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MIDWAY

Sheer Luck or Better Doctrine?

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Six decades after the spectacular American victory over the Imperial Japanese Navy's First Air Fleet, the reasons behind the U.S. Navy's success at the battle of Midway are still not fully understood. Though the details of this famous battle continue to be argued in the pages of scholarly journals, the critical role of doctrine has not been properly analyzed.[1] Yet it was better doctrine that ultimately led to the American victory once the forces were engaged, a victory that changed the course of war in the Pacific.

Doctrine, as defined by the U.S. Department of Defense, comprises the fundamental principles by which military forces guide their actions.[2] For the Navy it is the foundation upon which tactics, techniques, and procedures are built—a shared way of thinking that must be uniformly known and understood to be useful and effective.[3] Because doctrine articulates the operational concepts that govern the employment of armed forces, it is critical for the success of any military operation—thus its importance in evaluating the actions of the forces engaged at the battle of Midway. An analysis of the doctrinal thinking of the two protagonists reveals significant differences in their approaches to carrier warfare, differences that were fundamental to the victor's success.

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The battle of Midway also marked the final phase in a revolution in military affairs (RMA) in which the aircraft carrier supplanted the battleship as the absolute determinant of naval supremacy. It was the culmination of a technical revolution in which carrier airpower displaced gunnery as the primary means of delivering naval ordnance. Moreover, it is one of the few instances in the history of RMAs in which the dominant player (in this case the U.S. Navy) was successful in implementing a revolutionary change in the basic character of warfare.[4]

Technology-driven RMAs, such as the paradigm shift to carrier warfare, are characterized by the introduction of a number of technological innovations in a series of stages over time. Richard Hundley terms this process the "Multiple Innovation Model" of an RMA.[5] Evaluating the development of carrier warfare on the basis of this model (table 1) is useful for analyzing how the doctrine of carrier warfare evolved along parallel, though slightly different, lines in the Japanese and American navies. This article will explore how these differences affected the outcome at Midway and their ramifications vis-à-vis the theory of RMAs.

TABLE 1
MULTIPLE INNOVATION MODEL OF THE RMA IN CARRIER WARFARE

Stage*	Basic Model	Carrier Warfare Model
1	New technology	Science of Aeronautics
2	New device	Airplane
3	New system	Carrier and Its Aircraft
4	New operational concept	Carrier Air Strike
5	New force structure & doctrine	USN = Task Force IJN = Air Fleet

* The innovations associated with the stages in the basic model do not always occur in order.

The quintessential element in the development of carrier warfare took place in stage three of the model, as shown in table 1, when the aircraft carrier came into being as a totally new system for taking land-based aircraft to sea. The aircraft carrier, which was introduced by the Royal Navy in World War I, did not become an important capital ship until the Washington Treaty on Naval Arms Limitations was enacted in 1922. The treaty, which severely limited the size and total tonnage of battleships in service among the major navies of the world, placed limitations on the total carrier tonnage allowed each navy and restricted any new carrier (i.e., built from the keel up) to twenty-seven thousand tons standard displacement. A special provision of the treaty permitted the Japanese and American navies to exceed this limitation, however, by allowing each to convert two incomplete battle cruisers that would otherwise have been scrapped under the treaty. As a result of this provision the Japanese and American navies began plans to construct two thirty-three-thousand-ton aircraft carriers apiece.[6] Once completed, the ships would dwarf any aircraft carrier then in existence. Each

would be capable of operating far more aircraft than had ever been put in the air by a single ship. How to conduct flight operations in the most efficient manner with such a large air group had yet to be determined by either navy.

Neither the Japanese nor American navy had any operational experience with carriers at the time of the treaty's signing in February 1922. Though both were commissioning their first experimental carriers, the first flights (from the Japanese *Hosho* and the American *Langley*) would not take place for the better part of a year. In the interim, both navies had to rely for the most part on whatever knowledge could be gleaned from the British, who had been conducting flight operations from the full-deck carriers HMS *Argus* and HMS *Eagle*. *Argus,* which entered service in 1918, was the first aircraft carrier to have a single flight deck extending the entire ship's length. Although *Eagle* was not placed in commission until 2 February 1924, an extensive series of flight tests was conducted from its deck in 1920.

The Americans were fortunate in having acquired a great deal of information on flight operations and carrier design from their British allies during World War I and the period shortly thereafter.[7] The data provided a firm foundation for the carrier design studies conducted by the U.S. Navy in the early 1920s. These studies led to the continuous single-flight-deck arrangement on the *Saratoga* and *Lexington,* converted from the two battle cruisers allocated to the U.S. Navy by the Washington Treaty. The two navies had ceased to share information by the time of the treaty. The lack of direct contact may have been a godsend to the U.S. Navy, for it probably prevented a grievous error in carrier design—the twin-hangar dual flight deck.

This failed innovation appeared on the next generation of British carriers—*Furious, Glorious,* and *Courageous*—the basic design characteristics of which were established in 1920.[8] Unlike the Japanese and American conversions, the new British carriers were produced from fast but poorly armed and underprotected cruisers built late in the war. To accommodate the maximum number of aircraft in the smaller space available, with constraints regarding the arrangement of boiler uptakes, their designers added a second hangar. Adding a small second flight deck as well, forward of the upper hangar, would (the designers believed) permit dual-flight-deck operations. In theory this would increase the speed of launching, so more aircraft could be placed in the air in the least time—a necessary improvement, as demonstrated by the poor trial performance of the single-deck *Eagle*. Because of the time required to spot aircraft between launchings, *Eagle* could keep only six aircraft in the air at one time.[9]

The Japanese too benefited from their wartime relationship with the Royal Navy. Their first aircraft carrier, *Hosho,* had been designed largely with British help, and in 1920 a Japanese representative observed air operations on board

Furious.[10] In the absence of documentary evidence, one can only make an educated guess as to the design process for the *Akagi* and *Kaga*.[11] It seems likely, based on the timing and similarities in design to *Furious, Glorious,* and *Courageous,* that the multiple-flight-deck arrangement of the Japanese vessels was influenced by information obtained from the Semple Naval Air Mission, which arrived in Japan in 1921.[12] This unofficial delegation of British aviation experts was invited to provide technical assistance and training to the Imperial Japanese Navy (IJN) in all aspects of aviation. Although its members were mostly pilots and aircraft designers, it is logical to assume that at least one or two were familiar with the twin-deck carrier then under development in Great Britain.

The "smoking gun" for this assumption can be seen in features of the first large Japanese carriers, *Akagi* and *Kaga,* commissioned in 1927 and 1928 respectively. Like their British contemporaries, both Japanese carriers sported multiple flight decks when completed.[13] This arrangement proved so unsatisfactory, however, that both had to be redesigned and rebuilt in the mid-1930s with single flight decks.[14] This unfortunate detour cost the Japanese dearly in lost time—time that might have been used to explore better methods of conducting flight operations with the single-deck design that emerged as the standard for the fleet carriers operated by the IJN in World War II.

This is precisely what transpired on the American side. Like the Japanese flyers on board the *Hosho,* naval airmen on board *Langley* initially copied British operating procedures. Those procedures required a clear deck for landing; as soon as an aircraft landed it was struck below.[15] Although this practice gave flexibility in takeoffs and landings, the time it took to stop an airplane, move it onto the elevator, and bring it below lengthened the landing cycle. This in turn limited the number of aircraft that could be operated to the capacity of the ship's hangar; the number was also determined to some extent by the time it took a group of returning aircraft to form up overhead and land.[16]

The clear-deck landing procedure was used until Captain Joseph M. Reeves took command of Aircraft Squadrons, Battle Fleet in mid-October 1925. Reeves, then the U.S. Navy's foremost authority on battleship gunnery, had just come from the Naval War College in Newport, Rhode Island, where he had served two tours of duty—first as a student, then as head of the Tactics Department. It was there that Reeves learned the importance of aircraft and the critical need to secure command of the air in any future engagement of the Battle Fleet.[17]

When Reeves took over the Aircraft Squadrons he was surprised to discover that *Langley* had put no more than six planes in the air at one time.[18] This seemed an absurdly small figure to Reeves; he would dramatically change it. The years spent in the fleet perfecting gunnery had taught Reeves the critical importance of meticulous practice and thorough training. He had also learned the

value of faultless procedures for ensuring speed and safety during any potentially dangerous shipboard activity.[19] These same principles he used to cajole *Langley*'s air wing to find ways to speed up takeoffs and landings—the recovery cycle, in modern jargon—so that as many aircraft as possible could be put into the air and recovered, in the least time. Under Reeves's tutelage, *Langley*'s crew invented the deck park, the crash barrier, specialized teams of flight-deck personnel identified by jerseys of various colors, and a host of other innovations that radically changed the way operations were conducted on cramped flight decks.

At first the object was to get as many planes in the air as possible in order to defend the fleet against attacking bombers. Slowly but surely, the number of planes operating from *Langley* expanded, and the time required to launch and recover aircraft decreased. By February 1926 sixteen planes could be kept in the air at one time. One year later the number had increased to twenty-two. This was a big improvement, but Reeves, who had been promoted to flag rank in 1927, now wanted *Langley* to operate even more planes. When the ship returned from its yearly overhaul in early 1928, he ordered thirty-six aircraft placed on its flight deck.[20] Six more planes were stowed below, so that when *Langley* departed from San Diego on 9 April 1928 to join the fleet headed on a transit to Hawaii, it had forty-two aircraft on board.[21]

The carriers' position within the force structure was not fully resolved until Pearl Harbor, when carriers became the U.S. Navy's preeminent striking force by default.

By then *Saratoga* and *Lexington* had arrived on the West Coast. The progress made on *Langley*'s flight deck paved the way for a spectacular eighty-three-plane raid launched in an exercise from *Saratoga*'s flight deck against the locks and facilities of the Panama Canal on 26 January 1929. The success of this record-breaking operation—more planes put in the air at one time by one carrier than ever before—laid the groundwork for the developments that took place in stage four of the Carrier Warfare Model, establishing the operational concepts that would determine the carrier's role in the fleet's battle plan. During the next few years the *Lexington* and *Saratoga* faced off in a series of simulated engagements conducted during yearly exercises known as "Fleet Problems." The carrier-versus-carrier duels that frequently occurred during these exercises brought to light the importance of quickly locating the opposing carrier so that air strikes could be launched against the enemy's flight deck as soon as possible to forestall a counterstrike. Time after time, the carrier that struck first emerged victorious. Thus, by the mid-1930s it was understood that the job of the American carriers was to seek out and destroy the enemy's flight decks. This unwritten doctrine—it was not codified until 1941—was responsible for

the development of a new aircraft type unique to the U.S. Navy, the scout bomber.[22] It was also instrumental in determining the makeup of air groups aboard American carriers.

While the U.S. Navy was busy experimenting with the carrier-versus-carrier duels that would so heavily influence its future battle doctrine, the Japanese were still struggling to perfect their carrier doctrine. Sidetracked by the war in China, Japanese naval aviators made little progress in working out an effective strategy for dealing with enemy flight decks.[23] Like their American counterparts, the Japanese expected aerial operations to precede the "decisive" clash of battleships that both sides predicted would determine the outcome of the next war.[24] Unlike the Americans, however, they failed to anticipate the importance of carrier-based scouting, concentrating entirely on the attack mission.[25] No scouting units were assigned to the Japanese carriers, and little emphasis was placed on this important aspect of carrier warfare. Reconnaissance was relegated to a few floatplanes, which would be catapulted from accompanying cruisers. The Japanese also overlooked or failed to develop the deck park, relying instead on the hangar deck to store and prepare aircraft for flight. On the Japanese carriers, aircraft capacity was determined by the size of the hangar, not of the flight deck, as was the case for the Americans.[26] The disparity in aircraft-handling procedures and search strategies resulted in substantial differences in the makeup of the typical air group deployed by the two sides.

As can be seen from table 2, the U.S. Navy, because of its innovative use of the deck park, was able to deploy more planes per carrier. Each carrier operated with seventy-two aircraft, on average, organized into four squadrons: one fighter (VF), one scout (VS), one bombing (VB), and one torpedo (VT). The Japanese,

TABLE 2
STANDARD CARRIER AIR GROUP COMPLEMENTS ON THE EVE OF WORLD WAR II

	IJN			USN		
Type*	**Mfg/Model**	**Number**	**%**	**Mfg/Model**	**Number**	**%**
VF	Mitsubishi A6M	21	33	Grumman F4F	18	25
VB	Aichi D3A	21	33	Douglas SBD	18	25
VS		—	—	Douglas SBD	18	25
VT	Nakajima B2N	21	33	Douglas TBD	18	25
Total Aircraft		63			72	

* VF = fighter, VB = dive-bomber, VS = scouting, VT = torpedo bomber

on average, operated with just sixty-three aircraft, organized into three twenty-one-plane squadrons: one fighter, one carrier attack, and one bombing.

The VS squadron on American carriers and the preponderance of scout bombers in air groups attest to the significance the Americans placed on

scouting. The exercises of the early 1930s had pointed to the need for a fast, well armed scout plane that could not only find the enemy carrier but attack its flight deck. Heeding the advice of the aviators, the U.S. Navy's Bureau of Aeronautics began to develop a series of scout bombers that evolved into the SBD, a plane that proved to be a superb dive-bomber as well as an effective scout.

The contrasting lack of reconnaissance planes and the preponderance of torpedo and dive-bombing aircraft on board Japanese carriers were in keeping with the IJN's emphasis on attack. The IJN's preference for the torpedo plane (the "carrier attack plane," in Japanese naval parlance) was in keeping with the IJN's faith in the torpedo as a weapon that could inflict severe underwater damage on almost any warship. This was contrary to the view of U.S. naval aviators, who believed that the torpedo was an inefficient weapon of aerial warfare, based on the small size of its warhead in relation to the total weight. To the Americans, hitting under the waterline did not appear to be a unique advantage; tests conducted in 1924 on the incomplete battleship *Washington* had shown that a heavy bomb falling close alongside would produce the same damage.[27] American pilots were also skeptical of the torpedo plane's ability to survive at the slow speeds and low altitudes required for a successful attack. It was only because the torpedo (in the absence of an effective armor-piercing bomb capable of penetrating four inches of hardened steel) was the only aerial weapon that could significantly damage a heavily armored battleship that a VT squadron was retained in limited numbers on American carriers.[28]

While the airmen on both sides were perfecting the tactical procedures and aircraft that would ultimately define their respective air groups, their flag officers were wrestling with the force-structure and doctrinal issues (the last stage in Hundley's model) raised by the increasing combat effectiveness of air warfare and the growing number of carriers within their fleets. The conundrum facing all these leaders was how to protect the inherently vulnerable carrier and yet maximize its tactical effectiveness.

In the U.S. Navy, the main question was the positioning of carriers with respect to the main body of the fleet. Although the carrier task force had become a regular feature of exercises, the Navy's battleship admirals continued to insist that carriers remain with the battleships for mutual support.[29] At issue was the survival of the carriers, which were now considered essential for fleet air defense. Tying the carriers to the slow battleships was the kiss of death, according to the Navy's airmen, who argued "that evasive movements at high speed were a carrier's best protection against attack."[30] The Americans continued to experiment until the fleet moved to Hawaii in 1940; by then, carriers had become the center of the cruising formation when operating with the fleet. The question of the carriers' position within the fleet's force structure—both its physical location and

tactical function—was not fully resolved in the U.S. Navy until after the Japanese attack on Pearl Harbor, when carriers became its preeminent striking force by default. When hostilities commenced, however, all the pieces were in place for the deployment of a number of carrier task forces, complete with heavy escorts of cruisers and destroyers, and accompanied in every instance by an oiler for logistic support.[31]

In the meantime, the Japanese navy had embarked on a much different path. As Mark Peattie and the late Dave Evans explain in their groundbreaking history, the lessons learned during warfare with China inevitably led Japan's naval leaders to conclude that carriers had to be concentrated to provide the large numbers of aircraft that seemed needed to achieve air superiority.[32] However, like their American counterparts, they understood the vulnerability of aircraft carriers and that grouping them together would be extremely dangerous, not only tactically but operationally—all the force's carriers would be exposed to attack if any one of them was detected. A solution to this dilemma, one that Peattie and Evans describe as one of "tactical effectiveness versus strategic risk," emerged at the end of 1940, when the "box" carrier formation was first introduced in the IJN.[33] The arrangement enabled the rapid massing of air groups for offensive operations but also an augmented protective combat air patrol.

Langley's *crew invented the deck park, the crash barrier, flight-deck teams in jerseys of various colors, and a host of other innovations that radically changed the way operations were conducted.*

Operational experiments with this new formation were conducted in early 1941. By then Admiral Isoroku Yamamoto, commander in chief of the Combined Fleet, had submitted a paper to the navy minister, Koshiro Oikawa, insisting that the IJN "deliver a fierce attack on the American fleet at the outset of hostilities to demoralize the U.S. Navy."[34] The instrument that would be chosen for Yamamoto's surprise attack was the First Air Fleet, a unit of the Japanese navy that came into being in April 1941, when all three carrier divisions were combined with two seaplane divisions and ten destroyers into what was then "the most powerful agglomeration of naval air power in the world."[35] Although the First Air Fleet represented a radical innovation in terms of naval organization, it was not a tactical formation that could undertake a naval operation on its own, for it would need escorts and logistical support.

Though the multicarrier attack was a brilliant tactical innovation, it did not challenge the concepts underlying the IJN's overall strategy of overpowering the U.S. Navy by destroying its battle line at sea.[36] When the Combined Fleet sailed for Midway at the end of May 1942, the battleship remained the centerpiece of

Yamamoto's strategy for dominating the Pacific. "For all his lip service to the principle of the offensive and to naval air power," he "still . . . visualized the battleship as the queen of the fleet."[37] As part of the operation, Yamamoto hoped to draw out remnants of the U.S. Pacific Fleet so that it could be engaged in the "decisive battle" that still remained the focus of Japanese naval strategy.[38] Instead of using his battleships in direct support of his carriers (as suggested by Rear Admiral Tamon Yamaguchi), Yamamoto stationed the three powerful dreadnoughts of the Combined Fleet far to the rear, to surprise and destroy any American surface force bold enough to attempt to interfere with the invasion of Midway.[39]

While the First Air Fleet (designated the "Mobile Force" in this operation) was steaming in what would prove to be its highly vulnerable box formation toward Midway, the three carriers *(Yorktown, Enterprise, and Hornet)* available to the commander in chief of the Pacific Ocean Area at the end of May 1942, Admiral Chester W. Nimitz, sortied from Pearl Harbor. They steamed in two task forces, the tactical units that had come to dominate U.S. naval operations since 7 December 1941. Unlike its adversary across the Pacific, the U.S. Navy's love affair with the battleship now rested in the mud of Pearl Harbor, where a number of its cherished "battlewagons" were being laboriously salvaged. Though Nimitz still had a strong force of battleships (Task Force 1 comprised *Pennsylvania, Maryland, Colorado, Idaho, Tennessee, New Mexico,* and *Mississippi*), he chose not to deploy them; they would only slow the carriers down and would require screening ships that were needed more elsewhere.[40] Nimitz also deployed a number of submarines for the defense of Midway; however, they too would not be a factor in the battle, the outcome of which would be determined by airpower alone.

The outcome of the battle of Midway was decided, and the fate of the IJN was sealed, at precisely 10:22 AM on 4 June 1942, when the first of three squadrons of American dive-bombers from *Yorktown* and *Enterprise* attacked the First Air Fleet as it was preparing to launch its own planes against the U.S. carriers.[41] The American planes struck the *Kaga, Akagi,* and *Soryu* in quick succession, setting all three ablaze within three minutes. The surviving Japanese carrier, *Hiryu,* quickly retaliated. After an exchange of air strikes that afternoon, *Hiryu* was burning from stem to stern, while its opponent, *Yorktown,* was dead in the water, without power. *Hiryu* sank the next day. *Yorktown* survived long enough to be taken under tow but then was torpedoed by a Japanese submarine.

The different paths of carrier development taken by the Japanese and American navies led to differences in carrier doctrine—differences that had a tremendous impact once the two forces were engaged. First and foremost of these was the American airmen's obsession with locating the enemy's carriers first so they

could be struck first. This principle became sacrosanct in U.S. carrier doctrine as soon as commanders realized that the best way to achieve air supremacy was to attack the opposing carrier before it had a chance to get its own planes in the air. Once launched, such a strike would be almost impossible to fend off, since (prior to the introduction of radar) there was virtually no way to detect approaching enemy planes or direct fighters to intercept them.[42] Although the Japanese understood this principle, they made no attempt to find an adequate means of locating the enemy's carriers.[43] As Mark Peattie aptly points out, success "depended not only upon the time required for carriers to launch their attack squadrons but, even before that, upon finding the enemy first."[44]

That the lack of a carrier-borne capability for scouting (reconnaissance, in Japanese naval parlance) contributed greatly to the demise of the Japanese carriers was affirmed by *Akagi*'s former air officer, Mitsuo Fuchida. As Fuchida explained, writing in 1955, Japanese carrier forces were devoted entirely to the attack mission.[45] There were no organic scouting units of any appreciable size in the Japanese navy, and very little emphasis was placed on this important aspect of carrier warfare: "In both training and organization our naval aviators [devoted] too much importance and effort . . . to attack."[46] Reluctance to weaken the carriers' striking power led to a single-phase search plan that was insufficient—in Fuchida's opinion—to ensure the carriers' security. "Had Admiral [Chuichi] Nagumo [the commander of the Mobile Force] carried out an earlier and more carefully planned two-phase search . . . the disaster that followed might have been avoided."[47]

The second doctrine-based difference was the predominance of the scout/dive-bomber on the American side. This type was unique to the U.S. Navy and could both locate and attack an enemy carrier. The effectiveness of the scout/dive-bomber (particularly the superb SBD, which outflew, outdove, and outbombed the Japanese Val) was proved beyond the shadow of a doubt at Midway.[48]

Last, but certainly not least, was the adoption of the deck park and the associated handling procedures devised by American airmen to maximize the number of aircraft that could be operated at one time from an aircraft carrier. This system enabled the U.S. Navy to operate more aircraft per carrier than its Japanese counterparts and thus to fly almost as many aircraft as the Japanese at Midway, with one less carrier. The deck park allowed a second dive-bombing squadron (though bearing the VS designation) to be added to each carrier's air group. It was one of these squadrons, VS-6 from the *Enterprise,* that made up for the lost planes from the *Hornet,* which failed to locate the enemy carriers. The extra squadron allowed the United States to strike three carriers at once, leaving just one. The outcome at Midway would have been very different had VS-6 not been present.

On the downside, the U.S. Navy's reliance on the deck park meant that the entire air strike group had to be launched at one time. This worked well during the short-range simulated engagements conducted during the thirties, when the various squadron types could circle the carrier while the air group formed up. At Midway differences in aircraft range, cruising speed, and the takeoff run for each type (VF, VB, VTB), combined with the extreme range to target, played havoc with the air group's ability to conduct any kind of a coordinated attack. The piecemeal commitment of forces that resulted from this approach and the lack of satisfactory air cover had disastrous consequences for the torpedo squadrons, which were all but annihilated.

Midway is one of the few instances in the history of RMAs in which the dominant player was successful in implementing a revolutionary change in the basic character of warfare.

In terms of launching aircraft, the Japanese had devised a workable doctrine that was in some ways superior to the U.S. technique. By contrast they developed the concept of the "deckload spot," wherein each carrier contributed one of its attack units (VB or VTB) and then some number of escort fighters.[49] Not only was this technique better suited to the smaller flight decks of the *Hiryu* and the *Soryu,* but it was highly advantageous when it came to coordinating air strikes from multiple carriers. The latter enabled the Japanese to conduct the massive air strikes that were the hallmark of the First Air Fleet.

The lack of coordination among the American carriers was a major deficiency that could have cost them the battle. Instead of assembling for a coordinated strike, individual flights from different carriers—both torpedo and dive-bombing—arrived over the target independently of each other and attacked separately. This resulted in the ineffective torpedo plane attacks that preceded the arrival of the two flights of dive-bombers, whose simultaneous appearance at this critical juncture of the battle was extremely fortuitous (many would say "sheer luck"). A third flight of dive-bombers from the *Hornet* never found the Japanese carriers.

The American victory at the battle of Midway was abetted by major weaknesses in Japanese carrier doctrine. The most significant of these was the IJN's inability to ensure (its leadership having previously failed to allocate sufficient assets for searching) that no enemy carriers were in striking range of its own. This fatal flaw in doctrine caused the Japanese to be caught while their hangar decks were packed with aircraft being fueled and armed. The outcome of an attack in such circumstances had been first predicted in 1933 by Commander Hugh Douglas, U.S. Navy, before an audience at the Naval War College: "In case an

enemy carrier is encountered with planes on deck, a successful dive bombing attack by even a small number of planes may greatly influence future operations."[50] The deadliness of such a contingency was well understood by American carrier aviators, who continually worried about being caught in that perilous situation.[51]

The Japanese determination to deliver a massed air attack on Midway meant that all four Japanese carriers were committed to preparations for a follow-up strike just as the U.S. carriers were discovered. This deprived the Mobile Force of the flexibility it needed to preempt the threat. Further, the box formation, which was established to facilitate the massive aerial attacks invented by the IJN, also contributed to the demise of the First Air Fleet. It would have been much more difficult to locate and hit three Japanese carriers at once had the elements of the Mobile Force been separated. Various arguments have been put forward in defense of the box formation—indeed, the four-carrier task force was adopted by the U.S. Navy later in the war; nevertheless, the fact remains that all three carriers were caught together.

The doctrinal differences concerning the deployment of the naval forces available to each side indicate just how far each navy had come in adjusting to the concepts later embodied in the Carrier Warfare Model of seapower. The disparity has important ramifications for the theory of revolutions in military affairs, for it supports Hundley's contention that it is not enough to be aware of an emerging RMA. To avert the kind of disaster visited upon the Japanese at Midway, a military must also be responsive to the implications of that RMA.[52] The Imperial Japanese Navy failed at Midway to take account of the consequences of the fundamental changes in naval warfare that they themselves had helped to initiate at Pearl Harbor.[53]

Several conclusions can be drawn. First, force structure and doctrine play critical roles; both are crucial to successful transformation in an armed service's ability to wage war. Second—and this, to some bureaucrats at least, is a painful revelation—technological prowess alone is insufficient to achieve a revolution in military affairs. Lastly, but most unsettling to military leaders, different paths lead to different technical solutions. The examples analyzed here show that chance and circumstances often play major roles in the evolutionary path taken by a military establishment as it attempts to adapt to new technologies and the changes they bring to the character of warfare.

NOTES

1. See Dallas Woodbury Isom, "The Battle of Midway: Why the Japanese Lost," *Naval War College Review* 54, no. 3 (Summer 2000), pp. 60–100; and its rebuttal by Jonathan B. Parshall, David D. Dickson, and Anthony P. Tully, "Doctrine Matters: Why the Japanese Lost at Midway," *Naval War College Review* 54, no. 2 (Spring 2001), pp. 140–51.
2. *DOD Dictionary of Military Terms,* 29 October 2000, available at www.dtic.mil.doctrine/doddict/doctrine.htm.
3. U.S. Navy Dept., *Naval Warfare Doctrine,* Naval Doctrine Publication 1 (Washington, D.C.: Navy Staff, 1994), available at www.nwdc.navy.mil/navagation/doctrine.htm.
4. Richard Hundley, *Past Revolution, Future Transformations: What Can the History of Revolutions in Military Affairs Tell Us about Transforming the U.S. Military?* (Santa Monica, Calif.: RAND Corporation, 1999), rand.org/publications/MR/MR1029/, p. 12.
5. Ibid., pp. 22–24.
6. Although the Washington Treaty limited the nominal size of these ships to thirty-three thousand tons, another provision, providing for modernization of existing capital ships to protect them against air and underwater damage, was applied by the U.S. Navy to bring the tonnage up to thirty-six thousand. See Norman Friedman, *U.S. Aircraft Carriers: An Illustrated History* (Annapolis, Md.: Naval Institute Press, 1983), p. 43.
7. Ibid., pp. 31–32.
8. For design details of these ships and the dual-flight-deck arrangement see Norman Friedman, *British Carrier Aviation: The Evolution of the Ships and Their Aircraft* (Annapolis, Md.: Naval Institute Press, 1988), pp. 91–92.
9. Ibid., p. 91.
10. David Evans and Mark Peattie, *Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy 1887–1941* (Annapolis, Md.: Naval Institute Press, 1997), pp. 168, 180–81.
11. The incomplete battle cruiser *Amagi* was initially designated as one of the two battle cruisers slated for conversion, but it was ruined in the earthquake of 1923. The incomplete hull of the battleship *Kaga* was used instead. My thanks to Professor Frank Uhlig for pointing this out.
12. Evans and Peattie, p. 301; Mark R. Peattie, *Sunburst: The Rise of Japanese Naval Air Power, 1909–1941* (Annapolis, Md.: Naval Institute Press, 2001), pp. 19–20, 54.
13. *Akagi* had three separated, vertically arranged flight decks: an upper landing deck 190 meters (624 feet) in length, a middle takeoff deck for fighters 18 meters (60 feet) long, and a 49-meter (160-foot) deck beneath that for launching torpedo bombers (Peattie, p. 54).
14. Evans and Peattie, p. 249.
15. Friedman, *U.S. Aircraft Carriers*, p. 84.
16. Thomas C. Hone, Norman Friedman, and Mark D. Mandeles, *American & British Aircraft Carrier Development, 1919–1941* (Annapolis, Md.: Naval Institute Press, 1999), p. 113.
17. For a comprehensive analysis of Reeves's activities at the Naval War College and the reasons for his selection as ComAirBatFlt, see Thomas Wildenberg, "In Support of the Battle Line: Gunnery's Influence on the Development of Carrier Aviation in the U.S. Navy," *Journal of Military History* 65 (July 2001), pp. 702–707.
18. Logbook, USS *Langley,* entry for 18 December 1925, Record Group [hereafter RG] 45, National Archive and Records Administration, Washington, D.C. [NARA].
19. For example, see Joseph M. Reeves, "Divisional Officer's Report, Record Target Practice of the Aft Turret Division [Battleship *Wisconsin*]," 27 February 1905, serial file 17213, Bureau of Ordnance General Correspondence 1904–1911, RG 74, NARA.
20. Eugene Wilson, *Slipstream: The Autobiography of an Air Craftsman* (New York: McGraw-Hill, 1950), p. 124; *The Reminiscences of Eugene Wilson* (New York: Oral History Office, Columbia University), pp. 390–91.
21. DeWitt C. Ramsey to Emory S. Land, 16 April 1928, Ramsey Papers, Operational Archives, Naval Historical Center, Washington, D.C.
22. The doctrine was codified in the 1941 revisions to USF 74 ("Current Tactical Orders and Doctrine, U.S. Fleet Aircraft"). Included

were the following statements: "Once the enemy is located all other considerations are secondary to the delivery of heavy bombing and torpedo attacks"; and "The surest and quickest means of gaining control of the air is the destruction of enemy carriers."

23. Peattie, pp. 72–73; Evans and Peattie, p. 342.
24. Yoichi Hirama, "Japanese Naval Preparations for World War II," *Naval War College Review* 44, no. 2 (Spring 1991), pp. 70–71; Evans and Peattie, p. 262.
25. Mitsuo Fuchida and Masatake Okumiya, *Midway: The Battle That Doomed Japan* (Annapolis, Md.: Naval Institute Press, 1955), pp. 148–50.
26. Peattie, p. 63. While American carriers normally parked most of their aircraft on the flight deck and used the hangars below only for aircraft repair and maintenance, Japanese carriers used their hangars as their main aircraft-stowage area.
27. Board to the Secretary of the Navy, "Subject: Tests on BB47, Ex-Washington, November 1924," in binder "Ordnance Allowances," Bureau of Aeronautics Secret Correspondence, 1921–38, RG 72, NARA. For a summary of the results see Theodore Roscoe's *On the Sea and in the Skies: A History of the U.S. Navy's Airpower* (New York: Hawthorne Books, 1970), p. 161.
28. It could also be used in conditions of low overcast, which would preclude dive-bombing. The Navy abandoned its shore-based torpedo squadrons after the Pratt-MacArthur Agreement, and no torpedo squadrons were assigned to the *Ranger*. Only two torpedo squadrons were retained until the *Yorktown* entered service in September 1937.
29. Mark A. Campbell, "The Influence of Air Power upon the Evolution of Battle Doctrine in the U.S. Navy, 1922–1941" (master's thesis, History Department, University of Massachusetts, Boston, 1992), pp. 174–78.
30. ComAirBatFor [Frederick J. Horne], "Comments and Recommendations: Fleet Problem XVIII," p. 7, microfilm series M964 [reel 23], NARA.
31. See the author's *Gray Steel and Black Oil: Fast Tankers and Replenishment at Sea in the U.S. Navy, 1912–1992* (Annapolis, Md.: Naval Institute Press, 1996.), p. 170 table 17, and "Chester Nimitz and the Development of Fueling at Sea," *Naval War College Review* 46, no. 4 (Autumn 1993), pp. 52–62.
32. Evans and Peattie, p. 347.
33. Admiral Ernest J. King, then the commander of Aircraft Squadrons, Battle Force, reached this same conclusion in the early part of 1939, when he brought four U.S. carriers together for combined exercises; see Thomas Buell, *Master of Seapower* (New York: Little, Brown, 1974), pp. 114–15.
34. *Hawai Sakusen* [The Hawaii operation], Senshi Sosho Series (Asagumo Shimbunsha, 1979), pp. 83–84, as cited by Hirama, p. 75.
35. Evans and Peattie, p. 349.
36. As Peter Rosen points out, "A major innovation involves a change in the concepts . . . governing the ways it [a combat arm] uses forces to win a campaign, as opposed to a tactical innovation." See *Winning the Next War: Innovation and the Modern Military* (Ithaca, N.Y.: Cornell Univ. Press, 1961), p. 7; see also Gordon W. Prange's analysis in *Miracle at Midway* (New York: McGraw-Hill, 1982), pp. 249–50.
37. Prange, p. 34.
38. Fuchida and Okumiya, p. 78.
39. Prange, p. 29.
40. Ibid., p. 59.
41. Two more squadrons from the *Hornet* never found the Japanese and did not take part in the battle.
42. This was especially true for the dive-bomber, which was virtually unstoppable once it entered its dive.
43. The reasons for this remain unclear. Since Japanese carrier doctrine was integrated into the combined strategy for defeating the U.S. fleet in a decisive naval engagement, presumably the Japanese believed they would find the American carriers with the rest of the fleet. Thus it was not essential to allocate critical flight-deck resources to this task.
44. Peattie, pp. 153–55. As Peattie explains, maneuvers conducted by the Combined Fleet as early as 1939 had demonstrated that success in preemptive attack was usually a matter of only a few minutes' advantage.
45. Fuchida and Okumiya, pp. 148–50.

46. Ibid.
47. Ibid. For a contrasting view, see Dallas Woodbury Isom (in the article cited in note 1 above), who argues that Nagumo's choices at Midway were calculated and reasonable, if ill fated. See his "The Battle of Midway," esp. pp. 70–77, for the detailed calculus involved.
48. U.S. pilots attacking the Japanese carriers at Midway achieved a hit rate of 27.5 percent. This exceptional achievement—the average during prewar bombing exercises against maneuvering targets had been only about 20 percent—was aided by the Japanese carriers' having just turned into the wind when the American planes arrived overhead. The dive-bombers could dive out of the sun along the long axis of a non-maneuvering target, with no crosswind—an ideal situation.
49. Jonathan Parshall, correspondence to author, 16 August 2004.
50. Hugh Douglas, "Air Tactics," lecture delivered at the Naval War College on 23 October 1933, file 1846A, Historical Collection, Naval War College.
51. In 1936 Miles Browning (who later became Spruance's air adviser at Midway) wrote: "Every carrier we have has known what it means to be 'bopped' with all planes on deck, because her hands were tied by uncertainty as to her next move." See Clarke G. Reynolds, "The Truth about Miles Browning," in *A Glorious Page in Our History* (Missoula, Mont.: Pictorial Histories, 1990), p. 214.
52. Hundley, p. 3. Craig Koerner suggests that a case can be made that the Japanese were overresponsive to an RMA. As he points out, "One of their major fears in this battle was that land-based bombers out of Midway would savage the invasion fleet, leading them to strike the airfield from long range with the unified carrier force."
53. The Royal Navy deserves some of the credit for the Japanese success at Pearl Harbor, by paving the way at Taranto.