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BIG MISSILES AND BIG DECKS: THE VIABILITY OF AIRCRAFT CARRIERS IN AN A2/AD WORLD

by

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LIST OF ACRONYMS AND ABBREVIATIONS

A2/AD	Anti-Access/Area Denial
ASB	Air-Sea Battle
ASBM	Anti-ship Ballistic Missile
ASCM	Anti-Ship Cruise Missile
AWACS	Airborne Warning and Control System
C2	Command and Control
CEP	Circular Error Probable
CSBA	Center for Strategic and Budgetary Assessments
ECM	Electronic Countermeasure
EMCON	Emissions Control
FON	Freedom of Navigation
GIUK	Greenland-Iceland-United Kingdom
IADS	Integrated Air Defense System
ISR	Intelligence Surveillance Reconnaissance
JASSM-ER	Joint Air-to-Surface Standoff Missile-Extended Range
JOAC	Joint Operational Access Concept
JSOW-ER	Joint Stand-off Extended Range
MaRV	Maneuverable Reentry Vehicle
MOC	Maritime Operations Centers
RIMPAC	Rim of the Pacific
RORSAT	Reconnaissance Satellite
SAG	Surface Action Group
SOSS	Soviet Ocean Surveillance System
SRBM	Short-Range Ballistic Missile
UCAS-D	Unmanned Combat Air System Demonstrator
UCAV	Unmanned Combat Air Vehicle
UNCLOS	United Nations Convention on the Law of the Sea
VLS	Vertical Launch System
VSTOL	Vetrical/Short Take-off

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I. INTRODUCTION

A. MAJOR RESEARCH QUESTION

The aircraft carrier has long served as a defining symbol of the United States of America's military capability and national prosperity. Its ability to transport an air wing's strike capability across the world's oceans–nearly three-quarters of the Earth's surface–and deliver air power without the need for diplomatic arrangements of land-based alternatives has provided U.S. leaders with valuable options for responding to crises around the world. Also, the high financial cost of its construction serves as a testament to the financial strength of the United States. The true value of a warship, however, lies in what it is credibly capable of doing. There has been ample debate over the past several years concerning the aircraft carrier's viability in the modern security environment. The advent of long-range anti-access capabilities, such as ground-based anti-ship cruise missiles, combined with the decreasing striking range of carrier air wings, greatly increases the likelihood of aircraft carriers having to operate within range of modern anti-access systems. Considering the growing threat from long-range anti-access weapons and the high cost of building and maintaining modern aircraft carriers, this thesis examines the question: what are the implications of modern anti-access/area denial (A2/AD) capabilities on the use of aircraft carriers in executing U.S. maritime strategy? As a corollary, how might the United States respond to A2/AD capabilities from either an operational or technical perspective? Finally, does the aircraft carriers' performance, or any of its proposed alternatives, against A2/AD capabilities warrant a shift in the aims of U.S. maritime strategy, a shift in force structure, or both?

B. SIGNIFICANCE OF THE RESEARCH QUESTION

The latest declaration of U.S. maritime strategy, *A Cooperative Strategy for 21st Century Seapower*, cites the technological advancement and growing proliferation of A2/AD capabilities as a significant challenge to U.S. and allied global maritime access.[1]

[1] James Dunford, Jonathan Greenert, and Paul Zukunft, *Forward, Engaged, Ready: A Cooperative Strategy for 21st Century Seapower*, (Washington, DC: Department of Defense, March 2015), 1.

Considering the vital role access to the maritime commons plays in the execution of any naval function, the *Cooperative Strategy* goes so far as to add "all domain access" to the list of essential functions the Sea Services (Navy, Marine Corps, and Coast Guard) shall provide.[2] While the *Cooperative Strategy* expounds on the role the Sea Services play in executing national security and national military strategies, it fails to describe the necessary force structure required to meet its demands.

The challenges modern A2/AD capabilities pose to current maritime strategies and military units have led many to debate the utility of the Navy's current force structure and reconsider future procurement plans.[3] Various organizations have pursued an operational analysis approach toward designing an optimum "balanced" fleet, specifically in how to improve its striking capability. The new A2/AD weapon systems significantly complicate military options, limiting the locations for ground-based assets, forcing carrier strike groups and their air wings to operate at greater ranges, and limiting their freedom to gain positional advantage. Additionally, the threat of modern A2/AD capabilities, combined with the present fiscal environment, have forced U.S. officials to weigh the strategic benefits of aircraft carriers against their operational risk in an A2/AD environment.

Considering the range of modern anti-ship cruise missiles and their proliferation, however, a response at the military level may not be sufficient to counter a strategy that employs anti-access or area denial capabilities. The increased range of A2/AD capabilities threatens a much larger number of states, both on land and at sea, than has been historically possible. As a result, potential users of an anti-access or area denial strategies are capable of threatening military retaliation against any state that might provide access to a perceived competitor (i.e., China could threaten to strike military bases in Southeast Asia if states continue to grant U.S. access). In light of such a threat, a

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[2] Dunford et al, *A Cooperative Strategy*, 2.

[3] For example, see: Robert C. Rubel, "The Navy's Changing Force Paradigm," Naval War College Review 62, no. 2 (Spring 2009); Bryan C. McGrath, "On the $uperfluous Carrier," Information Dissemination, last modified May 6, 2011. http://www.informationdissemination.net/2011/05/on-uperflous-carrier.html; and Henry J. Hendrix, *At What Cost a Carrier?* (Washington, DC: Center for a New American Security, 2013).

counter-strategy may require the United States to promise more than a military guarantee. Building an effective maritime strategy and counter- strategy may require a combination of efforts spanning the various levels of political power: diplomatic, information, military, and economic. With that in mind, any decision to change the current fleet structure ought to consider the role the navy plays across all levels of power.

Since World War II, the aircraft carrier has played a significant role in U.S. maritime strategy. The size and cost of aircraft carriers serve as a diplomatic symbol of a state's economic strength. Their size and capabilities provide a means of delivering substantial military power while also serving as a platform for intelligence gathering. Finally, their facilities and adaptability allow them to adjust from a military role to a humanitarian one as seen in recent disaster responses. This thesis will analyze the role current aircraft carriers and their strike groups play across the various levels of power in executing national maritime strategy, and evaluate whether their strategic impact outweighs the operational risk of operating within an A2/AD environment.

C. LITERATURE REVIEW

The phrase "anti-access/area denial" has implications on the strategic, operational, and tactical levels. Military analysts Andrew Krepinevich, Barry Watts, and Robert Work separate the terms based on strategic versus operational levels. Conceptually, they argue, "anti-access" is a strategy intended to prevent another's forces from entering into a theater of operations, whereas "area denial" is the operationalized prevention of one's "freedom of action" in an area under the defender's control.[4]

Another way of discerning between the two concepts is in terms of tactical "actions and capabilities." The Department of Defense's *Joint Operational Access Concept* (*JOAC*) describes anti-access actions and capabilities as "usually long-range, designed to prevent an opposing force from entering an operational area."[5] Conversely,

[4] Andrew Krepinevich, Barry Watts, and Robert Work, *Meeting the Anti-Access and Area Denial Challenge* (Washington, DC: Center for Strategic and Budgetary Assessments, 2003), ii.

[5] U.S. Department of Defense, *Joint Operational Access Concept*, Version 1.0 (Washington, DC: Department of Defense, 2012), 6.

the *JOAC* deems area denial as "usually of shorter range, designed not to keep an opposing force out, but to limit its freedom of action within the operational area."[6]

Both Krepinevich et al.'s and the *JOAC*'s definition agree that there is a distinction in the range, or scope, between anti-access and area denial, but the variation in their definitions highlights the second issue in defining "anti-access/area denial": is it merely a description of a capability, or a strategic concept with military and political objectives? It is necessary to discern between these two, as they have differing implications on the current and future role of the aircraft carrier.

1. Strategic Responses to A2/AD

Although there is a large supply of capabilities-based assessments and analyses of other states' military doctrines in an effort to predict how they might employ A2/AD capabilities, very few attempt to address the strategies behind A2/AD from an historical perspective. Sam Tangredi's seminal work, *Anti-Access Warfare: Countering A2/AD Strategies* purports that states have employed the strategic concepts behind A2/AD since the Persian War of 480 BC. In his analysis of several historic case studies, Tangredi notes that a majority of the successful counter-strategies relied on one's superior maritime power. Interestingly, Tangredi's analysis also demonstrates that, although anti-access technological developments change the range and scope of the A2/AD threat, new capabilities like anti-ship cruise missiles or even ballistic missiles are merely evolutionary, not revolutionary, changes in A2/AD strategy. Rather than rely on technological advancements to restore or ensure access, Tangredi argues, a successful approach to countering A2/AD must encompass a "whole of government" response while understanding any military response will require the combined use of air, land, and sea power.[7]

While Tangredi cogently argues the importance of a combined effort between U.S. political and military power to counter A2/AD strategies, Gary Weir and Sandra J.

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[6] Ibid., 7.

[7] Sam J. Tangredi, *Anti-Access Warfare: Countering A2/AD Strategies* (Annapolis, MD: Naval Institute Press, 2013), 79–83.

Doyle stress the importance of an international alliances and cooperation in maritime strategy.[8] Weir and Doyle's work provides a historical account of the important roles maritime coalitions have played in maintaining maritime security and ensuring open access to the commons from 1991 through 2003. One interesting characteristic of Weir and Doyle's research, though not necessarily intentional, is how the majority of their examples of maritime cooperation revolve around the supporting or defending of coalition aircraft carriers to achieve operational objectives.

Expanding on Tangredi's recommendation for joint military response to the A2/AD challenge, Aaron Freidberg's *Beyond Air-Sea Battle* examines the operational concept of Air-Sea Battle (ASB) from an operational and strategic perspective. In his analysis of ASB, Freidberg describes the operational concept as relying heavily on naval and air power to disrupt, defeat, and destroy an opponent's A2/AD capabilities, all at the expense of ground forces.[9] Friedberg further analyzes the role of ASB from a strategic standpoint in an effort to assess the military and political outcomes of a hypothetical Sino-American conflict, and contrasts the ASB's direct approach with other indirect approaches such as distant blockades or mine warfare. Whether the United States chooses to employ a direct approach towards A2/AD as proposed by the Air-Sea Battle concept, or an indirect approach of various escalatory steps, Freidberg concludes that a U.S. counter-strategy to A2/AD must: reduce U.S. military vulnerability; maintain the threat of blockade in a protracted conflict; and develop offensive options. An example of such a strategy would be one that improves active and passive defenses, improves long-range strike and undersea warfare capabilities, and seeks out opportunities for allied support.[10]

2. A2/AD and the Aircraft Carrier

Understanding the strategic objectives behind the use of A2/AD capabilities, and how the United States might respond across diplomatic, informational, military, and

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[8] Gary E. Weir and Sandra J. Doyle, eds., *You Cannot Surge Trust: Combined Naval Operations of the Royal Australian Navy, Canadian Navy, and United States Navy, 1991–2003*, Department of the Navy, (Washington, DC, 2013).

[9] Aaron Freidberg *Beyond Air-sea Battle: The Debate over U.S. Military Strategy in Asia* (New York: Routledge, 2014), 78–80.

[10] Ibid., 133–149.

economic levels of power, is a critical starting point in addressing how A2/AD strategies affect the role of the aircraft carrier. Additionally, deciding on the degree to which a military response will rely on the carrier's striking power also affects how one might view the viability of the aircraft carrier in a contested area. In summarizing the current debate about how current and future A2/AD capabilities impact the role the aircraft carrier, one can look to the works of three of the debate's predominant participants: Henry J. Hendrix, Bryan McGrath, and Robert C. Rubel.

In assessing how A2/AD capabilities affect the strategic value of aircraft carriers, retired Navy Capt. Henry J. Hendrix concludes that the United States has created a military asset that is so powerful, so large, and so expensive, that the United States can no longer afford to lose one. Hendrix focuses on how technological advancements in missile range and targeting capabilities have pushed aircraft carriers into operating at ever-increasing ranges and, when combined with the shrinking operating range of modern carrier air wings, that aircraft carriers no longer provide the military benefit they did in the past.[11] Hendrix urges the Navy to take the A2/AD threat as an opportunity to "slowly divest" from aircraft carriers while simultaneously shifting its financial investments into unmanned strike capabilities like the "unmanned combat air vehicle" (UCAV).[12] Such a shift in mindset and investment would eventually make way for the Navy to pursue a new fleet force structure centered around a new platform, possibly a Tomahawk-laden submarine or arsenal ship, that can provide greater striking power at decreased operational risk.[13]

Bryan McGrath, also a retired naval officer, reaches a less pessimistic conclusion regarding the aircraft carrier's future utility, and cautions that a final decision must not lose sight of the United States' global maritime strategy. In McGrath's view, Hendrix correctly assess how modern anti-ship cruise missiles and ballistic missiles have

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[11] These topics are the focus of both Hendrix's report *At What Cost a Carrier?* and his follow-up report: *Retreat from Range: The Rise and Fall of Carrier Aviation*, (Washington DC: Center for a New American Security, 2013).

[12] Henry J. Hendrix, *At What Cost a Carrier?* (Washington, D: Center for New American Security, 2013), 10.

[13] Ibid.

significantly decreased the utility of the aircraft carrier's air wing, but McGrath contends that Hendrix extends the conclusion too far by suggesting the necessary step is to abandon the aircraft carrier and the carrier strike group model.[14] Rather, McGrath argues that improving the air wing through new platforms with longer range will buoy the aircraft carrier back into a position of importance.[15] McGrath extends the debate further by addressing the aircraft carrier's role in the Navy's current maritime strategy. In evaluating the current strategic environment in relation to the Navy's 2007 decision to decrease its carrier fleet from 12 to 11, McGrath et al. conclude that the Navy actually requires more aircraft carriers to provide operational commanders greater flexibility and resources in meeting their strategic objectives of global sea control, power projection, and crisis response.[16]

Whereas Hendrix bases his perspective on the carrier debate on the tactical and operational implications, and McGrath on the tactical-strategic effects, Robert C. Rubel shifts the carrier debate to how changes in strategy demand changes in force structure. Rubel argues that, before the Navy can decide how to proceed with the future of the aircraft carrier program, it must first recognize that the current geo-political climate and the *Cooperative Strategy for 21st Century Seapower* require a paradigm shift in general force structure planning.[17] Following the end of the Cold War, the Navy has enjoyed a period of freedom from any near-peer naval competitors. The freedom to maneuver into a battle space uncontested resulted in the Navy focusing its efforts on using aircraft carriers mainly as political chess pieces—symbols of American military might—and airbases at sea capable of delivering striking power to a battle space "from the sea." Rather than attempting to scale up the current system—which is designed around maintaining two major hubs: the Middle East and the Western Pacific—centered around post-Cold War

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[14] Bryan C. McGrath, "On the $uperfluous Carrier," Information Dissemination, last modified May 6, 2011, http://www.informationdissemination.net/2011/05/on-uperflous-carrier.html.

[15] McGrath, "On the $uperfluous Carrier."

[16] Seth Cropsey, Bryan C. McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, DC: Hudson Institute, 2015), 91–99.

[17] Robert C. Rubel, "The Navy's Changing Force Paradigm," *Naval War College Review* 62, no. 4 (Spring 2009), 13.

carrier strike groups, Rubel contends that the current environment of non-state actors and near-peer naval powers requires a new naval model.[18]

Rubel's proposed new naval force would center around four principal segments: a missile-centric "access generation" force, a carrier-centric "power projection" force, a constabulary "maritime security" force, and a group of maritime operations centers (MOCs) focused on information operations.[19] This model allows the Navy to tailor its force structure based on which segment or segments it needs more of to meet national strategic objectives. According to Rubel, the present geo-strategic environment, for example, calls for a navy with increased "access generation" and "maritime security" forces while maintaining the "projection forces" at the present level. Rubel does not discount the value of the aircraft carrier in future scenarios. Instead, he contends that present A2/AD capabilities demand the Navy consider shifting the aircraft carrier from the predominant striking force of the fleet back to its earlier roll of serving as the "eyes of the fleet," using its current and future air wings to provide maritime domain awareness.[20] Rubel does not rule out the possibility of the aircraft carrier eventually returning to other previous doctrinal roles in naval strategy, but cautions that such a transition will require technological improvements in order to permit their operation in A2/AD environments at reduced risk.[21]

3. The Way Forward

Answering the question of the aircraft carrier's current and future relevance requires more than a tactical level of analysis. Any shift in the procurement plan of future aircraft carriers or in their operational employment will significantly impact the resources and capabilities available for operational commanders to meet current and future national strategic requirements. Similarly, any adjustment in national strategy will require the Navy to consider if its current force structure is capable of or appropriate for meeting its

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[18] Rubel, "The Navy's Changing Force Paradigm," 13.

[19] Ibid., 18–19.

[20] Robert C. Rubel, "The Future of Aircraft Carriers," *Naval War College Review* 64, no. 4 (Autumn 2011), 22–24.

[21] Rubel, "The Future of Aircraft Carriers," 26–27.

objectives. As evidenced in the reviewed literature, the current debate has historical parallels both in operational adjustments and improvements in ship capabilities. By analyzing these historical interactions, this thesis will attempt to provide recommendations for how the Navy should proceed in answering the current A2/AD concerns while considering how any response will impact its global maritime strategy.

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

The aircraft carrier has remained a valuable piece of U.S. naval power since the commissioning of the USS *Langley* in 1922, and became the central component of U.S. maritime strategy following World War II, surviving multiple debates over its survivability, affordability, and adaptability. Answering the question over the future role of the aircraft carrier in U.S. maritime strategy requires first answering several other questions. First, what is the current objective of U.S. maritime strategy? Second, what are the implications of A2/AD capabilities on U.S. maritime strategy? Third, can the aircraft carrier's role in current and alternative maritime strategies be fulfilled by another platform or combination of platforms? Fourth, can the aircraft carrier adapt to overcome the restrictions of an A2/AD environment?

Considering the contents of the latest *Cooperative Strategy*, one can discern the current objectives of U.S. maritime strategy: maintaining the ability for the United States military to establish sea control in any region of its choosing. A secondary objective of the national maritime strategy is to capitalize on foreign partners and allies to conduct constabulary operations to ensure the free flow of international trade.

In determining the role of the aircraft carrier in current maritime strategy, one can again look to stated policies in national strategy publications and Congressional testimonies, especially those of Naval leadership responsible for procurement and strategy. Review of these sources shows a high desire for aircraft carriers because of their ability to escalate their roles across a spectrum of military and non-military scenarios. This helps to answer the third question: whether or not a different platform or a collection of platforms can provide the same or better solution. While such a solution may be

possible, it will require financial investment both in new platforms and necessary support capacity.

After identifying the current maritime strategic objectives and identifying the current role the aircraft carrier plays within the maritime strategy, one can reach three possible conclusions based on the impact of operating within an A2/AD environment. One option is that A2/AD strategies may simply force the Navy to adjust the striking capability of the aircraft carrier—namely, the air wing—thereby allowing the carrier strike group to operate as normal. A second option is that A2/AD strategies affect the entire naval fleet model, thereby requiring an entirely new approach to how the United States projects and delivers its military power. A third possible conclusion is that the United States may need to reconsider its maritime strategic objectives in light of what it can accomplish in the face of an A2/AD threat, and choose to cede its global sea control objectives for smaller, local sea control in specific theaters.

E. RESEARCH DESIGN

This thesis centers on a historical case study of two periods in which the United States and its carrier fleet faced some degree of anti-access or area denial threat to its maritime strategy: Imperial Japan in the Pacific theater in World War II, and the Soviet maritime reconnaissance-strike complex threat during the Cold War. The purpose of these cases is twofold: first, to identify the similarity between contemporary and past challenges; second, to examine how the Navy pursued innovative operational solutions regarding the use of its aircraft carriers to counter strategic challenges.

After establishing a historical comparison between the case studies and the present debate, this thesis turns to the proposed recommendations from the current literature regarding the aircraft carrier's capabilities, its shortfalls, and proposed alternative ship-types or roles for the aircraft carrier. The analysis of each recommendation centers on: how it addresses the A2/AD challenge, what it proposes for the role of the aircraft carrier, and the viability of its recommendation. Finally, the conclusion attempts to make a general recommendation on force structure considerations, while highlighting areas for future debate and research.

II. PAST AS PROLOGUE

Military technological advancements have begun to threaten the United States' sea power, specifically by challenging its ability to assert local sea control and project power ashore. Additionally, these technological advancements are changing the nature of sea power: ships upon the sea are at increasingly greater risk from space-based targeting systems and land-based anti-access/area denial systems. The effect of such developments, as David C. Gompert points out, is a shift in "the balance between defense and offense at sea in favor of the former, making (sea) control harder and (sea) denial easier."[22]

The United States has faced anti-access/area denial (A2/AD) challenges in the past, and examining these previous experiences provides valuable lessons for possible ways forward. Imperial Japan's use of land-based bombers and kamikazes, and the Soviet Union's maritime strike-reconnaissance complex closely parallel the current threats of shore-based strike systems. In both of these situations, the United States sought technological and operational solutions to the threats against its ability to assert sea control and project power ashore. Additionally, these previous approaches demonstrate the vital role aircraft carriers, their air wings, and the carrier battle group as a whole played in U.S. maritime strategy. The parallels between these case studies and the contemporary debate over the efficacy of the aircraft carrier in an A2/AD environment provide valuable lessons for alternative methods in how the United States can operate its forces while still achieving its desired ends: power projection and sea control.

A. CONTEMPORARY CONCERNS

The United States currently faces several technological threats to its ability to establish and maintain sea control. Countries such as Iran, Russia, and China have pursued military developments in ship-to-ship missiles, mines, land-based fighter and bomber aircraft, surface ships and submarines, and unmanned aerial vehicles. While technological advancements in these systems have improved their range, speed, and

[22] David C. Gompert, *Sea Power and American Interests in the Western Pacific* (Santa Monica, CA: RAND, 2013), 7.

effectiveness, they represent evolutionary improvements of previous anti-access and area denial capabilities. Additionally, these technological advancements are changing the nature of sea power: ships upon the sea are at increasingly greater risk from space-based targeting systems and land-based anti-access/area denial systems. One particular trend, however, poses a revolutionary strategic challenge to how the United States can maintain its power projection and sea control capabilities: the use of land-based systems to conduct sea denial.

1. CHINESE LAND-BASED CAPABILITIES

China's recent military modernization efforts, and its specific interest in A2/AD capabilities, stem largely from its experience during the 1996 Taiwan Strait Crisis. In an effort to influence Taiwan's first free election, China conducted several missile tests aimed in Taiwan's proximity. In response to China's actions, the United States–under President Clinton–ordered two carrier battle groups to sail between China and Taiwan in an effort to deter Chinese actions and deescalate regional tension.[23] The United States' actions awakened the Chinese to their inability to counter U.S. power projection capabilities. To this end, several military analysts believe China's objective behind the buildup has been to challenge the United States' ability to project power and influence within the region.[24] Thus, a critical component of China's military modernization has been long-range asymmetric weapons systems capable of threatening U.S. forward bases and ships within the Pacific.

Since 1996, China has conducted both qualitative and quantitative improvements on the Second Artillery's ballistic missile force. Improvements in DF-15 and DF-11 missile guidance systems have reduced their circular error probable (CEP) from 600 meters to between five to ten meters.[25] Additionally, China's inventory of short-range ballistic missiles (SRBMs) increased from only a mere handful in the 1980s to

[23] Freidberg *Beyond Air-sea Battle*, 12.

[24] Ibid.

[25] Eric Heginbotham et al., "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power" (Santa Monica, CA: RAND, 2015), 47.

approximately 1,200 by 2015.[26] Between the range of China's various short, medium, and long-range ballistic missiles, and their significantly improved accuracy, China is capable of threatening nearly every U.S. forward base within the Pacific area of operations.

For the past several years, China has deployed a land-based ballistic missile designed to target surface ships at ranges exceeding 900 nm. Through the use of a broad-area maritime surveillance and targeting system, and armed with a maneuverable reentry vehicle (MaRV), the DF-21D ASBM is capable of threatening U.S. aircraft carriers or other allied ships within Pacific region.[27] Presently, the United States lacks a weapon system capable of striking China's mobile ASBMs while also avoiding the other components of its layered A2/AD capabilities.[28]

A 2007 RAND report details the implications of these capabilities based on four categories: attacks on forward airbases; attacks on command and control (C^2) infrastructure, attacks on logistical support functions, and attacks on aircraft carriers.[29] First, by targeting U.S. airfields, China could destroy aerial refueling aircraft—a critical resource if aircraft carriers are forced to operate at long range–early-warning aircraft, and long-range bombers. Second, were China to attack U.S. C^2 systems, it could also disrupt the coordination of any counter-attack. Third, targeting U.S. logistics support would similarly disrupt a U.S. response by preventing the movement or re-supply of troops and equipment. Finally, attacking an aircraft carrier at sea builds upon the potential loss of forward air bases and targets the final potential supplier of U.S. air power. Considering the vital role air superiority has played in the U.S. way of war for the past two decades, the potential loss of this capability could force the United States into avoiding a conflict altogether.

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[26] Heginbotham, "The U.S.-China Military Scorecard," 47.

[27] Ronald O'Rourke, "China Naval Modernization: Implications for U.S. Navy Capabilities–Background and Issues for Congress," *CRS Report for Congress*, RL33153, May 31, 2016, 9.

[28] For a broad discussion on the range of Chinese A2/AD capabilities, see O'Rourke, "China Naval Modernization" (2016).

[29] Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, and Kevin L. Pollpeter, *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Santa Monica, CA.: RAND, 2007), 81.

China's modernization efforts since the Taiwan Crisis have significantly increased its ability to challenge the United States' forward presence, and its ability to operate power projection forces within the region. Perhaps the most significant impact of these capabilities, however, has been on U.S. strategy.

2. STRATEGIC IMPACT

The current U.S. maritime strategy, *A Cooperative Strategy for 21st Century Seapower*, states two of the Navy's essential functions include "all domain access, deterrence, sea control and power projection."[30] It goes on to describe the purpose of these functions is to establish "local maritime superiority while denying an adversary the same ability" in order to destroy enemy naval forces, suppress enemy sea commerce, protect vital sea lanes, and affect operations on the land.[31] Executing these functions, the *Cooperative Strategy* argues, enables the United States to "defeat aggression, respond to crises, and strengthen partnerships," achieving what Alfred Thayer Mahan might consider exercising "international influence."[32]

Land-based A2/AD capabilities specifically target the components of U.S. power projection and sea power, threatening their ability to achieve their functions, and thereby jeopardizing the United States' ability to achieve its desired ends. Specifically, China's A2/AD capabilities pose five major strategic implications for the United States and the Pacific region.[33] First, their range and precision increases the vulnerability of U.S. forward bases and ships at sea. Second, the threat of their use raises the potential cost—in blood and treasure—of U.S. intervention in a regional confrontation. Third, as China's capabilities increase relative to the United States' ability to counter them, they call into question the credibility of U.S. security guarantees to its regional allies and partners. Fourth, the asymmetric financial benefit of investing in affordable land-based missiles

[30] Dunford, et al., *A Cooperative Strategy*, 19

[31] Ibid., 22-24

[32] Ibid., 35

[33] Aaron Freidberg, "Beyond Air-Sea Battle: The Debate over U.S. Military Strategy in Asia," YouTube video, 10:00, International Institute for Strategic Studies, published June 11, 2014, https://www.youtube.com/watch?v=8tkVqH9ii14.

over capital-intensive warships places the United States at a financial disadvantage, as it will have to invest much more financially to maintain its relative position than China will to dislodge it. Finally, as China's capabilities increase, so too might its confidence in its ability to credibly deter U.S. intervention. Should China overestimate its deterrent ability, it is possible that China could miscalculate U.S. interests in a given scenario, and thereby fall into the very conflict it had attempted to avoid.

In light of these strategic implications, the following section examines some of the previous ways in which the United States alleviated similar concerns. The World War II example addresses how the United States mitigated the risk of deploying its aircraft carriers within range of Imperial Japan's capabilities in order to support operations on the land. The Cold War example provides a valuable lesson as it addresses the U.S. response challenge against its regional security guarantees. Additionally, it demonstrates how the United States employed existing capabilities in innovative ways without pursuing financially burdensome technical capabilities.

B. LESSONS FROM THE PAST

Anti-access and area denial weapons systems directly challenge the United States' ability to gain or exercise command of the sea, whether for commercial or military use, potentially limiting its international influence or its ability to pursue broader national objectives. Specifically, A2/AD capabilities can prevent the fleet from maneuvering into or operating within a specific region, force it to operate beyond its preferred range, and in turn deny or degrade its ability to support other military operations. In previous iterations of A2/AD challenges, U.S. opponents focused on sea denial, preventing the United States the use of its naval advantage. Technological improvements, however, have opened the door for states to use their A2/AD capabilities in new ways. By capitalizing on the improvements in range and targeting, for example, it is possible that a state with sufficient weaponry could use its land-based systems to gain and exercise its own command of the sea, if only in a local area or for only a temporary amount of time.[34]

[34] For more discussion of this concept in regards to China, see Andrew S. Erickson and David D. Yang, "Using the Land to Control the Seas: Chinese Analysts Consider the Antiship Ballistic Missile," *Naval War College Review* 62, no. 4 (Autumn, 2009), 53–86.

The following section will examine how Imperial Japan and the Soviet Union sought to use various sea- and land-based anti-access/area denial technologies to oppose U.S. sea control and power projection, and how the United States responded both technologically and operationally. The discussion will then turn to the present A2/AD challenges the United States faces, specifically those in the Pacific region.

1. Imperial Japan and WWII

One of Japan's strategic objectives in the Pacific was to deter U.S. interference against Japan's military and political pursuits. Sam Tangredi illustrates this point in his analysis of historical A2/AD strategies:

> [Japan's] strike at Pearl Harbor was not intended as a prelude to an invasion of Hawaii or the continental United States, but to knock over the chessboard so that the Americans would decide that—as far as the Asia-Pacific region was concerned—it was too costly to put their pieces back into the game. This constitutes a classic anti-access approach.[35]

Thus, in order for the United States to achieve its political objectives of Japan's unconditional surrender, it had to first defeat Japan's anti-access and area denial capabilities.

Following the agreements of the London Naval Treaty, Japan tied its fleet size to a three-fifths ratio of its U.S. and British counterparts. Ostensibly, this meant that in the event of a conflict between the parties, Japan would be fighting from a weakened position, both in terms of numbers and tonnage. In order to offset this disadvantage, Japan utilized its geographic advantage and technological improvements to inflict asymmetric damage on its militarily superior opponents.[36]

Geography played a significant role in Japan's strategy. Whereas the United States had to transport its fleet, troops, and supplies across the Pacific Ocean and into the theater, the Japanese benefited from significantly shorter sea lines of communication. The

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[35] Tangredi, *Anti-Access Warfare*, 2–3.

[36] Toshi Yoshihara, "Anti-Access in Comparative Perspective: Imperial Japan, the Soviet Union, and 21st-Century China," in National Institute of Defense Studies, "History of the Joint and Combined Operations," (September 17, 2014), last accessed May 27, 2016, http://www.nids.go.jp/english/event/forum/pdf/2014/10.pdf, 123.

operational factor of space played into Japan's advantage as the distance the United States had to travel in order to reach the Pacific theater allowed Japan the opportunity to strike U.S. convoys multiple times, whittling away at U.S. ships and supplies, in a sort of Fabian strategy, before finally reaching Japan's battle fleets.[37]

Technological advancements, namely in the development and use of air power also supported Japan's anti-access/area denial strategy. Japan utilized sea-based air power and multi-carrier operations to attack U.S. power projection and sea control. The surprise attack on Pearl Harbor and the destruction of the U.S. battleships demonstrated that coordinated strikes from multiple aircraft carriers were capable of inflicting massive damage on an enemy fleet. With the loss of its battleships, the United States suffered a temporary loss in its power projection and sea control capabilities until it exercised an innovative alternative in the form of its own aircraft carriers.

Similarly, Japan's land-based airpower proved important in administering asymmetric costs on U.S. and allied sea power. Using forward deployed bases throughout the Pacific, Japan used long-range bombers, such as the Mitsubishi G3M and G4M, to conduct strikes against U.S. and allied fleets as part of its strategic defensive.[38] Japan demonstrated the destructive power and operational influence of land-based air over sea control in its destruction of the British naval squadron, Force Z, on December 10, 1941. The British squadron, lacking air cover, was unable to defend against the bombers, resulting in the sinking of two British capital ships—the battleship HMS *Prince of Wales* and the battlecruiser HMS *Repulse*—in the South China Sea.

The most infamous use of Japanese air power to deny U.S. maritime operations was the use of *kamikazes*. Initially, bomb-laden Zeke and other frontline aircraft constituted Japan's variation on "precision-guided" munitions. Shortly after the Battle of Leyte Gulf, Japan eventually developed new platforms—such as the *Oka*, or "Cherry

[37] A Fabian strategy is a war policy of indirect approach wherein a weaker force avoids decisive battles with the enemy and creates delay in a war of attrition until the weaker force can deliver a decisive blow at a time and place of its choosing. Basil Henry Liddell Hart, *Strategy: The Indirect Approach* (New Delhi Pentagon Press, 2012), 31.

[38] Toshi Yoshihara, "Anti-Access Lessons from the Past," *U.S. Naval Institute Proceedings* 139, no. 12 (December 2013): last accessed, October 15, 2015, http://www.usni.org/print/28403.

Blossom"—specifically designed for the suicide mission. Japanese land-based bombers carried the *Oka* and released the manned rocket within range of the enemy fleet, allowing the *Oka*'s pilot to target and strike allied warships. *Kamikaze* pilots targeted U.S. and allied carriers, but they achieved their most destructive results when striking the lightly armored picket line destroyers.[39] Between 1944 and 1945, Japan conducted nearly 2,800 *kamikaze* attacks, and sank or damaged more than 100 ships during the battle for Okinawa alone.[40]

a. U.S. Response

As the U.S. fleet faced increasing losses as a result of Japanese bombers and kamikazes, it turned to the adaptability of the aircraft carrier to help turn the tide. Aircraft carriers transitioned from a scouting role to a more offensive configuration. The increased size and improvements in armor of the *Essex*-class carriers over the earlier *Yorktown*-class allowed an increase in air wing size and composition, and improved the carriers' survivability. The carriers' air wings increased the American fleet's maritime domain awareness, allowing the fleets to detect enemy ships well beyond visual range. Additionally, the air wings' torpedo and dive bombers brought devastating results against Japan's surface ships, and helped turn the tide of the war in the Pacific.

During the fight against the Japanese fleet for sea control, U.S. carrier air wings consisted primarily of dive and torpedo bombers.[41] In order to defend against the Japanese aerial assaults and establish air superiority, American carriers adapted their air wings to the new threat by shifting towards a larger mix of fighter aircraft. Additionally, rather than wait to attack the Japanese aircraft in the skies over U.S. forces, carriers began operating closer to shore in order to allow their air wings to strike the kamikazes and bombers on the ground, and destroy the airfields from which they operated. This

[39] For a detailed chronicle of the *kamikaze* program, see Robin L. Rielly's *Kamikaze Attacks of World War II: A Complete History of Japanese Suicide Strikes on American Ships, by Aircraft and Other Means*, (London: McFarland and Company Inc., 2010).

[40] Robin L. Rielly *Kamikaze Attacks of World War II: A Complete History of Japanese Suicide Strikes on American Ships, by Aircraft and Other Means*, (London: McFarland and Company Inc., 2010), 317-325.

[41] Thomas P. Ehrhard and Robert O. Work, *Range, Persistence, Stealth, and Networking: The Case for Carrier-Based Unmanned Combat Air System* (Washington, DC: Center for Strategic and Budgetary Assessment, 2008), 30.

methodology required carriers to accept higher risk by operating within range of Japanese aircraft, but it provided the benefit of striking the Japanese threat at its source, embodying the now common idea of "shooting the archer and not the arrows."

The United States' experiences in the Cold War against the Soviet Union's maritime reconnaissance-strike complex nearly forty years after World War II builds upon these lessons and serves a valuable example of the possible challenges the United States may face against contemporary systems.

2. Soviet Union and the Cold War

Where the U.S. experience during World War II describes how one can respond to an A2/AD threat in the midst of conflict, the example of the U.S. response to the Soviet Union's capabilities demonstrates important considerations in a non-combat environment. Although the Soviet Union was primarily a continental power whose naval fleet could not directly challenge U.S. naval supremacy, it possessed a range of capabilities that contested the United States' ability to project power ashore.[42] Specifically, Soviet capabilities threatened to create a virtual no-go zone for U.S. and NATO forces within the Mediterranean, forcing the United States to develop innovative operational and tactical solutions in order to maintain its forward presence and influence within the region.[43]

The strategic objective of Soviet containment drove the United States to maintain a forward presence in order to deter Soviet expansion and assure its allies of U.S. assistance in the event of a crisis. Part of the United States' security guarantee relied on its ability to conduct conventional and nuclear strikes against Soviet targets in the Eastern Mediterranean and the naval bastions north of the Greenland-Iceland-United Kingdom (GIUK) gap. Limited by the striking range of the air wings aboard the *Midway*-class aircraft carriers, American ships would have to operate within range of Soviet submarines and shore-based aircraft. To obviate these risks, U.S. Navy leadership sought innovative

[42] Robert G. Angevine, "Hiding in Plain Sight: The U.S. Navy and Dispersed Operations under EMCON, 1956–1972," *Naval War College Review*, Spring 2011, 80.

[43] Andrew F. Krepinevich, *Maritime Competition in a Mature Precision-Strike Regime*, (Washington, D.C.: Center for Strategic Budgetary Assessment, 2014), 41.

operational approaches to permit the carrier strike groups to maneuver within range, deploy and recover its strike aircraft, and exit the Soviet engagement envelope while minimizing or eliminating the Soviet Union's ability to locate or attack them.[44] The HAYSTACK operational concepts of the 1950s focused on the use of dispersed operations and emissions control (EMCON) conditions in order to restore American carrier strike groups' freedom of maneuver against the Soviets A2/AD capabilities.

Haystack's central concept was to "thwart and delay" the detection of the aircraft carriers.[45] To do so, it recommended that the strike group should "disperse widely and intermingle with commercial shipping in order to eliminate the unmistakable appearance on airborne radar scopes of the standard close, circular ('bulls-eye') formation."[46] As the Haystack experiments progressed, the results demonstrated the importance of combining disciplined EMCON conditions with dispersed operations in order to prevent Soviet electronic countermeasure (ECM) aircraft from detecting and homing in on U.S. radars or navigational aids. By dispersing the carrier strike groups and masking or limiting its electronic signatures, the Haystack experiments increased the strike groups' time to detection, and subsequently its survival time, from less than two hours to at least eight hours, significantly restoring some of the strike groups' ability to fulfill its power projection role.[47]

There is a truism in strategy that cautions, "the enemy gets a vote." While the Haystack experiments helped the United States develop a means of countering Soviet detection, the Soviet Navy deployed wide-area sensor capabilities to improve its detection capabilities. Through the fusing of its space-based Radar Ocean Reconnaissance Satellite (RORSAT) and other sources into the Soviet Ocean Surveillance System (SOSS), the Soviet Union could again locate and track American warships, and direct its long-range, supersonic Tu-22 Backfire bombers within range to deploy their anti-ship cruise missiles (ASCMs). The Soviets also employed a strategic

[44] Krepinevich, *Maritime Competition*, 41.

[45] Angevine, "Hiding in Plain Sight", 81.

[46] Ibid.

[47] Ibid., 83.

defensive of concentric rings around its naval bastions. Within the inner ring, the Soviets utilized surface ships and submarines armed with ASCMs to maintain sea control. Conversely, between the outer and inner rings, the Soviet Union focused on sea denial using its long-range bombers and ASCMs, forcing the U.S. fleets to operate beyond the range of their strike aircraft and Tomahawk missiles.

In light of the Soviet defensive strategy, the United States combined its lessons from the Haystack experiments and its experience in World War II. The goal was to maneuver the carrier strike groups within range of its targets, undetected, while using air patrols and picket ships to again "shoot the archers" (Soviet bombers) before they could deploy their missiles. Fortunately, neither the Soviets nor the United States had an opportunity to test their strategies against the other; however, several U.S. military leaders during that period contend that the United States' offensive approach was controversial and could have possibly forced the Soviets to employ nuclear weapons.[48] This potential threat of escalating a conflict to nuclear war provides an important lesson when considering how to respond to a nuclear state's A2/AD capabilities, such as China.

3. Lessons Learned

Examining the U.S. response to Japanese and Soviet A2/AD efforts provides several lessons that are applicable for today's concerns. First, countering Japan's anti-access strategy was costly both in time and materiel. The U.S. naval campaign in the Pacific lasted more than forty months and more than 700 ships were lost.[49] The United States must consider the costs it is willing to bear in countering contemporary challenges in terms of time, materiel, and its capacity to rebuild.

Another lesson for the United States is that no single platform or technology will secure the objective; it requires both a fleet-wide and joint response. Aircraft carriers and their air wings were vital in destroying Japanese ships and provided the final blows against the kamikaze threat. Similarly, the air wings during the Cold War were central in

[48] Ehrhard and Work, *Range, Persistence, Stealth, and Networking*, 89.

[49] Beginning with the Battle of the Coral Sea on May 4, 1942 and ending with Japan's surrender on September 2, 1945.

the nuclear targeting plans against the Soviet Union. In neither case were the carriers capable of performing their tasks alone, however. Picket lines of destroyers and cruisers provided the defensive screens that were critical in limiting the Japanese bombers' and kamikazes' effectiveness once in range of the fleet, and in providing counter-air defenses against Soviet bombers.

The United States must also consider the importance of survivability and adaptability. Small and lightly armored ships constituted the greatest number of ships destroyed by kamikaze aircraft, whereas the larger and more heavily armored aircraft carriers proved more survivable. It is interesting to note that British carriers suffered far less damage than their U.S. counterparts during these attacks. The main reason for such a difference was in the materials used in both countries' flight deck construction–the British using steel as opposed to the Americans' wooden decks.[50] Flight decks notwithstanding, larger ships allowed for more survivable construction techniques, enabling them to stay in the fight longer, or to return shortly after being repaired.[51] The success of the aircraft carriers also demonstrates the importance of adaptable payloads. Aircraft carriers were able to adjust their air wing compositions as necessary to fit the operational circumstances, helping to first defend against the kamikaze "arrows" and then eventually striking their airfields, or "archers." Adaptability in a ship's payload allows a state to account for variation in the threat situation or changes in the objective.

Closely tied with the idea of adaptable payloads is the requirement to have alternative payloads readily available. The larger aircraft carriers were able to adjust their air wings only because smaller escort and fast carriers were nearby carrying the spare aircraft. Also, considering A2/AD strategies seek to attrite an adversary's force, it is critical that the United States be able to replenish or replace the forces lost during a campaign.

[50] Krepinevich, *Maritime Competition*, 38.

[51] Ibid.

C. APPLICABILITY OF CASE STUDIES

Imperial Japan's and the Soviet Union's pursuit of asymmetric means to inflict high cost against the United States–in terms of both blood and treasure–is in direct line with the general principle of anti-access and area denial strategies.[52] Additionally, the use of land-based aircraft to attack U.S. and allied sea power serves as a useful parallel to the current A2/AD environment. First, land-based aircraft do not need to operate within the size limitations of their sea-based counterparts, allowing for increased size, range, and ordnance. The range advantage of Japanese and Soviet bombers over American sea-based air power forced U.S. carriers to choose between operating further from their targets at a decreased efficiency, or accepting higher levels of risk by operating closer to shore and within range of enemy aircraft. The current *Nimitz* and *Ford*-class carriers face a similar challenge considering their air wings' average unrefueld range of 496 nautical miles is within engagement zone of several anti-ship cruise missile (ASCM) systems.[53]

Another parallel between these case studies and contemporary concerns is that of precision guidance systems. The individual pilots conducting the kamikaze attacks identified and selected their targets, and flew their manned cruise missiles into their targets' decks. Similarly, advancements in Soviet space-based reconnaissance systems and electronic signal detection were critical in locating U.S. ships and directing its sea denial forces. China, a modern purveyor of A2/AD capabilities, employs detection and targeting systems that have evolved from the Soviet maritime reconnaissance-strike complex.

Imperial Japan's approach to anti-access/area denial in the final years of the war reflected not only the asymmetric impact such capabilities can have against a larger force, but also the asymmetric financial costs. Building a fleet of kamikaze pilots and aircraft designed for a one-way mission delivered destructive capabilities at much lower costs than training fighter pilots or aircraft capable designed for establishing air superiority. Similarly, a strategy centered on a battery of ASCMs to affect anti-access or area denial

[52] Tangredi, *Anti-Access Warfare*, 13.

[53] This particular topic of the air wing's range in relation to ASCMs and other threats is the topic of Dr. Jerry Hendrix's work, *Retreat from Range: The Rise and Fall of Carrier Aviation*.

on the sea is considerably less expensive than building the naval ships necessary to perform sea control beyond a state's territorial waters. These points demonstrate that both Imperial Japan's strategy and actions during World War II, and those of the Soviet Union during the Cold War, have parallels in today's environment both in their design and methodology. All points considered, though, contemporary A2/AD capabilities have introduced significant strategic challenges that complicate any potential U.S. response.

D. CONCLUSION

As the previous case studies demonstrate, this is not the first time U.S. forces have confronted or been outranged by A2/AD systems. Analyzing some of the lessons learned from those case studies highlights several technical improvements U.S. forces could pursue in order to increase the range of U.S. weapons and strike platforms. Additionally, employing innovative operational methods could counter China's maritime surveillance system and provide a valuable window of opportunity for current U.S. capabilities to target China's weapons systems. Recent operational concepts such as Air-Sea Battle and Offshore Control detail how U.S. forces could utilize joint capabilities in the event of a conflict between the United States and an adversary employing similar systems as China.

The purpose of this chapter has been to describe some of the modern A2/AD capabilities, identify their strategic implications, and analyze some of the technological and operational approaches the United States has employed against A2/AD strategic challenges in the past. The United States' experiences with Japanese and Soviet A2/AD challenges share many similarities with today's strategic environment. While there are valuable tactical and operational lessons for U.S. military leaders to draw upon from these case studies, continued advancements in modern land-based systems, and changes in the geo-strategic environment, limit the applicability of employing some of these lessons.

III. ANALYSIS OF ALTERNATIVES

The purpose of this chapter is to analyze whether the capabilities that the current *Ford* class and other super carriers provide justify their continued development and employment, or whether alternative systems can provide the same or greater effect at lower opportunity costs given the current strategic environment. First, this chapter will briefly describe the broader strategic environment and risks the Navy has been operating within for the past two decades and the role the aircraft carrier has played in U.S. military operations. Next, the chapter will discuss the current challenges to U.S. maritime strategy by providing specific examples of modern anti-access/area denial capabilities and how they challenge the efficacy of the aircraft carrier and air wing in their current form. The chapter will then consider several alternative systems to the aircraft carrier, specifically missile-centric surface and subsurface combatants, and air-capable amphibious assault ships. Finally, the chapter will present recommendations for a way forward in an effort to minimize any remaining capability shortfalls.

A. STRATEGIC ENVIRONMENT/RISKS

With the collapse of the Soviet Union, U.S. military strategy has enjoyed several decades of uncontested access across the various domains–air, sea, land, space, and cyberspace. U.S. maritime strategies and force structures have capitalized on this access by focusing on delivering rapid and sustainable air power from the sea in order to affect or support operations on the shore. The Navy encapsulated these objectives in its strategy white papers "…From the Sea" and "Forward…From the Sea," which called for an emphasis in operating naval forces in the littoral areas closer to an adversary's shore. Secretary of the Navy Sean O'Keefe's "From the Sea" strategy described the strategic environment:

> Our ability to command the seas in areas where we anticipate future operations allows us to resize our naval forces and to concentrate more on capabilities required in the complex operating environment of the "littoral" or coastlines of the earth. With the demise of the Soviet Union, the free nations of the world claim preeminent control of the seas and ensure freedom of commercial maritime passage. As a result, our national

> maritime policies can afford to de-emphasize efforts in some naval warfare areas.[54]

Today's carrier air wing is largely a product of the post-Cold War strategic environment. Reflecting the strategic guidance of "…From the Sea" and "Forward…From the Sea," naval strike warfare shifted its focus from long-range fighter escorts and nuclear-capable bombers towards short-range multi-purpose platforms and increased sortie rates.[55] As Naval officials remarked in a Congressional Research Service F/A-18E/F program brief, "greater range/payload capabilities…[were] less essential for fleet defense with the demise of a Soviet threat."[56]

Aircraft carriers have provided significant advantages to combatant commanders during the two decades of uncontested access. These advantages include the ability to transport approximately 75 aircraft (including more than 40 strike fighters) across the globe in a matter of days or weeks, and the ability to conduct approximately 200 sorties per day. Additionally, aircraft carriers have provided combatant commanders with scalable and precise firepower that can be used in various levels of conflict and across the range of military operations, and the option to deliver these capabilities from international waters without the need for negotiating basing rights from other countries. The 2006 iteration of *Naval Aviation Vision 2020* describes the importance of aircraft carriers in military operations since 1998:

> The aircraft carrier is the cornerstone of naval aviation, in the past ten years alone, large-deck carriers have been called upon to respond to, and engage in, over 20 separate international crises, ranging from deterring Iraqi aggression (Operations Northern and Southern Watch) to thwarting attacks on civilians in the former Republic of Yugoslavia (Operation Deliberate Force). In OEF, carrier-based air wings flew strike and combat support missions against Taliban and Al-Qaeda terrorist forces in

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[54] Sean O'Keefe, Frank B. Kelso II, and Carl E. Mundy Jr., "…From the Sea: Preparing the Naval Service for the 21st Century," *U.S. Naval Institute Proceedings* 118, no. 11 (November 1992): 93.

[55] In 1996, the American carrier air wings included F-14 Tomcats and A-6 Intruders, and had an average unrefueld combat range of 815nm. By 2006, however, the air wings consisted mainly of F/A-18 Hornet variants, and the average unrefueled range was only 496nm. See Jerry Hendrix, *Retreat from Range: The Rise and Fall of Carrier Aviation*, specifically Ch. 3: "The Post-Cold War Retreat from Deep Strike."

[56] Christopher Bolkcom, Bert Cooper, "F/A-18E/F Super Hornet Aircraft Program," *CRS Report for Congress*, July 12, 2000, 2.

> Afghanistan. In OIF, the carriers operated around-the-clock, immune to hazards such as sandstorms that grounded land-based aircraft. Organic air wings provided strike, electronic attack, airborne early warning, ISR, and other combat capabilities, clearly demonstrating the role of the large-deck aircraft carrier as a permanent fixture in our national defense strategy.[57]

The contributions of the aircraft carrier and its air wing to military operations since the Cold War, however, have been possible mainly due to the aircraft carrier's freedom to move into and within a theater of operations. Unfortunately, the strategic environment is transforming in a way that challenges these previous notions of guaranteed, or assured, access.

In 2003, a Center for Strategic and Budgetary Assessments (CSBA) report identified a rising challenge to U.S. power projection capabilities.[58] Specifically, the CSBA report cautions that the proliferation of satellite services and missile technology would "allow even regional rogue states both to pre-target key fixed facilities and to monitor U.S. deployments into forward bases," thereby jeopardizing the United States' access into a theater—commonly referred to as "anti-access."[59] Additionally, adversary capabilities such as "long-range, anti-ship cruise, or even ballistic, missiles, and long-range submarines" comprise an "area denial" threat, which challenges U.S. freedom to maneuver within a theater of operations.[60]

Concern over anti-access/area denial capabilities in general, and their implications on the efficacy of the aircraft carrier specifically, have grown in parallel with the United States' "re-balancing" to Asia. The geography of the Pacific necessitates a primarily naval focus. The most recent U.S. maritime strategy, *A Cooperative Strategy for 21st Century Seapower*, describes the Navy's vital role in maintaining access to the maritime commons for domestic and global economic prosperity.[61] As the United States has

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[57] James M. Zortman, Walter B. Massenburg and Kilkline, Thomas J., Jr, "Naval Aviation Vision 2020," Naval Aviation Enterprise, 2006, http://depts.washington.edu/uwnrotc/intro/Naval_Aviation_Vision_2020.pdf (accessed April 20, 2016), 36.

[58] Andrew Krepinevich, Barry Watts, and Robert Work, *Meeting the Anti-Access and Area Denial Challenge* (Washington, DC: Center for Strategic and Budgetary Assessments, 2003).

[59] Ibid., 4.

[60] Ibid., 5.

[61] Dunford, et al., *A Cooperative Strategy*, 8.

attempted to shift its foreign policy focus towards Asia, it has come to recognize a rising, and possibly peer-competitor in China. While the United States and China continue to maintain amicable relations, Chinese military advancements have highlighted several challenges to the United States' current methodology for employing its aircraft carriers for both sea control and power projection and serve as a benchmark for potential capabilities the United States may encounter in future conflicts.[62]

Since the 1990s, and specifically after the 1996 Taiwan Strait Crisis, China has embarked on a broad naval modernization campaign to develop or improve its A2/AD capabilities.[63] One significant advancement has been China's Anti-Ship Ballistic Missiles (ASBMs), such as the DF-21D, which possess the capability of attacking surface ships at a range of approximately 1,500 km (nearly 810 nautical miles) and includes a maneuverable warhead (MaRV) increasing its ability to strike a moving ship.[64] Combined with a precision guidance network consisting of satellite tracking or over-the-horizon radar, China's ASBMs potentially pose a significant anti-access threat to U.S. aircraft carriers and other surface vessels, challenging their ability to establish sea control or project power ashore.

China has also developed several area denial capabilities that threaten the United States' ability to maneuver within a theater of operations. The submarine-launched Anti-Ship Cruise Missile (ASCM) SS-N-27B Sizzler, for example, "is specifically designed to defeat the U.S. Aegis anti-air warfare system, penetrate a task force's defenses, and strike high-value surface warships, to include carriers."[65] Additionally, China has deployed a layered integrated air defense system (IADS) comprised of radars, surface-to-air missiles,

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[62] The majority of this discussion focuses on China's A2/AD capabilities. This is not to discount the myriad of other states' capabilities, however, such as Iran or Russia. For a more detailed depiction of other states' capabilities, see Andrew F. Krepinevich, *Why AirSea Battle?*, (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2010).

[63] See O'Rourke's summary of these advancements in, *China Naval Modernization: Implications for U.S. Navy Capabilities–Background and Issues for Congress*.

[64] The DF-21D is only one of China's many military advancements aimed at preventing foreign power projection in the region. This system is highlighted here due to its specific focus as an "anti-carrier" weapon. For a description of its characteristics, see: Harry J. Kazianis, "Is China's 'Carrier-Killer' Really a Threat to the U.S. Navy?," *The National Interest*, http://nationalinterest.org/blog/the-buzz/chinas-carrier-killer-really-threat-the-us-navy-13765, (posted September, 25, 2015).

[65] Andrew F. Krepinevich, *Why Airsea Battle?*, 22.

and land-based aircraft along its eastern border challenging U.S. air superiority from either sea-based or land-based aircraft.[66] In short, China's military advancements threaten the United States' ability to operate its aircraft carriers in the manner it has relied upon for the past two decades.

B. ANALYSIS OF ALTERNATIVES

The combination of China's anti-access and area denial capabilities poses a significant challenge to the aircraft carrier's operations within the Pacific. An advanced maritime surveillance network and ASBMs threaten the ability to move an aircraft carrier into a position to deploy its air wing. If a carrier were to get in position, however, it then faces sea- and submarine launched ASCMs while surface-to-air missiles obviate the use of the air wing. In light of the potential operational risks aircraft carriers face in a contemporary A2/AD environment, several military strategy and force structure experts have questioned the efficacy of their continued development, and deployment. These recommendations range from divesting from the aircraft carrier as a whole and pursuing alternative surface and subsurface ship types, including smaller aircraft carriers, to addressing the aircraft carrier's primary weapon system: its air wing. The following section will describe these proposed alternatives and highlight their merits and shortfalls.

1. Surface and Subsurface Missile Carriers

One of the primary mission areas for a carrier air wing is strike warfare, or "attack to damage or destroy an objective or a capability."[67] In its contemporary use, the term is synonymous with the idea of attacking land-based targets, although it can certainly apply to sea or undersea vessels as well. Nearly every naval vessel maintains a capability of performing some degree of strike warfare, with the difference being in the volume, precision, and destructive capacity of their weaponry. As advanced radar systems, have improved ships' targeting abilities, and improvements in rocket and warhead technology

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[66] Ibid., 23.

[67] *Department of Defense Dictionary of Military and Associated Terms*, Joint Publication (JP) 1–02, Washington, D.C.: U.S. Government Printing Office, 15 January 2016, 227.

have increased the range and destructive capability of surface-launched missiles, potentially replacing the aircraft carrier and its air wing in the strike warfare role.

Multi-purpose surface ships equipped with the AEGIS radar system and vertical launch system (VLS), such as the *Ticonderoga*-class cruiser offer a modular strike alternative. Increasing previous missile payloads from 88 to 122, the VLS configuration can employ an array of weapons spanning across land-attack, anti-surface, anti-air, and anti-submarine capabilities.[68] The major benefit of these systems, as Commander Phillip E. Pournelle argues, is in their cost efficiency when compared to an air wing; smaller surface ships are cheaper to purchase, and the missiles do not require delivery from a costly air wing.[69] Additionally, the United States could deploy a flotilla of approximately 64 low-cost, missile-laden surface ships into an A2/AD environment in order to distribute their strike capabilities over a wider area, thereby complicating an adversary's targeting solution and delivering a strike capability comparable to that of several air wings.[70]

The use of submarines as an alternative strike platform to the aircraft carrier builds on the surface combatant argument, but adds the tactical benefit of operating under the water's surface, complicating an adversary's maritime domain awareness. The U.S. Navy converted four *Ohio*-class ballistic missile submarines (SSBNs) into a conventional land attack role (SSGN) between 2002 and 2007.[71] Armed with 155 conventional Tomahawk missiles, an SSGN maintains some of the same benefits of an aircraft carrier (i.e.: operating a strike platform from international waters) and without the susceptibility of surface combatants to ASCMs.

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[68] Lockhead Martin, "Mk 41 Vertical Launch System (VLS)," http://www.lockheedmartin.com/content/dam/lockheed/data/ms2/documents/launchers/MK41_VLS_factsheet.pdf, accessed May 10, 2016.

[69] Phillip E. Pournelle, "The Rise of the Missile Carriers," *Proceedings*, Vol. 139/5/1, 323 (May 2013), http://www.usni.org/magazines/proceedings/2013-05/rise-missile-carriers.

[70] Wayne P. Hughes and Jeff Kline, "Transitioning to a 21st Century U.S. Navy," Presentation for the Strategic Discussion Group (December 10, 2013), http://hdl.handle.net/10945/39569.

[71] "Guided Missile Submarines - SSGN," U.S. Navy Fact File, updated November 9, 2015. http://www.navy.mil/navydata/fact_display.asp?cid=4100&tid=300&ct=4.

2. Critique of the Missile Carriers

A missile-centric force, some argue—whether based on the surface or under the sea—provides a more cost and risk efficient alternative in an A2/AD environment than the aircraft carrier. Pournelle argues in support of these alternatives:

> Missile carriers are far more combat-effective and survivable than aircraft carriers because of the rapid volume of fire they can deliver, the distribution in several shooters, and the low signature relative to an aircraft carrier…The ability to deliver a massive strike rapidly means the launching platform can rush in, execute the mission, and withdraw. The carrier, on the other hand, must remain vulnerable to attack while the air wing is launched and recovered through multiple cycles.[72]

Pournelle's argument specifically, and the support of missile carriers in general, fails to account for several shortfalls.

First, missile carriers do not provide a significantly greater strike capability than the current air wing. A six-destroyer Surface Action Group (SAG) following Pournelle's recommended loadout would carry 288 TLAMs. Based on Benjamin Lambeth's report for RAND Corporation, however, one air wing provides "the target-coverage equivalent of 4,000–5,000 TLAMs over the course of a 30-day operation."[73] Additionally, any capacity advantage missile carriers might provide is quickly negated when one considers their re-load capability. As Seth Cropsey, Bryan C. McGrath, and Timothy A. Walton describe in their report for the Hudson Institute, there is currently no method for re-arming the Navy's Mk 41 VLS system at sea.[74] This capability shortfall, therefore, would require any missile carrier to depart the area of operations to re-arm, sacrificing valuable time during its transit.[75]

Second, a missile-centric force does not account for two critical capabilities of airpower: its scalability, and its contribution to battle-space awareness. When an aircraft

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[72] Pournelle, "The Rise of the Missile Carriers."

[73] Benjamin S. Lambeth, *American Carrier Air Power at the Dawn of a New Century* (Santa Monica, CA: RAND, 2005), p.90 (footnote 19).

[74] Cropsey et al., *Sharpening the Spear* 48

[75] Jan Van Tol, Mark Gunzinger, Andrew Krepinevich and Jim Thomas, *AirSea Battle: A Point of Departure Operational Concept* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2010), 40.

takes off, it can escalate its response to a threat starting with a show-of-presence, escalating to a show-of-force, and terminating with an eventual kinetic strike. A missile, however, is only capable of the latter. While this discrepancy is of arguably less value in the middle of a conflict, the ability to provide a scalable response can help in avoiding or deescalating tensions in the early stages of a crisis.

With regards to battle-space awareness, there is currently no missile-based alternative to the capabilities of carrier-based aircraft. The mainstay of an air wing's airborne command and control and situational awareness capabilities are the E-2C and E-2D Hawkeye variants, and the Navy currently lacks a sea-based alternative that can provide the same duration or sensor capabilities. While land-based alternatives exist in the form of the E-3 Sentry Airborne Warning and Control System (AWACS), relying on such assets in a maritime environment would assume the availability and survivability of allied airfields in the midst of conflict—a dangerous presumption that forgoes the tactical benefits of maneuver warfare.[76]

Surface and submarine forces, armed with a myriad of strike capabilities, provide an additive benefit to the aircraft carrier in an A2/AD environment. Their ability to deliver quick hits against an enemy's missile launchers or command and control targets can help reduce the risks to conducting carrier operations, and the modularity of their VLS payloads can enable a transition from a strike to an air defense role—albeit for a limited time based on their inventory. Arguing for their total replacement of the aircraft carrier, however, does more to highlight their capability shortfalls than promote their strengths. While a missile-centric force cannot replace the current capabilities of carrier-based aviation, other proposals promote transitioning from a few large super carriers and towards more, smaller carriers.

3. Escort Carriers and LHDs

Arguments in favor of transitioning to smaller aircraft carriers acknowledge the value of sea-based air, but argue against the financial and tactical costs of building a platform that is becoming "big, expensive, and vulnerable–and surprisingly irrelevant to

[76] Krepinevich et al. *Meeting the A2/AD Challenge*, 19.

the conflicts of the time."[77] Some of the proposed benefits of this transition include: reduced operating costs, an increase in available funds for more production, the distribution of air power across a larger number of ships and over a wider geographic area, and a reduction in the risk of suffering mass casualties aboard a single ship.[78] While these benefits appear viable at first glance, closer inspection reveals several critical shortfalls in three areas: the types of aircraft required, air wing size, and vulnerability.[79]

The aircraft available for different ship designs are directly related to the size of the ship. Current U.S. amphibious carriers (LHDs and LHAs) do not incorporate a catapult or arresting gear system. Additionally, they do not utilize the ski-jump flight deck that is popular in other foreign iterations of aircraft carriers. Therefore, fixed-wing aircraft on U.S. amphibious carriers rely on Vertical/Short Take-Off, Landing (VSTOL) capabilities for their launch and recovery. The nature of VSTOL technology significantly limits the range of capabilities aircraft can pursue. Consider the AV-8B Harrier and its combat radius of approximately 300 nautical miles as compared to the near 1,000 nautical miles of the F/A-18E Super Hornet. Comparing the VSTOL and carrier-suitable version of the F-35 Joint Strike Fighter provides a more equitable comparison: 450 nautical miles versus 600 nautical miles.[80] If VSTOL aircraft are limited in range compared to their non-VSTOL alternatives, and if a main argument against the viability of the super carrier design is its inability to operate outside the range of an adversary's A2/AD capabilities, then an alternative carrier design that relies on VSTOL aircraft does not alleviate the military problem of an A2/AD environment.

The second shortfall of the smaller carrier argument is the impact on air wing size, which in turn affects mission capability and sortie rate. Inherently, a larger ship platform can accommodate more aircraft than a smaller one. An ability to accommodate more aircraft also allows for more mission specialization amongst airframes. For

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[77] Hendrix, *What Cost a Carrier?*, 3.

[78] Cropsey et al., *Sharpening the Spear,* 85.

[79] John Lehman, "Aircraft Carriers: The Real Choices," (Beverly Hills, CA: Sage Publications, 1978), 55.

[80] Jeremiah Gertler, *F-35 Joint Strike Fighter (JSF) Program: Background and Issues for Congress* (Washington, DC: Congressional Research Service, RL30563, April 26, 2011), 50.

example, a *Wasp*-class LHD in a sea control role can embark up to 20 AV-8B Harriers (although it routinely only carries six), and the USS *Wasp* is expected to deploy with 16 F-35Bs in 2017.[81] Conversely, a typical carrier air wing's fixed-wing component includes 44 F/A-18E/F Super Hornets for air superiority and strike warfare, five EA-18G Growlers for electronic attack, and four E-2C/D Hawkeyes airborne early warning. Thus, the super carrier model allows for a wider range of aircraft capable of performing a larger range of mission sets simultaneously. The LHD/LHA model, however, can only provide a ground-attack asset and currently lacks any airborne early warning capability.[82]

With respect to sortie rate, a smaller carrier design–with its smaller air wing–would have fewer aircraft available for sorties at any given time when compared to a super carrier. A 2015 Congressional Budget Office analysis reports that the future LHA-6 class of amphibious assault ships (a re-designed version of the LHA-1 class that includes a well-deck) will have a per unit cost of $3.7 billion.[83] At nearly one-quarter the cost of the *Ford* (CVN-78), the Navy could potentially make up for the sortie shortfall of a single smaller carrier by purchasing more LHDs/LHAs. Unfortunately, sortie capabilities do not scale so efficiently. Comparing the *Ford*-class to a French Navy *Charles de Gaulle* aircraft carrier modernized to include advanced launch and recovery systems shows the smaller carrier provides only a fraction of financial savings (approximately 22%), but at extreme costs in operational capabilities (a 53% decrease in embarked aircraft, 225% less aviation fuel storage, and 383% less munitions storage).[84]

Finally, current ship designs for small and medium sized aircraft carriers are no less susceptible to the same A2/AD threats aimed against super carriers.[85] Cropsey et al. also highlight that the smaller model's decreased fuel and ammo capacity would require

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[81] Jane's "World Navies," last accessed May 18, 2016, https://janes.ihs.com.libproxy.nps.edu/Janes/Display/1322789#Wasp-class%20LHD.

[82] The F-35B will be capable of conducting several other mission areas, but not to the degree of a full carrier air wing.

[83] Keith Hall, "An Analysis of the Navy's Fiscal Year 2016 Shipbuilding Plan," (Washington, D.C.: Congressional Budget Office, 2014), 29.

[84] Cropsey, et al. *Sharpening the Spear*, 86–87.

[85] Ibid., 85.

additional logistics support, straining what they identify as an already strained supply system.[86] Thus, divesting from the super carrier towards the current LHA/LHD model provides a significant decrease in operational capability while accepting the same, if not higher, level of risk.

C. POTENTIAL AREAS FOR CHANGE

While the proposed alternatives for replacing the aircraft carrier contain several shortfalls, there remain several avenues for improving the aircraft carrier's viability in an A2/AD environment. Specifically, the Navy can reconsider the doctrinal role the aircraft carrier plays in its maritime strategy. Also, there are multiple avenues for addressing the aircraft carrier's chief weapon system: the air wing.

1. Doctrinal Roles

The aircraft carrier has played several different roles since its inception in the early 1900s. Professor Robert C. Rubel of the Naval War College classifies them into six categories: (1) "Eyes of the Fleet"; (2) "Cavalry;" (3) "Capital Ship;" (4) "Nuclear-Strike Platform;" (5) "Airfield at Sea;" and (6) "Geopolitical Chess Piece."[87]

The aircraft carrier's progression along each role reflected the capability developments in aircraft striking power and ship survivability. As the air wing's striking power increased, air wings transitioned from scouting and spotting ("Eyes of the Fleet") towards striking and disrupting enemy naval operations ("Cavalry"). Increased survivability of the aircraft carrier, coupled with continuing advancements in air wing performance, allowed for direct and sustained engagements with an enemy's fleet ("Capital Ship"). In the nuclear age, the Navy sought to repeat the aircraft carriers' cavalry role by utilizing their speed to provide pulsing nuclear-armed air strikes and survive any nuclear or conventional retaliation ("Nuclear-Strike Platform").[88]

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[86] Ibid., 88.

[87] Rubel, "The Future of Aircraft Carriers," 14–18.

[88] Rubel, "The Future of Aircraft Carriers," 16.

In areas without a significant threat to an aircraft carrier's survival, military operations have utilized aircraft carriers as "Airfields at Sea," capitalizing on the carrier's and air wing's capabilities to deliver near-continuous air support within a theater of operations. The challenge with this role, however, has been the need for carriers to operate ever closer to an adversary's shores due to the air wings' shrinking range. Finally, as a product of their substantial cost and the technological innovations required for their operation, the United States has used aircraft carriers as a form of strategic communication ("Geopolitical Chess Piece") to demonstrate "American concern, resolve, or outright anger."[89]

As contemporary A2/AD capabilities increase the risk to aircraft carriers operating as airfields at sea, military leaders must consider operating the ships further out to sea. The current air wing can continue to provide a scout and spot capability, with its MH-60R helicopters searching for enemy submarines, the E-2D providing early warning and battlespace awareness, and its F/A-18 variants maintaining local air superiority. Additionally, tactical experimentation focusing on emissions control techniques and multi-carrier engagements may restore the ships' cavalry role. Unfortunately, this methodology only provides an innovative change in how the Navy uses its current capabilities; it does not address improving the air wing's susceptibility to advanced air defenses or modernizing the aircraft within the air wing.[90]

2. Changing the Air Wing

Larger aircraft carriers have the added benefit of being able to incorporate new technological advancements. Considering that aircraft carrier hulls are intended to last more than 40 years, their design must accommodate advancements both in launch and recovery systems and airframes. The USS *Midway* (CV-41), for example, originally embarked an air wing comprised of propeller-driven aircraft after its commissioning in 1945, and did not include steam-driven catapults. By its decommissioning in 1991,

[89] Ibid., 17.

[90] Ibid., 22.

however, the *Midway* had launched A-6 Intruders, F/A-18 Hornets, EA-6B Prowlers, and E-2C Hawkeyes off of its modernized flight deck in support of Operation Desert Storm.[91]

The chief complaint against the modern air wing is its decreased effective range. Hendrix, Rubel, McGrath, Cropsey, and current Deputy Secretary of Defense Robert O. Work agree that addressing this shortfall is a critical step regardless of the aircraft carrier's long-term future. Reducing or stopping the purchase of the F-35C and replacing it with a renewed purchase contract for more F/A-18E/F Super Hornets, as Hendrix recommends, provides a stop-gap measure, marginally increasing the air wing's average range from 725nm to 789nm while also increasing the average payload capacity from 8,443 pounds to 15,920 pounds per aircraft.[92] Additionally, modernization in the air wing's weapons systems can extend the reach of their lethal touch. By adding the Joint Stand-Off Weapon-Extended Range (JSOW-ER) and the Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER) to the air wing's arsenal, defense planners would extend the aircraft carrier's strike range by 250nm and 500nm respectively.[93] Providing sea-based air with the ability to deploy its weapons from further out, while avoiding an adversary's IADS, would also improve the aircraft carrier's ability to fill the cavalry role or even serve as an airfield at sea.

Improving the performance and range of manned aircraft and their weaponry has a limited potential. If the present trend in A2/AD ranges continues to grow, then manned aircraft will eventually reach their maximum performance limit: the physiological constraints of the human body. One way of offsetting this trend is to incorporate the use of Unmanned Aerial Vehicles (UAVs) into the air wing. While the Navy has faced several institutional, financial, and technological challenges developing a carrier-based UAV, the Navy has made great strides in this endeavor recently, with Northrop Grumman's X-47B Unmanned Combat Air System Demonstrator (UCAS-D) conducting

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[91] David H. Buss, William F. Moran, and Thomas J. Moore, "Why America Still Needs Aircraft Carriers," *Foreign Policy*, 26 April 2013, http://foreignpolicy.com/2013/04/26/why-america-still-needs-aircraft-carriers/.

[92] Hendrix, *Retreat from Range*, 54–58.

[93] Cropsey, et al. *Sharpening the Spear*, 41–42.

autonomous take-offs, aerial refueling, and recoveries aboard the USS *George H. W. Bush* (CVN-77) in 2013.[94]

The X-47B specifically, and future UAVs in general, demonstrate a game-changing modernization to the air wing in terms of range, payload capacity, and low-observability characteristics.[95] Initial testing of the X-47B demonstrated a range of 2100nm–roughly the same distance between the continental U.S. and Hawaii.[96] Such a radical increase in range in comparison to current manned aircraft, combined with the removal of aircrew endurance requirements (potentially lasting several days with aerial refueling), provides the aircraft carrier with several options based on payload. For instance, the UAV can provide a persistent Intelligence, Surveillance, and Reconnaissance (ISR) capability far ahead of the carrier strike group. If armed, the low-observable aircraft could reach mobile targets within an adversary's A2/AD wall without jeopardizing the lives of aircrew.

Such results are still over the horizon, however, and incorporating UAVs into the air wing will continue to face technological, financial, and institutional barriers towards its adoption. In the long run, however, UAVs represent a strong candidate for modernizing the air wing and restoring the efficacy of the aircraft carrier in an A2/AD environment.

D. CONCLUSION

The advancements in military capabilities designed to counter the United States' ability to project power and influence operations on the land from the sea pose a significant risk to the aircraft carrier and its air wing. Strategically, the Navy no longer enjoys the freedom to maneuver its carriers within a battlespace and must entertain the idea of attaining only temporary sea control over a specific area. Operationally, the Navy

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[94] Clay Dillow, "What the X-47B Reveals About the Future of Autonomous Flight," *Popular Science*, Technology, posted July, 5, 2013, http://www.popsci.com/technology/article/2013-05/five-things-you-need-know-about-x-47b-and-coming-era-autonomous-flight.

[95] Hendrix, *Retreat from Range*, 53.

[96] Ehrhard and Work, *Range, Persistence, Stealth, and Networking*, 211.

must consider operating aircraft carriers further from the shore, reducing the effectiveness of an air wing due to their reliance on aerial refueling.

Several alternative systems attempt to alleviate these challenges and, as some of their proponents argue, relegate the aircraft carrier either into diminished importance or even obsolescence. As this chapter demonstrates, however, no single proposed system can totally replace the range of capabilities aircraft carriers provide, nor do they decrease the value of sea-based air. Additionally, this chapter demonstrates that the aircraft carrier and its air wing, in their current form, face significant operational challenges, and capability shortfalls. Rather than signaling the death knell of the aircraft carrier, however, the A2/AD challenge highlights the need for the Navy to consider innovative new employments of the aircraft carrier, and the need to look critically at airframes that comprise the air wing. If the Navy does not take this opportunity to adapt the aircraft carrier to the challenges it faces, then the ships will be of little more value than the battleships they replaced.

While there are valuable operational and tactical lessons for U.S. military leaders to draw upon from both the case studies and analysis of alternatives, continued advancements in modern land-based systems create geo-strategic issues for a military response. In order for the United States to counter the strategic implications of A2/AD capabilities, it must first re-evaluate its strategic aims. Only after identifying the ends of its strategy can the United States properly identify the ways and means necessary to help it reach its objectives.

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IV. CONCLUSION

A. SUMMARY

Modern anti-access/area denial capabilities pose a significant threat to the Navy's ability to operate in an A2/AD environment in general, and its ability to employ its aircraft carriers specifically. Additionally, contemporary A2/AD capabilities threaten the United States' freedom of action within the maritime commons to effectively conduct sea control and project power ashore in order to "defeat aggression, respond to crises, and strengthen partnerships."[97] This thesis utilized each of these areas of concern as a basis for determining innovative operational and technical solutions U.S. political and military leaders should consider when determining the future of the aircraft carrier in U.S. maritime strategy.

This thesis first discussed the technical characteristics of contemporary A2/AD systems and their parallels to previous A2/AD capabilities in World War II and the Cold War in order to demonstrate how innovative operational solutions can both mitigate the risk to aircraft carriers, and restore the United States' ability to project power ashore. The significance of the lessons learned is that they demonstrate how the United States can better address its A2/AD concerns while utilizing its existing fleet structure and capabilities.

Next, the thesis turned towards the debate regarding the possible technical solutions the U.S. Navy could pursue in order to address the capability shortfalls of its aircraft carriers and air wings in an A2/AD environment. The analysis in this section demonstrated that, although the proposed alternatives show potential promise in increasing the Navy's ability to strike shore-based targets, none of the alternatives can sufficiently provide the range of necessary capabilities across a range of military operations as the aircraft carrier and its air wing. It is important to note, however, that the analysis acknowledged the need for technical improvements in the aircraft carrier's

[97] Dunford et al., *A Cooperative Strategy*, 2.

defensive capabilities and the capabilities of naval aircraft, and provided several recommendations for how U.S. leadership ought to proceed.

B. OTHER CONSIDERATIONS

In describing the viability of the aircraft carrier as a component of U.S. sea power in an A2/AD environment, the analysis in this thesis has revolved around how best to achieve the current aims of U.S. maritime strategy through military means—whether through innovative operational approaches, capability enhancements, or both. One area this thesis has not discussed, but certainly bears asking, is what are the non-military components of maritime strategy the United States can pursue in countering A2/AD capabilities.

Emphasizing the use of naval diplomacy is an excellent means for U.S. maritime strategy to counter the rise, and deter the use, of A2/AD capabilities. Geoffrey Till describes "naval diplomacy" as ranging from "limited compellent attack at one extreme, through deterrence to amicable cooperation at the other. The aim is to influence other people."[98] Till also notes that, like all other forms of diplomacy, naval diplomacy can have "a wide range of purposes and effects."[99] The key in applying naval diplomacy as a deterrent against A2/AD capabilities and their strategies lies in correctly identifying these appropriate purposes and effects.

Reconsider Tangredi's portrayal of anti-access strategies as "great walls" whose purposes are to consolidate power within, and block intruders from without. If anti-access capabilities (anti-ship missiles, anti-satellite weapons, etc.) are the wall itself, and present U.S. military capabilities are not sufficiently capable of breaking down the wall directly, then naval diplomacy offers an ability to erode the foundation under the wall, or even attack the power behind the wall indirectly, thus preventing the capabilities from achieving their political objectives. Therefore, some appropriate targets for naval

[98] Geoffrey Till, *Seapower: A Guide for the Twenty-First Century*, 2nd ed., (New York: Routledge, 2009), 280.

[99] Ibid.

diplomacy are China's territorial claims, and its need for control of the commons for its domestic prosperity.

A maritime strategy built around an increased role for naval diplomacy does not ignore the benefit of the use of force, or in developing military capabilities. Under such a strategy, the United States can and should continue to pursue research and development in technology capable of overcoming the shortfalls in its current naval forces. Fortunately, by building a strong diplomatic foundation with an anti-access state, however, these military advancements need not be seen as backhanded or two-faced. Instead, the United States can justify its pursuits by using its established relations to ease China's fears, arguing that developing its capabilities is necessary for other threats in other regions, and that failing to do so would be to invite unnecessary risk. Such advancements would also lend increased credibility to the United States' deterrence against any anti-access strategy.

There are several ways U.S. maritime strategy can use naval diplomacy to erode the foundation of China's anti-access strategy. First, the United States can continue to demonstrate its support of, and commitment to, the international norms codified in the United Nations Convention on the Law of the Sea (UNCLOS). Consistent use of what the Navy calls "Freedom of Navigation Operations" (FON), such as sailing within China's claimed territorial seas of Subi Reef, or conducting military activities in and over China's Economic Exclusion Zone, undermine China's legal warfare and demonstrate the United States' resolve to protecting the commons to the international community.[100]

Additional options for the use of naval diplomacy involve different means of including China in the collective security apparatus. By finding opportunities for multilateral cooperation, as naval historian John B. Hattendorf argues, "neighboring navies in a particular region can join forces and share responsibilities costs for

[100] Jonathan Odom, "How China Shot Down its own A2/AD Lawfare Strategy," The National Interest, posted October 8, 2015, http://nationalinterest.org/feature/how-china-shot-down-its-own-a2-ad-lawfare-strategy-14037?page=show.

surveillance, and control of maritime regions. These shared duties could prevent conflict that could arise from neglect."[101]

Both the 2007 *Cooperative Strategy* and the 2015 version offer recommendations that could enhance cooperation. The 2007 strategy noted that maritime forces could "build confidence and trust among nations through collective efforts that focus on common threats and mutual interests in an open, multi-polar world."[102] Speaking specifically in regards to China, the 2015 strategy refresh highlights counter-piracy operations in the Gulf of Aden, humanitarian assistance and disaster relief missions, and involvement in multi-national naval exercises as plausible opportunities for increased maritime relations between China and the United States.[103]

In light of these objectives, the United States and China have successfully executed several combined anti-piracy operations since 2012, and China attended its first "Rim of the Pacific" (RIMPAC) exercise in 2014.[104] Conducting such operations, and capitalizing on what Hattendorf refers to as the "triple criteria of shared values, geographical proximity, and shared interests," is improving naval cooperation, preventing misunderstanding, and building a history of shared solutions to crises.[105] The overall objective of building such a relationship lies in the bringing of a state employing A2/AD capabilities into the shared protection and access of the contested region, thereby eroding the desire for building or exercising its A2/AD capabilities.

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[101] John B. Hattendorf, "Sea Power and Sea Control in Contemporary Times," in *Naval History and Maritime Strategy: Collected Essays,* 262.

[102] James T. Conway, Gary Roughead, and Thad W. Allen, *A Cooperative Strategy for 21st Century Seapower,* (Washington, DC: Department of the Navy, 2007), 3.

[103] Dunford et al., *A Cooperative Strategy* 3-4.

[104] For more information about previous combined U.S.-China maritime operations, see the following: Travis Alston and Eric Coffer, "US, China Conduct Anti-Piracy Exercise," Navy Times, posted December 12, 2014, http://www.navy.mil/submit/display.asp?story_id=84858; Andrew Erickson and Austin Strange, "China and the International Antipiracy Effort," The Diplomat, posted November 1, 2013, http://thediplomat.com/2013/11/china-and-the-international-antipiracy-effort/; Russia Today, "Chinese Navy near Hawaii: First Time Participation in US-led RIMPAC Drills," posted June 27, 2014, https://www.rt.com/news/168828-china-participation-rimpac-exercise/.

[105] Hattendorf, "Sea Power and Sea Control," 263; Ibid., 262.

C. CONCLUSION

Sea control, power projection and ensuring access to the maritime commons, for both commercial and military use, are central functions of the United States' national maritime strategy. Modern A2/AD capabilities target the United States' ability to perform these functions. The 2010 Quadrennial Defense Review summarizes the significance of these capabilities:

> Anti-access strategies seek to deny outside countries the ability to project power into a region, thereby allowing aggression or other destabilizing actions to be conducted by the anti-access power. Without dominant U.S. capabilities to project power, the integrity of U.S. alliances and security partnerships could be called into question, reducing U.S. security and influence and increasing the possibility of conflict.[106]

There is a definite need for the United States to address its capability shortfalls in the face of A2/AD capabilities, but the threat against aircraft carriers does not nullify their value, nor does it signal the end of its history.

The aircraft carrier has served a critical role in U.S. maritime strategy due to its operational flexibility in transporting and delivering air power across the world's oceans without requiring foreign basing rights, and its adaptability to changing airframes. Just as modern A2/AD capabilities have taken an evolutionary step from previous attempts to counter the United States' military advantage, so too can the aircraft carrier respond with incremental, evolutionary improvements. In the meantime, the United States has several operational methods it can utilize to mitigate the risk to its naval forces, while simultaneously pursuing non-military avenues for dissuading a state to employ its A2/AD capabilities. The time will most likely come when a capability signals the end of the big deck aircraft carrier as a viable component of naval sea power. Today's big missiles are not that threat, and today is not that time.

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[106] Robert M. Gates, *Quadrennial Defense Review Report* (Washington DC: Department of Defense, February 2010), 31.

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