INNOVATION FROM THE SEA: A NET ASSESSMENT OF THE DEVELOPMENT OF U.S. NAVY UNMANNED AERIAL SYSTEM POLICY

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by

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14. ABSTRACT
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UAS, Unmanned Aircraft, UA, UCAV, UAV, RPV, Policy, QH-50 DASH, RQ-2 *Pioneer*, A2/AD, MQ-8B/C *FireScout*, MQ-4C *Triton*, UCLASS, CBARS, RAQ-25, MQ-25, *Stingray*, US Navy, US Marine Corps, US Air Force

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ABSTRACT

INNOVATION FROM THE SEA: A NET ASSESSMENT OF THE DEVELOPMENT
OF U.S. NAVY UNMANNED AERIAL SYSTEM POLICY, by LCDR Daniel M.
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The U.S. Navy's contributions to the development of Unmanned Aerial Systems (UAS)
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overcome its intrinsic biases towards UAS in order to leverage both manned and
unmanned assets to meet the challenges of the 21st century.

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ACRONYMS

9/11	Terrorist Attacks of 11 September 2001
A2/AD	Anti-Access/Area Denial
ASROC	Anti-Submarine Rocket
ASW	Anti-Submarine Warfare
BAMS-D	Broad Area Maritime Surveillance-Demonstrator
BDA	Battle Damage Assessment
BuAer	Bureau of Aeronautics
BuOrd	Bureau of Ordnance
C4I	Command, Control, Communications, Computers, and Intelligence
CBARS	Carrier-Based Aerial Refueling System
CEC	Cooperative Engagement Capability
CNO	Chief of Naval Operations
CONOPS	Concept of Operations
CS-21	*A Cooperative Strategy for 21st Century Seapower* (2007)
CS-21R	*A Cooperative Strategy for 21st Century Seapower*, Revised Version (2015)
CSG	Carrier Strike Group
DARO	Defense Airborne Reconnaissance Office
DARPA	Defense Advanced Research Projects Agency
DASH	Drone Anti-Submarine Helicopter
DoD	Department of Defense
DoN	Department of the Navy
GAO	General Accounting Office / Government Accountability Office (2004)

GWOT	Global War on Terrorism
ISR	Intelligence, Surveillance, and Reconnaissance
J-UCAS	Joint Unmanned Combat Air System
JPO	Joint Program Office
JROC	Joint Requirements Oversight Council
MR-UAV	Medium Range Unmanned Aerial Vehicle
N-UCAS	Navy Unmanned Combat Air System
N-UCAV	Navy Unmanned Combat Air Vehicle
NAVAIR	Naval Air Systems Command
NGFS	Naval Gunfire Support
NM	Nautical Mile
OSD	Office of the Secretary of Defense
OTH	Over-the-horizon
PEO	Program Executive Officer
QDR	Quadrennial Defense Review
RFP	Request for Proposal
RPV	Remotely Piloted Vehicle
SEAD	Suppression of Enemy Air Defenses
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
UA	Unmanned Aircraft
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UCAS-D	Unmanned Combat Air System Demonstration
UCAV	Unmanned Combat Air Vehicle

UCAV-N   Navy Unmanned Combat Air Vehicle

UCLASS   Unmanned Carrier-Launched Airborne Surveillance and Strike

TABLES

CHAPTER 1

INTRODUCTION

Since the early days of aviation and up to the present day, the United States (US) Navy has taken a preeminent role in the development of manned and unmanned aviation assets for naval operations. The US Navy financed the bulk of the first Unmanned Aircraft (UA) to achieve autonomous flight within a decade of the first manned aerial flight.[1] The Navy conducted the first US combat mission employing weapons onboard a UA during the Second World War.[2] In the 1960s, the Navy developed and operationally fielded the first weapons-delivery Unmanned Aerial System (UAS)–the revolutionary Drone Anti-Submarine Helicopter (DASH).[3] Nearly fifty years later, the Navy is again at the forefront of UAS advancement with its development of a carrier-based UAS that promises to revolutionize the traditional concept of the carrier air wing and influence future naval operations around the globe. This study outlines the Navy's policy of UAS innovation throughout its history, and will analyze whether the Navy has been successful in implementing that policy, and to what degree. To understand how much US Navy UAS policy has developed and changed over the course of Naval Aviation, it is necessary to analyze the historical development of US Navy policy, the internal and external forces

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[1] Laurence R. Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (Reston, VA: American Institute of Aeronautics and Astronautics, 2004), 16.

[2] John D. Blom, *Unmanned Aerial Systems: A Historical Perspective* (Ft. Leavenworth, KS: Combat Studies Institute Press, September 2010), 47.

[3] Thomas P. Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation" (Ph.D. dissertation, Johns Hopkins University, Baltimore, 2000), 304.

that affected it, and how historical events, conflicts, and personalities have influenced the decisions of naval leaders across past decades.

The primary question this thesis will answer is how the US Navy has developed policy for the utilization and employment of UAS technology throughout its history. While history has shown that the major driving forces of technological innovation in a wartime environment are the reactive demands raised by the nature of the conflict itself, this study will analyze whether this notion proves true to US Navy UAS policy as well.[4] As the US Navy seeks to reinvigorate its presence in the Asia-Pacific region, this analysis will help to provide the reader with the historical lessons that worked best with regard to US Navy UAS policy development and UAS employment in past conflicts. UAS hold a unique position among all other current and future warfighting technologies as the technology with the greatest capacity to directly influence the conduct of warfare in the 21st century. The naval-specific policies that have led to UAS development lends itself well to such a developmental analysis, with implications from this assessment resonating across the Armed Forces.)

Terminology

In keeping with current Department of Defense (DoD) terminology, this thesis utilizes the preferred terms of Unmanned Aircraft (UA) and Unmanned Aerial System (UAS) to refer to the various platforms of unmanned aircraft and the corresponding

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[4] Ibid., 571, 577, 579.

equipment required to launch, employ, and recover such aircraft.[5] Although the term

"Unmanned Aerial Vehicle" (UAV) came into general use in the early 1990s to describe

robotic aircraft, replacing the generally used terms "drone" (prior to 1970) and then

"Remotely Piloted Vehicle" (RPV; from 1970 to 1988), none of these are the primary

terms used by industry, the Department of Defense, or the Federal Aviation

Administration.[6] Instead, in referring to unmanned airborne platforms, the term UAS is

preferred as it encompasses all aspects of deploying a UA rather than simply referring to

the platform itself. In such a way, the term UAS distinguishes an unmanned aerial

platform from ballistic vehicles, artillery projectiles, cruise missiles, gliders (which are

unpowered), balloons and blimps (which float rather than employ aerodynamic lift), and

tethered objects (which lack autonomy or remote control).[7] In some cases, the terms UA

and drone will be used interchangeably in this thesis, based on the prevailing use of either

term in the source material. However, in accordance with JP 1-02, and where appropriate

in this thesis, an individual unmanned aerial platform will be referred to as a UA, and that

system whose components include the necessary equipment, network, and personnel to

control a UA will be referred to as a UAS.[8]

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[5] Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: Department of Defense, November 2010, as amended through 15 June 2015), 254.

[6] Newcome, 1.

[7] Ibid., 2.

[8] Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1-02, 254.

<center>Background</center>

Following Orville and Wilbur Wright's first flight in 1903, a new era of possibility was born. The concept of flight was an unknown frontier, and many early aviation pioneers looked to the skies for innovation. At the same time manned flight was being explored, the concept of unmanned aviation was also taking its first steps. In 1913, after two years of development, Elmer Sperry, the inventor of the gyroscope, obtained US Navy financial support for the first successful utilization of the gyroscope in stabilized flight.[9] By the time America had entered World War I (WWI), Sperry, along with fellow inventors Dr. Peter Cooper Hewitt and Glenn Curtiss, partnered with Secretary of the Navy (SECNAV) Josephus Daniels to provide the Navy with its first UA, the forerunner of today's cruise missile known as the aerial torpedo.[10] Although interest in offensive UA technology waned after WWI, interest in using UA as aerial target drones to test integrated ship defenses grew. The interest in drones shifted back to the concept of unmanned aerial ordnance delivery during the early stages of World War II (WWII) when then-Chief of Naval Operations (CNO) Admiral Harold R. Stark directed the development of a radio-controlled aircraft capable of deploying ordnance.[11] The subsequently developed "drones" saw action against the Japanese in the Pacific theater, and were also employed by the Navy in the early stages of the Korean War.[12]

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[9] John F. Keane and Stephen S. Carr, "A Brief History of Early Unmanned Aircraft," *Johns Hopkins APL Technical Digest* 32, no. 2 (2013): 559.

[10] Ibid., 560.

[11] Clark G. Reynolds and John H. Towers, *The Struggle for Naval Air Supremacy* (Annapolis, MD: Naval Institute Press, 1991), 449.

[12] Keane and Carr, 566.

<center>4</center>

With the onset of the Cold War, the Navy continued its aerial target drone development but also sought to develop a UAS to counter the Soviet submarine threat in the 1950s, and turned to the first operational unmanned helicopter designed for a combat role, marking a watershed moment in UAS development.[13] Following the U-2 incident during the Cuban Missile Crisis, the importance of unmanned reconnaissance became clear to Navy leadership, and this need was carried into the Vietnam War.

The Vietnam War was important to future Navy UAS policy development since it was the first war in which reconnaissance UAS were employed, and was also the first war to see the wide use of drones, with nearly one drone flight per day of the entire conflict.[14] Unfortunately, due to budget cuts, the Navy cancelled the development of its first Unmanned Combat Aerial Vehicle (UCAV) during the war in favor of high-speed missile systems, and further developments and expenditures on reconnaissance-based UAS were put on hold for nearly a decade.[15]

Based on their successful employment by the Israelis in 1973 and 1982, and a perceived need for surveillance, in 1985 the Navy procured a new UAS of its own in order to conduct battle damage assessment (BDA) for naval gunfire support (NGFS). The RQ-2 *Pioneer* UAS was employed over Beirut in 1989 and was widely used during the

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[13] Gyrodyne Helicopter Historical Foundation, "DASH Weapon System," accessed 20 December 2015, http://www.gyrodynehelicopters.com/dash_history.htm.

[14] Keane and Carr, 567.

[15] Ibid., 569.

Persian Gulf War of 1990-1991, to great operational effect.[16] With a greater demand for near-constant intelligence, surveillance, and reconnaissance (ISR) arising in the aftermath of 11 September 2001 (9/11), *Pioneer* also played a primary role for the Navy in the Second Persian Gulf War and the Global War on Terrorism (GWOT) as new programs to support maritime ISR subsequently grew.[17]

Currently, the Navy is pursuing a number of UAS developments based on an increased interest in the capabilities and potential of these systems to fulfill and supplement key naval mission sets. A stated goal of the Navy is to achieve effective integration of manned and unmanned systems in order to fully realize the potential and possibilities offered by these programs, with an eventual goal of one day achieving full UAS automation.[18]

Accordingly, the future roles for naval UAS hold great promise. UAS are widely perceived as a force multiplier, and their utilization from a Carrier Strike Group (CSG) perspective will extend the range and capability of traditional manned aircraft in ways not yet operationally proven.[19]

Recently, current actions by China in the South China Sea have led the US military to reconsider its established strategy that focused on winning a major conflict

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[16] John Pike, "Pioneer Short Range (SR) UAV," Federation of American Scientists, accessed 7 February 2015, https://www.fas.org/irp/program/collect/pioneer.htm; Ehrhard, 371.

[17] Keane and Carr, 569.

[18] Mark W. Darrah, "The Age of Unmanned Systems," *United States Naval Institute Proceedings* 141, no. 9 (September 2015): 27.

[19] Ibid.

with China to one that revolves around "collecting more information on Chinese actions" and "increased air and naval operations that will challenge efforts by China to claim control of new areas."[20] During his confirmation hearing, CNO Admiral John M. Richardson specifically mentioned that one of his greatest concerns was the "anti-access area denial capabilities" (A2/AD) currently being developed by the Chinese military as a means to counter US naval presence in the Pacific region.[21] With the DoD's rebalance (or "pivot") to Asia, the importance of employing autonomous systems in innovative operational and organizational constructs will be necessary to ensure freedom of access for US forces in a contested A2/AD environment.[22] In the South China Sea in particular, China has been widely viewed as employing a "creeping assertion of control" that "often involves civilian rather than naval vessels," which is a "sort of grey area that would not normally warrant any response from the U.S.," and in response, a greater amount of consistent, reliable ISR data is seen as an essential means to send a message to China that "we know what you are doing, your actions have consequences and we have the capacity and the will and we are here."[23] Due to their long loiter times, advanced intelligence-

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[20] Ronald O'Rourke, CRS Report R42784, *Maritime Territorial and Exclusive Economic Zone (EEZ) Disputes Involving China: Issues for Congress* (Washington, DC: Congressional Research Service, August 2015), 32.

[21] United States Congressional Transcripts, *Senate Armed Services Committee Holds Hearing on Nomination of Adm. John Richardson to be Chief of Naval Operations*, 114th Cong., 1st sess., 30 July 2015, 23.

[22] Department of Defense, *The Asia-Pacific Maritime Security Strategy: Achieving U.S. National Security Objectives in a Changing Environment* (Washington, DC: Department of Defense, August 2015), 22.

[23] O'Rourke, *Maritime Territorial and Exclusive Economic Zone (EEZ) Disputes Involving China: Issues for Congress*, 33.

gathering suites, and ability to stage off of naval vessels present in the region, naval UAS are uniquely capable of meeting this global policy demand and ensuring the US military's freedom of navigation to conduct operations while also promoting China's compliance with the international law of the sea.[24] Concurrently, a distinct trend of future naval operations will be a much greater use of unmanned and autonomous aerial vehicles, as evidenced by the Navy's simultaneous development of carrier-launched UAS, land-based maritime patrol UAS, and ship-based tactical UAS, and the ensuing challenges this technology has already brought to traditional naval tactics, techniques, and procedures.[25]

Primary Research Question

Throughout history, how has the US Navy developed policy for the utilization and employment of UAS technology?

Secondary Research Questions

1. What historical events have influenced the development of US Navy UAS policy?

2. What historical factors have improved the development of US Navy UAS policy?

3. What historical factors have hindered the development of US Navy UAS policy?

4. What does the literature say about the historical development of UAS policy?

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[24] Ibid., 49.

[25] Department of the Navy, *How We Fight–Handbook for the Naval Warfighter* (Washington, DC: Department of the Navy, April 2015), 160.

5. How has overall US Navy policy, developed both internally and externally to the Navy itself, shaped US Navy UAS-specific policy development?

6. Are there any historical examples of where US Navy UAS policy contributed to the success or failure of a battle or major military operation?

7. What are the future implications for US Navy UAS policy?

8. In light of such considerations, what recommendations can be made to improve future US Navy UAS policy?

9. What are areas for further research beyond the scope of this study?

<u>Significance</u>

UAS technology currently stands at the cutting edge of Naval Aviation. Due to their ability to maintain domain awareness, observe operational and deployment patterns, and continuously employ across the entire kill chain, UAS are revolutionizing warfare in ways never before encountered. Their unique features of expendability, scalability, capacity, and affordability across mission sets perceived as "dull, dangerous, and dirty" underscore their potential to shape warfighting concepts, force structure, and future applications as these systems are developed, tested, fielded, and integrated into the operational Fleet.[26] UAS have been specifically identified by CNO Admiral John M. Richardson as key components of the supplying of combat-ready naval aviation forces set forth in the Naval Aviation Enterprise[27] and as essential role players in present and future

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[26] Darrah, 24.

[27] Department of the Navy, *Naval Aviation Vision 2014-2025* (Washington, DC: Department of the Navy, April 2014), 42.

global naval operations.[28] As UAS technology develops, the capabilities of naval UAS will correspondingly increase and their role in naval operations will consequently grow. It is essential for the professional US Navy officer to understand the origin of UAS policy so as to better comprehend and effectively leverage the wide spectrum of UAS capabilities in future naval operations.

Assumptions

This study assumes that overall US Navy policy has had a quantifiable effect on the development of UAS policy, and that overall US Navy policy has continued to drive innovation in the design, procurement, fielding, and employment of naval-specific UAS. This study also assumes that throughout the majority of its history, the development of US Navy UAS policy has been largely driven by a reactionary need arising from the demands of the preeminent naval conflict of the day or from a specifically identified mission requirement, rather than a previously anticipated, quantifiable request for development or delivery of a given capability or technology.

Limitations

As a net assessment, this study will analyze available data to suggest strategic insights in an effort to possibly enlighten policy makers.[29] This study will focus on US Navy UAS-specific policy as it applies to US Navy UAS from a historical perspective as

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[28] United States Congressional Transcripts, *Senate Armed Services Committee Holds Hearing on Nomination of Adm. John Richardson to be Chief of Naval Operations*, 114th Cong., 1st sess., 30 July 2015, 23.

[29] Paul Bracken, "Net Assessment: A Practical Guide," *Parameters* 36 (Spring 2006): 90-100.

a means to understanding US Navy UAS development within an unclassified, open-domain context. In accordance with the most recent JP 1-02 nomenclature, current Federal Aviation Administration terminology, and industry preference, unless specifically delineated, the utilization of the UAS acronym in this study will refer to the previously utilized term "Unmanned Aerial Vehicle" (UAV). The term "Unmanned Combat Aerial Vehicle" (UCAV) will be used when referring to specific DoD platforms designated for an aerial strike mission (i.e. the Unmanned Carrier-Launched Airborne Surveillance and Strike platform, known as UCLASS), although the use of the UAS term to refer to such platforms remains doctrinally correct.[30] This study will also be limited by time constraints and travel funding for research purposes provided by the US Army Command and General Staff College.

<u>Delimitations</u>

This study will confine itself to a net assessment of the historical development of UAS policy specific to the US Navy from the employment of the first aerial torpedoes in WWI (actually termed "flying bombs") to the UAS of the present day. While the development of both naval UAs and cruise missiles are inherently intertwined, this study will focus on the development of the US Navy's UAS policy (and associated technologies) instead of its cruise missile development and associated policy. Although the development of satellite technologies also affected the policy, development, and employment of ISR-focused UAS, this study will not address the impact of those satellite technologies, only alluding briefly to the policy impact of satellites on the mission of ISR

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[30] Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1-02, 254.

for UAS. This study will confine its focus to the UAS systems utilized primarily by the US Navy rather than those exclusively utilized by the United States Marine Corps or any other service. This study will not focus on the reasons behind historical departmental reorganizations of bureaucratic entities responsible for Navy aircraft research development, fielding, and management. Additionally, the author will not make any recommendation for the procurement of a specific UAS platform or system, nor will he provide any recommendations for perceived needs or capabilities for future UAS platforms. The research conducted here was drawn from unclassified, open-source documents, and did not utilize any For Official Use Only or classified documents.

Research Methodology

This thesis encompasses a detailed net assessment of the historical origin and development of US Navy UAS policy by focusing on the operational demands placed on naval assets by conflicts of the particular time period, while also providing a basic insight into the personalities and institutional attitudes that drove the UAS-specific Navy policy of a given era. Naval involvement from a UAS perspective within a specific conflict will be primarily referenced, with only passing mention made regarding joint service contributions to Navy UAS policy development where applicable. This study will explore the early relationship between cruise missile and UAS development, and address the split of naval UAS development in the 1980s into distinct armed strike (i.e., UCAV) and surveillance-specific (i.e., ISR-centric UAS) families. The subsequent development of naval policy regarding technologies in strike-capable and ISR-focused naval UASs will then be explored through the lens of more recent conflicts, coupled with reference to the overall US Navy policy present behind such development. Reference will also be made to

the most recent deployment of naval UAS, as well as the most recent policy guidance provided by the Navy with regard to the vision for future UAS employment within the Naval Aviation Enterprise. At the conclusion of the study, a reflection on insights gained will be provided in order to provide the reader with the means to fully leverage US Navy UAS policy within future naval operations.

Research conducted for this study includes sources obtained from the US Army's Command and General Staff College Combined Arms Research Library (CARL), the author's personal research, and sources provided by CARL staff. The most relevant sources are those that provide historical documentation of the institutional attitude exhibited by Navy leadership in a given era. The sources that then identified the specific UAS platform or program that embodied this particular paradigm were also especially applicable.

Data was first gathered with regard to specific time periods, beginning with the Navy's first employment of early UA technology following the advent of manned flight. Sources specific to the Navy's development of UAS technology in World Wars I and II, the Korean War, and the Vietnam War were then analyzed for similar decision threads. Research into the Navy's desire for a capable unmanned ISR platform in the 1980s was then expanded upon, leading to an analysis of Navy UAS in the Persian Gulf War that culminated in research into the policy behind the most recent employment of UAS by the Navy in the wars in Iraq and Afghanistan. The final focused area of research was conducted on the most current policies affecting Navy UAS development, largely on the UCAS-D system due to its revolutionary nature and controversial development process. Additional research into the newest Navy UAS under development was also conducted in

order to provide a conceptual framework and for current Navy UAS policy and insight into future Navy UAS policy.

The focus of this study is on the effects that drove US Navy UAS policy development, and whether or not those effects were a direct result of the preeminent conflict facing the Navy at that time. Once all research is completed, the author will examine the data to derive useable insight into the policy behind Navy UAS development over time. Finally, this thesis will draw conclusions based on the insights gained in the course of the author's research, and offer areas for further research on the topic. Reference to the DoD classification and specifications of notable US Navy UAS can be found in Appendix A.

Chapter 2 of this thesis addresses the historical and analytical research referenced throughout this study in the form of a literature review. This chapter provides a detailed explanation of the source material used, and why it is applicable and relevant to the study.

Chapter 3 provides a historical background of Navy UAS usage and policy development from its inception through World War I, through the interwar period to the conclusion of World War II. This chapter explores the conceptual stage of UAS as the technology and associated policy during this time are most theoretical in nature, as conceptions regarding the technology are formulated, but with little practical application and employment.

Chapter 4 provides a historical background of Navy UAS usage and policy development from the Korean War through the 1960s, the Vietnam War, and the 1970s. This chapter explains the Navy's reluctance to embrace UAS in a widespread role despite

a perceived need for the technology based on perceived threats, as evidenced in the fielding of DASH despite the immaturity of the technology and subsequent limitations in meeting mission requirements.

Chapter 5 provides a historical background of Navy UAS usage and policy development from the 1980s, through Operation Desert Storm, and through the 1990s, as UAS concepts are augmented with battlefield experience. This chapter explores the growth stage or "field testing" stage of UAS within the Navy through the use of the *Pioneer* system, the individual behind the program, and the implications of DoD's efforts to centralize funding and joint development for UAS across the services during this period.

Chapter 6 provides a historical background of Navy UAS usage and policy development in the 2000s, following 9/11 and continuing through the Global War on Terrorism (GWOT) to the present day. This chapter highlights this period in particular as a period of maturation for UAS, demonstrating the widespread utilization of the technology across the range of naval operations in support of offensive, defensive, security, and stability operations.

Chapter 7 presents conclusions and offers recommendations for further research, drawing from insight into present-day Navy UAS usage and policy development, with some insight provided into future Navy UAS programs. This chapter provides a summary of conclusions from the previous chapters, and offers recommendations for future Navy UAS policy and development. This chapter also offers a perspective for future Navy UAS policy and development based on the historical data gathered and presented throughout this study.

CHAPTER 2

LITERATURE REVIEW

This study analyzes the historical environment that led to the specific direction of US Navy UAS policy over time. In drawing from both primary and secondary sources, this study traces UAS development in comparison to Navy policies and personalities that led to the major steps in Navy UAS development, acquisition, and employment. The following review identifies the primary and secondary sources that played a key role in the completion of this study.

The primary sources used in this study were essential to providing the contextual setting for various periods of Navy UAS history. Most beneficial for analysis of modern Navy UAS policy are the multiple DoD, Department of the Navy (DoN), and the Office of the Secretary of Defense (OSD) sources that provided doctrinal guidance, policy goals and priorities, and strategies and visions from a US Navy aviation, maritime, and UAS perspective.

Recent overall policy regarding UAS utilization by the Navy became readily apparent while tracing the Navy's doctrine through *...From the* Sea (1992) and *Forward...From the Sea* (1994) to the Navy's focus on UAS through multiple *Quadrennial Defense Review Reports* (2006, 2010, 2014) into the DoD's *Unmanned Aerial Vehicles (UAV) Roadmap 2002-2027* (2002), *Unmanned Aircraft Systems Roadmap 2005-2030* (2005), *Unmanned Aircraft System Airspace Integration Plan* (2011) and the *Unmanned Systems Integrated Roadmap FY2013-2038* (2013), and then into the DoN's *Naval Operations Concept 2010–Implementing the Maritime Strategy* (2010), the *Naval Aviation Vision 2020* (2005), the *Naval Aviation Vision* (2010), the

Naval Aviation Vision 2014-2025 (2014), and both versions of *A Cooperative Strategy for 21st Century Seapower* (2007, 2015). The Defense Advanced Research Projects Agency's (DARPA) *J-UCAS Overview* was particularly useful in its explanation of the evolution of the Navy Unmanned Combat Air Vehicle (N-UCAV) UAS to today's UCAS-D. Rear Admiral Mark W. Darrah's "The Age of Unmanned Systems" from the *United States Naval Institute Proceedings* provided exceptional insight into the current and immediate future of the Navy's UAS integration plan. As the Program Executive Officer for Unmanned Aviation and Strike Weapons at the Naval Air Systems Command (NAVAIR), Darrah is a definitive source regarding the Navy's approach to obtain and employ UAS as key enablers to provide All Domain Access to the Fleet. Similarly, the Congressional transcript hearing of Admiral John Richardson's nomination as the next CNO provided insight into the Navy's modern-day UAS policy in light of recent global events from the perspective of the Navy's most senior officer. The two US Government Accountability Office articles cited in this study were useful in tracing external policy drivers outside the Navy regarding US Navy UAS developments.

Secondary sources utilized in this study predominantly provided historical background information regarding the types of UAS developed by the Navy, as well as identifying the historical context that existed when these platforms were developed, brought on line, and employed. Other sources were helpful in addressing the institutional attitude of the Navy during specific periods of time, which can be largely attributed as a major driving factor behind Navy-specific UAS policy development.

The most beneficial study in this regard was Thomas P. Ehrhard's Ph.D. dissertation "Unmanned Aerial Vehicles in the United States Armed Services: A

Comparative Study of Weapon System Innovation." The author provides a comprehensive view of the service-specific UAS and unmanned weapons systems that defined America's role in multiple conflicts across modern history, from initial conception up to the terrorist attacks on the United States on 9/11. From a historical perspective, this source provides a peerless level of detail regarding the US military's development of unmanned aerial technologies, with a very specific focus provided on the Navy's UAS-specific policy and the factors that influenced it. Additionally, John D. Blom's *Unmanned Aerial Systems: A Historical Perspective* was useful in its detailed analysis of UAS development over the course of the history of the US military, with a particular focus on their use as surveillance platforms. His study encompasses over 60 years of UAS technological development, peaking with the culmination of UAS employment in Iraq and Afghanistan. Blom also provides valuable personal insight into potential future UAS applications.

Lawrence R. Newcome's *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* chronicles the lengthy history of UAS development back to their roots as aerial "bombs" (technically torpedoes) by one of America's foremost experts on UAS. Newcome argues that the development of unmanned systems throughout history has been reactionary in nature to the current conflict at hand, as engineers would repeatedly "get to work on the latest unmanned concepts, all but blind to the work of those who came before them." A detailed consideration of UAS employment during the Cold War, Vietnam, and in Israel are highlights of the author's research, as those examples are then tied into modern day UAS development.

In his monograph entitled "The Unmanned Aerial Vehicle's Identity Crisis," Lt. Col. Dennis Larm, USAF argues that the "sense of identity" of UAS in the US military is ambiguous due to past utilization and the relative infancy of its application as compared to manned aircraft. In a relatively concise manner, Larm examines the historical background of UAS to identify and documents the reasons for its immaturity, touching on issues of development, policy, and technological limitations that have all hampered UAS employment.

The historical analysis entitled *Attack of the Drones: A History of Unmanned Aerial Combat* by Bill Yenne provides a detailed level of analysis of the history of UAS employment in combat operations. Yenne provides a popular view concerning the history of unmanned combat aircraft since the 1940s. It is mostly referential in style, employing a great deal of technical data and photographs of various UAS, however, the author's focus is primarily on American UAS, which limits the book's overall scope. The amount of policy that influenced UAS development is also minimally included by the author, leaving the historical background of some platforms open to interpretation by the reader.

George W. Baer's *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990* provides a well-researched perspective on the evolving historical relationship between elements of naval power and the national policies they enforced. Explanations of how the Navy defined its purpose in the century after 1890, with specific attention given to the doctrine and policies following up to, during, and after a given conflict, were essential in identifying the role of the Navy's UAS programs through such a lens. Consideration is given to the Navy's attempts to reinvent itself in the wake of the Mahanian revolution, adapting its principles in the face of a Soviet naval threat, and then modifying those

principles again to fit a new doctrine of littoral warfare. By outlining how the Navy has responded as an organization in terms of doctrine, strategy, and operations, Baer provides a clear, easy-to-follow narrative of the evolution of Navy policy.

Specific to the development of the UCLASS system, Jeremiah Gertler's *History of the Navy UCLASS Program Requirements: In Brief* provides a concise yet detailed description of the lengthy and tenuous development of the Navy's UCLASS program from conception to the current day. This report traces the Navy-specific and joint policy guidance that started with the development of the N-UCAV, which became the J-UCAS, then the N-UCAS, and now currently the UCLASS. Gertler's exhaustive research of the history of UCLASS requirements development through the program's evolution to its current stage provides the most in-depth discussion of this system based on available open-domain information.

"Retreat From Range: The Rise and Fall of Carrier Aviation" by CAPT Henry "Jerry" Hendrix, USN (Ret.) of the Center for a New American Security provides an argument for carrier-specific application of UAS as a means to increase the lethality range of the US carrier fleet. By comparing ISR-centric UAS advocates of today to the battleship admirals of the 1920s and 1930s, Hendrix makes a convincing argument for a return to a carrier air wing capable of greater range utilizing UAS as a means to providing the Navy with a stealthy, deep strike capability with consideration given to payload, persistence, range, and mass. Hendrix argues for an integration of UAS into the air wing that can operate at a stand-off distance from an enemy's A2/AD networks.

Gautam Mukunda's article entitled "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy" from the periodical *Security Studies* provides a

summary an application of the theory of "disruptive innovation," which contends that a successful business would not be successful if it routinely neglected innovation, but argues that not all innovation has the same effect. Using the Royal Navy of World War I as an example, Mukunda argues that the theory of disruptive innovation explains why the Royal Navy was successful in developing a system of anti-submarine warfare (ASW) to protect its fleet, yet struggled to counter that same submarine threat to its merchant shipping. Attributing the Royal Navy's focus on the primary ASW task to the detriment of the performance of its secondary task within disruptive innovation theory, Mukunda offers this theory as a means of analyzing similar organizations. Applying the theory of disruptive innovation to the US Navy's historical approach to the integration of UAS within the Fleet provides deeper insight into the Navy's approach when first presented with the technology, and a means to judge the Navy's reaction to UAS.

A historical analysis of UAS development was also provided by John F. Keane and Stephen S. Carr's article "A Brief History of Early Unmanned Aircraft," from the *Johns Hopkins APL Technical Digest*. The authors provide a succinct historical survey on the early development of selected UAS across the US military and their subsequent service-specific applications. Focusing on early UAS development through the Persian Gulf War, the authors highlight the key individuals that played a role in UAS development across the decades. The authors argue that the history of UAS and cruise missiles is inherently intertwined, as "many of the technologies experimented with in cruise missiles made their way to [UAS], and vice versa."

Norman Polmar's "The Pioneering Pioneer" from *Naval History Magazine* provides a popular historical summary that explains how the US Navy has played a lead

role in the use of unmanned aircraft from early drones to the development of modern UAS. He specifically focuses on the transitional period from the Navy's use of DASH to its use of the *Pioneer* UAS as directed by then-SECNAV John F. Lehman, Jr. He argues that the *Pioneer's* decades of service marked a significant step in the development and operation of UAS throughout the US armed forces, not just the Navy.

The article entitled "Pigeon Holes or Paradigm Shift: How the Navy Can Get the Most of its Unmanned Aerial Vehicles" by CAPT Robert C. Rubel, USN (Ret.) from the *United States Naval Institute Proceedings* (hereafter *Proceedings*) provides a modern day argument for the US Navy to combine future innovations with "tested ideas" in order to maximize the effectiveness of its UAS. With an eye to the future, Rubel describes several historical examples of "paradigm shifts" in aviation innovation that he argues should provide a basis for future UAS development and employment. As the dean of the Center for Naval Warfare Studies at the U.S. Naval War College and a former naval aviator, Rubel's professional expertise provides a well-argued position for the future of US Navy aviation with specific regard to its UAS programs.

Additional articles from *Proceedings*, the *United States Naval Institute News*, and *Naval Forces* publications also provided timely insight into myriad Navy UAS-related topics, from both a current and historical standpoint.

Literature Summary

The literature referenced in this study provides a significant amount of information specific to the historical background of UAS, the historical development and employment of unmanned aviation technology over time, as well as insight into the individuals who made UAS-specific policy decisions within a naval context. In certain

cases, parallels and comparisons to the development and use of unmanned aviation technology in other services was also provided, but to varying degrees between sources, and some provided only a passing reference to the subsequent impact on Navy UAS policy specifically. This required an analytical inference concerning the Navy's policy to be drawn out of the approaches made by other services regarding UAS development, employment, and policy. The historical UAS-specific context provided by these sources merged well within the context of overall Navy operations during specific time periods, which helped highlight the Navy's approach concerning UAS across various conflicts as the technology itself developed, matured, and changed based on operational need, levels of technological maturity, and the vision of Navy leadership.

Areas for additional study include the original (and in some cases classified) documents released by specific Navy commanders throughout the Navy's history specific to UAS, which will provide layers of additional detail into the considerations, decisions, and personalities affecting higher-level Navy leaders that directly impacted the Navy's approach to UAS. Short of analyzing additional autobiographical material for UAS-specific insight into the personalities behind Navy UAS policy, conducting interviews with the leaders that made and drove Navy UAS policy decisions would be helpful in determining the operational environment and constraints that affected those decisions. This information will provide additional granularity and a level of understanding into the questions researched throughout this study for the benefit of the reader.

CHAPTER 3

US NAVY UAS POLICY IN THE WORLD WAR I, INTERWAR, AND

WORLD WAR II ERAS

Just as manned aviation was beginning to take shape within a military construct, engineers and intellectuals of the time were already considering the distant implications of the unmanned aerial technology. As the Navy sought to leverage the technological advantages of aviation, initial interest in the concept and applicability of UAS took flight. However, the immaturity of the technology at this time remained a key impediment to UAS development. The Navy perceived UAS as a novelty through WWII as manned aviation assets proved their value in both theaters of the war. During this time, naval UAS were perceived as "disruptive technologies" rather than as revolutionary, transformative newcomers.

<u>Early Beginnings</u>

In 1884, a young Serbian immigrant named Nikola Tesla arrived at Ellis Island in New York Harbor, reportedly with four cents in his pocket, a book of poems he had written, and his plans for a remotely controlled unmanned airplane.[31] At the time, Tesla claimed he could invent a remotely piloted aircraft that "could change its direction in flight, explode *at will*, and . . . never make a miss."[32] To demonstrate his hypothesis, Tesla explored the use of remote control on a four-foot-long boat in a tub of water,

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[31] Newcome, 11.

[32] M. J. Seifer, *Wizard: The Life and Times of Nikola Tesla* (Secaucus, NJ: Birch Lane Press, 1996), 199.

making it start and stop, turn left and right, and flash its lights using different radio frequencies. The concept was dismissed as a trick of no practical value, no military interest came from the demonstration, and Tesla subsequently turned his attention to other pursuits.[33] The idea of unmanned aircraft was left to others to realize, but its conception within an aquatic setting presaged the role the US Navy would play in the field.

Following the first flight of the Wright brothers in December 1903, widespread interest in the possibilities of aviation inspired many inventors of the time period. Nearly two decades after Tesla's demonstration, Dr. Peter Cooper Hewitt, a friend and contemporary of Tesla, proposed Tesla's idea of a remotely piloted airplane to fellow New York inventor Elmer Sperry. In 1911, Sperry provided the first practical demonstration of Tesla's concept by developing small gyros that he installed in an airplane's pitch, roll, and yaw axes, using servomotors to connect them to the aircraft's flight controls.[34] After seeking support from the Army and receiving no response, Sperry obtained financial support and assistance from the Navy and personally oversaw 58 flight tests between 31 August and 4 October 1913 conducted by LT P. N. L. Bellinger at Hammondsport, New York, where the application of the gyroscope to stabilized flight proved successful.[35] Further tests continued to a lesser degree through 1914 as the start of

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[33] Ibid., 201.

[34] Newcome, 16

[35] Keane and Carr, 559.

WWI restricted experimentation with UAS within Europe, placing the efforts of the

United States at the forefront of the technology.[36]

<u>Early US Navy UAS Policy</u>

The specific Navy department tasked with aviation asset development and

procurement has changed drastically since its inception, mirroring the increased emphasis

the Navy has placed on aircraft throughout its history. The forerunner of these

departments was the Naval Consulting Board, founded in 1915 by then-SECNAV

Josephus Daniels out of concern for the Navy's access to the latest technologies. In 1915,

Sperry and Dr. Peter Cooper Hewitt were appointed members to the Aeronautical

Committee of the Naval Consulting Board led by Thomas A. Edison to advise SECNAV

Daniels on scientific matters.[37] Lagging behind the Europeans in combat aviation power,

the leadership of the US military sought to gain any edge through innovation, including

in the realm of unmanned aviation. Daniels was interested in any technological

breakthrough with widespread military applicability.[38] Instead of the Army, it was the

Navy that first explored the possibilities of unmanned aerial technology, primarily as a

means to attack an enemy's naval assets.[39] It was this desire to develop and capitalize on

technological innovation that best characterized the Navy's early policy regarding UAS.

In 1916, with Europe entangled to an even greater degree in WWI, Carl Norden

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[36] Ehrhard, 661.

[37] Adrian O. Van Wyen, *Naval Aviation in World War I* (Washington, DC: Chief of Naval Operations, 1969), 110.

[38] Ehrhard, 662.

[39] Ibid.

(developer of the Norden bombsight of WWII) joined with Sperry and Hewitt to develop the concept of a "flying bomb."[40] On 14 April 1917, eight days after America's entry into WWI, the group received a recommendation from the Naval Consulting Board to Secretary Daniels for a grant of $50,000 for experimental work on aerial torpedoes.[41] This was significant in that it marked the first military contract for an unmanned flight system.[42] In the ensuing tests, however, the complicated launch facilities and the randomness of the aerial torpedo attack (having a three mile miss at a range of ten miles) made the weapon impractical for ship attack without some method of terminal guidance.[43] In response to these efforts, in November 1917 Daniels approved $200,000 in funding for the development of an improved Sperry flying torpedo using a gyroscopically-controlled Curtiss N-9 seaplane.[44] While launches with a pilot onboard were successful, unmanned catapult launches of this version were unsuccessful as the forces of acceleration scrambled the delicate internal mechanisms of the gyroscope.[45] Despite these difficulties, the project was kept alive due to the ardent support of Rear Admiral Ralph Earle, the US Navy Chief of the Bureau of Ordnance, who sought to employ this technology against the German U-boat menace, and consequently

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[40] Roy A. Grossnick and William J. Armstrong, *United States Naval Aviation, 1910-1995* (Washington, DC: Naval Historical Center, Department of the Navy, 1997), 78.

[41] Keane and Carr, 559.

[42] Blom, 45.

[43] Ehrhard, 661.

[44] Van Wyen, 111.

[45] Ehrhard, 662.

experimentation and development continued up until the end of the war.[46] Heavily

influenced by the sinking of the *RMS Lusitania* in 1915, and the widespread impact of U-

boats on European merchant shipping, Earle argued for the further maturation of the

flying torpedo as a means to revolutionize naval warfare.[47] However, the immaturity of

unmanned aerial technology during this time greatly hindered its widespread

applicability.

On 6 March 1918, the Curtiss-Sperry aerial torpedo (termed a "flying bomb"), a

precursor of the modern cruise missile, made its longest successful flight of over 1,000

yards, and on 17 October 1918, a pilotless version was successfully launched; it flew its

prescribed course but failed to land at a preset range of 14,500 yards and crashed at sea.[48]

Before the Armistice was signed on 11 November 1918, more than 100 aerial torpedo

tests had been conducted by the Navy, but the technology was never approved for

wartime service.[49] The Navy's reactionary and limited outlook on aviation in 1919 was

summarized by the first CNO, Admiral William S. Benson, who presaged the parochial

divisions that would come to characterize the Navy when he argued that he could not

"conceive of any use the fleet will ever have for aviation," while simultaneously

attempting to abolish the Navy's Aviation Division.[50] Despite the Navy's limited outlook

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[46] Ibid.

[47] Ibid.

[48] Grossnick and Armstrong, 82.

[49] Keane and Carr, 560

[50] Jeffrey S. Underwood, *The Wings of Democracy: The Influence of Air Power on the Roosevelt Administration, 1933-1941* (College Station, TX: Texas A&M University Press, 1991), 11.

on the promise of aviation, Earle continued with the project until declining budgets and the sheer number of crashes compelled him to recommend to then-CNO Admiral Robert E. Coontz that further tests be discontinued, and the last flight of the flying torpedo program took place on 25 April 1921, due in large part to the immaturity of the technology available to consistently and successfully pilot an unmanned aircraft.[51]

The Interwar Years

Following the Armistice, interest in unmanned flight waned along with military budgets as hostilities ceased.[52] With the termination of the aerial torpedo project, however, the Navy continued its pursuit of innovation, sponsoring several tests involving radio-controlled aircraft developed at the Naval Research Laboratory and flown at the Naval Proving Ground in Dahlgren, Virginia.[53] In 1921, the Naval Consulting Board was replaced by the Bureau of Aeronautics (BuAer), initially headed by Admiral William A. Moffett, providing material-support organization for naval aviation from 1921 to 1959. BuAer had responsibility for the design, procurement, and support of naval aircraft and related systems, while aerial weapons were the responsibility of the Navy's Bureau of Ordnance (BuOrd). Following a series of demonstrations of the capabilities of manned aircraft against capital ships off the Virginia Capes in June 1921, Admiral Moffett, Chief of BuAer, stressed the need for the development of radio-controlled target aircraft for use

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[51] Ehrhard, 662.

[52] Keane and Carr, 561.

[53] James J. Hall, *American Kamikaze* (Titusville, FL: J. Bryant, 1984), 31.

in fleet training exercises.[54] Moffett, considered the architect of naval aviation, was an outspoken proponent of sea-based aviation as an innovative means of achieving naval supremacy.[55] To this end, BuOrd directed the Naval Proving Ground in May 1922 to acquire one of the original N-9 aircraft used in the aerial torpedo experiments and to fit it with a Norden radio-control system to determine the feasibility of autonomous takeoff and landing.[56] On 15 September 1924, the Naval Research Laboratory successfully conducted three test flights demonstrating the viability of both the automatic stabilization and radio-control systems of an unmanned Curtiss F-5L aircraft. For the first time in history, with Navy funding, a radio-controlled aircraft was flown remotely through all phases of flight–takeoff, maneuvering flight, and landing.[57] Tests continued over the course of the next 14 months, but following an unsuccessful test on 11 December 1925, the project was suspended, but not cancelled, although it remained dormant until 1936.[58]

Interest in the prospect of unmanned aviation in the Navy was renewed in 1933 when then-CNO Admiral William H. Standley observed a remote-controlled British UA being used as a target for naval anti-aircraft artillery. The model, known as the *Fairley Queen*, successfully evaded naval gunfire for two hours, illustrating the ability of a UA to

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[54] Lloyd N. Scott, *Naval Consulting Board of the United States* (Washington, DC: Government Printing Office, 1930), 115.

[55] William F. Trimble, *Admiral William A. Moffett: Architect of Naval Aviation* (Washington, DC: Smithsonian Institute Press, 1994), 116.

[56] Linwood S. Howeth, *History of Communications–Electronics in the United States Navy* (Washington, DC: Bureau of Ships and Office of Naval History, 1963), 348.

[57] Ibid., 348-9, 480.

[58] Ibid., 349.

provide realistic training to naval anti-aircraft crews.[59] Standley saw the value in

employing this technology for training purposes, breathing new life into what was still a

relatively new role for unmanned aircraft. Following a demonstration of British aerial

targets at the London Disarmament Conference in 1935, he subsequently recommended

that the US Navy pursue a similar program.[60] After conferring with Rear Admiral Ernest

J. King, the Chief of the Bureau of Aeronautics, in May 1936 Standley directed King and

Rear Admiral Harold G. Bowen, the Chief of the Bureau of Engineering, to proceed with

the development of radio-controlled airborne targets for use by the Navy.[61]

Lieutenant Commander Delmar S. Fahrney was subsequently designated officer-

in-charge of the Radio-Controlled Aircraft Project on 20 July 1936. In his semiannual

report, Fahrney introduced the term "drone" for aerial targets, the use of which continues

to this day.[62] Tests continued through May 1938, and on 24 August 1938, UA were

successfully used as aerial targets for the first time in the United States by the gunners of

USS *Ranger* (CV-4). The second test occurred on 14 September 1938, when gunners on

the USS *Utah* (AG-16) destroyed a drone simulating a dive-bombing attack.[63] Use of

radio-controlled UAs for targeting drills continued over the following year, helping the

Navy identify deficiencies in fleet air defense systems against maneuvering targets while

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[59] Blom, 46.

[60] Ibid., 47.

[61] Keane and Carr, 563.

[62] Delmar S. Fahrney, "The Birth of Guided Missiles," *United States Naval Institute Proceedings* (December 1980): 54.

[63] Newcome, 65.

simultaneously accelerating improvements in fire-control systems.[64] By the end of 1939, the Navy was "committed" to funding and developing assault UAs, and the use of UAs for ship gunnery training had become the standard.[65]

As a result of his work, Fahrney recommended that the aerial torpedo project of WWI be revived, and proposed to Rear Admiral Arthur B. Cook, the Chief of the Bureau of Aeronautics, that the use of radio control for the testing of new aircraft should be investigated.[66] Despite his original orders to develop only a radio-controlled target drone, Fahrney saw the potential to apply this technology to what were being termed "assault drones," and recommended that his project be expanded to include their development.[67] In the two years leading up to Pearl Harbor, several separate drone efforts were encouraged by senior Navy leadership, and these continued into the first year of the war in the Pacific.[68]

As in WWI, Navy policy of this time period was again largely focused on seeking technological innovation in the field of unmanned aerial technology, with the goal of achieving the successful combat employment of a UA. However, with the proven viability of using unmanned aerial technology for gunnery training purposes leading up to WWII, a precedent was set and a new mission was established. The aerial torpedo was

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[64] Richard M. Clark, CADRE Paper No. 8, *Uninhabited Combat Aerial Vehicles: Airpower by the People, for the People, But Not with the People* (Montgomery, AL: Air University Press, 2000), 3.

[65] Keane and Carr, 563.

[66] Fahrney, 55.

[67] Newcome, 66.

[68] Ibid.

designed to address a specific tactical requirement; however, its widespread use was again hampered by the inherent limitations of the technology of the time.[69] In contrast, the use of radio-controlled UA for gunnery training was more successful and more widespread, but it was an innovation developed first by the British and adopted by the US Navy. The Navy's approach towards the development and employment of UAS at this time can therefore be seen as desiring a breakthrough innovation rather than striving for widespread refinement or improvement of existing UA technologies. Such an approach characterized the Navy's employment of UAS technology in the next major naval conflict.

US Navy UAS Policy in WWII

Among the US services, the Navy again led the way in UAS innovation at the outset of WWII, conducting the first-ever experiments adding weapons to a UA in 1942.[70] With the entry of the United States into WWII, the Navy adopted the strategic policy of fighting both Germany and Japan simultaneously, and forces to accomplish a two-front naval campaign were severely lacking.[71] Naval forces in Europe submitted an urgent operational need for a weapon that could be flown into the reinforced U-boat pens along the coast of France. Similarly, in the South Pacific, the Navy searched for a weapon that could be used to strike heavily defended Japanese air defenses of the Japanese

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[69] Ehrhard, 616.

[70] Clark, 4.

[71] George W. Baer, *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990* (Stanford, CA: Stanford University Press, 1994), 187.

bastion of Rabaul in the Bismarck Archipelago east of New Guinea.[72] With a particularly

bleak operational picture in the Pacific, the unmanned assault drone offered a "Hail

Mary" option to Navy leadership.[73] This interest was spurred by the relative success of

prewar target drones and a lack of sufficient aircraft carriers and their associated

embarked air wings.[74] In January 1942, Rear Admiral John H. Towers, Chief of the

BuAer, pushed for the development of the forerunner of the modern-day UCAV, arguing

for the fielding of a radio-controlled assault drone capable of conducting offensive

operations by dropping either a torpedo or depth charge, rather than the pursuit of other

drone versions that were designed to be flown directly into their targets.[75] However, these

early versions were designed to be flown directly into their targets, making them more

closely related to cruise missiles than UAS.[76] Within three months, Towers reported to

then-CNO Admiral Harold R. Stark that radar was being developed to replace television

as the primary guidance system in order to allow the assault drone to operate under all

conditions of visibility.[77] Following his appointment as Stark's relief, as late as May

1942, then-CNO (appointed 18 March 1942) Admiral Ernest J. King directed the

development, fielding, and production in quantity of an assault drone "at the earliest

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[72] Keane and Carr, 564.

[73] Newcome, 66.

[74] Keane and Carr, 564.

[75] Clark, 4; Grossnick and Armstrong, 91.

[76] Keane and Carr, 564.

[77] Grossnick and Armstrong, 94.

practicable date."[78] Termed Operation Option, this approach was based on the premise

that an unmanned assault drone (designated TDR-1) should be used suddenly and over a

wide area to gain the element of surprise, and then used continuously and heavily in order

to overcome any countermeasures being developed against it.[79] Under the command of

Commodore Oscar Smith, and mirroring the approach taken by the Navy towards the end

of WWI, in Operation Option the Navy again sought to leverage this improved

technology against an enemy's naval force.[80] Initially a television camera, transmitter,

and torpedo were attached to the earliest versions of this UA, and it was designed to be

flown by an operator in a nearby manned "mother" aircraft using a television monitor for

feedback on a one-way attack run. Even with an upgrade to radar-guidance that enabled

attacks in all weather conditions and at night, maintenance problems and technological

issues again plagued the program, and the success of manned carrier aviation against the

Japanese fleet made many naval commanders skeptical of its usefulness, including

Admiral Chester W. Nimitz, Commander of the Pacific Fleet.[81] Nimitz revealed at the

time that he was "reluctant to accept a new and untried weapon when the combat

resources available to him were working so well."[82] Such a reaction reflects a paradigm

that remains prevalent to the current day, where leaders in different naval communities

sometimes find themselves at cross-purposes. During WWII in particular, autonomous

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[78] Newcome, 66.

[79] Ibid.

[80] Ehrhard, 616.

[81] Keane and Carr, 565.

[82] Dennis Larm, *The Unmanned Aerial Vehicle's Identity Crisis* (Carlisle, PA: U.S. Army War College, May 2004), 2.

bureau chiefs and naval commanders reported directly to the civilian SECNAV, and throughout the war strongly resisted attempts by the CNO to bring them under his control.[83]

The idea of "disruptive innovation" explains this approach, particularly as it applies to innovation in a specific area. As Professor Gautam Mukunda explores in "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy," innovations affecting the primary mission of an organization tend to be coped with effectively, while those affecting secondary missions tend to be overlooked.[84] Such "disruptive innovations" fail to affect change within an organization as the organization becomes more specialized towards its primary task to the neglect of secondary tasks. Lacking crucial information to fully acquire the innovation, and failing to create new organizations to study its impacts, the organization fails to fully develop the metrics to measure the effectiveness of the innovation.[85] Such an approach effectively characterizes the Navy's early response to UAS during WWII.

However, King and Admiral Raymond A. Spruance collaborated to push for additional UAS testing, leading to several groundbreaking developments by the Navy.[86] In March 1942, the Navy conducted the first successful live attack with a radio-controlled UAS that released a dummy torpedo against a maneuvering destroyer, the USS *Aaron*

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[83] Baer, 183.

[84] Gautam Mukunda, "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy," *Security Studies* 19, no. 1 (January 2010): 126.

[85] Ibid., 129-136.

[86] Ehrhard, 672.

Ward (DD-483).[87] Successful tests conducted throughout the summer of 1942 demonstrated in 47 of 50 attack runs that both depth charges and torpedoes could be dropped from a UA up to a maximum distance of six miles between the UA and its controlling aircraft as long as a clear television picture was maintained.[88] These successes led the Navy to order the procurement of 500 attack drones and 170 "mother" aircraft.[89] For further tests, Towers emphatically argued for the employment of obsolete aircraft (such as the TBD Devastator, SB2C Helldiver, and SB2D Destroyer) so that they could be manufactured in quantity outside the aircraft industry in order to prevent the industry from being burdened with the production of a weapon unproven in combat on top of manned aircraft production.[90] On 29 August 1943, the Navy established Special Air Task Group ONE to operate the TDR-1 drones, and they successfully demonstrated the feasibility of deploying the drones from fleet carriers. Despite this, the only combat use of these drones was to be from land.[91] In a series of combat tests between July and October of 1944, the Navy tested 46 TDR-1 drones, 29 of which reached the target area, and 18 of those achieved what were considered "successful" releases of ordnance on their targets.[92] On 19 October 1944, the Navy employed a TDR-1against the Japanese on Ballale Island in the Solomon Islands, dropping ten 500- and 100- lb bombs on gun

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[87] Keane and Carr, 564.

[88] Grossnick and Armstrong, 95.

[89] Clark, 5.

[90] Keane and Carr, 564.

[91] Clark, 6.

[92] Keane and Carr, 565; Newcome, 69.

emplacements before departing, although the UA crashed into the sea as a result of enemy anti-aircraft fire.[93] By this time, the major conflict had moved far to the north, so these strikes had little effect on the outcome in the South Pacific.[94] Despite this, the operational validity of a UCAV-type system was proven by the deployment of the TDR-1.[95] After a month of combat successes, the critics of the program prevailed when King cancelled the program before the tests were even completed, disestablishing Special Air Task Group ONE on 27 October 1944, the day after its last mission against a Japanese target.[96] In hindsight, of the 50 TDR-1 assault drones flown in combat, 15 were lost to mechanical/technical causes, three to enemy fire, and 31 hit or damaged their targets, all of which were accomplished without the loss of a single US aviator.[97]

At the same time in Europe, another Navy-specific experiment in unmanned flight during WWII, termed Operation Anvil, was part of the Allied effort to eliminate the V-1 rocket menace facing Britain.[98] Although Germany's deployment of V-1 and V-2 rockets was the most famous use of unmanned flight during the war, the Navy and the Army experimented with separate, uncoordinated efforts to employ remote-controlled bombers (B-24s and B-17s, respectively) with up to 25,000 pounds of explosives onboard,

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[93] Newcome, 69.

[94] Keane and Carr, 565.

[95] Newcome, 69.

[96] Blom, 47.

[97] Grossnick and Armstrong, 97.

[98] Blom, 48.

constituting the largest nonnuclear payload in history.[99] Project Anvil employed B-24s (termed BQ-8s) flown at 2,000' by Navy crews who bailed out of their explosive-laden aircraft before crossing the English Channel while another B-24 at an altitude of 20,000' then controlled the BQ-8 via radio control. This project achieved only a minor success when a BQ-8 damaged a German submarine pen in Helgoland, Germany, but overall it was remarkable only for the loss of the elder brother of President John F. Kennedy, Joseph Kennedy, Jr., who was killed along with his copilot when his BQ-8 exploded before either man could bail out.[100] In both the Pacific and European theaters, the Navy's innovation in the field of UA led to some remarkable milestones, but as in WWI, wider implementation of this technology was hampered by the immaturity of the technology, a lack of coordination across theaters and services, and the Navy's failure to fully leverage its potential.

<div align="center">US Navy WWII UAS Policy in Perspective</div>

As in WWI, the efforts to develop unmanned technologies were uncoordinated across the services and characterized by intra- and interservice politics, to include BuAer and BuOrd, resulting in limited operational success.[101] Although the Navy had dedicated target drone units as early as 1939, the Navy failed to field the same or better UA with a warhead, torpedo, or depth charge in the ensuing six years of WWII. One reason for this stagnation was self-victimization by project managers with regard to "requirements

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[99] Ibid.

[100] Clark, 7; Hall, 40.

[101] Keane and Carr, 564.

creep" as television guidance gave way to radar, then radar homing; each innovation delayed the assault drone's entry into service, drove its production potential down, and its price up.[102] Secondly, drones were labeled as unconventional or experimental, and Towers denied their manufacturers access to widespread industrial resources due to the ongoing ramp up of conventional wartime production assets.[103] Thirdly, target drones had relied on using obsolete or "cast-off" aircraft for the two years leading up to Pearl Harbor, leaving the assault drone production base with no foundation from which to build.[104] Finally, the theater commander and his staff, who would be the first to inherit and employ a new weapon, were not informed of the assault drone's existence until the war's outcome was nearly decided. In failing to gain the support of its ultimate customer from the outset, Nimitz did not perceive Operation Option as a long-awaited arrival but as a sudden and unwelcome intruder.[105] UAS technology was perceived as a disruptive innovation instead of a force multiplier. Far from being single incidents, these reasons resurfaced in subsequent conflicts as the Navy struggled to implement unmanned aviation technology.

Ultimately, widespread employment of assault drones faced the twin challenges of technological immaturity and competition from other platforms, effectively hampering their adoption by the Navy.[106] Not only were the drones not ready for widespread combat

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[102] Newcome, 70.

[103] Ibid.

[104] Keane and Carr, 564.

[105] Newcome, 70.

[106] Ehrhard, 674.

application, they did not easily fit into well-oiled and strategically dominant Navy carrier operations.[107] However, while the operational use of UAS by the Navy in WWII had many shortcomings, this time period was nonetheless significant in its utilization of UA for a variety of missions by the Navy. This was the first time the Navy purchased UAS in mass for target practice as well as for experimentation as ordnance-delivery vehicles.[108] Navy testing resulted in the first live attack by a UCAV that successfully employed ordnance against a maneuvering target.[109] Operational successes in the Pacific theater further demonstrated the feasibility of the UCAV concept.[110] With this additional validation of the concept of unmanned flight, research could now be conducted into furthering UAS experimentation in additional roles. The beginning of the Cold War ensured that defense spending was to be a high budget priority, and the rapid developments in aviation technology ensured a continuation of new research into unmanned flight.[111]

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[107] Ibid.

[108] Blom, 48.

[109] Keane and Carr, 564.

[110] Ibid.

[111] Blom, 48.

CHAPTER 4

US NAVY UAS POLICY FROM THE KOREAN WAR TO THE 1970s

The onset of the Cold War immediately following WWII brought about a new

role for UAS across the services and the Navy in particular. Navy policy was affected by

a major doctrinal commitment set forth by then-Deputy CNO for Operations Vice

Admiral Forrest in 1946 that held the Navy to the tradition of forward deployment and

offensive operations; a strategy that preserved the centrality of the aircraft carrier.[112] Such

an approach dovetailed with America's preeminent concern during this time period of

suppressing the spread of Communism, maintaining a nuclear weapons advantage, and its

emphasis on developing a significant intelligence database to support strategic

planning.[113]

US Navy UAS Policy Before, During and After the Korean War

During the Korean War, UAS played a role in the Navy's mission areas of ISR,

ASW, and strike. Between April 1950 and April 1969, 16 manned reconnaissance flights

flown by US Navy and Air Force crews encountered hostile fire, with the loss of 163

lives.[114] These losses led to a greater push for unmanned aircraft to assume the hazardous

missions of reconnaissance and surveillance, a role that increased in the decades to come.

US efforts to exploit space for intelligence purposes were also spurred by these losses,

starting in 1995 with a number of satellite reconnaissance programs being pursued by the

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[112] Baer, 287-288.

[113] Keane and Carr, 566.

[114] Howeth, 491.

Central Intelligence Agency, the Air Force, and the Navy.[115] In addition to a growing ISR

focus, on a tactical level, the Navy's concern for the growing capability of the Soviet

submarine threat spurred a significant investment in ASW. UAS technology employed in

combat towards the end of WWII also played a role in the Korean War, albeit an

insignificant one due to the unpreparedness of US forces following the outbreak of

hostilities on 25 June 1950. Unfortunately for the benefit of the US military as a whole,

the Navy's contribution to UAS during this period was hampered by its decision to

develop UAS to address very limited, tactical shortfalls, and only when pushed by a

strong executive personality.[116]

US Navy Policy Regarding Surveillance

Based on the premise stemming from the Cold War that the next war would be a

nuclear one, the US military surmised that reconnaissance missions in a post-nuclear

exchange environment would be too hazardous for manned aircrews.[117] Validated by the

radiation sickness incurred by pilots who flew data-gathering missions over Bikini Atoll

following nuclear tests in 1946, these missions introduced the "dirty" factor into

considering which missions should best be delegated to unmanned aircraft.[118] The

concept of using UA for reconnaissance naturally evolved during the mid-1950s from the

cruise missile and target decoy roles that they were already performing. As manned

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[115] Norman Friedman, *The Fifty Year War: Conflict and Strategy in the Cold War* (Annapolis, MD: Naval Institute Press, 2000), 205.

[116] Ehrhard, 303.

[117] Newcome, 71.

[118] Ibid.

aircraft competed with satellite developments during the 1950s in order to provide near-constant ISR, mission requirements for those aircraft also changed.[119] From an organizational standpoint, as aviation technology became increasingly complex after WWII, the Navy recognized the need for better integration between its aircraft and aerial weapons. Conflict arose between the work of BuOrd on guided missiles and the work of BuAer on UA due to technological convergence.[120] Critically, non-aerial intelligence assets of the era were unable to locate Soviet nuclear weapons facilities until U-2 overflights of the Soviet Union began in July 1956, and the launch of *Sputnik 1* on 4 October 1957 demonstrated the Soviet ability to rapidly exploit military technology.[121] In response, President Eisenhower established DARPA in February 1958 to provide DoD with new innovations to revolutionize military operations. Additionally, on 18 August 1959, Congress merged BuAer and BuOrd into the Bureau of Naval Weapons, who assumed responsibility for the procurement and support of naval aircraft and aerial weapons, as well as shipboard and submarine weapons.

As a result of these developmental concerns, intelligence flights became most significant driving factor for developing UAS specifically for a reconnaissance mission following the highly publicized Soviet shoot down of a U-2 in May 1960 and the subsequent trial of its pilot, Francis Gary Powers.[122] This "danger" factor, coupled with

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[119] Friedman, *The Fifty Year War: Conflict and Strategy in the Cold War,* 202.

[120] Grossnick and Armstrong, 228.

[121] Baer, 341.

[122] Dennis G. Fleishood, *Employment of RPVs in Support of Naval Operations* (Newport, RI: Naval War College Press, 1988), 21.

the political fallout when airmen were captured, also made the reconnaissance mission a logical candidate for UAS.[123] With US leadership still facing a murky intelligence picture in the early 1960s, the need for a long-loiter ISR asset that did not place pilots at risk was evident.[124] The Cuban Missile Crisis spurred the need for a concerted UAS development effort on the part of the US military, particularly in the realm of ISR, and by the August 1964 Tonkin Gulf incident, UAS had finally been accepted for wartime service.[125]

However, Navy leadership did not perceive a primary role for its aviation assets with regard to ISR, choosing instead to rely on the potential of satellite technology while leaving the Air Force and Army to embark on a number of "surveillance drone" programs throughout the 1950s.[126] Instead, the Navy focused its efforts in the realm of unmanned aviation to counter the Soviet submarine threat while the Air Force and Army pursued unmanned intelligence collection platforms.[127] In the mid-1960s, the Navy completely revised its material organization, replacing bureaus with System Commands. The Bureau of Naval Weapons was disestablished on 1 May 1966 and split into the current organizations Naval Air Systems Command (NAVAIR) and the Naval Ordnance Systems Command.[128] NAVAIR is organizationally aligned under the CNO and is tasked with providing full life-cycle support of naval aviation aircraft, weapons and systems, to

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[123] Newcome, 71-2.

[124] Friedman, *The Fifty Year War: Conflict and Strategy in the Cold War*, 239.

[125] Fleishood, 21.

[126] Newcome, 72.

[127] Larm, 9.

[128] Grossnick and Armstrong, 232-233.

include research, design, development and systems engineering, acquisition, test and evaluation, training facilities and equipment, repair and modification, and in-service engineering and logistics support.[129] NAVAIR's work on UAS within the Navy has subsequently been driven by the direction provided by Navy leadership in response to perceived threats.

Employment of Navy UAS in Combat

In addition to its groundbreaking innovation in the field of UAS employment, the Navy also demonstrated a reliance on previous tactics regarding the employment of UAS as a temporary solution at the outset of the Korean War. Having adopted the carrier and its air wing as its post-war centerpiece, when war commenced, the Navy found itself in an operational paradigm constrained by its adherence to the carrier.[130] With US forces in the Pacific again unprepared for war once hostilities began, the Navy fell back on its WWII-era plan to use assault drones as a means to gaining a tactical advantage in an attempt to gain time while conventional forces mobilized for the theater.[131] Once again, the Navy employed its "leftover" post-WWII era cruise missile technology as a stop-gap measure to overcome shortages in force assets.[132] With only one cruiser, four destroyers, and several minesweepers on station in the Sea of Japan in June 1950, the carrier USS

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[129] United States Navy, "About NAVAIR–U.S. Navy Naval Air Systems Command," accessed 29 February 2016, http://www.navair.navy.mil/index.cfm.

[130] Baer, 276.

[131] Grossnick and Armstrong, 135.

[132] William E. Burrows, *By Any Means Necessary: America's Secret Air War in the Cold War* (New York: Farrar, Straus, and Giroux, 2001), 38.

Boxer (CV-21) conducted a record Pacific transit, arriving on station in July with a complement of Navy and Air Force aircraft and personnel.[133] In addition to several manned aircraft squadrons, Guided Missile Unit 90 (GMU-90) embarked onboard *Boxer*, and conducted six missions between 28 August and 2 September 1952 involving F6F-5K Hellcat drones (each armed with a 1,000-pound bomb), targeting power plants, rail tunnels, and a bridge at Hungnam in North Korea.[134] Controlled by a manned AD-4N Skyraider "mother" aircraft once airborne, these UAs scored two direct hits and one near miss, but with an operational success rate of less than 50 percent, the program was terminated.[135] Though operationally insignificant, this marked the first launch of UAs in the form of guided missiles by a US aircraft carrier in combat.[136] Due to its lack of success, this type of employment was the Navy's last for the foreseeable future.

<center>The Emergence of DASH</center>

In the mid to late 1950s, the Navy was most concerned with the threat of a rapidly growing Soviet submarine force.[137] Any mobilization of US forces for war requires sea control, and with nearly 250 submarines by 1948, but only fifteen heavy surface ships and no aircraft carrier, the Soviet submarine force had the ability to put forward-deployed

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[133] Ibid., 39.

[134] Ibid.

[135] Ibid., 40.

[136] Norman Friedman, *US Naval Weapons* (London: Conway Maritime Press, 1983), 131.

[137] Reynolds and Towers, 525.

US naval operations at risk.[138] During WWII, Navy doctrine concerning the engagement of submarines relied heavily on the standard US Navy QHB sonar (capable of ranging a subsurface target out to 1,500 yards), and "hedgehogs" (depth charges launched 200 yards from the ship) or dropped depth charges to destroy a submerged submarine, which forced the ship to close on the enemy submarine and place itself in danger.[139] To address this problem, the Navy developed a 5,000 yard rocket-assisted torpedo in 1945 that proved to be unreliable and inaccurate. By 1955, the Navy's improved SQS-4 sonar ranged out to 8,000 yards, and the Navy also developed a nuclear depth charge-capable system called the anti-submarine rocket (ASROC).[140] ASROC experienced reliability, accuracy, and weight problems during its seven year development period, so the Navy continued to search for alternatives, of which DASH was the most promising and the most revolutionary.[141] Even as US sonar technology improved in the 1950s, the rapid expansion of the Soviet Union's submarine force stimulated "an ASW mobilization in the US Navy."[142] The improved speed of new Soviet submarines made long-range ASW weapons like ASROC especially important, and accurate weapons delivery also became a high priority.[143] The shortfall of ASW weapon rage and accuracy drove the Navy's

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[138] Baer, 289.

[139] Ehrhard, 307.

[140] Ibid.

[141] Gyrodyne Helicopter Historical Foundation, "DASH History," accessed 20 December 2015, http://www.gyrodynehelicopters.com/dash_history.htm.

[142] Ehrhard, 308.

[143] Ibid.

Atlantic Destroyer Force to propose a drone assisted torpedo in 1956, which became the forerunner of DASH (designated QH-50).[144] DASH's first unmanned landing aboard a ship at sea occurred in July 1960.[145] DASH established a number of firsts for unmanned aviation and the Navy as the first rotary wing UAS ever produced, the first UAS to take off from and land aboard a vessel at sea, and the first-ever unmanned reconnaissance helicopter, and the first-ever "hunter-killer" UAS.[146]

<center>The Personalities Behind DASH</center>

Admiral Arleigh A. Burke, CNO for an unprecedented six years from 1955 to 1961, played a dominant role in the development of DASH.[147] In a letter to Nimitz in 1956, Burke declared ASW to be the top priority of the Navy and its "greatest technical problem" due to the "tremendous submarine-building program of the Soviet Union."[148] As a senior change agent within the Navy, and one with a destroyer community background, Burke saw the potential for DASH to fill a key role in the Navy's ASW construct.[149] By incorporating air power via an unmanned asset while maintaining the autonomy of the surface warfare community outside of the Navy's carrier-focused hierarchy, and by then in his third term as CNO, Burke set the conditions for the

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[144] Gyrodyne Helicopter Historical Foundation, "DASH History."

[145] Blom, 53.

[146] Newcome, 88.

[147] E. B. Potter, *Admiral Arleigh Burke* (New York: Random House, 1990), 102-103.

[148] Ibid.

[149] Ibid., 104.

introduction of a radical innovation into the surface community.[150] However, Burke

pushed the DASH program into operational service before it was fully ready to a

community that did not fully embrace it, with unfortunate results.

Capable of lifting 1,000 pounds (two Mark 44 anti-submarine torpedoes or a

Mark 90 nuclear depth charge) while small enough to fit the tight space constraints of a

naval destroyer, when deployed on its parent surface ship, DASH was the premier ASW

weapon system of its time.[151] DASH allowed a destroyer to remain outside enemy

submarine torpedo range while holding a hostile subsurface contact at risk with its own

torpedoes remotely dropped by officers in the ship's combat information center.[152] The

Navy saw the value of this asset and invested in 746 DASH vehicles and associated

materials.[153] These UAS were paired with new and over 100 rehabilitated WWII

destroyers in an effort by Burke to shore up the Navy's antiquated destroyer fleet.[154]

However, DASH development did not keep up with the destroyer modification schedule,

and Burke's decision to field DASH with an antiquated "off-the-shelf" 1940s-era target

drone control system, coupled with a reluctance to upgrade it, was a critical mistake.[155]

The detailed Congressional oversight of weapon system testing that characterized

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[150] Ken Jones and Hubert Kelley, Jr., *Admiral Arleigh (31 Knot) Burke: The Story of a Fighting Sailor* (New York: Chilton, 1962), 187-188.

[151] Ehrhard, 305; Keane and Carr, 567.

[152] Grossnick and Armstrong, 8, 79, 131.

[153] Ibid.

[154] Edward A. Morgan, "The DASH Weapons System," *United States Naval Institute Proceedings* (January 1963): 151-152.

[155] Ehrhard, 313.

military development post-Vietnam did not apply in the 1960s, so the services could rush a system to the field and instead hope for subsequent upgrades to help the program along.[156] A subsequent Government Accountability Office (GAO) investigation in 1970 found that the DASH program had been reduced from a seven year development timeline to three years due to the rapid progress of Burke's destroyer modernization program.[157]

Burke was replaced as CNO on 1 August 1961 by Admiral George W. Anderson, Jr., who decelerated the DASH program due to its electronic control problems. The rigors of shipboard operations were too much for the outdated system, and the high rate of DASH losses at sea from 1963 to 1969 revealed how many corners the Navy had cut due to a mistaken belief that a naval drone could be a low cost, high volume program.[158] Since each crash was treated as an aviation mishap, requiring a detailed investigation by the Navy's Bureau of Aeronautics, destroyer captains came to resist employing DASH due to its high failure rate.[159] As such, proficiency flights for DASH crews were reduced or even eliminated, the Navy's surface community failed to deliver highly trained DASH operators to the fleet (leading to more crashes), and the surface community ultimately came to view the UAS as a distraction rather than a valued capability.[160] In 1964, when

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[156] Ibid.

[157] United States General Accounting Office, GAO Report B-160877, *Adverse Effects of Producing Drone Anti-Submarine Helicopters Before Completion of Developments and Tests* (Washington, DC: Government Printing Office, December 1970), 8-9.

[158] Ibid., 16.

[159] Ehrhard, 316.

[160] Ibid., 317.

Admiral Thomas H. Moorer, then-Commander of the Pacific Fleet, recommended a "permanent training cadre" to ensure the success of DASH, then-CNO Admiral David L. McDonald agreed, but instead of reallocating billets, McDonald asked Secretary of Defense (SECDEF) Robert McNamara for extra billets and urgent minor construction funds for DASH.[161] In a post-Burke Navy with a greater emphasis on cost analysis, neither request was approved.[162] In June 1966, the Deputy Chief of Naval Operations for Air, Vice Admiral Paul Ramsey, testified in front of the Senate Armed Services Committee that the Navy should use manned helicopters for the DASH mission because "in robots, you can't build judgment."[163] McNamara effectively ended the DASH program in December 1966 when he rejected the Navy's request for $31 million to further rehabilitate the DASH fleet, citing "higher-than-expected peacetime attrition and lower-than-expected performance."[164] DASH was removed from all surface vessels in 1971, its resources redirected to ASROC, with its legacy being "the bad taste it left in the

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[161] Immediate Office Files of the Chief of Naval Operations, "Message, CINCPACFLT to CNO, DASH WEAPONS SYSTEM SUPPORT, PERS REQMTS (U)," 31 July 1964 (Washington, DC: Naval History and Heritage Command, Archives Branch).

[162] Immediate Office Files of the Chief of Naval Operations, "Message, CNO to CINCPACFLT and CINCLANTFLT, DASH PROGRAM (U)," 4 August 1964 (Washington, DC: Naval History and Heritage Command, Archives Branch).

[163] Ehrhard, 322.

[164] Friedman, *US Naval Weapons*, 129.

Navy's mouth" concerning UAS.[165] However, its groundbreaking role as the first operational unmanned helicopter designed for combat cannot be overlooked.[166]

US Navy Korean War UAS Policy in Perspective

As in WWII, the Navy again found itself in a unique position to contribute to the development and fielding of unmanned aviation assets during the Korean War and the 1960s. However, institutional bias within the Navy and a narrow focus on employing UAs for a very specific role in combat operations prevented the Navy from achieving the level of integration that would have resulted in greater operational success. Admiral Arleigh Burke's visionary pursuit of the DASH program provided a clear shift from this paradigm, but unfortunately, Burke's control over the direction of the Navy did not last long enough to see the program through, the surface community proved too inflexible to employ an aviation asset, and a lack of technological improvements rendered a pilotless aircraft vulnerable to replacement by a manned aviation community incursion.[167] The failure of DASH proved how a non-aviation community desiring unmanned air capability, but failing to meet the needs of aviation technology, can undermine an otherwise innovative weapon system.[168] This failure of operator and system to achieve symbiosis highlights the necessity for both to reach a satisfactory level of accommodation in order to ensure successful employment of unmanned aviation assets. It also

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[165] Ehrhard, 326.

[166] Keane and Carr, 566.

[167] Ehrhard, 311.

[168] Ibid., 318.

underscores the dangerous and risky prospect of deploying a prototype UA using the operational Navy as a test bed. These lessons were borne out in the subsequent GAO investigation of the DASH program that recommended against concurrent development and production of military systems in the future.[169] Unfortunately, the Navy's failure to develop a policy of inclusion for the DASH program to supplant ASROC created greater barriers to inclusion for UAS within the surface warfare and carrier aviation communities in the years to come.[170]

<div align="center">US Navy UAS Policy During Vietnam and the 1970s</div>

The Navy entered the 1960s dealing with the fallout of the failed DASH program and less than three percent of the total DoD RPV research and development budget, resulting in a stagnation of UAS development during this time.[171] Facing an overbearing SECDEF in Robert McNamara who discouraged lateral connections to integrate service programs and subjected developmental systems to detailed cost analyses, the Navy struggled to innovate during this period of bureaucratic centralization.[172] Rather than attempting further innovation in the field of unmanned aviation, the Navy focused instead on investing in target drones for missile testing and air-to-air combat maneuvering

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[169] United States General Accounting Office, *Adverse Effects of Producing Drone Anti-Submarine Helicopters Before Completion of Developments and Tests*, 8.

[170] Ehrhard, 328.

[171] United States Congressional Transcripts, *History of Fiscal Year 1975 Department of Defense Research, Development, Test, and Evaluation Authorization and Appropriation*, 93rd Cong., 2nd sess., 11 October 1974, 19.

[172] Baer, 374.

training for fighter aircrews.[173] The Navy also decided in the 1960s to pursue satellites

ahead of aviation reconnaissance assets for ISR purposes.[174] The Navy's subsequent

neglect of UAS development during the majority of the 1960s and 1970s reflected a rigid

hierarchical disinterest in adopting UA technology across multiple naval communities,

despite a growing enthusiasm for RPVs within the Air Force and Army following the

1970 USAF/RAND Corporation symposium.[175] In 1969, however, the carrier aviation

community expressed interest in RPVs based on their employment in combat by the Air

Force, the perceived shortcomings in the Navy's tactical reconnaissance, and the increase

in Soviet air defense capabilities, in what was to be a short-lived investment.[176]

Following this fleeting interest, the Navy exhibited renewed interest in unmanned

reconnaissance aircraft again in 1977, but internal discord between the surface and carrier

aviation communities prevented any further innovation by the Navy in the realm of

unmanned aviation during this period, making it a largely stagnant time for UAS

development.[177]

<div align="center">The Limited US Navy Policy on Surveillance</div>

In the early part of the Vietnam War, under Project Snoopy, the Navy employed

DASH from its surface combatants to provide an unmanned reconnaissance capability to

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[173] Friedman, *US Naval Weapons*, 135.

[174] Ibid., 128.

[175] Ehrhard, 335.

[176] William Wagner, *Lightning Bugs and Other Reconnaissance Drones* (Fallbrook, CA: Aero Publishers, 1982), 157-160.

[177] Ibid., 161-164.

assist in the acquisition of targets and the adjustment of NGFS.[178] Equipped with a

television camera and transmitter instead of torpedoes, the operation was limited to

surveillance over littoral and coastal areas, but the payload modification of DASH

nonetheless reflected a shift in emphasis by the Navy towards ISR as a key role for

UAS.[179] Up until the complete removal of DASH from the Fleet in 1971, the system was

modified with a low-light television, a laser rangefinder and target designator, and a

moving-target indicator to give it a night and all-weather reconnaissance capability to

assist surface vessels providing NGFS.[180] During Vietnam, however, the Navy largely

emphasized strike warfare at the expense of an array of sea control functions, which

permitted the air wing to prosper but marginalized the surface warfare community.[181] In

an effort to complement the manned strike reconnaissance mission of the carrier-based

RA-5C *Vigilante*, beginning in November 1969, the Navy employed contractors to

rocket-launch modified Air Force Ryan Model 147 *Lightning Bug* surveillance RPVs on

over 30 combat reconnaissance missions from the aircraft carrier USS *Ranger* (CV-61) in

an operation called "Belfry Express."[182] These drones were modified to provide live

video feed, which like DASH was used to direct naval gunfire, but also for intelligence-

gathering for the planning of (manned) fixed-wing strike missions.[183] The program was

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[178] Blom, 64.

[179] Ibid.

[180] Newcome, 88.

[181] Baer, 393.

[182] Wagner, 165.

[183] Blom, 58.

quickly terminated due to numerous drone losses but also because of problems incorporating the drones into the highly choreographed routine of carrier flight deck operations, highlighting the perception of UAS by the Navy as a disruptive innovation.[184]

Though relatively insignificant in terms of operational impact, "Belfry Express" was significant in that it was the first attempt by the carrier aviation community to integrate UAS. This attempt demonstrated a genuine open-mindedness amongst the carrier aviation community with regard to the employment of UAS, despite the presence of a diminished incentive within this group to innovate by virtue of their "first among equals" status in the Navy.[185] Beginning with the DASH program, all Navy efforts at UAS development up to this point had been conducted by the surface warfare community on smaller surface combatants, where embarked organic aviation experience was minimal and operational challenges significant. Carrier aviators possessed the best possible sea-going aviation environment critical to efficient flight operations, combined with a lower overall risk for a UAS to operate in this environment (a large deck, embarked aviators, and trained support personnel). However, they faced a growing number of naval aircrew killed or captured in Vietnam and the leadership of the carrier aviation community failed to seriously consider the benefits and potential risk reduction of incorporating UAS into carrier operations outside of limited experimentation. The short-lived operational trial of the "Belfry Express" demonstrated that despite the perceived gains, the culture of the carrier aviation community was resistant to the adaptation of carrier operations to include UAS, due in large part to the inelastic, predetermined, circumscribed "ballet" of carrier

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[184] Ehrhard, 336.

[185] Ibid.

flight operations and the reliance on aviator skill and competence to safely launch and recover aircraft at sea. The challenge of UAS incorporation into this established mode of operation proved to be too great for the existing establishment, and the lack of a directive leader to push for change was evident.[186]

In 1975, the Navy appointed a combat RPV manager for the first time since DASH, reacquiring the Air Force's *Lightning Bug* RPV as detailed above, while also seeing new innovation opportunities in UAS development. However, due to a low level of interest, internal squabbling, and negative memories of the DASH program, the subsequent Navy RPV programs developed during this time were short-lived failures.[187] The first program was the development by the Defense Advanced Research Projects Agency (DARPA) in 1975 involved a stealthy RPV for small surface ships, termed the Ship Tactical Airborne RPV (STAR), which was ultimately abandoned due to operational shortcomings in 1977.[188]

Also in 1977, the carrier aviation community wrote a development proposal for a "carrier tactical reconnaissance RPV" designed to replace the manned RF-8 *Crusader* tactical reconnaissance jet. In the same year, the surface community wrote a development proposal for an over-the-horizon (OTH) RPV to act as a target acquisition sensor for the new *Harpoon* ship-to-ship cruise missile.[189] Although each proposal filled a tactical need

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[186] Ibid.

[187] Wagner, 162.

[188] Ibid.

[189] Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell Air Force Base, AL: Air University Press, 1996), 150-151.

specific to a naval warfare community, both projects ended up competing against each other for approval because both were overseen by NAVAIR, the Navy's aviation acquisition agent, and both were to be funded through the naval aviation budget.[190] The adoption of either proposal therefore became unlikely because if the surface community's RPV was approved, it would be competing for funding with naval aviation assets, but if the carrier aviation community's RPV was approved, the surface community would likely add their requirements to the proposal.[191] After the ensuing friction and competition between the two communities had subsided, the surface community's OTH RPV version was approved due to the more pressing need for surface ship crews to identify *Harpoon* targets while keeping their ship outside the range of Soviet *Styx* ship-to-ship cruise missiles.[192] However, the surface community's mission requirements for the OTH RPV (including autonomous operation, automatic target searching, a secure data link, a 100 nautical mile (NM) range, and the ability to be recovered aboard ship in up to 13-foot waves) came to an estimated $150 million for development and another $850 million for production, for a total of $1 billion. In an austere post-Vietnam war defense budget environment, this cost was unacceptable and the OTH RPV program was immediately terminated.[193]

As a solution, in 1978, then-CNO Admiral James L. Holloway announced full scale development of the Light Airborne Multi-Purpose System Mark III, which

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[190] Wagner, 162.

[191] Ehrhard, 338.

[192] Ibid., 340.

[193] Ibid., 341.

incorporated a surface search radar into the existing manned SH-60B *Seahawk* helicopter for anti-ship surveillance and targeting purposes, effectively assuming the mission requirements for the OTH RPV.[194] Despite tactical needs that pointed the Navy in the direction of unmanned aviation, Navy leadership instead chose to settle for a more conventional (and comfortable) mix of missiles and manned aviation assets. Even the relatively innovative surface community was not ready to take on another UAS after DASH.[195] Similar attitudes characterized the Navy's general outlook concerning UAS in the coming years.

<div align="center">US Navy Vietnam Era UAS Policy in Perspective</div>

Despite a self-perceived need for unmanned aerial reconnaissance assets, the carrier aviation community in the 1970s was unable to view unmanned aviation with a view to incorporation and adaptation. This reluctance to adopt UAS was due to the potential interruption of the intricate routine of the launch and recovery cycle developed over decades of experience conducting carrier operations at sea. The leaders of the carrier aviation community again characterized UAS as a disruptive innovation, focusing on the difficulty of adapting the routine of the carrier cycle to a UAS, and thereby overlooking any potential opportunities within the field of unmanned aviation in favor of maintaining the established routine of manned flight operations. At this time, the Navy perceived that unmanned aviation demanded more from the carrier aviation community while

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[194] Werrell, 153.

[195] Ehrhard, 343.

apparently offering too little capability in return.[196] The segmentation of communities within the Navy led to intra-service parochialism, each with its own goals and stipulations, and inhibited the development and fielding of any significant unmanned aviation assets during this period. The high cost of fully developing an OTH RPV for the surface community was an insurmountable hurdle that was made larger by the segmentation of the communities within the Navy, and their separate mission requirements. The demise of the OTH RPV therefore brought about a "decade of paper UAV projects for the Navy" in the 1970s. While tactical needs that brought about the implementation of DASH still pointed to the promise of unmanned aviation, the Navy instead chose to rely on established, proven methods, systems, and procedures.[197] In addition, the absence of any external forces driving the development of a UAS to meet an identified tactical need, and the absence of an autocratic executive to push a program through to fielding restricted the development of any wide-reaching UAS policy and limited the contributions of the Navy to the field of unmanned aviation during this time.

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[196] Ibid., 337.

[197] Ibid., 342.

CHAPTER 5

US NAVY UAS POLICY IN THE 1980s, DESERT STORM, AND THE 1990s

This period of time was a transitory one as the Navy had to rethink its role within a global campaign from its potential use in the event of a third world war to its revised contributions to national defense following the demise of the Soviet Union at the end of the 1980s. The impact of a forceful personality in SECNAV John F. Lehman, Jr. played a key role in shaping the Navy's use of UAS, and his influence would last for over two decades. During this time, naval UAS served with distinction in combat, but these valuable experiences were nearly lost completely due to the negative external influence forced on the Navy's UAS programs.

US Navy UAS Policy in the 1980s

In the 1980s, Admirals Thomas B. Hayward (CNO, 1 July 1978 to 30 June 1982) and James D. Watkins (CNO, 30 June 1982 to 30 June 1986), together with SECNAV John F. Lehman, Jr. (5 February 1981 to 1 May 1987) developed a comprehensive, easily understood doctrine termed "the Maritime Strategy" that recommitted the Navy to power-projection missions of direct air-and-amphibious support in a European land war, as well as to offensive sea control by aggressively pursuing ASW.[198] Following another period of drawdown and disarmament following the Vietnam War, the Navy regained interest in the application of UAS in support of this doctrine following its widespread use for surveillance purposes by Israel in the 1982 Lebanon War.[199] The impetus behind the

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[198] Baer, 418.

[199] Newcome, 94.

Navy's renewed level of interest was driven by a disastrous naval strike in Lebanon's

Bekaa Valley in 1983. Following the loss of 241 American service members in the

bombing of a Marine compound in Beirut on 23 October 1983, the Navy responded to a

request to support a Marine peacekeeping contingent by sailing Task Force 60 with

carriers USS *John F. Kennedy* (CV-67) and USS *Independence* (CV-62) off the coast of

Lebanon.[200] The two-carrier task force conducted numerous air operations over Lebanon,

including reconnaissance flights by F-14 *Tomcat* fighters equipped with a Tactical Aerial

Reconnaissance Pod System designed to collect imagery of hostile forces threatening the

Marines. After the Syrians fired upon an F-14 on a reconnaissance mission on 3

December 1983, President Reagan ordered a retaliatory strike the following day on

Syrian air defense positions in the Bekaa Valley.[201] The task force employed a classic

Vietnam-era tactic called an "alpha strike," which involved putting a maximum number

of aircraft over the target at one time to overwhelm defenders. SECNAV Lehman, a

former naval aviator, remarked that the tactic involved "no surprise, no deception, no

countermeasures."[202] Ultimately, three US Navy aircraft were destroyed, one pilot was

killed, and a bomber-navigator was taken prisoner. The Bekaa Valley air strike was a

crushing setback for the naval aviation community because it resulted in the first loss of

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[200] Ehrhard, 344.

[201] Friedman, *US Naval Weapons*, 149.

[202] John F. Lehman, Jr., *Command of the Seas: Building the 600 Ship Navy* (New York: Charles Scribner's Sons, 1988), 330.

US Navy fixed wing aircraft in combat since January 1973.[203] This event in particular vividly highlighted the need for UAS in support of naval air operations for surveillance purposes, but also for UAS employment in the surface warfare community. The reconstituted battleship USS *New Jersey* (BB-62), on station off Beirut, was not employed because the Navy lacked a feasible option for the spotting of its 16-inch guns, since it would have required the use of either a Marine air and naval gunfire liaison company on the ground or the use of a manned aerial spotter, neither of which were considered viable alternatives.[204] Then-CNO Admiral James D. Watkins cited the potential for collateral damage as the reason for not using the battleship, saying, "there is always concern that without the forward spotter you cannot be sure of achieving pinpoint accuracy."[205] Lehman, who found the labyrinthine internal workings of the Navy "incompatible with both my objectives and my temperament," immediately used the failed Bekaa Valley raid as a "catalyst" to address what he described as the Navy's "glacial" approach to policy change.[206] Adopting UAS integration as a key pillar of his transformation plan, namely, using UAS in a surveillance role for aerial gunnery, Lehman upended the Navy's paradigm regarding unmanned aviation.

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[203] Ship Command Operations Reports, *1983 Command History, USS Independence (CV-62)* (Washington, DC: Naval History and Heritage Command, Archives Branch), 115.

[204] Ehrhard, 346-7; Lehman, 327.

[205] George C. Wilson, *Supercarrier: An Inside Account of Life Aboard the World's Most Powerful Ship, the USS John F. Kennedy* (New York: Macmillan, 1986), 127.

[206] Lehman, 116, 335.

Secretary Lehman and the *Pioneer* RPV

Following the Bekaa Valley incident, Lehman investigated why the Israeli Air Force had been more successful attacking Syrian positions in Lebanon, and discovered the Israelis widely employed unmanned tactical air-launched decoys and surveillance RPVs, to include *Mastiff*, a small, pusher propeller-driven forerunner of what the US developed into the RQ-2 *Pioneer* UAS.[207] Navy leadership was also interested in *Mastiff's* use by the Israelis for artillery fire adjustment.[208] Lehman provided the Marines with an early version of *Pioneer* at the request of the Commandant, and the Navy conducted operational tests of the UAS onboard the USS *Tarawa* (LHA-1) in 1985 to develop the capability to launch and recover the system at sea.[209] Following a successful air strike by the Navy and Air Force against Libya on 14 April 1986, Lehman ordered the acceleration of qualifying *Pioneer* for at-sea use in a BDA role in a program termed "Quick Go."[210] Instead of the planned two-year timeline to demonstrate the feasibility of rocket launch and net recovery of a UAS on board a ship at sea by the summer of 1988, under "Quick Go" the program office found a way to launch, operate, and recover *Pioneer* onboard the battleship USS *Iowa* (BB-61) for BDA purposes in only four months.[211] Learning from its DASH experience, the Navy manned its *Pioneer* detachments with aviation officers and aviation-rated sailors, with each detachment

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[207] Lehman, 338.

[208] Blom, 72.

[209] Ibid.

[210] Newcome, 97.

[211] Ehrhard, 355.

commander and mission commander being a rated naval aviator.[212] Through the

employment of naval aviators in an oversight and leadership role, and the 100 percent

aviation-rated enlisted and officer manning of Navy *Pioneer* detachments, the surface

community was better able to coordinate the launch and operation of *Pioneer* within a

crowded airspace environment than had their non-aviation predecessors with DASH.[213]

This coordination extended itself to the leadership in the surface warfare community as

well. Following *Pioneer's* fifth flight at a gunnery range in April 1987, the gun crews of

the *Iowa* were able to watch their rounds impact on actual land targets 19 miles

downrange via a television monitor and subsequently correct their follow-up shots to

great effect. Vice Admiral Joseph Metcalf, III, the Deputy Chief of Staff of Naval

Operations for Surface Warfare, witnessed the proof-of-concept exercise, calling it a

"total revolution in gunnery," and became a "believer" in RPVs as a result.[214] Although

he had not pushed the employment of RPVs up to this point, Metcalf embodied the

gradual embrace of the leadership of the operational Navy to the use of UAS, and as the

"baron" of the surface community, he represented a strong constituency that had long

resisted the use of such technology.[215] Despite the failures of the *Pioneer* program up to

this point, this compelling demonstration signified a breakthrough that solidified support

for the program. Following this successful "shakedown cruise," the Navy approved the

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[212] Lehman, 341.

[213] Ehrhard, 357.

[214] Vice Admiral Joseph Metcalf III, USN (Ret.) interview by Thomas P. Ehrhard, 28 April 1999, quoted in Ehrhard, 358.

[215] Ibid.

Iowa and its *Pioneer* detachment for an operational cruise to the Persian Gulf just five months later.[216] Such a rapid testing and subsequent operational fielding of a UAS were unprecedented in Navy history and are attributable in large part to Lehman's drive and the motivation of the sailors who worked tirelessly to integrate the system onboard the *Iowa*.

Despite these efforts, *Pioneer* faced several obstacles to its widespread employment across the Fleet. The most severe restrictions placed on *Pioneer* were imposed by Congress as the system was originally intended to be an "interim" solution that wound up requiring millions of dollars for militarization (costing over $50 million to develop its ability to launch and recover at sea) despite Lehman's original desire to obtain an "off-the-shelf system" for use by the Navy.[217] Also, Lehman's actions to field *Pioneer* quickly also violated the processes and prerogatives of the Navy's acquisition corps, and the constant high-level oversight of the program brought about by the tens of millions that went into short-term fixes to militarize *Pioneer* created a groundswell of animosity within the Navy towards the program. At this point, *Pioneer* was not the "non-developmental item" that Lehman had hoped for, and it was not as inexpensive as it first seemed, but the program had a foothold in the operational Navy.[218]

However, when Lehman left office on 10 April 1987, then-CNO Admiral Carlisle A. H. Trost moved to cancel *Pioneer* within a week of Lehman's departure. Lehman's

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[216] Captain Larry Seaquist, USN (Ret.) interview by Thomas P. Ehrhard, 25 May 1999, quoted in Ehrhard, 359.

[217] Lehman, 339; Blom, 75.

[218] Lehman, 339-341.

aggressiveness had alienated a number of admirals who traditionally ran the Navy with little civilian interference, and terminating *Pioneer* was a way to "clear the deck" of Lehman's regime.[219] In response, Metcalf personally and successfully pleaded for *Pioneer's* retention as he saw its value to the revived battleship force and shipbuilding program, successfully overcoming the widespread hatred of Lehman and the opposition of carrier aviators, who had resisted the RPV concept from the start.[220] Metcalf flatly stated, "If Lehman hadn't backed [RPVs], they wouldn't be on any navy ship due to resistance by the aviators."[221] *Pioneer* struggled in the Fleet for several more years under insufficient Congressional support, until the Navy was faced with war in the Middle East. Fortunately for UAS advocates, Iraq's invasion of Kuwait in August 1990 provided an opportunity to prove that unmanned aircraft were not just a novelty, but worthwhile and meaningful contributors to combat operations.[222]

<div align="center">US Navy UAS Policy During and After the Persian Gulf War</div>

Despite Lehman's stated desire for multi-mission utilization, *Pioneer* was initially tasked to assist with the Navy's NGFS role during the Persian Gulf War, although it proved even greater value as a surveillance and reconnaissance asset.[223] The system went to war aboard two Navy battleships, the USS *Missouri* (BB-63) and the USS *Wisconsin*

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[219] Ibid.

[220] Ehrhard, 360-361.

[221] Vice Admiral Joseph Metcalf III, USN (Ret.) interview by Thomas P. Ehrhard, 28 April 1999, quoted in Ehrhard, 361.

[222] Ehrhard, 368.

[223] Newcome, 97.

(BB-64), where it proved invaluable for the spotting of their 16-inch guns.[224] The Navy's

lone squadron operating RPVs, VC-6, commenced flight operations off the *Missouri* on 9

January 1991. Much like the units that trained DASH crews, VC-6 was a "composite"

squadron that operated a variety of test systems, including aerial target drones; it was not

a dedicated UAS unit.[225] Despite this potential to repeat a lesson learned during the

DASH era, however, VC-6's *Pioneer* operators innovatively discovered that by loitering

over one area they could determine enemy patterns of operation, and then quickly

confirm a target for engagement in real time. *Pioneer* aircraft tracked mobile Iraqi 9K52

Luna-M (FROG-7) missile launchers to their hiding sites, and observed vehicles

gathering at resupply points, and passed their location on for subsequent NGFS missions.

The discovery of the RPV's utility for overhead surveillance without being noticed or

shot down was an important operational concept that emerged from the Persian Gulf

War.[226] In addition to spotting for over 1,000 naval gunfire rounds in support of the

ground war, *Pioneer* also conducted mine location flights, oil field reconnaissance, and

provided surveillance for advancing Marine ground units, allowing for the direction of

Navy strike aircraft onto enemy targets outside the range of battleship guns.[227] Famously,

on 1 March 1991, hundreds of Iraqi soldiers on Faylaka Island surrendered to a low-

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[224] Norman Polmar, "Historic Aircraft–The Pioneering Pioneer," *Naval History Magazine* 27, no. 5 (October 2013): 14.

[225] Ehrhard, 368.

[226] Polmar, 14; Ehrhard, 370.

[227] Polmar, 14; Ehrhard, 368, 370; Blom, 88.

flying *Pioneer* that appeared overhead after their positions were shelled by the

Wisconsin.[228]

During the course of Operations Desert Storm (16 January to 27 February 1991),

the *Missouri* alone expended over one million pounds of ordnance against Iraqi targets

with the assistance of *Pioneer*. In all, 40 *Pioneers* flew for a total of 1,641 hours, with at

least one airborne at all times during the conflict.[229] Of their employment during the

Persian Gulf War, Rear Admiral William M. Fogarty, commander of Navy surface forces

during the war, stated "RPVs are essential for optimum battleship naval gunfire support

effectiveness."[230] The DoD report on the Persian Gulf War concluded, "Using a UAV in

this manner increased the battleship's flexibility to provide NGFS because it allowed

each battleship to receive real-time target acquisition and BDA without relying on

external spotting and intelligence assets."[231] In addition to its targeting role, a 1993 report

from the House Oversight and Investigations Committee highlighted *Pioneer's* viability

as an ISR asset, stating, "The *Pioneer* UAV provided substantial imagery support to

Marine, Army, and Navy units during Operation Desert Storm. They were so good that

many more could have been used."[232] The Navy's employment of *Pioneer* proved the

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[228] Polmar, 15.

[229] Polmar, 15; Blom, 89.

[230] Les Garrison, "*Pioneer* in the Gulf War," unpublished manuscript, 15 May 1992, Garrison personal files, 15.

[231] Department of Defense, *Conduct of the Persian Gulf War (Vol. I)* (Washington, DC: Government Printing Office, April 1992), 292.

[232] United States Congressional Transcripts, *Intelligence Successes and Failures in Operations Desert Shield/Storm, Report of the Oversight and Investigations Subcommittee, Committee on Armed Services*, 103rd Cong., 1st sess., 10 August 1993, 9.

viability, utility, and integration capability of UAS as a means to support naval operations, beyond the role for spotting as originally intended. Despite its widely praised performance during the Persian Gulf War, which appeared to have secured its future within the Navy, *Pioneer* was nearly terminated again in the years immediately following the conflict.[233]

Post-Cold War budget cutbacks following the Persian Gulf War led the Navy to retire its battleships for the second time in 1993, leaving *Pioneer* without a platform and eliminating its mission of NGFS.[234] The Navy modified three amphibious helicopter carriers (Dock Landing Ships) to launch and recover *Pioneer*, but its future was in doubt; despite its prowess at surveillance and reconnaissance, the Navy's intention for *Pioneer* was as a gunnery and damage assessment spotter.[235] This decision conflicted with the potential for *Pioneer* outlined in the final DoD report on the war, which stated, "The Navy *Pioneer* UAV system's availability exceeded expectations. Established sortie rates indicated a deployed unit could sustain 60 flight hours per month."[236] Like DASH, *Pioneer* had a specific tactical role, and when the window for its mission closed, the system suffered. Even though the Persian Gulf War revealed a shortfall in tactical reconnaissance and "proved" the UAS, the Navy still could not overcome its endemic

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[233] Department of Defense, *Conduct of the Persian Gulf War (Vol. I)*, 295.

[234] Ehrhard, 377.

[235] Garrison, 16.

[236] Department of Defense, *Conduct of the Persian Gulf War, Final Report to Congress* (Washington, DC: Government Printing Office, April 1992), 808.

resistance to unmanned aviation.[237] The Navy's resistance to the program, coupled with the logistics-based problems of sustainability, maintainability, and reliability *Pioneer* faced (by 1998, for example, *Pioneer* had a 17 percent peacetime attrition rate due to mechanical issues compared to less than 1 percent for manned helicopters), could have been overcome with more robust flight testing rather than simply pushing the program to the Fleet for immediate use. These lessons learned are reminiscent of the Navy's approach to DASH. But unlike DASH, *Pioneer* found another maritime home when it was embraced by the Marine Corps as an aerial reconnaissance platform.[238] With the backing of the Marine Corps, *Pioneer* would fly with the Navy until 2002, and with the Marines until 2007, nearly two decades past its original planned date of termination.[239]

External Influences on US Navy UAS Policy–Congress, JROC, and DARO

The passing of the Goldwater-Nichols Department of Defense Reorganization Act of 1986 had a drastic effect on all the services, and the Navy in particular saw restrictions placed on its leaders' ability to influence the development of strategy and formulation of the defense budget. With senior naval leadership no longer in complete control of the Fleet, and with an ensuing focus on joint ventures, the Navy comprised the greatest organized opposition to the legislation. While the Navy struggled to adjust to the tenets of the law, a new international situation, and a new internal DoD organization, the

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[237] Garrison, 18.

[238] Department of Defense, *Conduct of the Persian Gulf War, Final Report to Congress*, 803; Polmar, 13; Ehrhard, 378.

[239] Blom, 73; Newcome, 96-7.

immediate effects of Goldwater-Nichols curtailed Navy-specific efforts in the realm of

UAS for the immediate future.[240]

From late 1985 to 1988, the House and Senate Armed Services Committee and

the Senate Appropriations Committee, concerned by UAS cost overruns, including those

of *Pioneer*, questioned the effectiveness of each service maintaining its own UAS

program.[241] The House Armed Services Committee requested that DoD compose a report

outlining how it planned to minimize waste in the process of UAS development. In the

ensuing FY1988 budget, Congress transferred the funds from each service's UAS

program into a joint program managed by the OSD. In response, DoD published its first

of what would become an annual UAV Master Plan for UAV Development in 1988. The

report outlined the types of UAS needed by each service, and the process to be used to

reduce overlap and increase operability.[242] The UAV Master Plan represented the first

comprehensive policy statement by DoD regarding UAV development, describing for the

first time the types of missions in which DoD hoped to employ UAS, including ISR,

target acquisition, target spotting, BDA, command and control, meteorological data

collection, nuclear biological and chemical detection, and disruption and deception. This

list comprised the range of missions that UAS might perform, and the UAV Master Plan

supplemented these missions with the various types of UAS in terms of range, endurance,

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[240] Steven Wills, "The Effect of the Goldwater-Nichols Act of 1986 on Naval Strategy, 1987-1994," *Naval War College Review* 69, no. 2 (Spring 2016): 25, 37.

[241] Blom, 73.

[242] United States Government Accountability Office, GAO Report B-229489, *Assessment of DOD's Unmanned Aerial Vehicle Master Plan* (Washington, DC: Government Printing Office, December 1988), 1-2.

and specific mission each service required.[243] In it, the Navy outlined three separate UAS

groups to support the Fleet in three mission areas: targeting for battleships, target

acquisition in support of carrier strike operations, and targeting and electronic warfare

capabilities for smaller surface ships.[244] However, the UAV Master Plan did not attempt

to determine if such interoperable systems would save money, or whether such systems

were even technically possible at the time. Additionally, DoD did not even propose

spending money on the four joint programs until FY1990. Instead, money was to

continue to go to individual service programs, with the idea that components developed

by the services could later provide the foundation for the joint UAS programs.[245] The

GAO criticized the UAV Master Plan for not eliminating single service UAS programs

for another two years, its limited applicability to only nonlethal and recoverable UAS

(excluding UCAVs and target drones), and the plan's failure to adequately address

payload commonality, noting that the potential for overlap continued.[246] Another inherent

limitation of the UAV Master Plan was its formulation within the context of the Cold

War, while the collapse of the Soviet Union brought about drastic changes in US defense

policy in the 1990s.[247] The advent of the Persian Gulf War, however, brought together the

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[243] Department of Defense, *DOD Joint UAV Program Master Plan* (Washington DC: Government Printing Office, July 1988), 10-14.

[244] Ibid., 20-21.

[245] Ibid., 23-46.

[246] United States Government Accountability Office, *Assessment of DOD's Unmanned Aerial Vehicle Master Plan*, 5-7.

[247] Blom, 76.

long history of aerial reconnaissance in support of combat forces and unmanned aviation for the first time.

Although combat operations during the Persian Gulf War did much to advance the mission of UAS within the Navy, naval UAS policy was also largely influenced by two government organizations that sought to achieve efficiencies through weapons system design across the services. The first was a system of formalized acquisition cooperation that emerged in late 1985 as a faculty of the Joint Chiefs of Staff–the Joint Requirements Oversight Council (JROC).[248] Consisting of the four vice chiefs of each service and chaired by the Vice Chairman of the Joint Chiefs, JROC was responsible for certifying the "jointness" of a system (its compatibility and lack of overlap with other systems) before it could be acquired by the services.[249] Although it did not control service budgets, JROC assumed significant power over the weapons system requirements process.[250] The first task of JROC was to consolidate UAS development between the Navy, Air Force, and Marine Corps that was formalized in the medium range UAV (MR-UAV) program designed to fill a need for tactical reconnaissance for manned strike missions across all three services.[251] After the 1983 Bekaa strike, Lehman directed the Navy investigate a jet-powered drone that would incorporate advanced data links and replaced manned surveillance missions. Unlike *Pioneer*, however, the Israelis did not possess a jet-powered UAS of similar design that Lehman could push directly to the Fleet, resulting in

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[248] Ehrhard, 386.

[249] Ibid., 502.

[250] Ibid.

[251] Ibid., 387.

the Navy's reliance on the development of this technology through normal acquisition and procurement channels.[252] The concept of "jointness" in UAS development advocated by JROC led to an agreement between the Navy and Air Force that divided the jet-powered tactical reconnaissance task between the two services–the Navy was responsible for the development of the MR-UAV airframe while the Air Force was responsible for developing the imaging and data link payload.[253] The decision to create a programmatic division between airframe and payload, each with its own program manager, added greater diffusion and increased the likelihood for failure due to an absence of centralized program control.[254] By 1991, this lack of unity of command resulted in excessive program requirements that grew the MR-UAV contract over budget by 200 percent.[255] With the MR-UAV cost growth straining Navy budgets, in March 1993 the carrier aviation community backed out of the program, with the surface community following suit in June 1993, opting instead for a shorter-range UAS that could be deployed on amphibious helicopter carriers.[256] DoD acquisition chief John Deutch cancelled the MR-UAV program outright in late 1993 due to the program's growing budget, the Air Force's waning support for the program, and a lack of support for the program in Congress.[257] The failure of the MR-UAV program demonstrated how, as interest in a practical UAS

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[252] Lehman, 340; Ehrhard, 388.

[253] Werrell, 156-158.

[254] Ibid., 159-160.

[255] Werrell, 162; Ehrhard, 391.

[256] Ehrhard, 392.

[257] Larm, 12.

wanes, a potentially innovative system works its way down the organizational ladder until it vanishes altogether. Within the Navy in particular, this program again highlights the entrenched parochial differences between the carrier and surface communities, and the additional lack of coordination on a joint level spelled the end of the MR-UAV despite a recognized need for the technology. In contrast to this approach, centralized management of US military UAS programs arrived in 1993, with the creation of the Defense Airborne Reconnaissance Office (DARO), which broke the previous cycle of exclusive maritime leadership that directed the Navy's UAS efforts, although this effort was short-lived.[258]

Since none of the services had been particularly consistent or successful with the adoption of UAS, DARO was established by OSD in November 1993 as a way to instill "jointness" into the military by stripping the services of their budgetary control over airborne reconnaissance, to include UAS.[259] DARO was an experiment in weapon system management that radically altered the environment for innovation in the area of unmanned aviation since it represented the most substantial civilian incursion into major military acquisition management since the establishment of the satellite-focused National Reconnaissance Office in 1961.[260] DARO was given full budgetary authority over each service's airborne reconnaissance acquisition budget, including UAS development and

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[258] Ehrhard, 344; Friedman, *US Naval Weapons*, 166.

[259] Ehrhard, 495.

[260] United States Department of Justice, Office of the Inspector General, *Audit Report, Department of Defense Acquisition of Unmanned Aerial Vehicles* (Washington, DC: United States Department of Justice, May 1994), 2.

upgrades, effectively supplanting the Title X "equip" function of the services.[261] While

the services retained full capacity to operate UAS and they participated in the DARO

process, they lost a significant degree of control over UAS development.[262] DARO was

established in contrast to the UAV Joint Program Office (JPO) that was officially

established by the FY1988 Defense Appropriations Act with the Navy as the sponsor

agency. The Navy-led JPO served as executive agent for all DoD UAS projects from

1988 to 1994, under the direct supervision of civilians on the SECNAV's staff and OSD,

making it an "interloper" into service-directed UAS research and development efforts.[263]

The creators of DARO failed to delineate the role of JPO in relation to the DARO, and

the uneasy relationship between the two organizations that developed was never resolved,

further burdening the realm of UAS acquisition with a more deeply fragmented

management structure.[264] None of JPO's development programs entered full production

before JPO was absorbed into DARO in 1995.[265] DARO's approach to UAS development

exacerbated existing service structural dysfunctions to an even larger degree, personified

in the example of the Army's *Aquila* UAS, where the Army was unable to rationalize

[261] United States Congress, House of Representatives, *National Defense Authorization Act for Fiscal Year 1994*, 103rd Cong., 1st sess., 10 November 1993, H. Res. 103-357, 599.

[262] United States Department of Justice, Office of the Inspector General, *Audit Report, Department of Defense Acquisition of Unmanned Aerial Vehicles*, 2.

[263] Ibid., 3; Blom, 81.

[264] Ehrhard, 511.

[265] United States Congressional Transcripts, *Hearings before a Subcommittee of the Committee on Appropriations, Department of Defense Appropriations for 1996*, 104th Cong., 1st sess., 28 December 1995, 786.

multiple branch requirements for the system, while also contending with stringent

maritime requirements placed on the system by the Navy and Marine Corps.[266] The

ambivalence of the maritime services towards UAS worsened during this time as their

interests became entangled in the conventional designs favored by the Army. Still, the

Navy felt an obligation to team with the Army on such "one-size-fits-all" UAS projects in

order to appear "joint," but the addition of myriad requirements to produce a system of

value to all services made the developmental efforts unsuccessful.[267] In all, DARO

effectively extended the general lethargy of US military integration during this time, and

in so doing, increasingly alienated both Congress and the services themselves.[268] By the

fall of 1998, after a decade of experimentation with weapon system innovation and under

pressure from Congress, OSD disestablished DARO on 1 October 1998, returning

appropriations for UAS to the individual services, with integration efforts within the

Navy the primary responsibility of the Program Executive Office for Command, Control,

Communications, Computers, and Intelligence (PEO C4I).[269] The Congressional

requirement that all UAS programs needed to be interservice compatible that brought

about DARO made the fielding of those systems all the more difficult, timely, and

expensive. However, DARO's utilization of the Advanced Concept Technology

Demonstrations acquisitions process, in which mature civil technologies are acquired to

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[266] Blom, 81-82.

[267] Ehrhard, 501.

[268] United States Department of Justice, Office of the Inspector General, *Audit Report, Department of Defense Acquisition of Unmanned Aerial Vehicles,* 3.

[269] J. R. Wilson, "Finding a Niche: US Unmanned Aerial Vehicles Finally Get Some Respect," *Armed Forces Journal International* 132 (July 1995): 34-35.

meet high-priority military needs, did permit the US military to make substantial and immediate gains with the deployment of *Predator* and *Global Hawk* UAS, both of which played a role within the Navy in the years to come.[270]

<p align="center">Naval Transformation in the 1990s</p>

With the fall of the Soviet Union in late 1991, in September 1992, the Navy released a "white paper" entitled *...From the Sea*, announcing a landmark shift in operational focus and a reordering of coordinated priorities for the Navy and Marine Corps.[271] In this document, then-SECNAV Sean C. O'Keefe and then-CNO Admiral Frank B. Kelso, II outlined a strategic concept intended to carry the Naval Service beyond the Cold War and into the 21st century. *...From the Sea* signaled a change in focus and priorities away from operations on the sea to influence events in the littoral regions of the world. Among other things, it emphasized the importance of unobtrusive forward presence (as opposed to the forward-defense concept of the Cold War) and the flexibility of sea-based forces. This meant that naval expeditionary forces not only come from the sea, but they are also sustained from the sea. While emphasizing a new direction for the Navy's strategic focus, *...From the Sea* validated the historical and traditional role of the Navy as a joint expeditionary force, combined with the Marine Corps.[272]

Two years later, then-SECNAV John H. Dalton and then-CNO Admiral Jeremy Michael Boorda issued *Forward...From the Sea*, reiterating the Navy's broader mission

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[270] Blom, 92.

[271] Department of the Navy, *...From the Sea* (Washington, DC: Department of the Navy, September 1992), 5.

[272] Ibid., 9-10.

beyond the purview of littoral warfare. Although this concept paper maintained

continuity with ...*From the Sea*, it also upheld the importance of the Navy's role in

fighting and winning America's wars at all levels while emphasizing the need to "be

engaged in forward areas, with the objective of preventing conflicts and controlling

crises."[273] While intending to augment the precepts of ...*From the Sea*, *Forward...From*

the Sea outlined five fundamental and enduring roles of the Naval Service in support of

the National Security Strategy: "projection of power from sea to land, sea control and

maritime supremacy, strategic deterrence, strategic sealift, and forward naval

presence."[274] Of these five, only power projection and forward presence are directly

associated with the expeditionary warfare concepts set forth in ...*From the Sea*. Although

UAS are not specifically mentioned in either document, the influence on *Forward...From*

the Sea by the various events occurring around the world at the time, to include

operations in Somalia, Haiti, Bosnia, and Iraq, represented a shift in planning focus

towards amphibious warfare, mine warfare, and defense against diesel-electric

submarines and small surface craft, all of which are UAS-capable missions.[275]

Forward...From the Sea defined land attack as a priority mission for naval ships, and the

Littoral Combat Ship (LCS) program that grew from the Navy's 1992 Surface Combatant

for the 21st Century Program was specifically identified as the platform to improve the

Navy's ability to operate in heavily defended littoral waters, while relying on UAS. The

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[273] Department of the Navy, *Forward...From the Sea* (Washington, DC: Department of the Navy, December 1994), 1.

[274] Ibid., 10.

[275] Ibid., 1, 6.

concept of LCS envisioned the ability to leverage both manned and unmanned aircraft assets as the principal means of defeating enemy A2/AD systems in heavily defended littoral waters. LCS has since become the platform of choice for the Navy's follow-on ship-based ISR UAS platform, due in large part to these two policy documents that directed the Navy's shipbuilding efforts and its ensuing development of UAS at the outset of the 21st century.[276]

<div align="center">Lessons from US Navy UAS Policy in the 1980s and 1990s</div>

Of all the factors affecting the Navy's UAS policy during this time, internal resistance within the Navy nearly derailed the implementation of what would prove to be its longest-serving UAS system to date–the *Pioneer*. Much in the same way that Admiral Arleigh A. Burke played a dominant role in the development of DASH, SECNAV John F. Lehman, Jr. also overcame a reluctant, feudal decision-making organizational structure, replacing it with a monarchic concept of leadership that facilitated the insertion of an innovative UAS.[277] In both cases, forceful leaders made impactful change regarding the Navy's UAS policy, but the bureaucracy that survived them and the animosity their actions engendered outlived their tenures in these key policy jobs. When Burke left, his efforts with DASH were undermined, and if not for the fortuitous intervention of Vice Admiral Joseph Metcalf, III, Lehman's *Pioneer* would also likely have been

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[276] Ronald O'Rourke, CRS Report RS20851, *Naval Transformation: Background and Issues for Congress* (Washington, DC: Congressional Research Service, June 2005), 3-4.

[277] Ehrhard, 361.

abandoned.[278] In a short period of time, *Pioneer* went from a Caribbean shakedown cruise on the USS *Iowa* (BB-61) to a combat-proven asset. In the end, the operational success of *Pioneer* was instrumental in demonstrating the effectiveness of unmanned aviation within the Navy's operational construct. While initially fielded for target spotting, *Pioneer* demonstrated a capacity for ISR and BDA that exceeded expectations. The Persian Gulf War encouraged UAS usage due to the precedent that was set in terms of casualty avoidance, but the Navy would never have had the opportunity to appreciate the utility of UAS had it not been for the imposition of *Pioneer* into the operational Navy in the years leading up to the war. Had UAS been even more widely embraced at an earlier time, their operational achievements in combat might very well have been even greater.

The imposition of centralized control over the Navy's UAS development during this time also affected its policy regarding UAS. Rather than smoothing the development of UAS, JROC and DARO in particular demonstrated how forced "jointness" can have the opposite effect. Differences between naval communities regarding the use of UAS and their desired mission requirements inhibited full UAS integration as one community again distanced itself from the other's efforts. Also, the persistent expectation by key civilians in Congress and OSD that UAS can be built to meet multi-service tactical and operational requirements at substantial cost savings and still be effective resulted in multiple examples of cost ballooning and the subsequent cancellation of numerous "joint" UAS programs during this time.[279] As expectations and requirements for UAS

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[278] Ibid.

[279] Ibid., 571.

grew, so did their program budgets, to the chagrin of Congress, the military, and taxpayers. On a sustainment level, the lack of maintenance-related upkeep and support funding cut by Congress for *Pioneer* starting in FY1988 in anticipation of a follow-on UAS to replace the interim *Pioneer* system failed to keep *Pioneer* at a maintainable level of deployable operational readiness across the Fleet in the years following the Persian Gulf War.[280]

The Navy also conducted an evaluation of its strategic concept for operations in the 21st century following the dissolution of the Soviet Union. The modification of the Navy's strategic concept set forth in *...From the Sea* (1992) and *Forward...From the Sea* (1994) directed big-picture UAS developmental and acquisition efforts as the Navy's focus shifted to the littoral regions of the world. Despite the program failures during this time brought about by a largely "hands-off" approach regarding UAS development and sustainment, and Congress' UAS interoperability mandate, by the time DoD dissolved DARO in 1998, the Navy had nonetheless achieved the integration of a UAS on an operational level within a combat environment.[281] The results of such an achievement were historic. More importantly, the experiences gathered from these deployments were vital in the coming War on Terror.[282]

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[280] Elizabeth Bone and Christopher Bolkom, CRS Report RL31872, *Unmanned Aerial Vehicles: Background and Issues for Congress* (Washington, DC: Congressional Research Service, April 2003), 25-26.

[281] Blom, 99-100.

[282] Also termed the Global War on Terrorism (GWOT); the international military campaign from 20 September 2001 to 23 May 2013.

CHAPTER 6

US NAVY UAS POLICY FROM 2000 TO THE PRESENT DAY

Technological progression and a growth in Navy-specific UAS policy during this period set the stage for widespread application of UAS technology across the spectrum of naval operations. However, the most revolutionary of the Navy's UAS pursuits, the MQ-25 *Stingray*, has had its mission and name changed and its planned operational fielding postponed numerous times due to modification by Navy leadership and ensuing legislative delays. Despite this specific example, in a world of increasingly varied and complex threats, Navy leadership is currently making great strides towards effectively integrating unmanned aerial technology into the Navy's operating construct in order to maximize the potential of UAS for future missions.

A Shift in Policy Focus

On 12 October 2000, the destroyer USS *Cole* (DDG-67) was attacked by a small boat laden with explosives during a brief refueling stop in the harbor of Aden, Yemen. The suicide terrorist attack killed 17 members of the ship's crew, wounded 39 others, and seriously damaged the ship. A broad DoD review of accountability was conducted by a special panel, and on 9 January 2001, the panel issued its report that avoided assigning blame but found significant shortcomings in the Navy's security posture against terrorist attacks, including inadequate training and intelligence gathering. A Navy investigation, the results of which were released by Admiral Robert J. Natter, Commander, US Atlantic Fleet, on 19 January 2001 concluded that many of the procedures in the ship's security plan had not been followed, but that even if they had been followed, the incident could

not have been prevented.[283] In a subsequent Congressional hearing, then-CNO Admiral

Vernon E. Clark was asked about the possibility of employing UAS as a means of

"standoff detection of explosives" in order to prevent a similar attack. Clark stated that

current unmanned aerial technology to "reliably perform standoff explosive detection"

did not currently exist.[284] Notably, only two weeks later, Section 220 of the FY2001

Defense Authorization Act of 30 October 2000 stated, "It shall be a goal of the Armed

Forces to achieve the fielding of unmanned, remotely controlled technology such that by

2010, one-third of the aircraft in the operational deep strike force aircraft fleet are

unmanned."[285] Although the *Cole* incident shook the Navy, and despite this guidance, the

incident prompted a widespread review of shipboard anti-terrorism and force protection

procedures, rather than an exploration of the use or adaptation of UAS to fill an ISR,

threat detection, or force protection mission.[286] It seemed a much larger catastrophe was

the only way to spur a change in the Navy's stagnant UAS policy.

On 4 September 2001, in a cabinet meeting, George J. Tenet, the director of the

CIA, presented the agency's plan to operate an armed version of the MQ-1 *Predator*

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[283] Raphael Perl and Ronald O'Rourke, CRS Report RS20721, *Terrorist Attack on USS Cole: Background and Issues for Congress* (Washington, DC: Congressional Research Service, January 2001), 2-3.

[284] United States Congressional Transcripts, *Lessons Learned From the Attack on U.S.S. Cole, On the Report of the Crouch-Gehman Commission, and on the Navy's Judge Advocate General Manual Investigation Into the Attack, Including a Review of Appropriate Standards of Accountability for U.S. Military Services*, 107th Cong., 1st sess., 3 May 2001, 33.

[285] National Research Council, Naval Studies Board, *Autonomous Vehicles in Support of Naval Operations* (Washington, DC: The National Academies Press, 2005), 256.

[286] Ibid.

UAS, a mission usually entrusted to the Air Force. The administration agreed that an armed *Predator* was needed, but the agency was given authorization only to pursue reconnaissance missions. One week later, in the aftermath of 9/11, President George W. Bush signed a directive creating a secret list of "high-value targets" that the CIA was authorized to kill without further presidential approval.[287] Just months after 9/11, the first operational armed strike by UAS took place in Afghanistan, marking a significant change in the conduct of modern war.[288] However, leading up to the terrorist attacks of 9/11, and the ensuing GWOT campaigns, the US Navy's policy on UAS utilization was largely one that sought to employ previous assets, specifically *Pioneer*, in the face of declining force levels and budget cuts.[289] Affected by the surface community's self-critique in reaction to the *Cole* bombing, the Navy's focus with UAS reflected the direction outlined in *...From the Sea* (1992) and *Forward...From the Sea* (1994). To a lesser extent, this policy also reflected Admiral Kelso's attempt to establish naval doctrine with the release of *Naval Doctrine Publication 1: Naval Warfare* (1994), which reiterated and reinforced the concepts set forth in *...From the Sea*.[290]

UAS development took a back seat to the parochial justification of the Navy's traditional mission in the years leading up to 9/11 in favor of focusing on the

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[287] James Risen and David Johnston, "Bush Has Widened Authority of CIA to Kill Terrorists," *New York Times*, 15 December 2002.

[288] Mary Ellen O'Connell, "Seductive Drones: Learning from a Decade of Lethal Operations," *Journal of Law, Information and Science* (August 2011): 4-5.

[289] Ehrhard, 627.

[290] Peter M. Swartz and Karin Duggan, *US Navy Capstone Strategies and Concepts (1991-2000): Strategy, Policy, Concept, and Vision Documents* (Washington, DC: Center for Naval Analyses, 2012), 58-60.

"fundamental and enduring roles" that Admiral Boorda and SECNAV John H. Dalton

cited in *Forward...From the Sea* in order to secure the Navy's budgetary funding.[291] To

that operational end, the Navy found no reason to explore additional UAS technologies

that could improve on previous mission performance, with the end result being that, by

FY2003-2004, *Pioneer* was still the Navy's only operational UAS.[292] Following the

Persian Gulf War, *Pioneer* flew operationally in Bosnia, Haiti, and Somalia, and it served

with the Marines as one of the primary UAS employed during the Second Persian Gulf

War (or Iraq War) from 2003 to 2007. This lack of innovation on the part of the Navy

also stems from Congressional and legal direction in early October 2001 that mandated

UAS be used primarily in reconnaissance roles, and the policy among the service chiefs

at the time that limited the attack capabilities of unmanned aircraft, particularly those of

the Air Force's *Predator* UAS.[293] At this point, the Navy was content to let the other

services take the lead in UAS development and employment.

Following 9/11, in October 2002 then-CNO Admiral Vernon E. Clark released

Sea Power 21 and Global CONOPS, emphasizing the Navy's ongoing efforts in

transformation in order to position the maximum amount of naval power forward as its

role in GWOT operations grew. However, the document was promoted as a "vision"

document, and mentioned UAS in an existing surveillance role, with the possibility of

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[291] Department of the Navy, *Forward...From the Sea*, 3; Larm, 13.

[292] Bone and Bolkom, 25.

[293] Bill Yenne, *Attack of the Drones: A History of Unmanned Aerial Combat* (Osceola, WI: Motorbooks International, 2004), 88; Larm, 14.

unmanned strike as a distant goal.[294] In December 2002, DoD published the *Unmanned Aerial Vehicles Roadmap 2002-2027* to provide a vision for developing and employing UAS and UCAVs over the next twenty-five years in an effort to "usher in a new era of capabilities and options for our military and civilian leaders."[295] In light of the Navy's lack of UAS development, a 2005 report by the Naval Studies Board reiterated the direction to rapidly field strike-capable UAS set forth in the FY2001 Defense Authorization Act, and recommended the Navy accelerate the introduction of unmanned assets, and UAS specifically.[296] The Navy responded with the release of *Naval Aviation Vision 2020* (2005), outlining the Navy's plan to procure UAS for three primary mission areas: long-dwell, standoff ISR operations; tactical surveillance and targeting operations; and penetrating surveillance/suppression of enemy air defenses (SEAD)/strike operations.[297] These mission areas endure to the present day, and were subsequently reinforced in 2007 by then-CNO Admiral Gary Roughead's *A Cooperative Strategy for 21st Century Seapower* (CS-21), which marked the Navy's first attempt to articulate a strategy for maritime power in a contemporary sea environment and set forth the Navy's

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[294] Department of the Navy, *Sea Power 21 and Global CONOPS* (Washington DC: Department of the Navy, October 2002), 6-9.

[295] E. C. Aldridge, Jr. and John P. Stenbit, *Unmanned Aerial Vehicles Roadmap 2002-2027* (Washington, DC: Government Printing Office, December 2002), iii.

[296] National Research Council, Naval Studies Board, *Autonomous Vehicles in Support of Naval Operations*, 256.

[297] Department of the Navy, *Naval Aviation Vision 2020* (Washington, DC: Department of the Navy, 2005), 43.

role in national and economic security beyond immediate GWOT operations.[298] The

subsequent revision of *A Cooperative Strategy for 21st Century Seapower* (CS-21R),

released in March 2015 by SECNAV Ray E. Mabus and then-CNO Admiral Jonathan W.

Greenert, expands upon the direction set forth in the 2007 version, but adds the key

mission area of All Domain Access and specifically mentions the requirement for

"developing and integrating" UAS in "highly contested, high-risk environments." In

addition to the air environment, this document also addresses how the Navy is pursuing

unmanned technologies in sea, undersea, and land-based applications.[299] In such a way,

while emphasizing the more recent missions of standoff ISR, tactical surveillance and

targeting, and penetrating SEAD and strike operations, the most recent Navy UAS policy

places significant focus on employing unmanned aerial technology to counter A2/AD

threats.

<div align="center">Present-Day US Navy UAS Policy</div>

Currently, the Navy's policy regarding the use of UAS is one that seeks to fully

integrate UAS across a joint and allied spectrum.[300] This policy is a development that has

grown out of the Navy and Air Force's controversial Air-Sea Battle (ASB) concept, first

introduced in 2009 to develop low-cost ways to defeat "asymmetric" modern and

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[298] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (Washington, DC: Department of the Navy, October 2007), 1.

[299] Department of the Navy, *A Cooperative Strategy for 21s^t Century Seapower* (Washington, DC: Department of the Navy, March 2015), 35.

[300] Mark W. Darrah, Rear Admiral, United States Navy, Program Executive Officer for Unmanned Aviation and Strike Weapons, interviewed by author, Ft. Leavenworth, KS, 20 August 2015.

emerging A2/AD threats that could deny US forces access to a potential battle space.[301]

In January 2015, the ASB concept was renamed the Joint Concept for Access and

Maneuver in the Global Commons in order to recognize the contribution of land forces to

the A2/AD mission, however, the focus on a potential adversary's ability to deny US

forces access to a contested area remains the highest priority for UAS utilization. This

focus is reflected in the guidance provided by the 2014 Quadrennial Defense Review

(QDR), which seeks to "increase the use and integration of unmanned aerial systems for

ISR" and utilize unmanned systems to "project power" in all domains.[302] Maritime forces

must now deal with a number of wide-ranging force application threats and demands,

including:

> Providing over-match capabilities against complex, highly adaptable adversaries who are rapidly integrating advanced technologies into their own weapons systems; conducting combat operations within a network-denied environment or compromised network due to cyber attacks; adapting advanced weapons systems to deal with innovative use of readily available legacy weapons and commercially available capabilities in an asymmetric manner by a well-organized insurgency; humanitarian operations within a devastated infrastructure; and freedom-of-navigation operations in support of coalition partners.[303]

How best to achieve these wide-ranging demands across a naval environment

remains elusive as UAS technology and tactics continue to evolve at rapid rates. Current

Navy UAS development is largely driven in response to A2/AD threats, which are

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[301] Sam LaGrone, "Pentagon Drops Air Sea Battle Name, Concept Lives On," *United States Naval Institute News*, 20 January 2015, accessed 8 September 2015, http://news.unsi.org/2015/01/20/pentagon-drops-air-sea-battle-name-concept-lives-on.

[302] Office of the Secretary of Defense, *Quadrennial Defense Review Report* (Washington, DC: Government Printing Office, March 2014), 20, 38.

[303] Darrah, 27.

perceived as the "most prominent" threat to America's naval supremacy.[304] An example

of such a threat is the development by China's People's Liberation Army Navy Surface

Force of an integrated shore and sea-based air defense network extending beyond coastal

ranges that mirrors the AEGIS system currently utilized by the US Navy. Such a system

employs "carrier killer" anti-ship ballistic missiles such as the Dong-Feng (DF) 21D and

DF-26.[305] With a range of over 800 and 1600 NM, respectively, these weapons feature a

maneuverable reentry vehicle warhead that approaches its target with at a near-vertical

ballistic angle, at hypersonic speed, and with the capacity to execute a series of complex

maneuvers during its descent, greatly complicating defensive counter-fire. Coupled with

land-based multilayered integrated air defense systems (IADS) comprised of redundant

layers of sensors, aircraft, and missiles that are dense, overlapping, and lethal, carrier-

based aircraft of limited operational range that rely upon vulnerable airborne tankers to

reach the threat zone are faced with the possibility of obsolescence.[306] In anticipation of

having to conduct future operations within a contested A2/AD environment, the Navy is

seeking a carrier-based UAS platform to assist in identifying and defeating threats to the

CSG from ever-increasing ranges.[307]

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[304] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (2015), 8.

[305] Department of Defense, *The Asia-Pacific Maritime Security Strategy: Achieving U.S. National Security Objectives in a Changing Environment* (Washington, DC: Government Printing Office, August 2015), 10-11.

[306] Henry J. Hendrix, *Retreat From Range: The Rise and Fall of Carrier Aviation* (Washington, DC: Center for a New American Security, 2015), 51-52.

[307] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (2015), 20.

<u>A Departmental Overview of Naval UAS Development</u>

A subsequent reorganization of the Navy's leadership structure with regard to UAS was announced by SECNAV Mabus in June 2015. Demonstrating growing interest in the field of unmanned technology, and UCAVs in particular, the Navy appointed Rear Admiral Robert P. Girrier as the first Director of Unmanned Weapon Systems.[308] The new directorate, termed N99, is designed to shepherd promising unmanned technologies– not just aerial ones–from development into the formalized regular acquisition system, and ultimately to the Fleet. N99 does not oversee all unmanned programs; it only oversees promising programs until they are ready to begin engineering work (an acquisitions step known as Milestone B), at which point, in the case of UAS programs, they will be transferred back under the management of NAVAIR. As Navy UAS are primarily ISR platforms, they are currently part of the Navy's N2/N6 Information Dominance portfolio.[309] Keeping promising unmanned technologies from failing to pick up budgetary sponsors will prevent the failure of previous ventures, such as the OTH RPV and the MR-UAV.[310] The addition of this directorate is long overdue, as its creation indicates that the Navy is mindful of the potential for unmanned technologies, their impact on the future of

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[308] Sam LaGrone, "Navy Names First Director of Unmanned Weapon Systems," *United States Naval Institute News*, 26 June 2015, accessed 28 February 2016, http://news.usni.org/2015/06/26/navy-names-first-director-of-unmanned-weapon-systems.

[309] Sam LaGrone, "Mabus: F-35 Will Be 'Last Manned Strike Fighter' the Navy, Marines 'Will Ever Buy or Fly,'" *United States Naval Institute News*, 15 April 2015, accessed 2 April 2016, http://news.usni.org/2015/04/15/mabus-f-35c-will-be-last-manned-strike-fighter-the-navy-marines-will-ever-buy-or-fly.

[310] See discussion of the OTH RPV provided in Chapter 4 and discussion of the MR-UAV provided in chapter 5.

the Navy, and the historical examples of how their potential has been mismanaged over time.

Today, as part of its mission within this operational construct, NAVAIR provides support, manpower, resources, and facilities to its aligned Program Executive Offices (PEOs). PEOs are responsible for the execution of major defense acquisition programs, to include meeting the cost, schedule, and performance requirements of their assigned programs.[311] The PEO, Unmanned Aviation and Strike Weapons (PEO(U&W)), currently headed by Rear Admiral Mark W. Darrah, is tasked with developing the Navy's UAS, but also integrating UAS assets across all spectrums, while optimizing their capabilities based on direction provided by Navy leadership.[312] Reporting to the CNO, while receiving guidance from SECNAV, PEO(U&W) is at the forefront of development and fielding of the Navy's current and future UAS efforts.

<u>US Navy UAS Policy Key Areas of Focus for Today</u>

Following the direction provided in *Naval Aviation Vision 2020* (2005) and CS-21R (2015), the Navy has focused its UAS development and acquisition efforts on the missions of standoff ISR, tactical surveillance and targeting, and penetrating SEAD and strike operations in order to ensure All Domain Access. The initial phase of the Navy's efforts in the mission area of long-dwell, standoff ISR was the procurement in FY2003 and FY2004 of two long-range Air Force *Global Hawk* UAS to conduct experiments for

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[311] United States Navy Naval Air Systems Command, "About NAVAIR–U.S. Navy Naval Air Systems Command," accessed 29 February 2016, http://www.navair.navy.mil/index.

[312] Darrah, 24.

developing payload concepts and concepts of operation.[313] While the Air Force created

its first armed UAS squadron in March 2002, the Navy did not initially embrace the

concept of armed unmanned aircraft, instead developing an experimental maritime

version of the more mature Air Force's MQ-9 *Reaper* (*Predator B*) in 2006, calling it the

Mariner. As part of the next phase in this mission area, following the *Mariner* program,

the Navy modified the *Global Hawk* into the RQ-4A Broad Area Maritime Surveillance-

Demonstrator (BAMS-D), with the mission of greatly improving maritime domain

awareness.[314] Operationally fielded in 2008, BAMS-D was so successful in its maritime

ISR role that it is now nearing its eighth continuous year of what was originally intended

to be a six month deployment. BAMS-D has provided more than fifty percent of ISR

missions in the 5th Fleet Area of Responsibility, and has accumulated over 15,000 hours

of tactical operations, which have provided direct, actionable intelligence to the deployed

warfighter. The most current iteration of this technology is the MQ-4C *Triton*, currently

under development as part of the Navy's BAMS program, with a planned Initial

Operational Capability (IOC) scheduled for 2018. The widespread success of this

program promises greater achievements for future Navy efforts in the realm of long-loiter

ISR, at an operational cost less than that of satellite technologies.[315]

    Navy efforts in the mission area of tactical surveillance and targeting are

represented by the procurement of Vertical Tactical UAVs that take off and land

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[313] O'Rourke, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress* (Washington, DC: Congressional Research Service, October 2006), 1.

[314] Darrah, 23-24.

[315] Ibid.

vertically from Navy surface combatants and other ships in order to replace the aged

Pioneer system. To this day, the Navy's main Vertical Tactical UAV effort remains the

MQ-8B/C *Fire Scout* UAS, which represents a return to the mission envisioned for the

DASH program from the 1960s.[316] Initially, as part of its FY2003 budget request, the

Navy announced that it would stop the *Fire Scout* program after completing the

engineering and manufacturing development phase, and not put *Fire Scout* into series

production. The Navy later reversed itself and announced that *Fire Scout* was to be used

by LCS in a reiteration of the importance of the land attack mission set forth in

Forward...From the Sea and personified in the Navy's 1992 Surface Combatant for the

21st century program.[317] After procuring the first five *Fire Scout* systems in FY2006, the

Navy now plans to deploy a total of 24 MQ-8Bs across the LCS fleet through 2016, while

purchasing a total of 96 MQ-8B/C platforms. This is based on the successful employment

of the MQ-8B over the course of six at-sea deployments from 2008 to 2013, where the

UAS flew over 10,000 flight hours in support of naval and ground forces.

  With the follow-on version of the MQ-8C *Fire Scout*, the Navy plans to arm this

UAS and use it in surface warfare missions in 2018 and mine countermeasure missions in

2020. In addition to its use as a targeting and tactical reconnaissance platform, *Fire Scout*

will give LCS a fifty NM ISR capability, with the additional capability to provide fleet

protection against small boats and asymmetric threats in an acknowledgement of the

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  [316] O'Rourke, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress*, 2.

  [317] Ronald O'Rourke, CRS Report RS21305, *Navy Littoral Combat Ship (LCS): Background and Issues for Congress* (Washington, DC: Congressional Research Service, October 2004), 1.

importance of this mission following the example of the USS *Cole* (DDG-67).[318] The success of this program across multiple missions provides the Navy with the opportunity to expand its role, and coupled with a dedicated ship platform (LCS), *Fire Scout* has significant potential to affect the future of the Navy's surface community in a way DASH was never able to achieve.

The lead platform of the Navy's future UAS construct in the mission area of penetrating surveillance, SEAD, and strike is the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) program, recently termed the MQ-25 *Stingray*. Throughout its ongoing development, *Stingray* and its predecessors were proposed to fill several distinct roles and to operate in a wide variety of air defense environments, playing a key role in the Navy's stated mission area of All Domain Access as well.[319] However, unlike any other US Navy UAS, overall governmental policy guidance, debate about the roles of *Stingray*, changes to mission and operational capabilities from the Navy and other sources, and approval for the final requirements for the system have created controversy. As a result, the program's execution has been continually delayed, illustrating the issues regarding Congressional oversight of Navy UAS development.[320]

The Navy's efforts regarding the development and fielding of *Stingray* originally focused on developing a stealthy, autonomous, carrier-based UAS that was called the

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[318] O'Rourke, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress*, 2.

[319] Jeremiah Gertler, CRS Report R44131, *History of the Navy UCLASS Program Requirements: In Brief* (Washington, DC: Congressional Research Service, August 2015), 1.

[320] Ibid.

Navy Unmanned Combat Air Vehicle (N-UCAV), more widely known as UCAV-N.

UCAV-N's initial mission focus was penetrating surveillance, with SEAD and strike

missions to follow. The development of UCAV-N, as the first predecessor to the

UCLASS/*Stingray* program, began in 1999 based on collaboration between the Navy and

DARPA, and UCAV-N design was distinct from the collaboration between the Air Force

and DARPA on a separate UCAV design.[321] At the time, manned aircraft were planned

for the conduct of SEAD and electronic attack, while UCAV-N was intended for

"reconnaissance missions, penetrating protected airspace to identify targets" for attack

waves of manned aircraft.[322] Under the UCAV-N program, Northrop Grumman

independently built a single X-47A air vehicle and flew it in February 2003.[323]

OSD issued a program decision memorandum on 31 December 2002 that directed

the Navy and Air Force to merge their UCAV development efforts and adjusted future

funding for this joint program.[324] Subsequently, the resulting Joint Unmanned Combat

Air Systems (J-UCAS) program was a combined effort between DARPA, the Air Force,

and the Navy to demonstrate the "technical feasibility, military utility, and operational

value of a networked system of high-performance, weaponized unmanned air vehicles,"

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[321] John M. Doyle, "If Navy Successful, AF Could Revisit J-UCAS Program," *Aerospace Daily and Defense Report* (March 16, 2006), 5.

[322] Thomas P. Ehrhard and Robert O. Work, *Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System* (Washington, DC: Center for Strategic and Budgetary Assessments, June 2008), accessed 23 August 2015, http://csbaonline.org/publications/2008/06/range-persistence-stealth-and-networking-the-case-for-a-carrier-based-unmanned-combat-air-system/.

[323] Defense Advanced Research Projects Agency, "J-UCAS Overview," accessed 23 August 2015, http://archive.darpa.mil/j-ucas/J-UCAS_Overview.htm.

[324] Ehrhard and Work.

whose missions included SEAD, electronic attack, precision strike, penetrating ISR, and persistent global attack.[325] The operational focus of J-UCAS was non-permissive combat environments involving "deep, denied enemy territory and the requirement for a survivable, persisting combat presence . . . operating and surviving in denied airspace."[326]

However, only three years later, due to budget cuts, priority changes, and mission divergences, the 2006 Quadrennial Defense Review mandated that the J-UCAS program be terminated. J-UCAS was expected to be a low-cost counterpart to a manned fighter, but instead evolved into a massive platform (with a maximum takeoff weight of up to 45 tons) designed to address the diverse requirements imposed upon it by two different services. The Air Force was directed to develop a new unmanned bomber while the Navy was instructed to:

> develop an unmanned longer-range carrier-based aircraft capable of being air-refueled to provide greater standoff capability, to expand payload and launch options, and to increase naval reach and persistence.

Moving ahead from the N-UCAV construct, this effort subsequently became known as the Navy Unmanned Combat Air System (N-UCAS).[327] Despite the constraint of operating from an aircraft carrier, the requirements of N-UCAS were very similar to those of J-UCAS, with a desired ability to provide "persistent, penetrating surveillance,

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[325] Gertler, 2.

[326] Defense Advanced Research Projects Agency, "J-UCAS Overview," accessed 23 August 2015, http://archive.darpa.mil/j-ucas/J-UCAS_Overview.htm.

[327] Office of the Secretary of Defense, *Quadrennial Defense Review Report* (Washington, DC: Government Printing Office, February 2006), 46.

and penetrating strike capability in high threat areas" as well as the option to "suppress enemy air defenses."[328]

As part of the N-UCAS program, in February 2006 the Navy initiated the Unmanned Combat Air System Demonstration (UCAS-D) program, intending to show the technical feasibility of operating an unmanned air combat system from an aircraft carrier at sea.[329] The Navy had initially attempted to reallocate the nearly $2 billion in funding associated with J-UCAS to other programs, effectively terminating the Navy's UCAV program in its infancy, but then-SECDEF Robert M. Gates intervened through the release of *Guidance for the Development of the Force* (2008). This document directed the development of the X-47B as a test vehicle for integrating unmanned combat craft into the carrier air wing.[330] In May 2013, under the UCAS-D program, the Navy successfully launched an X-47B from the aircraft carrier USS *George H. W. Bush* (CVN-77). In July 2013, an X-47B conducted the first ever unmanned arrested landing onboard the *Bush*. On 20 April 2015, an X-47B conducted the first ever unmanned autonomous aerial refueling with a manned tanker. As a subset of N-UCAS, the UCAS-D program did not have a separate set of program requirements, and upon achieving this final required demonstration criteria, the program was terminated in April 2015. In sum, the Navy invested more than $1.4 billion in the UCAS-D program. Concurrently, during the course of UCAS-D efforts, the Navy released a Request for Information on 19 March 2010 looking for a different stealthy UAV optimized for long-range surveillance and strike

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[328] Gertler, 3.

[329] Ibid.

[330] Hendrix, 52.

missions as well as irregular and hybrid warfare scenarios in a program it called UCLASS.[331] In 2011, the Navy received approval from DoD to begin its planning for the UCLASS acquisition program.[332]

Whereas the N-UCAS program had been a specific program to determine how to make a UAS demonstrate a number of the aspects of a manned fighter, the UCLASS program was designed to apply lessons learned from N-UCAS and "address a capability gap in sea-based surveillance and to enhance the Navy's ability to operate in highly contested environments defended by measures such as integrated air defenses or anti-ship missiles."[333] In other words, UCLASS was intended to demonstrate how to use unmanned technology to help address aerial aspects of A2/AD. On 9 June 2011, the Joint Requirements Oversight Council (JROC)–the requirements validation authority for major defense acquisition programs originally established in 1985–issued JROCM 087-11, a memorandum that approved the UCLASS Initial Capabilities Document.[334] JROCM 087-11 defined UCLASS as a "persistent, survivable carrier-based Intelligence, Surveillance, and Reconnaissance and precision strike asset."[335]

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[331] United States Government Accountability Office, GAO-15-374, *Unmanned Carrier-Based Aircraft System: Navy Needs to Demonstrate Match between its Requirements and Available Resources* (Washington, DC: Government Printing Office, May 2015), 3.

[332] Hendrix, 52.

[333] United States Government Accountability Office, *Unmanned Carrier-Based Aircraft System: Navy Needs to Demonstrate Match between its Requirements and Available Resources*, 3.

[334] Gertler, 4.

[335] Ibid.

However, in advance of the FY2014 budget submission, on 9 December 2012, the JROC drastically revised the UCLASS requirements, issuing JROCMs 086-12 and 196-12, which significantly altered "the requirements for UCLASS, heavily favoring permissive airspace intelligence, surveillance, and reconnaissance capabilities."[336] This reduction in strike capabilities was "born of fiscal realities," said Dyke Weatherington, the Pentagon's Director of Unmanned Warfare and Intelligence, Surveillance, and Reconnaissance.[337] In such a way, the Navy exhibited reluctance to fund expensive stealthy technologies, choosing instead to revise the UCLASS program's required capabilities. With regard to the effects of altered requirements on the UCLASS, the Navy stated:

> In support of affordability and adaptability directives, JROCMs 086-12 and 196-12 redefined the scope of JROCM 087-11 and affirmed the urgency for a platform that supports missions ranging from permissive counter-terrorism operations, to missions in low-end contested environments, to providing enabling capabilities for high-end denied operations, as well as supporting organic Naval missions.[338]

In response, OSD stated:

> In a December 2012 memorandum, the JROC emphasized affordability as the number one priority for the [UCLASS] program . . . Available funding to complete system development is also limited, pressuring industry to provide mature systems and emphasize cost during development.[339]

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[336] Dave Majumdar and Sam LaGrone, "UCLASS Timeline," *United States Naval Institute News*, 29 April 2014, accessed 24 August 2015, http://news.usni.org/2014/04/29/uclass-timeline.

[337] Sam LaGrone, "AUVSI 2013: UCLASS Requirements Modified Due to Budget Pressure," *United States Naval Institute News*, 14 August 2013, accessed 24 August 2015, http://news.usni.org/2013/08/14/auvsi-2013-uclass-requirements-modified-due-to-budget-pressure.

[338] Gertler, 4.

[339] Ibid.

The Navy ultimately issued a Request for Proposals (RFP) for a UCLASS preliminary design review in June 2013, more than three years after the initial Request for Information. Although such a period is seen as an excessive amount of time, it provides potential contractors a longer timeframe to further develop and refine their preliminary design reviews. UCLASS was to have a light strike capability to eliminate targets of opportunity and was still expected to develop the missions set forth prior to JROC memoranda 086-12 and 196-12. SECNAV Mabus stated that "the end state [for UCLASS] is an autonomous aircraft capable of precision strike in a contested environment, and it is expected to grow and expand its missions so that it is capable of extended range intelligence, surveillance, and reconnaissance, electronic warfare, tanking, and maritime domain awareness."[340] The evolving changes to the desired mission for the UCLASS program are summarized below:

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[340] Gertler, 5.

	N-UCAV, 1999	J-UCAS, 2003	N-UCAS, 2006	UCLASS ICD, 2011	UCLASS RFP, 2013
Suppression of Enemy Air Defenses		X	X	?	
Precision Strike		X	X	X	
Counter-Terrorism					X
Intelligence, Surveillance, & Reconnaissance	X	X	X	X	X
Electronic Attack		X		?	
Operating Environment	Protected airspace	Deep, denied enemy territory	High-threat areas	Highly contested	Uncontested, light strike permissive to low-end contested

Table 1.   Mission Requirements for the Navy UCLASS Program

Note: A "?" indicates a capability that may be included, but no definitive open source can support the claim.

Source: Adapted from Jeremiah Gertler, CRS Report R44131, *History of the Navy UCLASS Program Requirements: In Brief* (Washington, DC: Congressional Research Service, August 2015), 1.

On 10 February 2015, Deputy Secretary of Defense Bob Work announced a "pause" in the release of the UCLASS RFP due to an ongoing comprehensive review of the ISR capabilities of the UCLASS program by OSD amidst concern that the ISR capabilities of UCLASS would be redundant to the ISR capabilities of other Navy platforms, such as the P-8 *Poseidon* and MQ-4C *Triton*.[341] The Navy subsequently stated

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[341] Sam LaGrone, "WEST: Bob Work Says UCLASS Development Needs a 'Joint Perspective,'" *United States Naval Institute News*, 10 February 2015, accessed 23 August 2015, http://news.usni.org/2015/02/10/west-bob-work-says-uclass-development-needs-joint-perspective.

that as a result of the pause, the initial operating date for UCLASS would shift from 2020 to 2022 or 2023.[342]

While awaiting the results of the developmental pause, the House Armed Services Committee expressed its concern to the Secretary of Defense that current UCLASS requirements "will not address the emerging anti-access/area denial challenges to U.S. power projection" that originally motivated the development of the N-UCAS program during the 2006 Quadrennial Defense Review (QDR), and "were reaffirmed in the 2010 QDR and the 2012 Defense Strategic Guidance."[343] The final Navy requirements for UCLASS were finalized in the DoD UAV Strategic Program Review, released in December 2015.[344] The results of the Strategic Program Review led to a restructuring of the UCLASS program by OSD and the Navy for the Navy's FY2017 budget submission. Based on this input, on 9 February 2016, Rear Admiral William K. Lescher, the Deputy Assistant Secretary of the Navy for Budget, announced a shift from the UCLASS program's primary mission of providing lightly armed ISR to an aerial refueling tanker. The decision was made to reduce the platform's strike capabilities and ISR requirements in order to ease the burden on the F-18E/F *Super Hornet* fighters that currently serve as

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[342] Ibid.

[343] Dave Majumdar and Sam LaGrone, "House Committee Seeks to Stall UCLASS Program Pending New Pentagon Unmanned Aviation Study," *United States Naval Institute News*, 29 April 2014, accessed 23 August 2015, http://news.usni.org/2014/04/29/house-committee-seeks-stall-uclass-program-pending-new-pentagon-unmanned-aviation-study.

[344] Sam LaGrone, "Mabus: UCLASS Likely A Bridge to Autonomous Strike Aircraft, F/A-XX 'Should be Unmanned,'" *United States Naval Institute News*, 13 May 2015, accessed 26 August 2015, http://news.usni.org/2015/05/13/mabus-uclass-likely-a-bridge-to-autonomous-strike-aircraft-fa-xx-should-be-unmanned.

tankers for the carrier air wing. OSD designated the follow-on program as the Carrier-Based Aerial Refueling System (CBARS), which the Navy then changed to the RAQ-25 *Stingray* (its third name change in three months) before seeking a "multi-mission" MQ-25 designation for the program pending coordination with the Air Force to finalize the designation of the platform.[345] OSD announced that a final RFP for the program is expected in FY2017 with a contract award in FY2018.[346] Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations, Integration of Capabilities and Resources, stated that the Navy's intent with *Stingray* is to field the asset first, then "grow the class and increase the survivability [later]," explaining that "[*Stingray*] has to be more refueling, a little bit of ISR, weapons later and focus on its ability to be the flying truck."[347] A requirement for *Stingray* is to include pylons for drop fuel tanks for its tanking mission, which could ostensibly be used for weapons in the future. The tanking mission, however, again fails to meet the direction for a low-observable, deep strike UAS that the Navy was directed to pursue as part of the 2006 QDR, a mission reiterated by the House Armed Services

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[345] Sam LaGrone, "Navy Wants to Shed RAQ Designation from *Stingray* Carrier UAV," *United States Naval Institute News*, 11 March 2016, accessed 12 March 2016, http://news.usni.org/2016/03/10/navy-wants-to-shed-raq-prefix-from-stingray-carrier-uav.

[346] Sam LaGrone, "Unmanned CBARS Tanker Air Segment Draft RFP Expected Later This Year," *United States Naval Institute News*, 11 February 2016, accessed 12 February 2016, http://news.usni.org/2016/02/11/unmanned-cbars-tanker-air-segment-draft-rfp-expected-later-this-year.

[347] Sam LaGrone, "Navy Pushing New Name for Unmanned Aerial Tanker: RAQ-25 *Stingray*," *United States Naval Institute News*, 27 February 2016, accessed 29 February 2016, http://news.usni.org/2016/02/27/navy-pushing-new-name-for-unmanned-aerial-tanker-raq-25-stingray.

Committee in its version of the FY2017 defense bill.[348] The decision to modify the

Stingray's requirements again based on fiscal realities is mindful of the historical

examples of the DASH and STAR UAS programs.[349] As history has shown, the

operational fielding of an unmanned platform without setting the initial conditions to

accomplish the original mission or providing for its integration across one or more

services greatly increases its likelihood for failure.

<u>US Navy Efforts in ISR and Tactical Targeting</u>

Based on the guidance set forth in *Naval Aviation Vision 2010* (2005) and restated

in *Naval Aviation Vision 2020* (2005) and CS-21R (2015), the future of Navy high-

altitude, long-dwell, standoff ISR lies with the successor to the BAMS-D program, the

MQ-4C *Triton*. With an operational ceiling in excess of 52,000', a loitering ability of up

to 24 hours, and the ability to monitor one million square miles of ocean and littoral areas

at a time, *Triton* far exceeds the ISR capability of any planned or current manned asset in

the Navy's inventory.[350] Furthermore, the Navy's plan to integrate the unmanned *Triton*

with the manned P-8A *Poseidon* platform will allow for a more capable Maritime Patrol

Reconnaissance Force than either system could provide independently. This transition to

a mix of manned and unmanned aircraft illustrates the Navy's belief that UAS enhance

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[348] Sam LaGrone, "Navy Wants to Shed RAQ Designation from *Stingray* Carrier UAV," *United States Naval Institute News*, 11 March 2016, accessed 12 March 2016, http://news.usni.org/2016/03/10/navy-wants-to-shed-raq-prefix-from-stingray-carrier-uav.

[349] Outlines of the challenges the DASH and STAR UAS programs faced are provided in chapter 4.

[350] Darrah, 23.

existing mission communities by extending their reach and persistence, while also maintaining the flexibility and on-scene decision-making of manned aircraft, and emphasizing a trend towards a systems approach for broad maritime surveillance.[351] Additionally, the Navy is also exploring the employment of UAS as ISR assets from smaller surface combatants. This approach hearkens back to the previously identified need for an ISR platform from smaller surface combatants, which has been absent since the failed OTH RPV of the 1970s. In FY2008 the Navy invested in a new program for a small ISR-based UAS called the Small Tactical Unmanned Aircraft System designed to provide Navy surface ships with a means of detecting, classifying, and tracking objects within a small area of focus. The current variation on that project that is being explored is the Tactically Exploited Reconnaissance Node program, where the Navy and DARPA are exploring the possibility of employing forward-deployed surface combatants (primarily destroyers) as launch and recovery platforms for medium-altitude, long-endurance UAS for persistent ISR.[352] With the basing of such assets from highly mobile Navy platforms, the Navy's current ship-based UAS ISR range has the potential to extend out to 600 NM from 200 NM with the Tactically Exploited Reconnaissance Node program. A test flight of a full scale demonstration aircraft is currently planned for 2018, while in the interim, the Navy is conducting real-time maritime ISR experiments with Naval Special Forces teams employing NAVAIR's RQ-21A *Blackjack* UAS based off of amphibious shipping assets. Originally selected in 2010 for procurement by the Navy and Marine Corps to fill

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[351] Ibid.

[352] O'Rourke, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress*, 2.

the requirement for a small tactical unmanned aircraft system, *Blackjack* is designed to provide persistent maritime and land-based tactical reconnaissance, surveillance, and target acquisition data collection and dissemination.[353]

The Navy's mission of tactical surveillance and targeting operations set forth in *Naval Aviation Vision 2010* (2005) has been spearheaded by the *Fire Scout* program. In addition to its role as the Navy's lead program for such operations, based on guidance provided by CS-21R (2015), the Navy's utilization of the *Fire Scout* UAS in an anti-mine warfare role is a new concept that seeks to take advantage of the unique capabilities of this particular system. From 25 April to 16 May 2014, *Fire Scout* was employed as a composite manned/unmanned detachment on board the Littoral Combat Ship USS *Freedom* (LCS-1). During this deployment, the operators of the unmanned MQ-8B, working alongside the manned crews of MH-60R Seahawk helicopters, developed a first-of-its kind Concept of Operations (CONOPS) for the conduct of manned and unmanned aircraft on board a ship at sea.[354] As a result of these developments, during at-sea testing the MQ-8C *Fire Scout* is scheduled for 2017 to receive a mine-detection sensor termed the Coastal Battlefield Reconnaissance and Analysis that incorporates an airborne vehicle with a ground processing system for conducting surveillance of mine fields, obstacles, and camouflaged defenses in both the surf and inland areas. The Coastal Battlefield Reconnaissance and Analysis sensor's ability to detect naval mines in the littorals during

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[353] Jon Rosamond, "DSEI: ONR Faces Uphill Struggle to Cut UAV Manpower Costs," *United States Naval Institute News*, 16 September 2015, accessed 17 September 2015, http://news.usni.org/2015/09/16/desi-onr-faces-uphill-struggle-to-cut-uav-manpower-costs.

[354] Darrah, 25.

routine *Fire Scout* operations from LCS vessels has the potential to provide the Navy

with a replacement of the aging manned MH-53E *Sea Dragon* helicopter, which has been

the primary platform for the Navy's airborne minesweeping mission since 1986.[355] As the

planned upgrade to the MQ-8B, the MQ-8C *Fire Scout* promises to deliver even greater

capacity to what has been an extremely successful operational history for the program.

The planned integration of a manned aerial system (MH-60R) with a UAS (MQ-8B/C)

within the surface community is further evidence of the Navy's desire to operationally

integrate manned and unmanned systems to achieve greater mission effectiveness, and

represents an achievement decades in the making.

<u>Conclusions Regarding Modern-day US Navy UAS Policy</u>

Despite the challenges and opportunities resulting from the tragedy of the *Cole*,

the post-9/11 GWOT environment, and the Second Persian Gulf War, the Navy was slow

to embrace UAS development and employment in the first part of the 21st century as it

struggled to define its role in the face of evolving regional challenges and transnational

threats. Gradually, with the release of *Sea Power 21 and Global CONOPS* (2002) and

CS-21 (2007), the Navy perceived its role as one focusing on protecting and sustaining

the global economic system. More recently, with regard to UAS policy, *Naval Aviation*

Vision 2020 (2005) and CS-21R (2015) have directed the Navy's focus in three mission

areas for UAS: persistent ISR, tactical surveillance and targeting, and penetrating SEAD

and strike operations in order to ensure "All Domain Access." The use of UAS by the

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[355] Ibid.

Navy for these missions has been pursued to various degrees, with varying levels of success.

Notwithstanding, the ongoing debate regarding the requirements of the *Stingray* program, the incorporation of UAS into the naval ISR mission and the employment of the MQ-8B/C *Fire Scout* with manned aviation assets into a feasible CONOPS all signify a turning point in US Navy UAS policy. The interest and attempts at integration of multiple unmanned aviation platforms with manned systems underscores the direction set forth in the revised version of CS-21R (2015). In setting out a strategy that specifically focuses on the numerous challenges to maritime access that US forces must address, the Navy clearly recognizes that unmanned technologies, and UAS in particular, are in a unique position to increase the power projection of the carrier air wing, increase battlespace awareness by providing persistent surveillance of wide areas of ocean, the littorals and close-in coastal regions, and enable the Navy to accomplish tactical missions. However, acceptance of these systems by the Navy at the tactical and operational levels remains an unaddressed issue, and these platforms must prove their worth in a real world application in order to remain viable. Whether or not an innovative weapon system reaches operational status and full integration depends largely on how the service is able to process external and internal influences, based on unique functional, structural, and cultural characteristics.[356] Historically, this has been a significant weakness of the Navy. However, by anticipating the need for unmanned assets to fill critical mission areas, pursuing operational tests at greater sensor and operational ranges, and employing UAS to provide near-constant and far-reaching ISR data to supplement an early-warning

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[356] Ehrhard, 570.

capability to maritime assets, the Navy is applying a greater level of foresight to its UAS

policy than at any other time in its history. While the development of the *Stingray*

program has been particularly affected by fiscal realities preventing the achievement of

desired capabilities coupled with Congressional intervention, the successful incorporation

of an X-47B into fixed wing carrier-based operations is nothing short of an aviation

milestone.

The Navy's current efforts in the realm of UAS policy are due in large measure to

the threat posed by the growth and development of A2/AD technologies, including land-

based anti-ship ballistic missiles that threaten the typical off-shore zone where US

carriers have traditionally operated with impunity, but also reflect the maturation of UAS

technology for employment in an at-sea environment.[357] Historically, a threat drives

innovation, and the Navy's ensuing response to A2/AD threats provides it with a

significant opportunity in the realm of unmanned aviation.[358] Taking a proactive

approach to creating and modifying new CONOPS and fielding operational assets in

anticipation of a perceived threat are welcome shifts from the traditionally reactive nature

that has driven Navy UAS policy and system development in the past. Yet, the issue of

timely integration on the part of the Navy to meet such threats still remains. Ultimately,

the Navy's pursuit of UAS technology to counter A2/AD threats foresees a policy shift

away from direct, fleet-level engagement to a focus on defeating myriad unconventional

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[357] Dave Majumdar and Sam LaGrone, "UCLASS Requirements Shifted To Preserve Navy's Next Generation Fighter," *United States Naval Institute News*, 31 July 2014, accessed 26 August 2015, http://news.usni.org/2014/07/31/uclass-requirements-shifted-preserve-navys-next-generation-fighter.

[358] Williamson Murray and Allan R. Millett, eds. *Military Innovation in the Interwar Period* (Cambridge: Cambridge University Press, 1996), 311.

threats in an effort to extend the operational reach of the CSG and its associated assets. While A2/AD threats remain a significant concern, the Navy must change its historical paradigm of acceptance regarding UAS from the top down and bottom up in order sufficiently address the varied challenges the Navy must face in the 21st century.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

> Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur. In this period of rapid transition from one form to another, those who daringly take to the new road first will enjoy the incalculable advantages of the new means of war over the old.[359]
>
> — Giulio Douhet, *The Command of the Air*

A significant historical milestone in the realm of unmanned aviation was passed on 10 July 2013, when the X-47B successfully completed the first ever arrested landing by UAS onboard an aircraft carrier at sea. This effort marked a significant shift from the Navy's previous practice of operating UAS in a strictly tactical, non-integrated manner. Such attempts to achieve the integration of UAS into a combat platform as significant and central to the US Navy as an aircraft carrier foreshadow the US military's long term vision of full integration of manned and unmanned aerial assets. For the Navy in particular, efforts with unmanned aviation focus on a set of "revolutionary core capabilities centered around the aircraft carrier and its embarked air wing," reiterating the historical importance the Navy has placed on the aircraft carrier since the centrality of the aircraft carrier was reaffirmed in 1946.[360] In order for the Navy's carrier construct to remain relevant, however, the Navy must fully embrace UAS at every level to maintain the capability and lethality of its naval assets. The Navy's current and planned efforts

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[359] Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (New York: Coward-McCann, 1942), 30.

[360] Department of the Navy, *Naval Aviation Vision 2014-2025*, 8; Baer, 287-288.

with UAS research, development, and fielding hold great promise for the future, but these efforts must be embraced with a sense of commitment at every level to ensure success.

Conclusions

Historically, the Navy's approach to UAS policy and its subsequent integration were influenced by external political pressures, perceived enemy threats, the limitations of unmanned aerial technology, and most significantly, internal community discord and weak advocacy. Of these, politics played the smallest role, excluding the Congressional intervention that removed support for the *Pioneer* UAS, and the increased level of Congressional interest in the ongoing development of the UCLASS program.[361] Of the Navy's perceived enemy threats, Soviet capabilities were the most significant driving factor in UAS development.[362] DASH responded to the Soviet submarine threat, the OTH RPV sought to exploit a Soviet anti-ship missile range overmatch, *Pioneer* and the MR-UAV were developed in response to Soviet anti-air defenses, while the UCLASS was originally intended to overcome the growing reach of A2/AD threats.

Political pressures still play a key role in the Navy's modern-day UAS policy. As previously mentioned, DoD changed the way it managed UAS programs in 1998, permitting individual services to fund their own UAS programs, with the lead for

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[361] Ehrhard, 394; Sam LaGrone, "Pentagon to Navy: Convert UCLASS Program into Unmanned Aerial Tanker, Accelerate F-35 Development, Buy More Super Hornets," *United States Naval Institute News*, 2 February 2016, accessed 6 February 2016, http://news.usni.org/2016/02/01/pentagon-to-navy-convert-uclass-program-into-unmanned-aerial-tanker-accelerate-f-35-development-buy-more-super-hornets.

[362] Ehrhard, 394.

integration initiatives in the Navy under the responsibility of the PEO C4I.[363] While the

CNO coordinates with OSD and the JROC to tailor UAS developmental efforts to fit the

Navy's needs, PEO C4I works to realize integrated and interoperable C4I capability

across multiple air programs within the Navy and across the services. As the CNO and

SECNAV provide developmental and directional guidance, NAVAIR's PEO(U&W)

reports directly to the CNO as the specific executive office for the Navy's unmanned

aviation and strike weapons programs. This construct for Navy UAS development

provides a level of service specificity that represents a significant improvement over the

previous attempts by Congress to impose "jointness" on UAS development and fielding

efforts across multiple services. The challenge of balancing mission-specific performance

in areas like C4I with Congress' budgetary concerns remains a challenge for fielding

emergent technologies. The history reviewed in this study shows that imposed

interoperability and commonality across multiple services to meet multiple operational

needs drastically increases the overall cost of a given program.[364] Too often, this results

in the early termination of an otherwise revolutionary program.

Technology has also played a significant role in the Navy's UAS integration

because open-ocean combat operations present the single greatest technological obstacle

for UAS designers to overcome. Launch and recovery of a platform in heavy seas on a

pitching deck, often of constrained size, coupled with the requirements for extensive

saltwater corrosion protection, electromagnetic interference shielding, employing

independent propulsion systems that are capable of operating under semi-autonomous

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[363] See discussion of this transition in chapter 5.

[364] Blom, 130.

(and in some cases even autonomous control) all increase cost while decreasing range, payload, and altitude capabilities. These considerations are further exacerbated further by the range of the environment that the Navy operates in, from the littorals to the open ocean.

Unlike conventional aviation assets that face little competition, UAS technology faces strong, near-constant industrial and scientific competition that hinders widespread adoption. Missile technology and manned aviation assets possess traits that give them an edge in their competition with UAS. Missiles offer greater simplicity for the ship's crew in that they require little maintenance, relatively less technical training to employ, they do not interrupt concurrent operations, and there is no need to recover the missile once it is fired, meaning less possibility for damage to the ship. In contrast, UAS are intended to accomplish a mission without risking a manned asset, while offering the capability of returning to the ship to accomplish the mission again. However, throughout history, when given the choice between manned and unmanned aviation assets, Navy leadership has overwhelmingly sided with manned assets due to concerns of judgment, oversight, control, reliability, and predictability. From a historical standpoint, such apprehension was made manifest when manned Light Airborne Multi-Purpose System Mark III - capable helicopters assumed the ASW mission from DASH due to the greater autonomy of the flight crew, the crew's ability to pass a firing solution back to the ship, but also due to a healthy skepticism concerning the reliability of DASH.[365] Widespread questions of reliability and responsibility due to the limitations of immature technology have historically dimmed the promise of UAS.

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[365] Ehrhard, 395.

Despite these challenges, the most significant impediment to the Navy's integration of UAS has been the Navy itself. During the early days of Admiral William A. Moffett, the carrier aviation community exhibited a significant level of flexibility and innovative thinking as they grew in power and influence, but by the time UAS appeared as an alternative, carrier aviators had developed a hard-won, combat-proven, synchronized process of operation that avoided disruptive technologies.[366] Having established themselves as the preeminent expression of US naval power, the carrier aviation community subsequently took a gradual approach towards the incorporation of UAS. Ironically, the naval community with the skillset most capable of integrating UAS technology chose instead to reject it, leaving the surface warfare community, the one most unfamiliar with aviation, to attempt to overcome the obstacles of employing UAS at sea. With DASH specifically, the surface community struggled without properly trained operators to utilize a poorly integrated asset that was entirely foreign to their operating environment, and in light of those issues, naval aviators responded by producing a manned replacement for DASH that increased their budget share and corresponding power within the Navy hierarchy.

A lack of familiarity with aviation operations inhibited the surface warfare community's attempts to assume the majority of UAS development throughout the history examined here. Instead, surface officers attempted to leverage UAS as a way to gain a greater level of institutional power relative to the carrier aviation community by

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[366] The concept of "disruptive innovations" that impact a secondary mission and are subsequently overlooked are introduced in Chapter 3 and discussed again in Chapter 4. The theory is explored in a naval context in Professor Gautam Mukunda's article entitled "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy."

attempting to operationally employ a system despite an absence of aviation experience. Decades later, the same non-pilot operator problems resurfaced with *Pioneer*, but the Navy overcame these issues by placing flight-qualified officers as detachment officers-in-charge on the small number of battleships on which the system was deployed. Both experiences taught the surface community that they needed to outsource aviation skill in order to make the construct of aviation on small surface ships an operational possibility. This lesson remains relevant for the Navy today.

Weak advocacy for UAS within the Navy has also historically hampered the employment of unmanned technology. Despite the power of centralized control to bring about change, weapon systems require buy-in at the lowest level in the form of unit-level training, maintenance, and support in order to be effective. While the example of Vice Admiral Joseph Metcalf's advocacy for *Pioneer* displays a level of conversion, the failure of the Navy to replace, redesignate, or protect *Pioneer* following the retirement of its battleships highlights the absence of an internal constituency in support of UAS integration. This trend bears itself out over the Navy's history. While DASH was a novel program, it was pursued after failures with the rocket-assisted torpedo and ASROC. Born from aviation research and development and acquired with surface community funding, DASH struggled with a lack of program ownership and the inability of senior Navy leadership to fully understand its potential or advocate for its use. The carrier navy's drone tests in 1970 that explored the concept of an unmanned ISR asset from a carrier used models that had been operated by the Air Force for six years. Among the surface community, the OTH RPV proposal came out five years after its manned competitor, Light Airborne Multi-Purpose System Mark III, had commenced widespread

development. *Pioneer*, modeled on the Israeli *Mastiff*, gained operational status nearly ten years after Israel had operationally employed RPVs.[367] By allowing other services to expand on UAS technologies, and adopting those technologies for their own use after they matured, the Navy's historical policy regarding UAS implies a level of endemic resistance that exceeds the technological challenges of operating unmanned aviation at sea. Besides facing the resistance of those who view it as a threat, the full potential of advanced UAS technologies remains unrealized because of a failure of imagination.[368] The "outsider" nature of UAS when perceived as a disruptive technology presents a challenge that the culture within the Navy must overcome in order to fully leverage the technology, else it may risk being left behind as the technology inevitably continues to mature. Navy culture itself, sub-divided into the unique surface, aviation, and submarine major warfare communities, bears the greatest share of this responsibility as it has widely resisted unmanned technology since its introduction.

Incorporation of UAS at the operational level was achieved by the Navy twice in its history, in the fielding of DASH and *Pioneer*. The reason for these two successes was due in large part to the centralized, top-down approach provided by Navy leadership at the time. In the case of DASH, in the 1960s Admiral Arleigh A. Burke used personal influence, his role as the de facto head of the Navy's surface community, and his long tenure as CNO to incorporate DASH as part of a destroyer rehabilitation plan. Following his departure, however, the Navy curtailed DASH and all subsequent UAS development.

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[367] Ehrhard, 401.

[368] Robert C. Rubel, "Pigeon Holes or Paradigm Shift: How the Navy Can Get the Most of its Unmanned Aerial Vehicles," *United States Naval Institute Proceedings* (July 2012): 42.

In the 1980s, SECNAV Lehman imposed central authority and forced the *Pioneer* UAS upon the Navy and Marine Corps. Following his departure, similar attempts to terminate *Pioneer* were made, although the platform proved its worth in combat during the Persian Gulf War. In both instances, centralized control and the direct leadership of two strong personalities drove these two operational UAS into service. Both individuals also benefitted from particularly lengthy periods in their role as organizational leaders, which permitted them to institute such radical change. With the pending incorporation of the *Stingray* into carrier flight operations, the Navy needs a similar advocate to continually shepherd the program from conception and beyond so that the Fleet may fully reap its benefits.

Recommendations

The increased range of anti-ship missiles, most notably those of China, constitutes a serious tactical shortfall that provides an opportunity for full UAS integration into carrier flight operations, where CSG defense capabilities against such missiles lag dangerously behind the threat.[369] The Navy's only response is to operate at ranges that preclude its short-range airpower from having an operational effect, with drastic implications on the combat power of the carrier.[370] The Navy's decision to defer a response to the A2/AD threat despite the long-loiter, potential reconnaissance, warning, intercept, and strike capabilities of the *Stingray* platform in favor of using it as an airborne refueling platform in FY2017 represents a shortsighted view regarding this

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[369] Ehrhard, 616.

[370] Hendrix, 52.

revolutionary technology.[371] CNO Admiral John Richardson's characterization of this refueling mission for the *Stingray* as a "legitimate" primary use of the platform in order to "liberate" manned strike fighter aircraft from the airborne tanking mission reflects a view reminiscent of the historical mindset of naval admirals who perceived naval aviation as useful only as spotters in support of battleship gunfire.[372] The Navy's first UA, the aerial torpedoes of Sperry and Hewitt, were envisioned, researched, and developed to be weapons of destruction. During WWII, the Navy's first operational use of UAS in combat was for strategic attack. DASH was first conceived of as a weapons delivery system, as was UCLASS. With the modern day validation of the potential of unmanned strike, and with history as a lesson, the Navy needs to pursue all developments in the mission area of unmanned strike. The addition of unmanned strike aircraft into the carrier air wing will unquestionably complement and strengthen the mass, range, payload, persistence, and stealth characteristics of the air wing.[373] However, the gradual incorporation of the technology, and the number of ways in which the mission of the UCLASS program in particular has been changed repeatedly highlights the Navy's historical resistance to some types of change, especially those that threaten service and

[371] Sam LaGrone, "Pentagon to Navy: Convert UCLASS Program into Unmanned Aerial Tanker, Accelerate F-35 Development, Buy More Super Hornets," *United States Naval Institute News*, 2 February 2016, accessed 6 February 2016, http://news.usni.org/2016/02/01/pentagon-to-navy-convert-uclass-program-into-unmanned-aerial-tanker-accelerate-f-35-development-buy-more-super-hornets.

[372] Megan Eckstein, "CNO: Navy Should Quickly Field CBARS To Ease Tanking Burden on Super Hornets," *United States Naval Institute News*, 12 February 2016, accessed 1 March 2016, http://news.usni.org/2016/02/12/cno-navy-should-quickly-field-cbars-to-ease-tanking-burden-on-super-hornets; Hendrix, 53.

[373] Hendrix, 53.

community identities (e.g. manned aviation). As disruptive technologies tend to work against ingrained cultures, a successful organization must possess an open culture in order to effectively cope with innovation.[374] Despite the looming threat of growing A2/AD capabilities, it seems only a major disaster or another leader in the vein of Lehman will be capable of shocking the Navy into further development in the mission area of unmanned aerial strike.

The Navy must also actively engage with external agencies like Congress, OSD, the Joint Staff, CIA, sister services, and the nation's allies in order to stimulate greater UAS penetration within the Navy. Since previous experiments by Congress, OSD, and the Joint Staff to impose centralization on UAS development across the military have failed, the Navy must actively resist the idea that centralization above the level of the service can accomplish innovation, not only for pragmatic political reasons but for the potential impact of decreased military effectiveness.[375] This notion is particularly applicable in an era of budget austerity, since historically, military drawdowns following periods of conflict have proven to be detrimental to the development of new technologies. The modern-day period of increased budgetary constraints demands a high level of accountability in order for the Navy to avoid repeating similar breaks in the technological development and innovation of UAS. The Navy simply cannot afford to get its UAS wrong again.

Finally, the Navy must overcome its own intrinsic bias towards unmanned aviation and move towards a greater sense of acceptance and incorporation of the

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[374] Mukunda, 126-127.

[375] Ehrhard, 621.

technology. Following the example of a Burke or Lehman, higher level leadership that embraces the pioneering spirit of the first naval aviators within the construct of unmanned aviation is capable of implementing (or imposing) significant change from the top down. The direction set forth by Secretary of the Navy Ray Mabus in CS-21R (2015) indicates a greater level of openness towards the employment of UAS across the spectrum of naval operations. With multiple threats posed by near-peer potential adversaries, it is essential that the Navy incorporate a greater number of unmanned aerial assets into naval operations to address critical mission shortfalls. This point may be particularly salient considering the average time it takes to construct a UAS (six weeks) as opposed to training a Naval Aviator (usually in excess of two years).[376]

While inherent obstacles to innovation exist in all organizations, the Navy nonetheless has a tradition of UAS innovation, albeit an episodic one. From a historical standpoint, the Navy's adoption of unmanned aerial technology in innovative, paradigm-challenging ways has shown a potential capacity to revolutionize naval operations. However, this innovation is only widely effective to the degree that it is adopted, integrated, and employed across the Fleet. Integration will not happen without strong, focused leadership from the top, coupled with dedicated follow-through at the lowest levels. Should the Navy continue to pursue an approach favoring periodic and sporadic innovation rather than pursuing a greater attempt at widespread integration, history offers the lesson that very little will change.

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[376] Newcome, 137.

<u>Recommendations for Further Research</u>

The limited scope of this thesis provides several areas for future study. These recommendations are in several topic areas: the use of additional case studies across other services; an analysis of best practices for the Navy to achieve its stated objectives of integrating UAS and the best ways for the Navy to develop, establish, and deploy UAS; and a study conducting further research on the best ways for the Navy to integrate manned and unmanned assets against future threats.

Future areas for research on this topic are reflected in the Navy's principles for UAS set forth in the PEO(U&W) guidance for UAS programs. These areas reflect the degree that the Navy can achieve its recently stated objectives for UAS, including how best to integrate UAS into DoN culture, and the best ways for the Navy to develop, establish, and deploy UAS as a whole across the Fleet.[377] Additional areas for analysis include exploring the potential of a common UAS control system, common interfaces, data formats, and standards, as well as the potential modularity and scalability of sensor and weapons payloads for UAS, and how these concepts can facilitate widespread Fleet integration. Exploring how these aspects might facilitate the improved integration of UAS, attain increased levels of interoperability, and ensure a maximization of the Tasking, Collection, Processing, Exploitation, and Dissemination utilization construct will identify future areas of capability and capacity for Navy UAS programs. Examining the costs, benefits, and risks of the Advanced Concept Technology Demonstration process used to rapidly field modern technologies will also assist in the identification of

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[377] United States Navy Naval Air Systems Command, "PEO(U&W) Overview," accessed 1 March 2016, http://www.ndia.org/Divisions/Divisions/International/ Documents/NIID_PEO(UW)_UAS_Overview_8_Nov_2012.pptx.

best practices for getting cutting-edge UAS programs to the Fleet. A study of the Navy's desire to achieve greater interoperability across UAS platforms in the near and long term based on a recommended mix of manned and unmanned aerial assets will also shed greater light on the best way for the Navy to achieve greater persistence, capacity, flexibility, timeliness, and connectivity across its aerial arsenal moving forward.

<div align="center">Future Implications and Final Thoughts</div>

As new threats emerge across the naval operating construct, the capabilities of naval UAS and their level of Fleet-wide integration must also adapt to meet those threats. The near horizon for the next generation of Navy UAS is focused on the integration of manned and unmanned assets, primarily in the mission area of All Domain Access, and the related concepts of Cooperative Engagement Capability (CEC), and Naval Integrated Fire Control-Counter Air. In a seminar address in September 2015, the commander of the Office of Naval Research, Captain Clark Troyer, stated that the Navy is "looking for ideas for UAS to go beyond the dull, dangerous, and dirty missions" in favor of "systems that work as teams with warfighters." In developing the next generation of UAS, the Navy is looking to attain "persistence in unmanned systems," achieve "rapid dynamic responses to operational changes," and ensure "navigation and communications in denied environments."[378] These operational priorities directly relate to the Navy's mission of All Domain Access introduced in the March 2015 revised version of CS-21R. Referring to the Navy's means to counter A2/AD threats and assure access and freedom of action in

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[378] Rosamond.

any domain, this mission is an area of great potential for UAS.[379] Based on this guidance, the Navy is currently developing a number of concepts and tactics drawing on the strengths and potentials of UAS in order to best utilize them to counter A2/AD threats, provide near-constant maritime and littoral ISR, increase mine warfare capability, and overwhelm an enemy force.

Using UAS as the means to counter A2/AD threats relates to the guidance outlined in the "Third Offset Strategy," released by Secretary of Defense Chuck Hagel in November 2014. This strategy seeks to leverage innovative technologies to maintain the military supremacy of the US over its adversaries for the next 20 years.[380] Identifying the necessity of "innovation and adaptability" across the defense enterprise as the requirements upon which America's continued strategic dominance will rely, Secretary Hagel highlights these aspects as key enablers to meet the challenges posed by potential US adversaries. Although not specifically mentioned, UAS technologies must necessarily be included in this strategy as they will play an ever-increasing and essential role within the Navy as a means to enable freedom of operations at an increased range and facilitate an early friendly response to A2/AD threats. A greater level of innovation and adaptability within the culture of the Navy will permit wider adoption of UAS while achieving the goals set forth in the "Third Offset Strategy." The repercussions of failing to actively work in pursuit of these goals will be drastic, sudden, and severe.

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[379] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (2015), 19.

[380] Sydney J. Freedberg, Jr., "Hagel Lists Key Technologies For US Military, Launches 'Offset Strategy,'" *Breaking Defense*, 16 November 2014, accessed 28 March 2016, http://breakingdefense.com/2014/11/hagel-launches-offset-strategy-lists-key-technologies/.

CS-21R (2015) outlines a way for specific integration of UAS into the carrier-based sensor network known as CEC as one of the functional areas designed to support the A2/AD mission.[381] Utilizing a construct comprised of CSG air and missile defense capabilities, CEC draws data from multiple air-search sensors across multiple air and surface units into a single, real-time, composite track picture that subsequently bolsters Fleet air defense and permits the timely allocation of defensive missile assets. CEC was employed by the USS *Theodore Roosevelt* (CVN-71) CSG during its March 2015 deployment, marking the first operational deployment of an E-2D Advanced Hawkeye squadron with BAMS-D assets. In the future, CEC will form one of the key pillars of the CSG's Naval Integrated Fire Control-Counter Air capability, which will allow manned and unmanned air assets such as the F-35C Lightning II and the future UCLASS variant to act as forward observers for the CSG. These assets will then send their observations to an airborne E-2D for consolidation and subsequent real-time strike group utilization. The incorporation of UAS throughout this A2/AD construct will be essential to permit the Navy to maintain an appropriate level of freedom of action in the open sea and littoral operating environments.[382]

Ultimately, the wide-ranging array of force application demands and threats facing the US Navy coupled with modern-day fiscal constraints demand solutions beyond individual systems built to operate independently and address a specific threat. The Navy's imperative is to envision new ways to exploit its advanced technologies to gain

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[381] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (2015), 21.

[382] Ibid.

operational advantages over an adversary.[383] Only full integration of UAS at the operational and tactical levels will ensure the Navy's ability to achieve widespread mission success and attain All Domain Access in a maritime environment. In the immediate future, UAS will increase battlespace awareness by providing persistent surveillance of wide areas of ocean, the littorals, and close-in coastal regions to naval ships, submarines, aircraft, Marines, and special operations personnel. With greater advances in the autonomous functions of UAS, Secretary Mabus has outlined a shift from the current paradigm of one or more "operators" per vehicle to a "system-of-systems" approach in which UAS monitor themselves while a small number of people oversee multiple vehicles as "mission managers." This technology foreshadows a "swarming behavior" of UAS where a large number of relatively inexpensive systems autonomously collaborate to overwhelm an adversary. Future Navy UAS policy must keep pace with the ever-changing dynamic of modern warfare while seeking an integration of information from multiple autonomous sources across the battlespace that is "immediately converted to knowledge" and swiftly acted upon. As Mabus stated in 2015, autonomous UAS "have to be the new normal in ever-increasing areas."[384] Looking to the future, the Navy's ability to fully leverage UAS in concert with legacy manned systems while aggressively pursuing autonomous system technologies will pave the way for the next unmanned maritime aerial revolution.

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[383] Rubel, 46.

[384] Department of the Navy, *A Cooperative Strategy for 21st Century Seapower* (2015), 21; Sam LaGrone, "Mabus: F-35 Will Be 'Last Manned Strike Fighter' the Navy, Marines 'Will Ever Buy or Fly,'" *United States Naval Institute News*, 15 April 2015, accessed 2 April 2016, http://news.usni.org/2015/04/15/mabus-f-35c-will-be-last-manned-strike-fighter-the-navy-marines-will-ever-buy-or-fly.

APPENDIX A

DoD UAS CLASSIFICATION AND SPECIFICATIONS

With regard to the classification of UAS, DoD has its own classification system

that differs from that of civilian grouping or type categories. For the purposes of

clarification, this paper refers to the five DoD categories of UAS depicted below:

UAS Classification According to the Department of Defense					
Category	Size	Maximum Gross Takeoff Weight (lbs)	Normal Operating Altitude (ft)	Airspeed (knots)	Representative UAS
Group 1	Small	0-20	<1,200 AGL	<100	RQ-20 *Puma*
Group 2	Medium	21-55	<3,500 AGL	<250	*ScanEagle*, *Silver Fox*, MQ-19 *Aerosonde*
Group 3	Large	<1,320	<18,000 MSL	<250	RQ-2 *Pioneer*, RQ-15 *Neptune*, RQ-21A *Blackjack*
Group 4	Larger	>1,320	<18,000 MSL	Any airspeed	MQ-8B/C *Fire Scout*
Group 5	Largest	>1,320	>18,000 MSL	Any airspeed	BAMS-D, MQ-4C *Triton*, X-47B
AGL = Above Ground Level, MSL = Mean Sea Level, KIAS = Knots Indicated Airspeed Note: If the UAS has any one characteristic of the next level, it is classified within that level.					

Source: Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-30, *Command and Control of Joint Air Operations* (Washington, DC: Government Printing Office, February 2014), III-30.

Specifications of Notable US Navy UAS

The major UAS that have served or are currently serving in the Navy's inventory,

primarily drawn from those UAS included in the OSD's *Unmanned Aircraft Systems*

Roadmap 2005-2030 (2005) that are referred to throughout this study include the following:

The Gyrodyne QH-50 DASH, which was operationally deployed by the US Navy from 1963 to 1971, is a semiautonomous helicopter UAS designed for antisubmarine warfare. It was the first rotary wing UAS produced, the first UAS to take off and land back aboard a vessel at sea, and was the first unmanned reconnaissance helicopter.[385]

The RQ-2 *Pioneer* UAS, which was utilized by the US Navy from 1986 until 2007, is a rail launched semi-autonomous fixed wing surveillance system recoverable aboard ship that was used for gunnery spotting and ISR.[386]

The DRS RQ-15 *Neptune* UAS, which entered service with the US Navy in 2002, is a rail-launched semi-autonomous fixed wing ISR system that does not require an airfield for deployment, and is recoverable via parachute or water landing.

The *Silver Fox* UAS, which entered service with the US Navy in 2002, is a small rail-launched autonomous fixed wing ISR system that does not require an airfield for deployment.

The *ScanEagle* UAS, which entered service with the US Navy in 2005, is a catapult-launched autonomous fixed-wing ISR system that does not require an airfield for deployment.

The MQ-8B *Fire Scout* UAS, which entered service with the US Navy in 2006, is an autonomous helicopter designed to provide ISR, fire support and precision targeting

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[385] Newcome, 87-8.

[386] Ibid., 97.

support. Its subsequent replacement, the MQ-8C *Fire Scout*, is scheduled for shipboard testing in 2017.

The Broad Area Maritime Surveillance-Demonstrator (BAMS-D) UAS, which entered service with the Navy in 2008, is an experimental autonomous fixed-wing high-altitude ISR platform based on the Air Force's RQ-4A *Global Hawk*. Its replacement, the MQ-4C *Triton* UAV, is scheduled for Initial Operational Capability in 2018.

The AAI MQ-19 *Aerosonde* UAS, which entered service with the US Navy in 2009, is a catapult-launched small semi-autonomous fixed-wing ISR system that does not require an airfield for deployment.

The X-47B Unmanned Combat Air System Demonstration (UCAS-D) UCAV, which entered service with the US Navy in 2011, is an experimental semi-autonomous fixed-wing aircraft capable of integration within a carrier air wing that can be launched and recovered on board an aircraft carrier. The Unmanned Carrier-Launched Surveillance and Strike (UCLASS) system, renamed the Carrier-Based Aerial Refueling System (CBARS), and then designated the MQ-25 *Stingray*, promises to be the follow-on version to the X-47B UCAS-D, but its development has been repeatedly delayed.[387]

The RQ-20 *Puma* UAS, which entered service with the US Navy in 2012, is a hand-launched semi-autonomous ISR system that does not require an airfield for deployment.

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[387] Sam LaGrone, "WEST: Bob Work Says UCLASS Development Needs a 'Joint Perspective,'" *United States Naval Institute News*, 10 February 2015, accessed 23 August 2015, http://news.usni.org/2015/02/10/west-bob-work-says-uclass-development-needs-joint-perspective.

The RQ-21A *Blackjack* UAS, which entered service with the US Navy in 2012, is

a rail-launched fixed wing ISR system recovered via a "skyhook" recovery system.[388]

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[388] Newcome, 113-6.

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