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COMPLEXITY AT THE BATTLE OF MIDWAY: IMPLICATIONS FOR NETWORK-CENTRIC WARFARE

by

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Abstract

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IMPLICATIONS FOR NETWORK-CENTRIC WARFARE

The lessons of the battle of Midway are relevant to the U.S. Navy's effort to implement network-centric warfare. Japanese forces at the battle were superior to those of the United States both in number and quality. Both forces employed the same technology and similar tactics. The margin of U.S. victory was superior intelligence, and command and control that relied on the initiative of subordinates to self-organize to defeat the enemy. U.S. execution of the Midway battle plan exemplified the tenets of shared awareness, speed of command, and self-synchronization to meet the commander's intent that will underpin the network-centric Navy.

The U.S. Navy must adapt its concept of command and control to realize fully the benefits of network-centric operations. Navy doctrine should more explicitly recognize that its fighting forces are a complex adaptive system and command them as such. Control should become less rather than more centralized as the result of more information. The commander's intent will become even more important as subordinate levels of command gain more information and power to influence the battle. The principles of war, particularly simplicity, will retain their importance in the network-centric environment.

The lessons of Midway can serve as guidelines as the Navy transforms from a platform-centric to a network-centric force. Nimitz, Fletcher, and Spruance set the example. It remains for today's Navy leaders to adapt that example to the Information Age.

INTRODUCTION

The United States Navy annually celebrates two events: the anniversary of its establishment on 13 October 1775 and the anniversary of victory at the June 1942 battle of Midway. Midway is significant in Navy culture because it was the first operational victory the United States achieved in World War II in the Pacific, and is now recognized as the turning point of that war. Why use only the second naval battle in history in which the opposing combatant ships did not sight each other (the first was the battle of the Coral Sea in May 1942) as a model for information age warfare? There are four reasons. The first is that the fundamental nature of warfare is unchanging. Robert Rubel wrote, "Though forms of war change, people do not."[1] The lessons of previous conflicts should therefore be applicable to warfare in any age. The second is that people—members of the U.S. Navy—will implement network-centric warfare. Relating the new concept to a revered ideal like the battle of Midway will ingrain it into the Navy's culture in a fundamental way. Third, aspects of the battle of Midway exemplify the principles of network-centric warfare—speed of command and self-synchronization to meet the commander's intent. Finally, David S. Alberts wrote:

> Given that our potential adversaries have access to virtually the same information technology we have, the margin for victory will be the degree to which we manage our transformation into the information age.[2]

The margin for victory at Midway was command and control. The lessons of Midway will have enduring importance for the Navy as it transforms from a platform-centric into a network-centric force, and adapts its command and control doctrine for that transformation.

The battle of Midway, by standard force-on-force measures, should not have been close and certainly should not have resulted in a decisive U S. victory. The outcome of

Midway was due to more than the good fortune that allowed separate groups of U.S. dive-bombers to converge and sink three Japanese carriers after numerous individual attacks had failed. The victory can be credited to superior U.S. intelligence, the simplicity of the U.S. plan, heroism, and numerous lesser influences on both sides. Viewing the battle of Midway as a contest between two complex adaptive systems allows one to understand better how a force with fewer ships of all types and generally inferior aircraft could defeat a larger, technically superior one. Complexity theory provides insights into the battle of Midway that can direct the way ahead for the Navy's effort to develop the doctrine and command and control concepts essential to effective network-centric operations.

This paper will first describe the characteristics of a complex adaptive system. Second, it will relate complexity theory to the concept of network-centric warfare. Third, it will discuss the battle of Midway from the viewpoint of complexity theory and network-centric warfare. Finally, it will offer recommendations for implementing doctrine and command and control concepts that will be most effective for network-centric operations, based on the lessons of Midway.

COMPLEXITY THEORY AND COMPLEX ADAPTIVE SYSTEMS

Complexity theory is a relatively new way to analyze warfare, but war theorists have long recognized that the interaction of two opposing military forces is rarely a well-ordered, predictable business. Clausewitz used references to friction and magnetism in explaining interaction in war, both of which were high-tech concepts in the first three decades of the 1800s when he wrote On War.[3] His references to unpredictability and the importance of chance in war recognized that complex interactions, like battles in war, could not be described adequately by Newtonian methods.[4] Complexity theory is an attempt to explain the dynamics of interactions among biological systems, atmospheric systems, swarms of bees, colonies of ants, any "complex" system, and of most interest to those concerned with command and control in war, the interaction of armies or navies in battle.

In his article on the military implications of complexity theory, John F. Schmitt described a complex adaptive system as:

> Any system composed of numerous parts, or agents, each of which must act individually according to its own circumstances and requirements, but which by so acting has global effects which simultaneously change the circumstances and requirements affecting all the other agents.[5]

At the operational level, the interaction of two fleets, as at the battle of Midway, can be viewed as the interaction of two complex adaptive systems (CASs). At the tactical level, the aircraft involved in a strike can be viewed as a CAS. Each pilot's decisions and actions affect not only every other friendly aircraft involved in his and other attacks, but also the enemy's aircraft and ships. The effect can extend to the operational and strategic levels. Schmitt described this interaction as "a hierarchy of complex systems nested one inside the other."[6] This was true at Midway in that the tactical success of U.S. carrier air strikes resulted in an operational outcome—victory of the U.S. force over the Japanese Navy with the result that Midway was held and only one U.S. aircraft carrier was lost.

Emergence and self-organization are properties of CASs that help illustrate how command and control will function in the network-centric environment. Emergence, according to Schmitt, means that the overall behavior of a system is qualitatively different from the behavior of its parts. No amount of knowledge about the individual parts allows the behavior of the whole CAS to be known.[7] Contrast this to a machine, a propulsion train for example, where understanding the component parts—the number and types of turbine stages, steam supply and exhaust pressures, and reduction gear ratios enables one to understand virtually everything about the system. Emergence is the property that makes controlling a CAS so difficult. A commander cannot know what orders will cause the organization to produce the greatest effect because it is not possible to know the situations subordinate commanders will face. Reducing the problem to known subsets does not help. To quote ESPN's Chris Berman, "That is why they play the games."

Self-organization arises from personal interaction in an organization without detailed direction from above.[8] It occurs when members of a squad link up to complete a mission, or a group of fighter aircraft attaches itself to a group of bombers and escorts them to an objective as occurred at Midway. Self-organization is not a new concept. Any tactical commander who has received mission-type orders and conducted the mission as he saw fit, without detailed direction from higher levels of command, has used it. Germany's use of *auftragstaktik,* broad mission orders that relied on the initiative of junior leaders in executing blitzkrieg, is a familiar example.

NETWORK-CENTRIC WARFARE

The objective of network-centric warfare (NCW) is to allow U.S. forces to act with rapidity over such a wide scope and area of operations that enemy courses of action will become ineffective. Enemy strategies will therefore be "locked-out."[9] NCW, as envisioned, will exploit the advantages of complexity on a much larger scale than has been possible using Newtonian command and control. Individual tactical units will be networked to enhance self-organization and the emergent properties of CASs so a fleet, air wing, corps, or joint task force can act and react more quickly and precisely.

Cebrowski and Garstka envision that NCW will provide two key advantages over conventional platform-based warfare—speed of command and self-synchronization to meet the commander’s intent. They define speed of command as a force achieving information superiority and acting with speed and precision in order to mass effects and foreclose enemy courses of action. Further, they project that a force employing network-centric operations would be able to overcome disadvantages in numbers, technology, or position. The enabling technology for speed of command and self-synchronization comprises three grids—a sensor grid, an engagement grid, and the information grid that connects them to produce strikes, fires, or other desired effects.[10]

Implementing network-centric warfare will require more than simply installing hardware and software in tactical units and fielding various sensors to provide information to populate the networks. It will require fundamental changes in the way we think about military organizations and command and control. Complexity theory would have us take advantage of the adaptive qualities of our people to self-organize and find the best way to meet the commander’s intent. Theorists of network-centric warfare envision that: “Organizational behavior could be consciously designed to be an emergent property that derives from the commander’s intent.”[11] The command and control process will be one that relies on conveying the commander’s intent and providing the required information and resources to accomplish the mission. The key will be self-organization at the lowest possible levels to achieve the greatest combat effects. Control will take the form of feedback among the tactical units and to the commander. The commander will exert less control as the product of information superiority, rather than more. Plans will be less detailed, rather than more so.[12] NCW, in the most stressing application of it, will thus resemble the battle of Midway in that Admiral Nimitz, with exceptional knowledge of the battlespace and the enemy’s intentions, still gave his subordinate commanders great autonomy.

CONTEXT OF THE BATTLE OF MIDWAY

Midway Island and the Western Aleutian Islands were the objective of the second of a three phase Japanese offensive strategy in the Pacific in 1942. The objective of the first phase was Tulagi and Port Moresby to gain control of the Coral Sea. The battle of the Coral Sea (from 4-8 May 1942) resulted from U.S. defense of the first objective. Coral Sea was a U.S. tactical defeat, but a U.S. operational success in that the Japanese were prevented from occupying Port Moresby.[13] The loss of 33,000-ton carrier USS Lexington, oiler USS Neosho, and destroyer USS Sims in exchange for the Japanese 12,000-ton carrier Shoho and some smaller vessels clearly favored the Japanese, however.[14] The third phase of the Japanese offensive, occupying New Caledonia, Fiji, and Samoa to cut U.S. lines of communication to Australia, was canceled after their defeat at Midway.[15]

The Japanese desired Midway and the Aleutians to establish a forward perimeter for patrol aircraft and raids on Pearl Harbor, and to bring the U.S. Pacific Fleet to a decisive engagement. The Doolittle raid on Tokyo from USS Hornet in April 1942 made securing the Pacific bases doubly important to the Japanese strategy.[16] The United States entered the battle of Midway on the strategic defensive in the aftermath of Pearl Harbor and Japanese victories in the Philippines and Malaya, but with operational success at the battle of the Coral Sea and the morale-building effect of the Doolittle raid on which to build. Despite these moderate successes in the month prior to Midway, U.S. forces in the Pacific were clearly inferior to the Japanese both in number and quality.

Nearly 140 Japanese combatant ships in four groups participated in the battle of Midway. The Carrier Striking Force (also referred to as the Mobile Force) commanded by Vice Admiral Chuichi Nagumo, comprising carriers Akagi, Kaga, Hiryu and Soryu with a total of 230 operational aircraft and their escorts, was the main force engaged in the battle.[17] An Advanced Expeditionary Force of 16 submarines conducted surveillance between Pearl Harbor and Midway, and provided other services. The Midway Occupation Force of transports supported by cruisers, battleships, destroyers, seaplane carriers, and a minesweeping group approached Midway to the south of the Carrier Striking Force. The Main Body, with Combined Fleet Commander-in-Chief Yamamoto embarked, comprising battleships, cruisers, an extensive destroyer screening force, a light carrier, and two seaplane carriers, approached Midway about 500 miles behind the Carrier Striking Force.[18] Japanese plans called for a diversionary attack on the Aleutians to confuse the U.S. response and allow the surprise attack on Midway to proceed with little opposition. The Main Body was assigned to cover both the Midway and Aleutians attacks, but was not engaged in combat during the battle.

The U.S. force, under Nimitz's overall command, comprised three carriers, their escorts, support ships, and 234 aircraft (221 operational), Hornet and USS Enterprise in Task Force 16 commanded by Rear Admiral Raymond Spruance, and USS Yorktown in Task Force 17 under the command of Rear Admiral Frank Jack Fletcher. Fletcher had overall tactical command of both task forces entering the battle. Eighty combat aircraft and 32 reconnaissance aircraft under the command of Navy, Army Air Force, and Marine Corps commanders were based on Midway itself.[19] Nineteen submarines patrolled in an arc west to northwest of Midway and north of Oahu. A smaller task force was assigned to counter the Japanese in the Aleutians.

The U.S. force at Midway was roughly equal to the Japanese in number of aircraft, but was inferior in aircraft quality and pilot experience, had no battleships, and was inferior in other ship types.[20] It still decisively defeated a superior Japanese force, however. There are numerous reasons for the victory: the complexity of Yamamoto's plan; his division of forces into four groups that reduced the amount of his strength engaged; the simplicity of the U.S. plan; and the extraordinary heroism of U.S. Airmen, Sailors, Soldiers, and Marines. Speed of command, commander's intent, and self-synchronization are aspects of the Midway battle that can influence the Navy's contemporary implementation of network-centric warfare.

SPEED OF COMMAND

Admiral Nimitz used operational intelligence to achieve information superiority and a better understanding of the battlespace than the Japanese possessed. Nimitz's sensor grid consisted of fixed listening sites throughout the Pacific Theater and mobile platforms—mainly fleet warships, submarines, and patrol aircraft. Nimitz obtained clues to Japan's strategic intent from a Japanese flying boat attack against Hawaii on 3-4 March 1942 and from a Marine Corps fighter aircraft detection of a Japanese flying boat near Midway on 10 March. Back-bearing intelligence indicated that the enemy plane had refueled at French Frigate Shoals. All of this implied that the Pacific Ocean north of Hawaii was an active Japanese theater of operations. Further, American cryptanalysts were able to read ninety percent of all Japanese secure transmissions.[21] Nimitz's intelligence staff collected and analyzed the communications intercepts and provided him with a general outline of the Japanese operational plan beginning about 10 May 1942.[22] By 20 May, Nimitz was able to provide his subordinate commanders with an accurate estimate of the size and composition of the Japanese force with the exception of Admiral Yamamoto's Main Body. Despite that limitation, Nimitz's naval air commander at Pearl Harbor was able to predict the Japanese plan for the attack on Midway by 24 May.[23]

The information superiority payoff at the operational level was that Nimitz could concentrate his forces in time and space to allow his tactical commanders the best chance of success. It was the knowledge of Japanese intentions and timing that drove Nimitz's decision to make temporary repairs to Yorktown in three days rather the estimated ninety days for full repairs. Nimitz was able to get Task Force 16 underway on 28 May. Task Force 17 sortied on 30 May. A major advantage accrued to the U.S. force in that the fleet units left Pearl Harbor prior to the Japanese scouting submarines being in position to sight them.[24] U.S. shared awareness was further enhanced by the intelligence estimate of the force and timing of the Midway attack being published in CINCPAC Operations Plan 29-42 to govern U.S. operations at Midway.[25]

Yamamoto, on the other hand, had little early knowledge of U.S. plans or force disposition. Nimitz had allowed Enterprise and Hornet to be sighted near the Solomon Islands by a Japanese scout plane on 16 May, one day prior to ordering their return to Pearl Harbor. Thereafter, operational deception using a U.S. cruiser to broadcast fictitious radio traffic was effective in convincing Japanese intelligence that the American carrier force remained in the South Pacific until at least 1 June.[26] On 20 May, Yamamoto advised his subordinate commanders of his own revised estimate that there would be two or three American carriers in the Hawaii area.[27] This was the extent of shared awareness between Yamamoto and his operational commanders prior to combat operations. Most significantly, Vice Admiral Nagumo was unaware of significant intelligence developed after he sailed from Japan because of radio silence imposed by Yamamoto. Specifically, Nagumo did not know that battleship Yamato had intercepted an American submarine's radio transmission from near the Japanese transport group, that long-range air reconnaissance of Pearl Harbor had been canceled, or that Yamamoto had come to suspect a U.S. response to the Midway operation.[28] Thus, the Japanese strategic and operational leadership, except for the commander of the four carriers that comprised the center of gravity of the Japanese force, was aware of the potential for significant U.S. naval opposition at Midway.

This disparity of awareness between the subordinate commanders on the opposing sides was one of the most significant advantages possessed by the Americans. Nimitz, broadcasting freely from Pearl Harbor and using the underwater cable connection between Midway and Hawaii, ensured his commanders knew every bit of important information he had. The Japanese force, handicapped by the requirement to maintain radio silence, increasingly lost situational awareness each day from departure Japan until the battle began.

At the tactical level, the U.S. initial attack on 4 June 1942 exemplified speed of command. The force possessed a high-quality information back-plane and achieved information superiority by conducting an extensive air search using Midway-based aircraft, a scouting force of ten aircraft from Yorktown, the submarines west of Midway, and land-based radar on Midway itself. Nimitz thus had in place the mechanical analogy of a sensor grid and a radio-based information grid. The initial sighting of the Japanese carriers by a Midway-based patrol plane, followed by Fletcher's order to Spruance to proceed to the southwest and launch his attacks as soon as the Japanese carriers were definitely located, initiated the Midway engagement grid. Fletcher launched his own attack after recovering his search planes.

COMMANDER'S INTENT

The second key American advantage at Midway will also be critical to the success of network-centric operations—a straightforward plan with a single objective and clear commander's intent. CINCPAC Operation Plan 29-42 directed Fletcher and Spruance to position themselves on the Japanese flank northeast of Midway and, "Inflict maximum damage on enemy by employing strong attrition tactics."[29] Nimitz further refined his intent in a Letter of Instruction that stated:

> In carrying out the task assigned, . . . you will be governed by the principle of calculated risk, which you shall interpret to mean the avoidance of exposure of your force to attack by superior force without good prospect of inflicting, as a result of such exposure, greater damage on the enemy.[30]

Nimitz's plan embodied simplicity and clarity of objective. He clearly articulated his vision for the battle and established the boundary conditions that would guide his subordinate commanders. Thus, even though he had the ability to direct tactical actions if he thought it necessary, his clear statement of intent made it unnecessary.

At the tactical level, Spruance forwarded his intent by signal lamp to his Task Force 16 ships:

> An attack for the purpose of capturing Midway is expected. . . . If presence of Task Force 16 and 17 remains unknown to the enemy we should be able to make surprise attacks on enemy carriers from a position northeast of Midway. Further operations will be based on results of these attacks, damage inflicted by Midway forces, and information of enemy movements. . . .[31]

It is not clear that Fletcher transmitted a similar intent to Task Force 17. Assuming he did, the entire U.S. force entered the battle with a commonly understood picture of the enemy they would face, the objective of that enemy, their own objective, and the commander's intent. Thus, despite employing signal lamp technology, Nimitz's force developed shared awareness and created the conditions for the decisive tactical engagement of the battle.

SELF-SYNCHRONIZATION

The attack of the U.S. air groups on the Japanese carriers on 4 June was one of the most decisive naval tactical actions in U.S. history. Poorly coordinated attacks by three waves of U.S. torpedo bombers delayed rearming of the Japanese planes by forcing the Japanese formation to maneuver radically and drew the Japanese combat air patrol away from the U.S. dive bombers. The Japanese maneuvers spread their formation, reducing the effectiveness of their anti-aircraft fire. U.S. dive-bombers converged over the Japanese carriers just as U.S. torpedo plane attacks had drawn the Japanese fighter cover to low altitude to counter them. The resulting bomb hits on three of Nagumo's carriers were the decisive blows of the engagement.[32]

Spruance and Nagumo each made one key decision during the battle. Spruance launched what he intended to be an all or nothing strike at 0700 but ordered the aircraft airborne at 0745 to proceed with the attack so that they would burn less fuel orbiting the carriers waiting for the last two squadrons to launch.[33] Spruance accepted a less than maximum attack in exchange for the risk of separating and de-synchronizing his attacks. Fletcher followed with an attack at 0838 after he was satisfied that additional Japanese carriers would not be located.[34] Self-synchronization of the air groups from both task forces resulted in the decisive attack. Conversely, Nagumo delayed launching any attack on the U.S. carriers to allow all his planes to be rearmed, despite having available an adequate second strike of dive-bombers and fighters. Isom cites Nagumo's probable, "devotion to the doctrine of coordinated attack, using all three types of planes," for that decision.[35] He was unable to recover from that error once the U.S. attacks began. Spruance thus accepted the risk of a less than fully massed attack and relied on self-synchronization and the adaptability of his air groups to carry the day. Nagumo insisted on complete synchronization, with disastrous results.

Edward A. Smith credited the American success to getting inside Nagumo's OODA cycle.[36] Nagumo ordered his planes rearmed for a second strike on Midway upon receiving a report that a follow-up strike was needed there. He countermanded that order to prepare for an attack on the U.S. carriers when their presence was reported. The American attack occurred while the Japanese planes were being refueled and rearmed, with bombs and torpedoes either on deck or in the hangar bays of the Japanese carriers. The damage from the secondary explosions of fuel and ordnance eventually caused carriers Kaga, Akagi, and Soryu to sink, and left Hiryu vulnerable to Spruance's follow-on attack. The Japanese failure was thus the result of having two objectives during the battle—Midway and the U.S. carriers.

Incorrect reports to both Spruance and Nagumo had key effects on both of their decisions. Spruance's initial contact report on the Japanese carriers was 40 miles less than the actual range. Nagumo's initial report of the U.S. carriers was 30 miles greater than the actual range.[37] The reports tended to move up U.S. attack plans and delay those of the Japanese. The combination of these errors, the effect of the American attacks delaying the rearming of Japanese planes, and the Japanese delay in sighting the U.S. carriers, all affected the outcome of the battle. Imperfect information, a constant in war, thus played a key role in the battle of Midway.

THE LESSONS OF MIDWAY

The battle of Midway offers several insights that may be useful as the U.S. Navy implements network-centric warfare. Complexity theory asserts that it is not possible to obtain perfect information about one's enemy. In his after-action report, Admiral Nimitz stated: “Correct information is still one of the hardest things for a commander to get in action.”[38] This was true even with the wealth of intelligence on Japanese forces and intentions the U.S. Navy possessed prior to Midway. This condition will likely hold true despite the greater quantity of information available at all levels of war in the network-centric environment. Weather, incomplete or incorrect reports, and the action of the enemy will still require that commanders be willing to accept risk and empower subordinates to self-synchronize for the greatest effect. The key to future victories may well be commander’s ability to discern useful information out of the mass available to make command decisions.

The second lesson is that U.S. commanders must be willing to accept less hands-on control as the product of network-centric warfare, rather than more. Detailed command and control will certainly be possible in the network-centric environment. Commanders and political leaders must resist the temptation to interfere at the operational and tactical levels of war, despite having the ability to do so. Nimitz gave nearly complete autonomy to his subordinate commanders despite ample availability of reports from the Midway battle. The U.S. Navy must take advantage of its key asset—people—to adapt to changing situations, apply the commander’s intent, and self-synchronize to achieve the desired result.[39]

The third is the enduring importance of commander’s intent. The clarity of Nimitz’s intent at Midway—destroy enemy carriers—was key to the U.S. victory. The lack of clear intent was a key flaw in the Japanese plan. The Japanese attacking Midway were unable to reorient and attack the U.S. carriers quickly enough to be successful. A clearly communicated sense of mission is also important to complex, high technology organizations.[40] Commander’s intent may be the sole input the commander has on a battle if NCW achieves the envisioned rapid pace of operations.

Fourth, self-synchronization may increasingly supplant synchronization in the operational art. The battle of Midway illustrated the benefits of self-synchronization. Complexity theory recognizes that the ability for humans to understand and adapt is essentially unbounded.[41] Technological advances will only enhance that ability as each tactical unit has more and better quality information available.

Fifth, the U.S. Navy must adapt its command and control doctrine to recognize and take advantage of its fighting forces as a complex adaptive system. Current U.S. command and control doctrine has been criticized as being focused on minimizing mistakes and placing bandages on potential weaknesses.[42] The Marine Corps has advanced the farthest in recognizing that command and control will increasingly become an adaptive process. Marine Corps Doctrine Publication SIX states:

> An effective command and control system provides the means to adapt to changing conditions. We can thus look at command and control as a process of continuous adaptation. . . . Command and control is not so much a matter of one part of the organization "getting control over" another part as something that connects all the elements together in a cooperative effort. All parts of the organization contribute action and feedback – "command" and "control" – in overall cooperation.[43]

Nimitz and his forces achieved this effect at Midway. By revising its command and control doctrine, the network-centric Navy can do the same.

Sixth, simple plans that do not rely on centrally synchronized control to achieve unity of effort will optimize the characteristics of the complex, adaptive, network-centric Navy.[44] Nimitz's plan was sufficient to result in a decisive victory over a superior Japanese force reliant on a complex plan requiring surprise and perfect coordination for success. The impossibility of having complete, perfect knowledge of an enemy requires that our plans remain simple, and be tolerant and adaptable to rapidly changing situations.

Finally, network-centric warfare has to *work*. Spruance made the decisive decision at Midway by laying his fingers on a maneuvering board, judging range to the Japanese carriers, and giving the order to launch the attack. Maxfield noted the importance of understanding our artifacts, "the inanimate things we create and make," to understand human complex adaptive systems.[45] Spruance's maneuvering board worked. Whatever computer screen, Palm Pilot, or user interface the Navy creates for its networked systems will have to work for a human decision-maker. It is, after all, the human that changes most slowly in warfare.

CONCLUSION

The key to victory at Midway was not that Admiral Nimitz possessed knowledge of Japanese intentions, although this was a significant advantage. Fletcher credited the use of available information: "It was not so much luck; it was the intelligent use of the information we had."[46] Spruance credited Nimitz: "The credit must be given to Nimitz. Not only did he accept the intelligence picture but he acted on it at once."[47] Nimitz himself credited Spruance's judgment and intelligence, which gave him "as clear a picture as any command would want to have."[48]

Nimitz's force achieved what are now objectives for the U.S. Navy's network-centric approach to operations—speed of command and self-synchronization to meet the commander's intent. Achieving these objectives necessitates treating the military organization as a complex adaptive system. To do that, naval doctrine must embrace more command (commander's intent) and less instead of more control, as the product of the greater quantity of information available in network-centric operations. The U.S. Navy must evolve its concept of command and control to achieve fully the benefits of network-centric operations. Fortunately, there is no better model for that endeavor than the example of Nimitz, Fletcher, and Spruance at Midway.

NOTES

[1] Robert C. Rubel, "Gettysburg and Midway: Historical Parallels in Operational Command," Naval War College Review 48 (Winter 1995): 108.

[2] David S. Alberts, The Unintended Consequences of Information Age Technologies. (Washington, DC: National Defense University: 1996), 7.

[3] Alan Beyerchen, "Clausewitz, Nonlinearity and the Unpredictability of War," International Security 17 (Winter 1992/93), 70-71.

[4] Beyerchen, 72; John F. Schmitt, "Command and (Out of) Control: The Military Implications of Complexity Theory," in Complexity, Global Politics and National Security, eds. David S. Alberts and Thomas J. Czerwinski (Washington, DC: National Defense University: 1997), 220-225. Schmitt discusses Newtonian command and control as a highly methodical approach to military operations intended to impose order on battle through highly synchronized schemes and detailed orders. Schmitt contends that Newtonian war is linear, meaning that, "a direct and proportional connection can be established between each cause and effect."

[5] Schmitt, 233-234.

[6] Ibid., 235.

[7] Ibid.

[8] Robert R. Maxfield, "Complexity and Organization Management," in Complexity, Global Politics and National Security, eds. David S. Alberts and Thomas J. Czerwinski (Washington, DC: National Defense University: 1997), 176.

[9] Arthur K. Cebrowski and John J. Garstka, "Network-Centric Warfare–Its Origin and Future," U.S. Naval Institute Proceedings (January 1998): 32.

[10] Cebrowski and Garstka, 32.

[11] David S. Alberts, John J. Garstka, and Frederick P. Stein, Network Centric Warfare: Developing and Leveraging Information Superiority, 2nd ed. (Washington, DC: DOD C4ISR Cooperative Research Program, 1999), 160.

[12] Ibid., 159.

[13] Samuel Eliot Morison, History of United States Naval Operations in World War II, Vol. IV, Coral Sea, Midway and Submarine Actions, May 1942-August 1942. (Boston: Little, Brown and Company, 1950), 3-7.

[14] E. B. Potter, Nimitz (Annapolis, MD: Naval Institute Press 1976), 76.

[15] Morison, 5-6.

[16] Morison, 74-75; Potter, 65-68.

[17] Dallas Woodbury Isom, "The Battle of Midway: Why the Japanese Lost," Naval War College Review, 53 (Summer 2000): 61.

[18] Morison, 87-89.

[19] Isom, 61; Morison, 90-93.

[20] Isom, 61; Morison, 80-84.

[21] John Keegan, The Price of Admiralty: The Revolution in Naval Warfare (New York: Viking, 1988), 184-185.

[22] Morison, 79-80; Isom, 61.

[23] Ibid.

[24] Potter, 85-88; Morison, 81.

[25] Potter, 87.

[26] Mitsuo Fuchido and Masatake Okumiya, Midway: The Battle That Doomed Japan, eds. Clarke C. Kawakami and Roger Pineau (Annapolis, MD: Naval Institute Press, 1955), 433, 123; quoted in Isom, 92; Potter, 88.

[27] Isom, 92.

[28] Ibid., 92-93.

[29] Morison, 84; Potter, 87.

[30] Morison, 84.

[31] Thomas B. Buell, The Quiet Warrior (Annapolis, MD: Naval Institute Press, 1987; reprint, Boston: Little, Brown and Company, 1974), 141-142.

[32] Morison, 112-131; Isom, 67-86. Morison's classic or "Nagumo vacillates" account of the battle faults the reporting of the scout plane from the Japanese cruiser Tone and indecision on the part of Nagumo for the dive bombers striking the Japanese carriers while they were rearming and refueling planes. Isom provides a revised account that credits the Tone scout plane crew with excellent reporting on the ten escort ships of Task Force 16 separated from Spruance's carriers while they launched aircraft under cloud cover. The Isom account acknowledges mistakes made by Nagumo but provides a more detailed and plausible account of the rearming decisions and process on the Japanese carriers. Isom cites probable errors in Japanese log-keeping procedures for the difference in timing of major orders made by Nagumo.

[33] Keegan, 199.

[34] Morison, 115.

[35] Isom, 94.

[36] Edward A. Smith, Jr., "Network-Centric Warfare: What's the Point?" Naval War College Review, 54 (Winter 2001): 61, 65-66. The OODA loop or cycle is the "Observe, Orient, Decide, Act" decision-making process developed by U.S. Air Force Colonel John Boyd. Smith cites Boyd's, A Discourse On Winning and Losing (Maxwell AFB, Ala.: Air University Press, 1987).

[37] Isom, 84-86.

[38] C. W. Nimitz, "Battle of Midway: 4-7 June 1942, Online Action Reports: Commander in Chief, Pacific Fleet, Serial 01849 of 28 June 1942," Naval Historical Center, 14 April 1999, <http://www.history.navy.mil/docs/wwii/mid1.htm> [17 April 2001].

[39] Maxfield, 184.

[40] Ibid., 194.

[41] Maxfield, 191-192.

[42] Alberts, Garstka, and Stein, 163.

[43] U.S. Marine Corps, Command and Control, Marine Corps Doctrine Publication 6 (Quantico, VA: 1996), 45-47; quoted in Science Applications International Corporation, The Strategic Assessment Center, Defeat Mechanisms: Military Organizations As Complex, Adaptive, Nonlinear Systems, (McLean, VA: March 10, 2000), 24.

[44] Schmitt, 244.

[45] Maxfield, 178.

[46] Gordon W. Prange with Donald M. Goldstein and Katherine V. Dillon, Miracle at Midway (New York: McGraw-Hill, 1982), 391.

[47] Ibid., 393.

[48] Ibid., 394-395.