-in-fatal-collisions-investigations-find/. But there are also trade-offs for material and nonmaterial investments, and it is important not to undervalue the latter.

learning and adaptation are thus critical, as is their study: The more important nonmaterial behavior is for outcomes, the more salient learning becomes for projecting the long-term outcome of conflicts between major powers with the material capacity to sustain war efforts over years.[158] Close study of Savo Island and Cape Saint George shows what is possible for a skilled navy in combat against a materially superior but less-skilled opponent. But to exploit this potential will require astute choices by the USN both before and during any future war.

Other policy implications follow from the variability of outcomes in naval warfare. The most important net effects of the counterfactual variations that we consider in the online appendix are to eliminate just a few minutes of unopposed firing for the Japanese and to reposition the Allied squadron by a few thousand yards. These differences stem from a variety of changes in Allied behavior, but together they change the battle's timeline and geometry only slightly. Yet doing so changes the combat outcome dramatically. Subtle behavioral variations of this kind are difficult to anticipate in peacetime. Russia's tactics in its February 2022 invasion of Ukraine, for example, were famously different from those expected by most Western analysts. In general, it is easier for intelligence agencies to count ships, missiles, or aircraft than to anticipate sometimes subtle differences in human behavior, and especially so for war at sea, where the differences that matter can unfold during just a few minutes in combat.[159] Nor can intelligence analysts safely conclude that militaries will deploy a technology and use it to its full potential. Using radar was potentially advantageous for the USN in 1942, but an analyst who assumed that the navy would use radar to its fullest potential at Savo Island would have been wildly off the mark. Because outcomes are sensitive to variations in behavior that are hard to anticipate in peacetime, analysts should be cautious when projecting the likely results of naval combat. China would be wise to consider this inherent variability before concluding that invading Taiwan would be worth it—the cost of doing so could vary widely in ways that are hard to predict with high confidence.

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158. On wartime learning, see, for example: Michael A. Hunzeker, *Dying to Learn: Wartime Lessons from the Western Front* (Ithaca, NY: Cornell University Press, 2021), pp. 1–16; Stuart Griffin, "Military Innovation Studies: Multidisciplinary or Lacking Discipline?," *Journal of Strategic Studies*, Vol. 40, Nos. 1–2 (2017), pp. 196–224, https://doi.org/10.1080/01402390.2016.1196358; Adam Grissom, "The Future of Military Innovation Studies," *Journal of Strategic Studies*, Vol. 29, No. 5 (2006), pp. 905–934, https://doi.org/10.1080/01402390600901067.
159. Eliot A. Cohen and Phillips O'Brien, *The Russia-Ukraine War: A Study in Analytic Failure* (Washington, DC: Center for Strategic and International Studies, 2024).

For scholars, these results reinforce a central finding of the last generation of research in military effectiveness: the importance of nonmaterial variables. Most effectiveness research has focused on continental warfare, but we find that material variables alone are poor predictors of outcomes at sea as well.

Perhaps our most important scholarly contribution is to show that the study of naval warfare is inherently a social science undertaking—engineering and physics alone do not fully explain outcomes of war at sea. Physical scientists dominate much of the analytical enterprise in the U.S. defense planning community. While the physical sciences obviously have much to offer in this domain—and they are likely to be more important at the margin for naval warfare than for land combat—human behavior, human choices, and how humans use matériel are also important factors. The more that physical and social scientists collaborate and learn from each other the better our understanding of this critical domain will be.