"No One Can Afford To Say 'Damn the Torpedoes'": Battle Tactics and U.S. Naval History before World War I[1]

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Abstract

Historians overwhelmingly agree that the U.S. Navy changed dramatically between the early 1880s and World War I, but few have asked how the "New Navy" of this era planned to fight its battles. This article seeks to recover its ideas about battle tactics, using torpedo development as a point of entry. Although officials thought seriously about torpedoes' tactical implications, technological complexity and habits of institutional communication hindered the navy's ability to agree on them, and important questions remained unresolved on the eve of World War I in 1914.

[N]o one can afford to say "Damn the torpedoes; go ahead."

Mark Bristol, 29 June 1910[2]

Suppose battle with an equal confronted our mobilized fleet tomorrow, and you were its Commander-in-Chief. How would you form your fleet? Where would the weak vessels be, where the most powerful vessels? Where would you want the cruisers, the destroyers, the submarines, if they

1. See next page for list of abbreviations used in the notes.

2. Mark Bristol, "Torpedoes," lecture delivered at NWC, 29 June 1910, p. 20, RG8/B111/F3, NHC.

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were present? What position with relation to wind and sea would you desire? How would you seek to use the superior speed of some of your battleship divisions? What attention would you pay to a destroyer threat on the head of your column? What power of independent movement would you delegate to subordinate flag officers? What support would you expect an unexpected and hazardous movement of one of your battleship divisions to receive? What should be done if a battleship runs amuck [sic]*, falls out, or is torpedoed? How would you expect to reply to the concerted attack of twenty destroyers on your fleet while engaged with* [sic] *enemy fleet? How would you desire to use your minor forces? How will you distribute your fire? Will you attempt to designate targets to your ships? Will you advise concentration of fire? Will you advise splitting your fire? And over and above all who knows all these opinions you may have and who has confidence in them?*

Unidentified Naval Officer, Summer 1912[3]

Introduction

Historians agree that the U.S. Navy changed dramatically during the three decades before the outbreak of World War I in 1914. In what Walter Herrick famously termed the "American naval revolution," the navy began to plan for war

3. No author (but judging from the note in the Table of Contents to the volume, probably Commander Carl Vogelgesang and Commander Frank Schofield), n.d. (but summer 1912), Answer to Question 4, vol. 2, pp. 173–74, Problem of 1912, RG 12, NHC.

The following abbreviations are used in the notes:

B	Box
BB* / BBB*	
BuOrd	Bureau of Ordnance, Navy Department
CINC	Commander in Chief
CIO	Chief Intelligence Officer, Navy Department
CNTS	Commander of the Naval Torpedo Station, Newport, Rhode Island
CoO	Chief of the Bureau of Ordnance, Navy Department
DeptNav	Navy Department
E	Entry
F	Folder
GB	General Board
IoO	Inspector of Ordnance
NARA	National Archives and Records Administration, Washington, D.C.
NDL	Navy Department Library, Washington, D.C.
NTS	Naval Torpedo Station, Newport, Rhode Island
NHC	Naval Historical Collection, Newport, Rhode Island
P / PP	Page / Pages
RG	Record Group
V	Volume
VG**	
VR**	

against new enemies (most notably Germany and Japan) and transformed itself from a commerce-oriented cruiser force to a battle-oriented fleet of capital ships.[4] Moreover, this naval narrative has come to play a significant role in broader studies of American defense and foreign policy at the turn of the century.[5]

This historiographical consensus is missing a crucial element, however: few historians have investigated how the U.S. Navy actually would have fought a battle with its new vessels against its new enemies. Although surveys of American naval history always include at least a chapter on the emergence of the "New Navy" from the 1880s to World War I, they do not mention battle tactics more than superficially.[6] For cultural and diplomatic historians, the subject would seem to have little relevance: the social meanings and strategic uses of the fleet are what matter. The lack of interest among naval historians is more difficult to understand.[7] Surely the U.S. Navy did not spend millions of dollars on a new battlefleet without constantly asking itself, like the officer quoted above, "Suppose battle with an equal confronted our mobilized fleet tomorrow. . . ." By failing to comprehend precisely how it planned to conduct its core mission of fighting

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*At NARA, in RG74/E25 (BuOrd official files), the box numbering restarts twice. I adopted "B" to apply to the first series, "BB" to apply to the second series, and "BBB" to apply to the third series.

**At NARA, RG74/E26 (semi-official BuOrd files) is eccentric, and so are my abbreviations. They are:

B1B/VR (B[ox] 1, B[ound papers], V[olume] R[ed])

B1B/VG (B[ox] 1, B[ound papers], V[olume] G[reen])

B1L (B[ox] 1, L[oose papers])

4. Walter Herrick, *The American Naval Revolution* (Baton Rouge: Louisiana State University Press, 1966).

5. See, e.g., David M. Pletcher, *The Awkward Years: American Foreign Relations under Garfield and Arthur* (Columbia: University of Missouri Press, 1962), 116–36; Walter LaFeber, *The New Empire: An Interpretation of American Expansion, 1860–1898* (Ithaca, N.Y.: Cornell University Press, 1963), 58–60, 93, 121–27, 229–41; James Abrahamson, *America Arms for a New Century: The Making of a Great Military Power* (New York: Free Press, 1981), 20–29, 47–48, 120–23; Thomas Misa, *A Nation of Steel: The Making of Modern America, 1865–1925* (Baltimore, Md.: Johns Hopkins University Press, 1995), 95–96; Paul A. C. Koistinen, *Mobilizing for Modern War: The Political Economy of American Warfare, 1865–1919* (Lawrence: University Press of Kansas, 1997), 26–47.

6. See, e.g., Kenneth Hagan, *This People's Navy: The Making of American Sea Power* (New York: Free Press, 1991), 185–246; Robert Love, *History of the U.S. Navy, 1775–1941* (Harrisburg, Pa.: Stackpole Books, 1992), 345–466 (brief discussions on 411–13, 430–32). It may be reasonably argued that these synthetic accounts cannot be blamed for neglecting tactics when there are no analyses of tactics for them to draw on—but that argument merely begs the question of why there are no such analyses, and why the syntheses have not called for them.

7. The noteworthy exception here is Norman Friedman, who clearly kept battle tactics at the forefront of his mind in writing his series of books on the U.S. Navy.

a battle, naval historians have cooperated with their cultural and diplomatic counterparts in "black-boxing" the new American fleet—that is, placing tactics inside a "black box" which is not inquired into, or mistaken for a solution when it is in fact a problem. The result is to oversimplify a highly complex problem.

This black-boxing has weakened our understanding not only of American naval history but potentially of much wider issues. To understand why, it is helpful to consider the work of two scholars of Britain's Royal Navy, Jon Sumida and Nicholas Lambert, who have connected tactics to grand strategy. In brief, Sumida and Lambert have shown that tactical concerns about the ability of capital ships armed with heavy guns to win a decisive battle at an acceptable cost were among the main reasons that the Royal Navy developed fundamentally new ways of defining and applying naval power before World War I. Instead of seeking command of the sea through battle with battleships, the Royal Navy sought denial of "narrow" waters like the Channel using flotilla craft and control over the high seas using battle cruisers. It also developed a plan for exploiting British dominance of global communications, finance, and merchant shipping to defeat an enemy in a short war. These ideas, which de-emphasized the role of battle and battleships in naval power, and re-conceived the role of naval power in national strategy, were revolutionary. Tactical issues were by no means the sole cause of this chain reaction, but they were an important cause.[8] While the British case provides no guarantee that investigating American battle tactics will produce equally sensational insights into big questions about grand strategy and national policy, it does demonstrate the potential of the inquiry to reshape our understanding of matters far beyond its conventionally defined boundaries.

8. See Jon Sumida, *In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889–1914* (Boston: Unwin Hyman, 1989); Sumida, "The Quest for Reach: The Development of Long-Range Gunnery in the Royal Navy, 1901–1912," in *Military Transformation in the Industrial Age*, ed. Stephen D. Chiabotti (Chicago: Imprint, 1996), 49–96; Sumida, "A Matter of Timing: The Royal Navy and the Tactics of Decisive Battle, 1912–1916," *Journal of Military History* 67, no. 1 (January 2003): 85–136; Sumida, "Expectation, Adaptation, and Resignation: British Battle Fleet Tactical Planning, August 1914–April 1916," *Naval War College Review* 60, no. 3 (Summer 2007): 101–22; Nicholas A. Lambert, "Admiral Sir John Fisher and the Concept of Flotilla Defence, 1904–1909," *Journal of Military History* 59, no. 4 (October 1995): 639–60; Lambert, *Sir John Fisher's Naval Revolution* (Columbia: University of South Carolina Press, 1999), especially 199–234; Lambert, "Strategic Command and Control for Maneuver Warfare: Creation of the Royal Navy's 'War Room' System, 1905–1915," *Journal of Military History* 69, no. 2 (April 2005): 361–410; Lambert, *Planning Armageddon: British Economic Warfare and the First World War* (Cambridge, Mass.: Harvard University Press, 2012).

Unfortunately, there is nothing on the interplay between tactics and strategies in other navies comparable to what Sumida and Lambert have produced for the British navy. While torpedoes played a large role in the thought of the French *Jeune École* ("young school"), the strategy was directed against the British economy, not the British battle fleet (see Arne Røksund, *The Jeune École: The Strategy of the Weak* [Leiden: Brill, 2007], especially 51). For the German navy, This article, then, is a first attempt to unpack the "black box" in which historians have placed battle tactics, using torpedo development as its point of entry. This approach has both limitations and advantages. The subject of battle tactics is highly complex, requiring detailed knowledge of administrative practices, financial circumstances, personal rivalries, and available technologies, to name just some of the relevant factors.[9] Many of those factors have not been adequately explored in the existing literature on the U.S. Navy and are beyond the scope of this article. Moreover, while the main source used for this essay—namely, the tactical papers of the Naval War College—is underexploited and valuable, it constitutes only part of the extant documentary record relevant to the subject of torpedoes and battle tactics. In view of these limitations, this article cannot be regarded as an exhaustive treatment of prewar American naval battle tactics or even of the relationship between torpedo development and battle tactics.

Nevertheless, torpedo development does constitute a valuable angle onto the subject of battle tactics. Torpedoes numbered among several technologies, including rifled guns, steam propulsion, steel armor, radio, and fire control, that transformed—or seemed likely to transform—the conduct of naval battles in the decades before World War I. Like these other technologies, torpedoes were highly sophisticated industrial products which required expert care and handling in order to achieve their full tactical potential, along with accessory technologies such as fire control and tubes. Their best use was by no means obvious. Torpedoes were both "systems of systems," in which the failure of one part could cause the failure of the whole, and "systems within systems," in which the failure of torpedoes could cause the failure of an entire tactical plan. Given such mutual interdependence between the parts and the whole, it is impossible to isolate independent variables. Rather, the task is to trace the effects that changes in one dependent variable (like torpedo fire control) could have on another dependent variable (like gunnery fire control).

As this article will show, because the relevant variables were interdependent and changing rapidly, battle tactics were dynamic in the U.S. Navy. Officers did not cling monolithically or rigidly to tactics from the age of sail, like steaming in

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very little work has been done on battle tactics during Admiral Alfred von Tirpitz's tenure as State Secretary (1897–1916), despite suggestive comments in Ivo Lambi, *The Navy and German Power Politics, 1862–1914* (Boston: Allen and Unwin, 1984), e.g. 64. Patrick Kelly's useful work on German naval tactics covers the period before Tirpitz became State Secretary; see Kelly, "Strategy, Tactics, and Turf Wars: Tirpitz and the Oberkommando der Marine, 1892–1895," *Journal of Military History* 66, no. 4 (October 2002): 1033–60; Kelly, "Tirpitz and the Origins of the German Torpedo Arm, 1877–1889," in *New Interpretations in Naval History: Selected Papers from the Eleventh Naval History Symposium*, ed. Robert Love (Annapolis, Md.: Naval Institute Press, 2001), 220–38.

9. See especially Sumida, "A Matter of Timing," and "Expectation, Adaptation, and Resignation"; and Norman Friedman, *Naval Firepower: Battleship Guns and Gunnery in the Dreadnought Era* (Annapolis, Md.: Naval Institute Press, 2008), 84–99.

parallel lines or seeking to cap the enemy line. On the contrary, they queried the supposedly immutable lessons of history, such as the supremacy of battleships armed with heavy guns. If anything, officers tended to overestimate, not to underestimate, the capability of torpedoes to disrupt traditional naval tactics. This tendency arose both from the inherent difficulty of understanding all the factors that determined the tactical effectiveness of torpedoes and from patterns of institutional communication which exacerbated that difficulty. Although the hoary distinction between line and technical officers distorts more than it reveals, it is true that tactical and technological considerations did not inform each other as robustly as they might have in American torpedo development.

The modern torpedo was invented in the 1860s by the British engineer Robert Whitehead.[10] The earliest versions, which could make some 6 knots for 200 yards, were powered by reciprocating engines running on compressed cold air stored in an air flask. Their vertical accuracy was maintained by a device known as "The Secret," which combined a hydrostatic valve to control the depth and a pendulum to control the trim, but they lacked any means for maintaining their accuracy in the horizontal plane. Over the next three decades, Whitehead improved his torpedo to the point that it could make almost 30 knots for 800 yards—but it still lacked a mechanism for maintaining horizontal accuracy. In 1896, Whitehead overcame that problem by applying a gyroscope invented by Ludwig Obry to his torpedo. The Obry gyroscope was the first of two key inventions (the other being the "superheater," discussed below) which transformed the torpedo from an inaccurate, short-range weapon into an accurate, long-range one.[11]

The U.S. Navy purchased its first Whitehead torpedoes in 1891. Instead of buying directly from Whitehead, it arranged for a Brooklyn firm called the E. W. Bliss Company to build Whitehead torpedoes under license, including gyroscopic torpedoes after 1896. These early Whitehead torpedoes were distributed to battleships and torpedo boats, both of which fired torpedoes from above-water tubes; the first surface vessels to receive submerged tubes were the *Connecticut*-class battleships first ordered in 1902. The navy did not launch its first destroyer (*Bainbridge*) until 1899 or acquire its first submarine (*Holland*) until 1900.[12] Some

10. The following paragraph draws on Edwyn Gray, *The Devil's Device: Robert Whitehead and the History of the Torpedo* (Annapolis, Md.: Naval Institute Press, 1991), 14–59, 77–89.

11. The meaning of "long-range" changed over the period of time examined in this article. Around 1906, maximum torpedo ranges increased roughly from 2,000 yards to 4,000 yards. Around 1910, they increased again to 7,000 yards for 18-inch torpedoes and to 10,000 yards for 21-inch torpedoes. The exact timing depended on the navy and torpedo model in question.

12. Throughout this article, I have *not* used the terms "torpedo boat" and "destroyer" interchangeably. Torpedo boats originated in the 1870s, weighed several hundred tons less than destroyers, and had purely offensive missions. Destroyers (the name is actually an abbreviation of "torpedo-boat destroyer") emerged in the 1890s as an evolution from the failed torpedo-boat catchers of the 1880s. Initially, destroyers' mission was defensive—to protect their own fleet by

early cruisers carried above-water torpedo tubes (for example, *Cincinnati*), while others did not (for example, *Baltimore*). Within the Department of the Navy, the Bureau of Ordnance was responsible for torpedo development, aided by the Naval Torpedo Station in Newport, Rhode Island. Although the precise duties of the Station varied over time, they included torpedo maintenance, personnel instruction, research and development, and, after 1907, torpedo production.

The "New Navy," Battle Tactics, and the Bliss-Leavitt Torpedo

Although construction of the "New Navy" began in the early 1880s, it was not accompanied by the creation of any official or confidential forum for tactical discussion. The navy took its first step towards creating such a forum in the early 1890s, when the Naval War College (itself established in 1884) introduced a new feature into the curriculum: a "problem" to be solved during its annual summer conference. For a decade or so, these assigned "problems" focused overwhelmingly on strategy, and tactics were discussed only insofar as they seemed to bear on strategic issues. For instance, the discussion of tactics in 1899 was restricted to "A discussion of the tactical value of the harbors of the North Atlantic, with respect to the position of our battleship fleet"—a far cry from the question of how to operate the fleet in battle, notwithstanding the recent experience of the Spanish-American War (1898).[13] Insofar as the navy learned "lessons" from the two major naval battles of the war, these related to gunnery rather than torpedoes. At the battles of Manila Bay and Santiago de Cuba, both American and Spanish warships carried torpedo tubes but seemingly made little use of them. Despite maneuvering at will to achieve favorable gunnery positions, the U.S. Navy still managed hit rates of only 2.42 percent at Manila Bay and 1.29 percent at Santiago de Cuba. These abysmal results motivated the navy to improve its gunnery, but did little to encourage torpedo development.[14] In 1900, the study of tactics received another institutional boost with the establishment of the General Board, which collaborated with the War College to promote the subject.

In 1901, fleet battle tactics achieved a formal institutional foothold. That year, the annual "problems" began to feature sections on battle tactics, and the new

destroying enemy torpedo boats—but over time they came to be used offensively as torpedo boats themselves against enemy capital ships. Even when their offensive use was contemplated, I have consistently referred to destroyers as "destroyers" rather than as "torpedo boats" so as to avoid confusing two distinct types of vessel. On these issues, see David Lyon, *The First Destroyers* (London: Mercury Books, 1996), 6–16.

13. Ronald Spector, *Professors of War: The Naval War College and the Development of the Naval Profession* (Newport, R.I.: Naval War College Press, 1977), 71–73; Section C, Problem of 1899, RG12, NHC.

14. See Christopher Havern, Sr., "A Gunnery Manqué: William S. Sims and the Adoption of Continuous-Aim in the United States Navy, 1898–1910" (master's thesis, University of Maryland, 1995), especially 5–19 (hitting percentages given on pp. 9, 17).

lecturer in tactics, Lieutenant Commander J. B. Murdock, adjusted his lectures to focus on battle tactics. Justifying the new focus, Murdock proclaimed to his students "that we have to-day no battle tactics." At around the same time, the General Board and the War College began to design maneuvers to test and improve the maneuverability of the battle fleet.[15]

Although the study of battle tactics took root in 1901, the tactical impact of torpedo development received little attention. Murdock, the resident lecturer on tactics at the War College, spent most of his time and energy introducing his students to a recent phenomenon called line-of-bearing tactics, which were designed to facilitate both gunnery and maneuvering, and preaching the importance of target practice. Although he mentioned torpedoes in 1901 and 1902, he did so only to credit them with some moral influence and for turning thought away from ramming and mêlée, which many officers thought desirable for decades following the victory of Austrian ironclads over Italian ironclads at the battle of Lissa in 1866, and towards longer fighting ranges. In 1902, Murdock pointed out, but only in passing, that a retreating fleet had a major advantage over a pursuing fleet in torpedo fire. This was the extent of his attention to the effect of torpedoes on tactics.[16] Similarly, the solutions to the tactical problems presented at the 1901 and 1902 War College conferences focused overwhelmingly on concentrating gunfire, maneuvering so as to achieve it, and the command-and-control problems created by maneuvering.

In a paper for the 1902 conference, however, Murdock made two new points about torpedoes. First, he argued that the existence of torpedoes would tend to keep fleets from closing within 2,000 yards. Second, despite this pressure to keep the range long, he argued that whether by accident or by the desire of the fleet with inferior gunnery, battles were likely to include actions within 2,000 yards, where the torpedo could make an essential contribution to victory or defeat. "The War College therefore is of the opinion," he announced, "that it is a great error to design our battleships without torpedo tubes."[17] This statement was a concrete measure of the torpedo's impact on naval architecture (not to mention the close relationship between tactics and naval architecture), but its importance should not be overstated. Fundamentally, Murdock and the War College continued to think of gunnery as the controlling element in naval tactics, with torpedoes playing a supporting role.

15. Dewey to Commander, North Atlantic Squadron, 22 March 1901, RG80/E285/B1/V1/P181–83, NARA; Crowninshield to SecNav, 25 November 1901, RG80/E285/B1/V1/P390–93, NARA.

16. Murdock, "Battle Tactics," lecture delivered 20 June 1901, RG14/B2, NHC; Murdock, "Naval Tactics (4)" and "Naval Tactics (5)," lectures delivered summer 1902, ibid. The logic behind this point was that the pursuing fleet was moving towards the retreating fleet, thereby lengthening the effective range of the latter's torpedoes, while the retreating fleet was moving away from the pursuing fleet, thereby reducing the effective range of the latter's torpedoes.

17. Murdock's paper (quotation on p. 3), n.d., Problem of 1902, RG12, NHC.

Outside the War College, meanwhile, the Bureau of Ordnance and the Torpedo Station were preparing for torpedoes to play a leading role. The central figure in this effort was Charles O'Neil, the chief of the Bureau from spring 1897 to spring 1904. During this time, he was also president of the Board on Construction, established in 1889, which brought together the chiefs of the bureaus involved in naval construction (Construction and Repair, Steam Engineering, Equipment, and Ordnance), along with the Chief Intelligence Officer, to advise the Secretary of the Navy on ship design.

While O'Neil was chief of the Bureau of Ordnance, it undertook several torpedo-related initiatives with important tactical implications. First, in 1897, O'Neil negotiated with the Bliss Company to install the Obry gyroscope in torpedoes under contract, which greatly increased their accuracy.[18] Second, O'Neil began to negotiate with the British firm Armstrong, Whitworth & Co. for their patented submerged torpedo tube.[19] Third, he authorized experiments with gyroscopes capable of angle (or "curved") fire, which meant that the gyroscope could "curve" the torpedo through a particular angle after it was fired.[20] Angle fire was tactically significant both for torpedo boats, because it allowed them to fire three torpedoes on parallel courses, and for capital ships, because it allowed them to fire torpedoes on a particular bearing without turning the whole ship (and thereby ruining the accuracy of gunnery). Not all angle fire was created equal, however—the maximum angle setting and increments of angle settings could differ, and not all angle gyroscopes could be set from outside the torpedo tube—and so it is necessary to date particular capabilities very carefully.

Fourth, in 1901, O'Neil set in motion the development of the world's first practical superheater. Developed at the Bliss Company, this superheater was located inside the torpedo air flask (and thus known as an "inside" superheater), where it heated the compressed air before it entered the pipes passing to the engine. The effect was to dramatically increase torpedo speeds and ranges: the contract specifications leapt from 30 knots for 800 yards without much accuracy into a weapon that could make 35 knots for 1,200 yards.[21] When this first-generation superheater was paired with the first-generation Obry gyroscope, the torpedo began its gradual transformation into a high-speed, long-range, accurate weapon.

18. O'Neil to Bliss Co., 27 September 1897, BuOrd 7061/97-LS60/498–500 with 6864/96, RG74/E25/B266, NARA.

19. The negotiations with Armstrong can be found in BuOrd 5841/97, RG74/E25/B297, NARA.

20. See, e.g., O'Neil to McLean, 24 February 1899, BuOrd 2034/99-LS99/528, RG74/E25/B372, NARA.

21. Figures taken from "Specifications for the Manufacture of Whitehead Automobile Torpedoes, U.S.N., 5m x 45cm, Mark II, Fitted for Elswick Submerged Discharge," 21 February 1899, para. 18, B25-201, NTS; and "Specifications for the Manufacture of Bliss-Leavitt Automobile Torpedoes, U.S.N., 5m x 45cm, Mark III," November 1903, para. 18, B37-146, ibid.

Finally, in 1903, O'Neil decided to replace the reciprocating engines in American torpedoes with turbine engines.[22] The tactical significance of this change had to do not with maximum speeds and ranges, which were similar in both turbine and reciprocating torpedoes, but with the flexibility of speed and range settings. Unlike reciprocating engines, which could run efficiently at multiple speeds, turbines could run efficiently only at the particular speed for which they were designed. Aside from the consequent procurement challenges, this lack of flexibility meant that vessels could not use turbine torpedoes efficiently at different ranges in the same battle—a fact with particular significance for destroyers, which might otherwise have been expected to fire torpedoes at long ranges while protecting their capital ships and at short ranges while charging the enemy. While torpedo officers were well aware that running turbine torpedoes at anything other than their designed speed reduced their efficiency, strong evidence exists that they did so anyway.[23]

Although O'Neil initiated several important and bold developments in American torpedo technology, it was the apparent conservatism of another of his decisions that sparked the first sustained discussion about the tactical implications of torpedo development at the War College. In 1897, as chief of the Bureau of Ordnance, O'Neil had instigated the attempt to acquire a submerged tube, but in 1902, as president of the Board on Construction, he had recommended against the placement of submerged tubes on battleships. These actions were not inconsistent: O'Neil believed that submerged tubes were worth the cost and trouble of installation only if torpedoes were capable of adequate ranges and of angle fire, and as of late 1902, the latest torpedoes in the navy's arsenal lacked both. Given these limitations, O'Neil's Board on Construction recommended against placing submerged tubes on the five *Virginia*-class battleships.[24]

O'Neil's decision came in for heavy criticism at the War College conference in 1903. The hypothetical enemy before the officers that summer was Germany, whose navy presented particular difficulties from a torpedo perspective. The American fleet lost every war game but one due to inferior speed and lack of torpedoes on its capital ships. "A number of tactical games carefully played to develop the value of torpedoes shows that they turn the scale of battle in their favor in a most decided manner," a special subcommittee appointed to study the issue reported, and "[n]o weight of guns and armor can precisely compensate for even

22. See, e.g., O'Neil to Bliss Co., 2 November 1903, BuOrd 12865/03, RG74/E25/B664 [misfiled, should be in B575], NARA; "Contract for the Manufacture of Torpedoes, U.S. Navy, Fifty (50) Torpedoes, 5m x 45c/m, Mark IV," B50-158, NTS.

23. Gleaves, "Torpedoes," lecture delivered at the Naval War College on 23 July 1906, p. 42, B52-157, NTS; Gleaves to Mason, 6 October 1906, para. 7, BuOrd 19377/12, RG74/E25/B938, NARA.

24. Board on Construction [majority] to SecNav, 20 January and 27 December 1902, RG80/E180/V6/P191 and RG80/E180/V7/P55–60, respectively, NARA.

the smallest torpedo armament."[25] To avert defeat, the War College concluded that American capital ships must carry (submerged) torpedo tubes and long-range torpedoes. In September 1903, the General Board endorsed the War College's conclusions in a letter to the Secretary of the Navy.[26] To add insult to injury, O'Neil's own subordinate, Lieutenant F. K. Hill, who had the torpedo desk in the Bureau of Ordnance, lambasted the state of American torpedo development to the officers at the War College conference. While the short range of "our torpedoes as they now stand" might have justified the decision to keep submerged tubes off capital ships, Hill sarcastically allowed, the justification "certainly does not apply to the most modern torpedoes developed."[27] As chief of the Bureau of Ordnance and president of the Board on Construction, O'Neil was the obvious target of criticisms about submerged tubes and torpedo development in general.

Under pressure from the fleet, O'Neil took two key decisions. First, in early 1904, his Board on Construction reversed its position on submerged tubes in capital ships by recommending the installation of two forward submerged tubes on eighteen capital ships—the five *Virginia*-class battleships, five *Louisiana*-class battleships, six *Maryland*-class armored cruisers, and two *Tennessee*-class armored cruisers.[28] Second, around the same time (and on the basis of very limited trials), O'Neil signed contracts for fifty-two of the new turbine-powered, superheater-equipped torpedoes. These weapons, which were known as Bliss-Leavitt torpedoes, also carried angle gyroscopes.

As events unfolded, it became clear that O'Neil had gambled on an immature weapon, and the navy lost time trying to overcome its deficiencies while other torpedoes surged ahead. Not until 1907 did the Bureau of Ordnance admit to itself that the Bliss-Leavitt torpedo had fallen behind foreign models and resume the purchase of reciprocating-engine Whitehead torpedoes. In more practical and immediate terms, the navy's struggles to make the Bliss-Leavitt torpedo fit for service led to supply shortages which were still being felt nearly a decade later: as of 1911, capital ships carried only 75 percent of their full torpedo allowance.[29] Contracts on the books did not necessarily translate automatically into torpedoes on ships.

The reasons behind the problematic performance of the Bliss-Leavitt torpedoes were complex and remain very difficult to identify (in part because they became entangled in a lawsuit between the government and the Bliss Company,

25. Supplementary Tactics, Question 4, p. 46, Problem of 1903, RG12, NHC. See also Supplementary Tactics, Question 2, p. 43, and "Tactics: Report of a Special Committee, Appendix B: Torpedoes," pp. 6–7, ibid.

26. Dewey to SecNav, GB 420, 26 September 1903, RG80/E285/B1/V2/P368–69, NARA.

27. F. K. Hill, "Submerged Torpedo Tubes and Tactics of the Torpedo," lecture delivered at NWC, August 1903, RG8/B112/F1, NHC (emphasis in the original).

28. Board on Construction to SecNav, 27 February 1904, BuOrd 2550/04 with 14115/03, RG74/E25/B580, NARA.

29. Mason to SecNav, 6 May 1911, BuOrd 23736/13, RG74/E25/B1225, NARA.

and thus contemporary diagnoses of the problems must be treated with great caution). This is not the place for a detailed examination of the problems.[30] In the meantime, the temptation to draw a straight line from the shortcomings of the Bliss-Leavitt torpedo before World War I to the infamous troubles with the Mark 14 torpedo during World War II should be resisted.[31] The reduction of two exceedingly complicated stories to a simple one about technical competence would be hazardous in the extreme.

Potential and Reality: Variables Affecting the Tactical Effectiveness of Torpedoes

Tactical discussions at the War College proceeded at some remove from the navy's actual torpedo situation. In determining the tactical implications of torpedoes, officers tended to assume that they would imminently achieve their *potential* for speed, range, and accuracy—as stated in the contract specifications and by the Bureau of Ordnance—while de-emphasizing mechanical problems which precluded full achievement of their potential. This tendency alienated officers visiting the War College who had witnessed the mechanical problems with torpedoes at sea. "In the past there has been considerable service criticism of the weight afforded to torpedoes on the game board," a senior officer lecturing at the War College in 1909 allowed, "principally owing to prevalent doubts as to the reliability of the weapon, and to the former practice of plotting every torpedo fired as a satisfactory run."[32] The War College did not help itself by failing to inquire aggressively of the Torpedo Station (located just a few hundred yards away) as to the actual, rather than potential, capabilities of American torpedoes. Official inquiries to the torpedo experts from the General Board were also few and far between. Indeed, between 1903 and 1910, the files of the Bureau of Ordnance and the Torpedo Station do not seem to contain a single request for information about the capabilities of American torpedoes from either the War College or the General Board.[33]

By the same token, torpedo officers felt that "their" weapon was undervalued and that they received inadequate guidance on the desired tactical capabilities of torpedoes. "The Navy has neglected its most powerful weapon and has left it

30. For that, and for a detailed comparison with British torpedoes (which had their own problems), see Katherine Epstein, "Inventing the Military-Industrial Complex: Torpedo Development, Property Rights, and Naval Warfare in the United States and Great Britain before World War I" (Ph.D. dissertation, Ohio State University, 2011), especially chaps. 3 and 5.

31. On the latter, see Frederick Milford, "US Navy Torpedoes—Part Two: The Great Torpedo Scandal, 1941–43," *Submarine Review*, October 1996.

32. R. C. Smith, "Naval Tactics: Problems Suggested by War College Games, 1908–1909," lecture delivered at NWC, 8 July 1909, p. 12, RG14/B2, NHC.

33. See O'Neil to Fletcher, 8 October 1903, BuOrd 11855/03-LS222/70, RG74/E25/B572, NARA; Acting CoO to DeptNav, 15 August 1910, BuOrd 23696/1-LS571/293–99, RG74/E25/B1222, NARA.

absolutely undeveloped," a torpedo officer speaking to the War College in 1911 complained. The Torpedo Station had tried to get tactical guidance and been rebuffed: its files contained an unanswered question to the War College about the desired range and speed of torpedoes.[34] The commander of the Torpedo Station opened his lecture to the War College in 1914 by affirming, "[T]he responsibility for our deficiencies in torpedoes and mines, and for inadequacy of our designs, rests largely with the War College and General Board," since they had failed to provide a "statement of the relative values of the different desired characteristics," which was "necessary to good design."[35] In fact, the Torpedo Station and Bureau of Ordnance showed no more persistence in seeking advice from the War College and General Board than vice-versa.

The actual capabilities of American torpedoes from 1903 until World War I are very difficult to establish, because so many variables determined their effectiveness. Moreover, these variables changed at different times and left paper trails of varying exactitude and robustness. The contract specifications are relatively easy to find, but they cannot be taken as a reliable indicator of actual performance. While it may be impossible to know the details of all the relevant variables, it should at least be possible to identify the latter. Although the definition of a torpedo's tactical "effectiveness" was not fixed before World War I, a good working understanding is that effectiveness was proportional to the torpedo's probability of hitting and/or probability of causing the enemy to adopt disadvantageous tactics for fear of being hit. If the effectiveness of torpedoes is defined in this way, then what variables must have determined it?

First, the willingness of officers to shoot their torpedoes was a factor. Some were unwilling, due to a fear of circular runs caused by failure of the gyroscope. "Today the torpedo is not relied upon in the battle ship and is considered a source of danger more than anything else," a young officer serving on the battleship *Rhode Island* reported. "This need not be so for it has accuracy and it has range, and once the return or circling element is eliminated it will be valued as it should."[36] Obviously, if the fear of circular runs was great enough that officers would be unwilling to fire torpedoes in battle, no matter their range and speed, lest they endanger friendly vessels in formation, then the tactical value of torpedoes was nil. The Torpedo Station was acutely aware of the problem from an early stage and labored to overcome the prejudice against torpedoes caused by circular runs, but by World War I, it still had not invented an anti-circular run device trusted by the fleet.[37]

34. Charles Belknap, "Torpedoes," lecture delivered at NWC, n.d. (but summer 1911), p. 13, RG8/B111/F3, NHC.

35. J. K. Robison, "Development of Torpedoes and Mines," lecture delivered at NWC, 26 August 1914, p. 1, RG8/B111/F4, NHC.

36. Stapler to commanding officer, 8 February 1910, BuOrd 23014/2, RG74/E25/B1182, NARA.

37. There are many documents on this subject, but see, e.g., Chambers to O'Neil, 8 July 1903, BuOrd 8251/03 with 6041/02, RG74/E25/B511, NARA; Benton C. Decker, "The Prin-

Second, the competence of the torpedo personnel affected the weapon's effectiveness. Torpedoes could not reach the maximum speed, range, and accuracy of which they were physically capable unless personnel knew how to maintain and operate them properly. Evidently, the assigned personnel had significant knowledge gaps. In 1908, the Torpedo Station reported that the quality of personnel engaged in handling torpedoes at sea should be "very much improved."[38] In 1910, the commander of the Torpedo Station told a group of officers at the War College, "I freely confess that I sometimes think that the wish to escape torpedo practice is father to the thought that prompts much criticism [of torpedoes]."[39] In 1912, the chief of the Bureau of Ordnance admitted that mechanical faults in the torpedoes themselves were sometimes to blame, but he maintained that "a large part of the trouble is due to inexpertness of personnel."[40] This view received a strong endorsement from William Sims, commander of the Atlantic Torpedo Flotilla, who confirmed, "It is apparent that the material is capable of great improvement, but it is unquestionable that at present it is far in advance of the personnel."[41] Predictably, fleet personnel fired back that the torpedoes or faulty instruction were to blame. A typical example came from the young Harold Stark, who responded to the Torpedo Station's charges of incompetence in torpedo handling by admitting his inexpertness but stating "I believe the fault to lie primarily with this Station."[42] Whoever was to blame, the fact remained that incompetence on the part of personnel limited the capabilities of torpedoes.

The third limiting factor was torpedo fire control. Physical characteristics like speed, range, and potential accuracy were meaningless if the torpedo could not be aimed accurately at its target. It is therefore necessary to understand the elements that entered into the torpedo fire control problem, and the tools available for solving it. The main instrument in torpedo fire control was the director, essentially a sophisticated slide ruler. Using the course and speed of the enemy and the course and speed of the torpedo as input data, the director worked on the principle of

ciples and Practice of Tactics as Applied to Naval Conditions of the Present Day," 1 April 1913, RG13, NHC; Williams to Twining, 28 July 1913, BuOrd 25633/134, B78-305, NTS; Robison, "Development of Torpedoes and Mines," lecture delivered at the Naval War College, 26 August 1914, p. 4, RG8/B111/F4, NHC.

38. Torpedo Board to Mason, 19 August 1908, BuOrd 18172/32, B60-209, NTS.

39. Bristol, "Torpedoes," lecture delivered at NWC, 29 June 1910, p. 19, RG8/B111/F3, NHC.

40. Twining to SecNav, 7 November 1912, para. 8, RG74/E25/BBB226, NARA. See also Twining to Andrews, 19 September 1911, RG74/E26/B1B/VG/P236–238, NARA; First Committee, General Board, 9 December 1912, GB 407, RG80/GB407/B31, NARA; Williams to Twining, 26 February 1913, B79-306, NTS; and Strauss to SecNav, 13 November 1913, BuOrd 27593-LS12/1(A), RG74/E25/BBB226, NARA.

41. Sims to SecNav, 26 March 1914, BuOrd 27593/23, RG74/E25/BBB226, NARA. Sims had most likely been given command of the flotilla in order to do for torpedo practice what he had done for gunnery practice.

42. Endorsement by Stark to Bristol, 29 August 1909, B66-173, NTS.

similar triangles, reproducing the large triangle formed among the location of own ship, current location of target, and projected location of target in smaller form on the director, as illustrated in Figure 1 below.

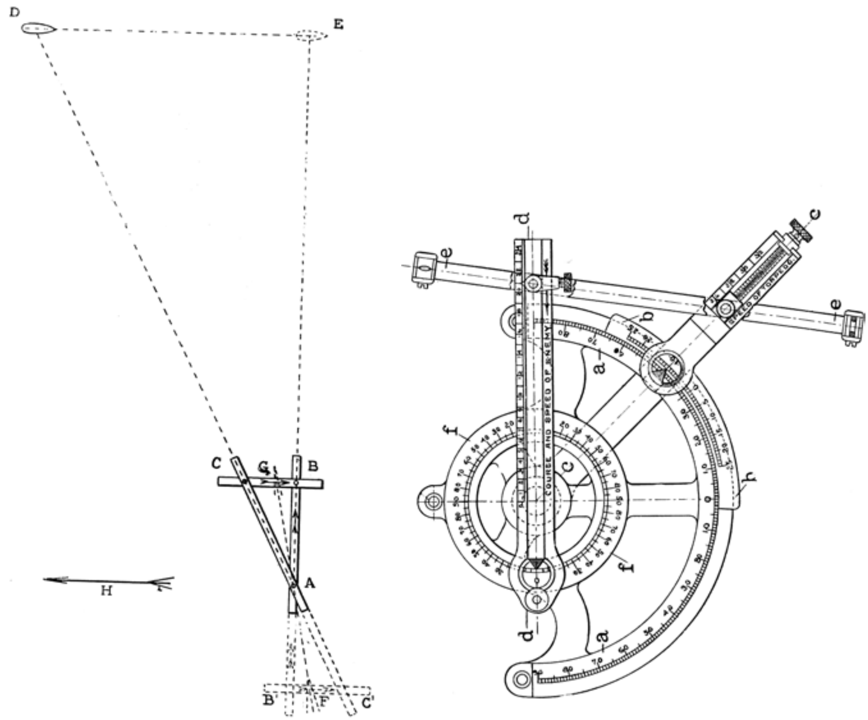

Figure 1: The torpedo triangle and director.

In the torpedo triangle, A is the position of own ship, D is the current position of the target, and E is the projected position of the target, which is derived from the target's estimated course and speed. Triangle ACB is similar to triangle ADE. Triangle ACB is recreated on the director, the main parts of which are the "course of speed and enemy bar" ("dd" on the diagram), the "speed of torpedo bar" ("cc" on the diagram), and the sighting bar ("ee" on the diagram). The principle of similar triangles does not work if the range has to be known.[43]

Torpedo fire control had points of similarity to and difference from gunfire control. In the latter, finding the range and correcting for roll, pitch, and yaw were serious challenges. In the former, by contrast, the torpedo's balance mechanism

43. Diagram of torpedo triangle taken from Plate 65, and director taken from Plate 69, *The Whitehead Torpedo, U.S.N. Parts III & IV. Above Water Launching Appratus. Torpedo Directors* (1901), NDL. I am grateful to Davis Elliott of the Navy Department Library for assistance in procuring the diagrams.

and gyroscope corrected for the effects of roll, pitch, and yaw. Furthermore, if the torpedo's speed was uniform and the shot was straight, then the range did not have to be known. If the torpedo's speed varied or the shot was angled, however, then the range had to be known, so that an average speed could be calculated. The range also had to be known if the director was located at a distance from the firing tube in order to account for parallax. To make the proper analogy, the director was to torpedoes as sights were to guns—not as range-finders or range-generators were to guns.

To achieve constant speed, and thus to eliminate the need to know the range for a straight shot using a director placed on the firing tube, the key device was not the engine but something called the reducer, which governed the pressure of air reaching the engine. The navy struggled to achieve uniform torpedo speeds even with single-speed reducers: in 1914, the Atlantic Torpedo Flotilla reported average variations of 3 knots.[44] Designing a multiple-speed reducer (that is, one capable of running a torpedo at more than one uniform speed) was even more challenging. The navy struggled to develop a reducer capable of running turbine torpedoes at multiple speeds, but it ran its turbine torpedoes at multiple speeds regardless.[45] Together, these facts mean that the navy was sometimes running torpedoes at varying speeds—and thus it needed to know the range in order to determine the average speed. The precision with which the range had to be known varied with the range and size of the target and with the speed of the torpedo. As the target range increased, as target size decreased, and as torpedo speed decreased, the range data needed to be more precise to maintain a given probability of hitting. (The same was also true for data about target course and speed.)

When angle fire was desired, the target range had to be known even if the torpedo's speed was constant, because allowance had to be made for the fact that the torpedo ran farther and longer in curving through an angle to reach the target than if running straight at the target.[46] To determine how much farther and longer an angled torpedo ran, its turning radius had to be known. Once it was, then the correct angle setting for hitting a target at a given range, course, and speed could be determined by reference to a table customized for a particular torpedo speed and turning radius. The navy used a series of directors which worked in conjunction with such a table—but even so, the commander of the Torpedo Station admitted in late 1913, "for actual battle conditions it is probable that better results would be obtained in the exercise of good judgment based on preparedness of mind" than

44. Sims to SecNav, 11 March 1914, para. 8, B80-232, NTS.

45. On the reducer, see Fletcher to Bristol, 31 May 1904, B39-223, NTS; Fletcher to Hepburn, 8 July 1904, B42-347, NTS; P. Williams to Fletcher, 13 September 1904, and Fletcher to Mason, 22 September 1904, BuOrd 11140/04 with 9890/03, RG74/E25/B565, NARA; Gleaves to Mason, 17 January 1905, BuOrd 15157/5, RG74/E25/B680, NARA; Torpedo Board to Mason, 5 September 1905, B44-358, NTS; and Mason to Gleaves, 18 September 1905, BuOrd 17761/28, B45-131, NTS. On running the turbine at multiple speeds, see Gleaves, "Torpedoes," 23 July 1906, lecture delivered at the Naval War College, p. 42, B52-157, NTS; Gleaves to Mason, 6 October 1906, para. 7, BuOrd 19377/12, RG74/E25/B938, NARA.

46. Fletcher to Chadwick, 28 May 1903, B36-135, NTS.

in using the director.[47] The ineffectiveness of the director for angle fire may have been due to the fact that individual torpedoes—let alone torpedoes of the same class—had inconsistent turning radii as well as inconsistent speeds.[48] Furthermore, even if the director had been more capable of generating correct angles, the lack of provision to set gyroscope angles from outside the torpedo tube would have limited the usefulness of this capability.[49]

Torpedo officers were less concerned by the errors arising from inconsistent turning radii and mistaken angle settings than by other errors. Chief among these were misestimates of the target course, speed, and range, but an increasingly serious source of error was the initial deflection that occurred while the gyroscope unlocked after the torpedo was fired. The period between the firing of the torpedo and the assumption of control by the gyroscope was known as the unlocking interval, which occurred because certain operations had to take place in the torpedo before the gyroscope could assume control. The gyroscope's steering engine, which magnified the effect of changes in the gyroscope's rotation on the rudders, relied on air from the torpedo's air flask, which could begin to flow only after the torpedo was out of the launching tube and in the water; and the stud that held the gyroscope wheel in place to ensure that it was in the proper plane while receiving its initial impulse of air could withdraw only after that impulse was given.[50] Torpedo officers knew that these delays in the operation of the gyroscope could affect the course of the torpedo at least as early as 1903, but so long as ranges remained relatively short, the problem did not appear to be pressing.[51] It grew urgent as ranges lengthened: for instance, a straight-shot torpedo with an initial deflection of 1 degree would miss the point of aim by 17.5 yards at 1,000 yards but by 174.6 yards (or roughly the length of a contemporary battleship) at 10,000 yards.

47. These directors were the Mark IV, Mark VI, and Mark VII (the Mark V was for submarines, which had a distinct set of torpedo control problems to confront). The Mark IV evolved from a design by two Torpedo Station officers in 1906 and passed into service in 1907 (see Cone and Davison to Gleaves, 26 May 1906, enclosed in BuOrd 12283/20, and Mason's endorsement of 3 July 1906 thereon, RG74/E25/B659, NARA; "General Description of Torpedo Director, U.S. Navy, Mark IV" (October 1907), B59-169, NTS; "Description of Mark VI and Mark VII Directors," undated typescript, B68-229, NTS). Quotation taken from Williams to Twining, 3 September 1913, BuOrd 28322/2, RG74/E25/BBB326, NARA.

48. Leavitt to Twining, 27 January 1912, BuOrd 25325/4, and 7 February 1912, BuOrd 25325/7, RG74/E25/BB145, NARA; endorsement by Williams to Strauss, 27 March 1914, BuOrd 29028/1, B68-229, NTS; Leavitt to Strauss, 11 August 1914, BuOrd 28688/58, RG74/E25/BBB362, NARA.

49. Fletcher to Schroeder, 9 August 1909, para. 10, BuOrd 22514/20, RG74/E25/B1143, NARA.

50. See *The Whitehead Torpedo. U.S.N., 45cm x 3.55m. Mark I, Mark II, Mark III, and 45cm x 5m. Mark I.*, 55–63, NDL.

51. See, e.g., Fletcher to O'Neil, 25 November 1903, para. 7, BuOrd 14468/03 with 6041/02, RG74/E25/B511, NARA; Leavitt to Mason, 2 February 1905, BuOrd 16686, and Gleaves to Mason, 14 February 1905, BuOrd 16686/3, RG74/E25/B769, NARA.

By early 1910, torpedo officers had become sufficiently concerned about the deflection problem to begin a three-year search for a device that would shorten the unlocking interval.[52] In the meantime, they consistently spurned attempts to determine the correct angle setting more accurately or to mechanize torpedo fire control on the grounds that remaining sources of error would overwhelm the improvements to be gained. In 1906, for instance, the commander of the Torpedo Station dismissed a suggestion to add telescopes to directors on the grounds that sighting errors were "insignificant when compared with the other errors (course and speed of enemy; speed of torpedo; setting of gyro; tactical radius; etc.) which enter into the problem."[53] In 1914, the chief of the Bureau of Ordnance rejected a device for plotting and computing corrections for angle fire because the errors it sought to correct were "so small" in comparison to the errors arising from other sources.[54]

Tactical Implications of Torpedo Development

The significance of these errors depended on the tactical situations in which torpedoes were used, and these situations were the subject of hot debate at the War College. As early as 1903, when officers at the War College were beginning to think seriously about the tactical implications of torpedo development, several had already made key inferences that would obtain ever more strongly over time. First, some officers realized that growing torpedo ranges would lead to longer battle and thus gunnery ranges as capital ships sought to reduce the risk of being sunk by torpedoes. These officers noted that "battle tactics and ship construction will depend much upon the views accepted in regard to the torpedo," and they were even willing to countenance the idea that torpedoes might be as important as guns.[55]

Second, some officers understood that growing torpedo ranges could make the target a formation instead of a single ship. Under those conditions, the probability of hitting equaled the ratio of ship space to water space. As one officer put it, "Ships in large groups suggest in relation to the torpedo a continuous wall of iron, with occasional loop-holes (intervals) through which the torpedo may

52. The files on this effort are too extensive to list here in full, but see, e.g., Strauss to Mason, 5 January 1910, BuOrd 22395/32, RG74/E25/B1134, NARA; endorsement by Leutze to Mason, 14 March 1910, BuOrd 23014/2, RG74/E25/B1182, NARA; Williams to Twining, 5 December 1911, BuOrd 25310/1, B71-230, NTS; Kaiser to Twining, 13 August 1912, BuOrd 25568/54, RG74/E25/BB203, NARA; Williams to Twining, 26 December 1912, BuOrd 25568/69, ibid.; Sawyer to Twining, 19 April 1913, BuOrd 25568/82, ibid.; Torpedo Board to Twining, 27 September 1913, BuOrd 26542/10, RG74/E25/BBB86, NARA.

53. Endorsement by Gleaves, 5 July 1906, BuOrd 12283/20, RG74/E25/B659, NARA.

54. Strauss to Hall, 6 January 1914, BuOrd 28682/1, RG74/E25/BBB362, NARA.

55. Tactical Committee to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix E: First Tactical Study of the Black Fleet," n.d. but Problem of 1903, RG12, NHC.

pass."[56] The ratio of "iron" to "loop-holes" would be lower if the fleet fought in line abreast rather than line ahead, but line abreast would force the fleet to fight at a gunnery disadvantage, its strength being on the broadside.[57] In line-ahead formation, the ratio of ship space to water space was generally calculated as roughly one to three. At long ranges (some 4,000 yards around 1906 and 10,000 yards around 1910), when a torpedo's target was a formation but a gun's target was a single ship, the torpedo had a much higher probability of hitting than the gun, and if it did hit, it was likely to do much more damage than a gun.[58] To be sure, the methods and mechanisms for solving gunnery fire control problems were much more sophisticated and precise than their counterparts for torpedo fire control problems. Nevertheless, the fact that the torpedo fire control problem was much easier to solve at longer ranges than the gunnery fire control problem helps to explain why officers were increasingly willing to rate the tactical significance of torpedoes at least as highly as that of guns.

Third, some officers identified the importance of speed in delivering a torpedo attack. This insight may have come from their study of the German fleet, which was faster and carried more torpedoes than its American counterpart, while the latter carried more guns. Officers at the War College believed that the German fleet

56. Bernadou to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix F: Second Tactical Study of the Black Fleet," 19 September 1903, para. 1, Problem of 1903, RG12, NHC.

57. Ibid., para. 3.

In line abreast, the ratio of ship space to water space was the same whether the fleet was bows-on or sterns-on, a fact that may lead some readers to wonder whether naval officers gave any thought to meeting a torpedo attack with a turn towards rather than a turn away from approaching torpedoes. The answer is yes, with the qualification that more research is needed to establish exactly when and under what conditions officers contemplated a turn towards. In the solutions to the 1903 and 1904 "problems" at the War College, the only defensive movement contemplated was a turn away (see Rodgers to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix G: The Comparison of Squadron Tactics for the Gun with Squadron Tactics for the Torpedo," September 1903, Problem of 1903, RG12, NHC; and Committee on Tactics and the Strength and Composition of the Fleet, Part III, "Tactics. Reports of a Special Committee on Tactics, and the Strength and Composition of the Fleet," Answer to Question 28, 21 September 1904, Problem of 1904, RG12, NHC). By 1911, it appears that the possibility of turning towards a torpedo attack was sufficiently widespread for it to be mentioned in a fairly offhand way (see Schofield and Frankenberger, Answer to Question 1, n.d., vol. 3, pt. 1, p. 30, Problem of 1911, RG12, NHC; and CINC Atlantic Fleet to SecNav, 11 September 1911, para. 14, RG8/B111/F3, NHC).

58. Conference attendees, Answer to Supplementary Tactics Question 4, n.d. but Problem of 1903, RG12, NHC; Fiske to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix B: Torpedoes," n.d. but Problem of 1903, ibid.; Rodgers to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix G: The Comparison of Squadron Tactics for the Gun with Squadron Tactics for the Torpedo," September 1903, Problem of 1903, ibid.

would exploit its superior speed to close the range and fire torpedoes; as one put it, "we are forced to the conclusion that [their speed] is intended as an aid to the more rapid attainment of torpedo range."[59] This connection between speed and torpedo attack may have been a factor in the decision by officers at the 1903 conference to recommend the addition of torpedo tubes not only to battleships but also to cruisers. It also marks the intellectual origin of the subsequent idea, which first appeared in 1904 and became entrenched over the next several years, to use the fast wing of a fleet to maneuver into position at the head of the enemy column and fire torpedoes down the line.[60] At least one American officer even went so far as to wonder why British battle cruisers did not carry an enhanced torpedo armament.[61] Firing down the column had the added advantage of increasing the ratio of ship space to water space, and thus increasing the probability of hitting.[62] Since torpedoes fired from the head of an enemy column would strike their targets at oblique rather than normal angles, this idea likely explains the subsequent concern with developing warheads that would detonate at narrow angles of impact.

Finally, some officers saw that longer torpedo ranges might transform destroyer missions. Although destroyers were originally built to defend their own capital ships from torpedo-boat attack, and by implication not to venture into the gunnery range of enemy capital ships during a daylight action, the advent of longer-range torpedoes meant that they might be able to launch offensive torpedo attacks on enemy capital ships while remaining outside an enemy's effective gun range. "The range now possible with the torpedo," wrote a committee specially designated to study tactical issues for the 1903 conference, "causes us to reexamine the question as to whether destroyers would be useful auxiliaries in a daylight fight between heavy ships."[63] Henceforward, the offensive potential of destroyers against capital ships would not be restricted to the night.

Yet it must be stressed that none of these views about the tactical implications of torpedoes were unanimous. The overwhelming majority of officers still believed that the gun would remain the controlling weapon in battle tactics. No officers of rank or influence were in close enough contact with the Bureau of Ordnance

59. Tactical Committee to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix E: First Tactical Study of the Black Fleet," n.d. but Problem of 1903, RG12, NHC; conference attendees, Answer to Supplementary Tactics Question 2, n.d. but Problem of 1903, ibid.

60. Committee on Tactics and the Strength and Composition of the Fleet, Part III, "Tactics. Reports of a Special Committee on Tactics, and the Strength and Composition of the Fleet," Answers to Questions 25 and 27, 21 September 1904, Problem of 1904, RG12, NHC.

61. R. H. Robinson, Answer to Question 2, 1 September 1912, p. 117, Problem of 1912, ibid.

62. Committee on Tactics and the Strength and Composition of the Fleet, "Tactics. Reports of a Special Committee on Tactics, and the Strength and Composition of the Fleet," Answer to Question 27, 21 September 1904, pt. 3, Problem of 1904, ibid.

63. Tactical Committee to Sperry, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix E: First Tactical Study of the Black Fleet," n.d. but Problem of 1903, ibid.

or the Torpedo Station to understand all the factors affecting the torpedo fire control problem or the capacity of existing means to solve it. Most dismissed the importance of speed for any purpose, let alone the delivery of torpedo attacks.[64] Some officers continued to believe that torpedo craft such as destroyers would not launch torpedo attacks during a daylight battle.[65]

The navy's first "battle plan," crafted in 1903, reflected the predominance of the gunnery school of thought. It is not clear that "Battle Plan No. 1," as it was labeled within the fleet, was really the navy's first fleet battle plan, or if it was simply the first to be awarded that particular title. Regardless, the controlling factors for the plan were signaling first and gunnery second, with torpedoes having very little influence. The plan seems to have sprung from conversations amongst officers on the War College staff in late 1902 as to whether line-of-bearing tactics or column tactics would work better in battle. A majority voted for the latter, on the grounds that the former required a reliable system of battle signals, which the fleet lacked.[66] The plan envisioned placement of the commander-in-chief at the center of the column, whence he could initiate a turn-towards or a turn-away by divisions without signals. A simultaneous turn by individual ships was quicker, but such a maneuver required signaling and was beyond the existing command-and-control capacity of the fleet. The price of giving the initiative for divisional movements to the commander-in-chief was that his second-in-command, at the head of the column, would have the initiative in deciding whether or not to give battle.[67] Shortly thereafter a modification was introduced to ensure that the U.S. fleet, in pursuing an enemy, would not come within range of enemy torpedoes, but that modification marked the extent of torpedoes' influence on the battle plan.[68] The fleet began to test Battle Plan No. 1 in 1906, and it remained "authoritative" at least into 1912.[69] A supplement known as Battle Plan No. 2, which provided

64. R. C. Smith, "Naval Tactics: Problems Suggested by War College Games, 1908–1909," lecture delivered at NWC, 8 July 1909, pp. 1–2, RG14/B2, NHC.

65. Conference attendees, "Considerations as to the Advisability of Suppressing the Intermediate Battery of Battleships," 23 November 1903, para. 5, Problem of 1903, RG12, NHC.

66. No author given, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix: Tactics of the Squadron in Battle," January 1903, pp. 70–71, Problem of 1903, RG12, NHC.

67. Bernadou, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix H: Study of Battle Plan No. 1," September 1903, pp. 51–61, Problem of 1903, ibid.

68. "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix: Modification No. 2, of Battle Plan No. 1," 30 September 1903, p. 77, Problem of 1903, ibid.

69. Dewey to SecNav, 20 June 1906, RG80/E285/B1/V4/P269–70, NARA; Answer to Question 26, n.d., pt. 3, pp. 18–20, Problem of 1906, RG12, NHC; Davis Board to CINC Atlantic Fleet, 9 March 1907, GB 418, RG80/GB418/B46, NARA; Emory Board to CINC Atlantic Fleet, 6 July 1907, GB418, ibid.; N. A. McCully, "Naval Battle Tactics," lecture delivered at the Naval War College, 28 August 1912, p. 12, RG8/B113/F2, NHC. A useful summary of studies on Battle Plan No. 1 can be found in Smith to Rodgers, 11 December 1909, GB 418, RG80/GB418/B46, NARA.

for two possible signals, was developed in 1908 and tested in 1911, for use when the commander-in-chief (in the center of the line), rather than his second-in-command (at the head of the line), initiated a change in course.[70]

The significance of these battle plans is difficult to gauge. It is unclear whether fleet commanders would have adopted them in the event of war. What is clear, however, is that officers felt that the basic problems of command-and-control left the fleet commander with few alternatives. From the day Battle Plan No. 1 was drafted, officers hoped that it would be no more than a stopgap: the navy still needed "the same old thing that is so often called for," namely, a practical system of battle signals.[71] Officers were fully aware that column tactics with minimal signaling had drawbacks, such as the greater time required for a turn-by-divisions than for a simultaneous turn. Yet year after year, those attending the War College summer conference agreed that the navy still lacked such a system.[72] Without one, it seemed that "for downright hard fighting the only practical formation is the column."[73]

Over time, officers increasingly chafed at the limitations imposed by column tactics. For one thing, as faster vessels entered service, the tendency of column tactics to reduce fleet speed to that of the slowest vessel in formation became ever more painful to accept. Instead of sacrificing fleet speed, officers saw that a more attractive option was to form a separate "fast wing" composed of the fastest vessels (namely cruisers) which would exploit their superior speed to obtain a position ahead of the enemy and from there use both guns and torpedoes. Merely the threat of having cruisers fire torpedoes down the line, War College officers thought, might impel the enemy to perform maneuvers disadvantageous to his gunnery; and if cruisers actually did fire torpedoes from ahead of the enemy column, the oblique presentment of the enemy vessels would increase the ratio of ship space to water space.[74]

70. A copy of Battle Plan No. 2 (which can be dated to January 1908, based on Smith to Rodgers, 11 December 1909, GB 418, RG80/GB418/B46, NARA) can be found with a covering memo dated 31 March 1911 in RG80/GB418/B46, NARA. See also McCully, "Naval Battle Tactics," lecture delivered at the Naval War College, 28 August 1912, pp. 21–22, RG8/B113/F2, NHC.

71. Bernadou, "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix H: Study of Battle Plan No. 1," September 1903, p. 59, Problem of 1903, RG12, NHC.

72. See, e.g., conference attendees, "Action of the Conference Upon Questions of Tactics Previously Reported Upon by All Standing Committees," n.d., pt. 4, p. 14, Problem of 1904, ibid.; Answer to Question 36, n.d., pt. 3, pp. 34–35, Problem of 1906, ibid.; Part VI, Answer to Question 13, n.d., pp. 60–61, Problem of 1907; Answer to Question 6, 15 September 1910, vol. 1, p. 88, Problem of 1910, ibid.

73. "Tactics: Report of a Special Committee. Report of Tactical Committee. Appendix: Tactics of the Squadron in Battle," January 1903, p. 70, Problem of 1903, ibid.

74. Committee on Tactics and the Strength and Composition of the Fleet, "Tactics. Reports of a Special Committee on Tactics, and the Strength and Composition of the Fleet," Answers to Questions 25 and 27, 21 September 1904, pt. 3, Problem of 1904, ibid.; conference attendees, Answers to Questions 16 (pt. 2, pp. 33–41), 20 (pt. 3, pp. 1–5), and 35 (pt. 3, p. 28), n.d., Problem of 1905, ibid.; conference attendees, Answer to Question 20, n.d., pt. 3, pp. 1–4, Problem of 1906, ibid.

The apogee of the link between the fast wing and torpedoes was the "torpedo battleship" envisioned by Lieutenant Commander F. H. Schofield. He first submitted his idea in January 1907, and the General Board recommended its careful consideration in March.[75] His vessel would have the speed of a cruiser and the protection of a battleship, but it would replace the gun armament of a conventional battleship with torpedo tubes. Speed was necessary to allow the ship to get into favorable position for attack, and armor was necessary because the ship would have to enter within enemy gun range in order to deliver its attack, given that the range of torpedoes in 1907 was roughly 4,000 yards. Over the summer of 1907, a committee at the War College concluded that the torpedo battleship would have great tactical value, provided that it was at least 5 knots faster than the enemy fleet and invulnerable to gunfire.[76] The General Board doubted that these conditions would obtain in reality, however, especially since Britain's introduction of the battle cruiser *Invincible*. With a powerful battery and high speed, this latter type seemed likely to be able to neutralize a torpedo battleship, and the General Board ventured that battle cruisers would be relatively more valuable.[77] Presumably in an effort to kill the torpedo battleship, the General Board declared that it could not render an opinion without certain information from the Board on Construction—and the Board on Construction had refused to give its opinion without further information from the General Board.[78] As a result, Schofield's idea was temporarily shelved.

In the meantime, torpedo technology improved, albeit slowly. In 1903, when officers at the War College had first proposed that destroyers might play a role in a daylight battle, the contract range of the most modern American torpedoes (30 x 5-meter Whitehead Mark II torpedoes ordered in November 1899) had been 800 yards. The first heated Bliss-Leavitt torpedoes were not ordered until November 1903, and only 100 of them had been ordered by mid-1905. Not until November 1905 did the navy place its first large order, for 300 Bliss-Leavitt torpedoes. Even then, the first 50 torpedoes delivered under the contract were unreliable, and fixing their problems took years. By 1908, when the last of the remaining 250 torpedoes were delivered, they carried a new type of superheater known as an outside superheater (so-called because it was located outside rather than inside the air flask), which was safer and enabled greater speeds and ranges than the first-generation inside superheater.[79] Moreover, in 1907 and 1908, the navy resumed

75. Dewey to SecNav, 27 March 1907, RG80/E285/B2/V5/P5, NARA.

76. War College findings summarized in Dewey to SecNav, 27 November 1907, RG80/E285/B2/V5/P158–60, NARA.

77. Dewey to SecNav, 27 March 1907, RG80/E285/B2/V5/P5, NARA.

78. Endorsement by Board on Construction to SecNav, 11 October 1907, RG80/E180/V9/P288–90, NARA. See also Norman Friedman, *U.S. Battleships: An Illustrated Design History* (Annapolis, Md.: Naval Institute Press, 1985), 143–44.

79. Bliss Co. to Mason, 17 December 1906, BuOrd 17761/172, RG74/E25/B843, NARA; Bliss Co. to Mason, 15 February 1907, BuOrd 17761/212, ibid.; Bliss IoO to Mason, 12 July 1907, BuOrd 20939/2, RG74/E25/B1038, NARA.

its purchase of reciprocating-engine Whitehead torpedoes, which by then also carried outside superheaters. These Whitehead torpedoes, designated Mark V, were the navy's first 4,000-yard torpedoes, guaranteed to make 27 knots for that distance.[80] By contrast, the newest Bliss-Leavitt torpedoes made only 34.9 knots for 1,200 yards and 32.6 knots for 2,000 yards in trials.[81] Officers at the War College prematurely overestimated American torpedo capabilities, declaring in 1906 that American torpedoes could make 28 knots for 4,000 yards, and therefore that likely battle ranges were 4,000–6,000 yards.[82]

The growing formidability of the torpedo strengthened the notion, first floated in 1903, that destroyers might attack capital ships during a daylight battle. The navy possessed few destroyers, however, having ordered none between 1899 (the *Truxtun* class) and 1906 (the *Smith* class).[83] In 1907, the same Lieutenant F. H. Schofield who had been behind the concept of the torpedo battleship deplored the navy's shortage of destroyers. With the advent of long-range (then 4,000-yard) torpedoes, he argued, "the torpedo vessel has left the ranks of the night-fighters to win recognition as an all around fighter, almost one of the battle line." Even in good weather, capital ships would find it difficult to control their gunfire both against their own kind and against torpedo craft, with the result that at least some destroyers launching an attack from ahead were likely to get within torpedo range. Not only did the U.S. Navy lack sufficient destroyers to exploit (or defend against) this possibility, but it also lacked "a single reliable long range torpedo." (Schofield was apparently better informed than some of his fellow officers about the true American torpedo situation.) He recommended that the navy invest in more destroyers and torpedoes forthwith. "I am fully aware," he concluded with a flourish, "that any officer who does not consider the big ship and the big guns all important is liable to be classed as a heretic in these days, yet I cannot but feel that the big ship will offer but small consolation to its advocates when it lies, for want of its running mate, the destroyer, on the ocean's bed, while the enemy's destroyers gambol in the waters of its grave."[84] The General Board endorsed Schofield's call for more destroyers.[85]

The growing torpedo menace was not the only reason that destroyers became more desirable: so was the decreasing ability of capital ships to defend themselves against torpedo craft. In 1903 and 1904, officers at the War College conference had recommended the abolition of intermediate batteries on American battleships,

80. Gleaves to Mason, 29 October 1907, para. 11, BuOrd 21017/9, RG74/E25/B1043, NARA.

81. Bliss IoO to Mason, 31 January 1908, BuOrd 20065/8, RG74/E25/B979, NARA.

82. Conference attendees, Answers to Questions 24 (pt. 3, pp. 13–16) and 28 (pt. 3, pp. 20–25), n.d., Problem of 1906, RG12, NHC.

83. A. MacArthur, Answer to Question 3, 11 September 1912, para. 3, Problem of 1912, RG8/B116/F8, NHC.

84. Schofield to SecNav, 9 September 1907, BuOrd 21141/1, RG74/E25/B1050, NARA.

85. Endorsement by Dewey to SecNav, 30 October 1907, RG80/E285/B2/V5/P145, NARA.

restricting the torpedo defense battery to 3-inch guns.[86] Over the next few years, however, the size of destroyers increased dramatically—for instance, whereas the American *Truxtun* class of 1899 displaced 430 tons, the *Smith* class of 1906 displaced 700 tons—and the range at which they could fire torpedoes also increased. At the 1906 conference, officers concluded that 3-inch guns could no longer stop these newer torpedo craft from firing torpedoes at 4,000 yards, and they called for the installation of 4-inch guns instead.[87] By 1907, the War College had increased its ideal anti-torpedo boat weapon to a 5-inch gun, while a board specially appointed to study the issue (known as the Marsh Board after its senior member) recommended 6-inch guns—close to the size of the 7-inch guns that had formed part of the intermediate battery on the last American pre-dreadnoughts, *Mississippi* and *Idaho*.[88] In other words, guns that had once been regarded as part of the "intermediate" battery on mixed-caliber ships were being reclassified as part of the "torpedo defense" battery on all-big-gun ships. Not only did American capital ships carry torpedo-defense guns too small to cope with modern destroyers, but they also lacked fire control capable of operating these guns effectively. In experiments carried out at Guantanamo Bay during the winter of 1910–11, American capital ships failed to stop cruisers—which were larger targets than destroyers—from launching torpedo attacks using "fast-wing" tactics, because the ships were unable to cope with attackers' high change-of-range rate.[89]

When the summer "problems" at the War College resumed in 1909, after a year-long hiatus for the famous Newport battleship conference, the attendees found that during the interim tactical uncertainty had only increased. Even as the necessity for destroyers to protect their own capital ships grew, officers at the conference argued that destroyers should focus on attacking enemy capital ships.[90] Officers did not remark upon the absence of a multispeed torpedo which destroyers could fire at longer ranges while defending their own ships and at shorter ranges when attacking the enemy. While holding that destroyers would not fire torpedoes within 7,000 yards, officers called for "battle cruisers" (of which the U.S. Navy had none) carrying sufficient protection to enable them to fire torpedoes at shorter ranges, on the grounds that battle cruisers using "fast wing" tactics could turn the enemy's line

86. Conference attendees, "Considerations as to the Advisability of Suppressing the Intermediate Battery of Battleships," pt. 8, pp. 71–76, Problem of 1903, RG12, NHC; Committee on Tactics and the Strength and Composition of the Fleet, Answer to Question 35, 21 September 1904, pt. 3, pp. 34–38, Problem of 1904, ibid.

87. Conference attendees, Answer to Question 28, n.d., pt. 3, pp. 20–25, Problem of 1906, ibid.

88. Conference attendees, Answer to Question 10, n.d., vol. 1, pt. 6, pp. 53–54, Problem of 1907, ibid.; Board on Torpedo Defense to SecNav, 15 October 1907, RG8/B112/F1, NHC.

89. W. S. Pye, Answer to Question 1, n.d., vol. 3, pt. 1, p. 7, Problem of 1911, RG12, NHC.

90. Reconciling Committee, Answer to Question 8, 10 August 1909, vol. 2, pt. 1, Problem of 1909, ibid.; conference attendees, Answer to Question 8, n.d., vol. 1, Problem of 1909, ibid.

more quickly with torpedoes than with gunfire.[91] The type of "battle cruiser" these officers envisioned was more like Schofield's torpedo battleship than the archetypal British *Invincible* class, and thus at odds with the General Board's preference for the latter. In addition, while officers argued for the retention of torpedo tubes on capital ships, the fleet had never tested the practicability of angle fire, which would make torpedoes on capital ships much more useful by sparing ships the necessity of turning to fire (and thereby upsetting the accuracy of their gunnery).[92] Conference attendees in 1910 were correct to note that the navy lacked adequate data on what its torpedoes could actually do and thus a system of torpedo tactics.[93]

The advent of the new "steam" torpedo introduced a new set of opportunities and problems. In contrast to the Bliss-Leavitt and Whitehead torpedoes ordered in 1907 and 1908, which carried "dry" outside superheaters, steam torpedoes carried "wet" outside superheaters, which injected water into the heated air passing to the engine and thereby increased its volume. In practical terms, wet superheaters increased the range of 18-inch torpedoes set at 30 knots from roughly 4,000 to 7,000 yards, and they could power 21-inch torpedoes at comparable speeds for 10,000 yards. The U.S. Navy ordered its first experimental steam torpedoes in 1911 and its first 10,000-yard torpedoes (the 21-inch by 21-foot Mark VIII) in 1912.[94]

In a paper for the 1911 War College conference, Captain William Sims considered the tactical implications of the 10,000-yard torpedo. Already, he wrote,

> we know very little of the relative fighting value of the battleship or cruiser as opposed to the number of the smaller vessels that could be built for the same money. In this connection, I mean the relative fighting value under the conditions of a modern battle—that is, which would under these conditions, [*sic*] be able to inflict the most damage on the enemy's fleet, the large vessel or the number of small vessels that could be built at the same cost?[95]

91. Report of 1st and 3rd Committees on Question 10, 11 August 1909, vol. 2, pt. 2, Problem of 1909, ibid.

92. Conference attendees, Answer to Question 10, 11 August 1909, and Answer to Question 21, n.d., vol. 1, Problem of 1909, ibid.; Conference attendees, Answer to Question 12, 17 September 1910, vol. 1, Problem of 1910, ibid. See also Bristol, "Torpedoes," lecture delivered at NWC, 29 June 1910, p. 22, RG8/B111/F3, NHC.

93. Conference attendees, Answer to Question 12, 17 September 1910, vol. 1, Problem of 1910, RG12, NHC.

94. Leavitt to Mason, 7 February 1911, BuOrd 23754/12, RG74/E25/B1226, NARA; "Contract for the Manufacture of Fifty (50) Torpedoes for the U. S. Navy, Bliss-Leavitt, 21-inch by 21-foot, Mark IV [changed to Mark VIII]," B75-316, NTS.

95. Sims, Answer to Question 11, n.d., vol. 3, pt. 2, p. 50, Problem of 1911, RG12, NHC. Note the striking similarity between Sims's framing of the question and British ideas about the "substitution policy" analyzed in Lambert, *Sir John Fisher's Naval Revolution*, 274–303, and "On Standards: A Reply to Christopher Bell," *War in History* 19, no. 2 (2012): 228–35.

The 10,000-yard torpedo would only make the process of evaluation more difficult. If such a weapon became practicable, Sims predicted, it would replace the gun as "the principal weapon—the one which will cause the most damage to an enemy, and which will dominate tactics."[96] Destroyers would become "an essential element of daylight battle," since they could fire torpedoes at ranges beyond what "any gun can be expected to make more than occasional chance hits against such small targets." Schofield's torpedo battleship would also become more formidable, since it could fire torpedoes from distances at which it required little protection and use the saved weight to obtain greater speed. Indeed, Sims concluded, the 10,000-yard torpedo seemed to make the construction of torpedo battleships "inevitable."[97] A War College committee subsequently appointed to revisit the torpedo battleship, however, concluded that the 10,000-yard torpedo weakened the case of the torpedo battleship by allowing destroyers to perform its functions more cheaply.[98]

Indeed, the advent of the 10,000-yard torpedo stimulated a burst of interest in the armament and design of destroyers. In 1911, the General Board asked the Bureau of Ordnance why two sizes of torpedo (18-inch and 21-inch) were supplied to the navy. Although the Bureau defended the practice, explaining that 18-inch torpedoes were better suited for destroyers due to considerations of both size and tactics, while 21-inch torpedoes were more appropriate for capital ships, the General Board remained unimpressed.[99] Employing the same logic as Sims, the War College and the General Board held that destroyers might make daylight attacks with 10,000-yard torpedoes, and they therefore recommended that all vessels carry interchangeable long-range torpedoes capable of multiple speed and range adjustments—so that, for instance, destroyers could attack with the long-range setting by day and with the short-range setting by night.[100] The latter suggestion betrayed incomprehension of the unsuitability of turbine torpedoes for multispeed settings.

The 10,000-yard torpedo may not have been such an important tactical milestone as it appeared to Sims, the General Board, and the War College. To achieve the full tactical potential envisioned by these officers, the 10,000-yard torpedo would have required better torpedo control systems than the U.S. Navy possessed or could conceive in 1911. It also would have required destroyers accustomed to maneuvering with capital ships and experienced at handling the attendant command-and-control problems. On the flip side, the 10,000-yard torpedo may not have made enemy fleets significantly more threatening to the

96. This prospect was also taken seriously in the British navy. See Sumida, "The Quest for Reach," 74; Lambert, *Sir John Fisher's Naval Revolution*, 211–21.

97. Sims, Answer to Question 11, n.d., vol. 3, pt. 2, p. 63, Problem of 1911, RG12, NHC.

98. Tactical Committee to Rodgers, 20 September 1911, RG8/B113/F2, NHC. Schofield submitted a dissenting report on 21 September 1911; see ibid.

99. Endorsement by Acting CoO to SecNav, 15 August 1911, BuOrd 23696/1-LS571/293–99; and Twining to General Board, 12 October 1911, BuOrd 23696/2, RG74/E25/B1222, NARA.

100. Rodgers to Aide for Operations, 5 October 1911, and endorsement by Dewey to SecNav, 25 October 1911, BuOrd 23696/2, ibid.

American fleet, simply because the latter was already so vulnerable to torpedo attack. The failure to order destroyers between 1899 and 1906 left the fleet woefully short of them, and in conjunction with the decision to adopt all-big-gun capital ships, as previously discussed, the fleet was left ill equipped to defend itself. Moreover, had the U.S. fleet sought to avoid torpedoes by turning away, it would have lost valuable time in making the movement by divisions, as envisioned in Battle Plans No. 1 and 2, rather than simultaneously.

The U.S. Navy was ill prepared to cope with the 10,000-yard torpedo in other ways as well. As one officer attending the War College pointed out to its president, the danger area of a 10,000-yard torpedo was actually greater than 10,000 yards. If a 20-knot fleet was advancing towards the torpedo, then the torpedo danger range extended to almost 18,000 yards: it would cover 10,000 yards in 11.5 minutes, while the advancing fleet would cover nearly 8,000 yards during the same period.[101] In order to remain safely out of enemy torpedo range, therefore, the navy had to be capable of fighting at ranges well over 10,000 yards. But it was not. In battle practices conducted from 1912 through 1914, the maximum range at which the fleet fired its 12-inch guns (its largest except for the 14-inch guns on the *New York* and *Texas*, commissioned in 1914) was 11,760 yards. The maximum range actually dropped below 10,000 yards in 1913 before rising again in 1914. Moreover, when conducting these practices, the firing battleships proceeded not at their maximum speeds but at the stately pace of 15 knots, meaning that they had little practical experience with the fire-and-maneuver tactics that constituted an important defense against torpedo fire, or with high change-of-range rates.[102] Officers who studied the Anglo-German battles during the first two years of World War I concluded that the U.S. fleet had routinely underestimated likely battle ranges by some 5,000 yards.[103]

Other weaknesses afflicted the U.S. fleet from a torpedo perspective. As one officer pointed out, the disposition of heavy guns on the center line, such that their strongest fire was on the broadside, impelled capital ships to fight with their longest presentment exposed to torpedo fire. This disposition of the big guns meant that if capital ships decided to fight in line abreast rather than line ahead in order to reduce the ratio of ship space to water space, they would be fighting at a gunnery disadvantage. Center-line disposition also limited the ability of capital ships to fight inside torpedo range, a risk they had to accept if they wished to achieve a decisive victory through gunfire. To fight inside torpedo range, the natural tactics were to approach rapidly and turn away before enemy torpedoes could reach them. These tactics would have restricted capital ships to their weakest arcs of fire

101. Unidentified officer, "Advantages of Long-Range Torpedoes," n.d. but c. October 1911, RG8/B112/F2, NHC.

102. Battle practice data taken from Klein to CNO, 10 May 1915, RG8/B96/F4, NHC.

103. J. H. Klein, Jr., to CNO, "Battle Practice—Discussion," 10 May 1915, RG8/B96/F4, NHC; H. E. Yarnell, "The Principles and Practice of Tactics as Applied to Naval Conditions of the Present Day," 30 May 1915, p. 6, RG13, NHC.

during the approach and retreat (not to mention involved high change-of-range rates and simultaneous maneuvers, neither of which the U.S. Navy had extensively practiced).[104] In effect, Sims's prediction that the 10,000-yard torpedo would replace the gun as the dominant weapon of naval warfare was a strong argument for switching from line-ahead formation to line abreast, and for disposing the heavy guns on the wings rather than the centerline.

Conclusion

In the minds of American naval officers before World War I, torpedo development had significant tactical implications. First, it exacerbated the already formidable problem of command-and-control. Capital ships in line-ahead formation, which was best suited to effective command-and-control, were at their most vulnerable to torpedo attack. Tactics that decreased the risk from torpedoes, such as line-abreast formation, operating in conjunction with destroyers, and simultaneous maneuvering, increased the difficulty of command-and-control, as did the use of "fast-wing" tactics to deliver a torpedo attack against the enemy. In effect, ideal command-and-control practices and ideal torpedo tactics were incompatible.

Torpedo development also exacerbated gunnery challenges. The growing range of torpedoes meant that fleets wishing to stay out of torpedo range while injuring the enemy needed to be able to fire their guns accurately at ever-longer ranges, but American gunfire control was not always up to the task. As the effective range of torpedoes gradually exceeded the effective range of guns, fighting outside torpedo range while retaining the ability to win a decisive gunnery victory (that is, by steaming a straight and steady course) ceased to be an option. If fleets wanted to win decisively with gunfire, they had to fight inside torpedo range; and if they wanted to avoid risking the loss of capital ships to torpedoes, they had to fight outside effective gun range. This competition for range between guns and torpedoes was at least as important as the better-known competition between guns and armor, and it threatened to upend battle tactics based on the primacy of the heavy gun and capital ship.

In general, American officers reached these conclusions about the tactical implications of torpedoes without adequate data on the variables affecting torpedo performance. For instance, their conclusions tended to assume competent personnel and efficient torpedo fire control. In reality, the personnel charged with operating torpedoes were often inexpert, and the methods for solving the torpedo fire control problem were crude. Moreover, American torpedoes displayed a number of characteristics, such as varying speed, inconsistent turning radii, and initial deflection, which introduced errors into torpedo fire control. Officers' requests for a multirange torpedo in 1911 betrayed unfamiliarity with the properties of turbine torpedoes and with the navy's struggle to develop an effective single-adjustment reducer.

104. Yates Stirling, "Notes on Tactical Principles," n.d. but War College Long Course 1911–1912, pp. 28–30, RG13, NHC.

The foregoing analysis demonstrates the difficulty of the Navy's tactical problems before World War I and the necessity of further research. It also demonstrates the danger of reading interwar and World War II–era developments back into the pre–World War I period. At that time, the navy had no centralized institutions capable of imposing tactics on the fleet—neither the Naval War College nor the General Board had executive powers—and it had no accepted "doctrine" in the way the term would later come to be understood. The navy was not seeking progress towards subsequent developments like greater administrative centralization and doctrinal formality; rather, it was trying to solve an extremely complex set of problems with the tools it had at hand. The contingent and contested nature of those efforts means that a wide range of voices affected the policy process, that no single body or set of records contains all the answers, and that it is vital not to mistake a part for the whole. To do otherwise is to confuse problems with solutions.