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14. ABSTRACT

Distributed lethality is the surface Navy's concept of conducting offensive sea control using modifications to existing ships with new weapons or sensors. As adversaries continue to develop surface warfare capabilities with extended range, there is a renewed effort to focus on the surface force's readiness. Supporting a surface experimental test squadron will aid in furthering distributed lethality / distributed maritime operations to provide advanced tactics and weapons development in the maritime domain. This paper traces the history of experimentation and establishment of testing commands of the four services. One of the key components of testing and evaluation is understanding the Department of Defense acquisition process and its role in weapons and systems fielding in the fleet. Drawing from an aviation squadron and their testing of unmanned aircraft can be an example for the surface community to emulate. Therefore, a proper assessment of distributed lethality is crucial for consideration of an experimental test squadron in the surface community.

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<u>Distributed Lethality and A Surface Experimental Test Squadron</u>

by

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Commander, USN

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of Gravely Naval Research Group.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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ABSTRACT

Distributed lethality is the surface Navy's concept of conducting offensive sea control using modifications to existing ships with new weapons or sensors. As adversaries continue to develop surface warfare capabilities with extended range, there is a renewed effort to focus on the surface force's combat readiness. Supporting a surface experimental test squadron will aid in furthering distributed lethality / distributed maritime operations concepts to provide advanced tactics and weapons development in the maritime domain. This paper traces the history of experimentation and establishment of testing commands of the four services. One of the key components of testing and evaluation is understanding the Department of Defense acquisition process and its role in weapons and systems fielding in the fleet. Drawing from an aviation squadron and their testing of unmanned aircraft can be an example for the surface community to emulate. Therefore, a proper assessment of distributed lethality is crucial for consideration of an experimental test squadron in the surface community.

INTRODUCTION

The Navy has long been involved in the development and testing of weapons and systems. Naval aviation and submarine communities have used experimentation in their squadrons in order to field advanced and affordable warfighting capabilities to remain ahead of adversaries. As adversaries develop surface warfare capabilities with extended range, there is a renewed effort to focus on the surface force's combat readiness. Distributed lethality is the surface warfare community's concept of operating offensively using modifications to existing ships with new weapons or sensors. As such, supporting a surface navy experimental test squadron will aid in furthering distributed lethality / distributed maritime operations concepts to develop and provide advanced tactics and weapons in the maritime domain.

Almost two years ago, the senior leaders of the sea services re-emphasized the importance of seapower to the nation's security in A Cooperative Strategy for 21st Century Seapower (CS-21R).[1] Considering the strategic attention shift to the Pacific, as well as continued fiscal constraints, the Navy swung back on the pendulum to seapower. While there are various aspects to the maritime strategy, it is important to examine how this strategy has influenced the surface navy's fundamental principle of distributed lethality. For decades, the U.S. has been able to project power across the world unchallenged. The presence of carriers with their embarked airwings and surface combatant escorts have been a regular feature in the maritime landscape. The offensive approach achieved through distributed lethality is an effective operational concept for the surface navy. Its objective can be

[1] Joseph Dunford, Jonathan Greenert and Paul Zukunft, *"A Cooperative Strategy for 21st Century Seapower: Forward, Engaged, Ready,"* U.S. Government Printing Office, Washington D.C., March 2015.

furthered through experimentation using large and small surface ships as well as unmanned surface vehicles (USVs).

The Navy's perspective has changed over the years and to understand where U.S. maritime strategy may be heading, it is important to understand its origin and processes that led to its current state. At the end of World War II the U.S. Navy had the largest fleet. By the 1970s several factors contributed to the Navy focusing primarily on power projection – a response to the Vietnam War and the fleet's experience in the use of the seas.[2] Post-World War II, as the budget became limited, the U.S. Navy began retiring aging ships while the Soviets began rebuilding their navy and expanding their operations in the eastern hemisphere. This expansion led to concerns the U.S. Navy would not be capable of winning a major conventional war at sea.[3]

To refocus efforts on strategy and warfighting at sea, the Chief of Naval Operations established the Strategic Studies Group in 1981 which published the Maritime Strategy of 1986.[4] However, in the years following the fall of the Soviet Union, the maritime strategy shifted in response to a new security challenge where naval forces concentrated on littoral warfare and maneuver from the sea.[5] It was an expeditionary focus near land and away from the strategy of operating in open ocean and power projection.

A little over a year after September 11, 2001, Sea Power 21 was published. It was a forward-looking vision of how emerging technology and capabilities could be used to aid in

[2] John T. Hanley Jr., "Creating the 1980s Maritime Strategy and Implications for Today," *Naval War College Review,* Spring 2014, Vol. 67, No. 2: 11-30.
[3] Ibid.
[4] Ibid.
[5] Sean O'Keefe, Frank B. Kelso II, and C.E. Mundy Jr., "From the Sea," Navy and Marine Corps White Paper, September 1992. Accessed January 15, 2017. http://www.navy.mil/navydata/policy/fromsea/fromsea.txt

meeting the Navy's missions.[6] Without a near peer competitor for the Navy, power projection was the primary focus, and offensive sea control atrophied. Continuing in the same theme of power projection, A Cooperative Strategy for 21st Century Seapower (CS-21) was released in 2007. It focused on opportunities, not threats, and forging partnerships with nations to promote security and prosperity around the world.[7] When the revised strategy was released in 2015, it emphasized five essential functions which included all domain access, deterrence, sea control, power projection and maritime security.[8] In retrospect, the maritime strategies were formulated based on the current political, economic, and security environment at the time. The same factors can be applied in updating the maritime strategy in response to the environment today as well as in the future. As such, a surface experimental test squadron is one avenue to further assist in accomplishing distributed lethality.

CHAPTER 1: HISTORY OF EXPERIMENTATION

Experimentation in the military is not a new concept. It involves developing and testing new systems while observing the results under various conditions. Not only can planners "explore how various operating techniques will work against surrogate opponents who use operational methods and tactics different from the U.S., they can learn how systems will work in simulated combat environments and how to equip forces against those threats."[9]

[6] Vern Clark, "Sea Power 21," *Proceedings*, October 2002. Accessed January 15, 2017. http://www.navy.mil/navydata/cno/proceedings.html
[7] *A Cooperative Strategy 21st Century*, October 2007. Accessed January 15, 2017. https://www.ise.gov/sites/default/files/Maritime_Strategy.pdf
[8] Joseph Dunford, Jonathan Greenert and Paul Zukunft, *"A Cooperative Strategy for 21st Century Seapower: Forward, Engaged, Ready."*
[9] *The Role of Experimentation in Building Future Naval Forces*, The National Academies Press, Washington D.C., 2004:1-255. Accessed December 12, 2016. http://www.nap.edu/catalog/11125.html

The use of experimentation has allowed the military to transform how they fight and how they use the information they have gathered to shape their forces. As a result, experimentation is an important aspect of building military capabilities. The next section provides a historical overview of the process and establishment of operational test commands for the Air Force, Army, Marine Corps, and Navy, and how experimentation is used to test and develop systems in service today.

A. **AIR FORCE**

Air Force testing and evaluation dates back to 1909 with the evaluation of the Wright Brothers airplane.[10] From World War I to World War II, the Army Air Corps established the Materiel Division and Air Proving Ground Command, testing ordnance, aviation equipment, and new aircraft.[11] By the end of the war more than 2,800 tests were conducted on fighters and bombers as well as proximity fuses, napalm, incendiary bombs, and fighter escorts.[12] However, after the Korean War, nuclear capabilities became the focus and the Air Proving Ground Command was dismantled because of budget cuts in conventional forces. Evidence suggests the main reason was because of the quick acquisition process and the lengthy time between the test and evaluation process, which encompassed eight phases. By the time a system or weapon arrived for suitability testing, it was too far into the production phase and would be costly if any modifications to the design were needed.[13] Additionally, the nuclear technology race accelerated the need for systems to be developed and used in the field.

[10] Lawrence R. Benson, "History of Air Force Operational Test and Evaluation (OT&E) Mission, Organization, and Policy," *DTIC*, December 1992: 1-55.
[11] Ibid., 5.
[12] Ibid.
[13] Ibid.

From the late 1950s to mid-1960 the Air Force streamlined the testing and evaluation process by reducing the eight-phase testing to three. There was also a renewed effort at operational testing and by the early 1970s "DoD began looking at how Operational Test and Evaluation (OT&E) could better contribute to procurement decision."[14] In 1972 the Commission on Government Procurement recommended OT&E be a separate entity from the developer and user.[15] The Air Force stood up their Test and Evaluation Center (AFTEC) in 1974 at Kirtland AFB, NM, with the intent of borrowing equipment, personnel, and facilities needed for field testing from the developing and operating commands.[16] The center was redesignated the Air Force Operational Test and Evaluation Center (AFOTEC) in April 1983 to clearly establish its role as the Air Force's operational test agency.[17]

Although the organization has undergone name changes, the basic procedures and policies the Air Force has followed has remained constant even today. The methods used for OT&E are as follows: Planning, Limitations, Test Execution, Analysis, Modeling and Simulation, and Reporting. After a user defines a requirement, AFOTEC starts advance planning which leads to the development of a test concept. Through a test planning review process AFOTEC prepares test and evaluation master plans and "identifies all the various elements to be evaluated, including critical operational issues, measures of effectiveness, test objectives, measures of performance, and evaluation criteria."[18]

The next step is identifying the limitations or constraints to the test. These can include safety or airspace restrictions, not enough support equipment, or limited capability

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[14] Ibid., 9.
[15] Ibid.
[16] Ibid., 11.
[17] Air Force Operational Test and Evaluation Center. Accessed April 20, 2017. http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104538/air-force-operational-test-and-evaluation-center/
[18] Benson, "History of Air Force Operational Test and Evaluation (OT&E) Mission, Organization, and Policy," 14.

software.[19] Furthermore, insufficient test ranges and facilities have also been limitations. Nine months before a start date the test teams are assembled to conduct OT&E and begin to process and interpret data.[20] These teams help identify deficiencies and recommend modifications. The results of the test are then analyzed to determine effectiveness and suitability of the system.

Since the 1980s the Air Force has maintained an exceptional modeling and simulation division. Although it could aid in early operational assessments, AFOTEC has "followed a firm policy that modeling and simulation can supplement but not substitute for actual testing."[21] So while actual testing may be more manpower and equipment intensive, it is more realistic in setting environmental conditions. The final step of the OT&E process is reporting. AFOTEC had undergone several iterations of their reporting documentation from the late 1970s to late 1980s until settling on providing overall conclusions about the system's effectiveness and suitability.[22] It is not uncommon to provide briefings and status updates along the testing process. It is up to the decision makers to take the information into consideration when looking at the overall OT&E program. Not only have final reports remained as a historical record of an OT&E program, but AFOTEC has also maintained a "Lessons Learned database of suggestions submitted by test teams."[23] This is an important part of the overall OT&E procedure to assist others who may encounter similar issues during their testing phase.

[19] Ibid.
[20] Ibid., 15.
[21] Ibid., 16.
[22] Ibid.
[23] Ibid., 17.

B. **ARMY**

The Army developed its own approach to OT&E. The Army Operational Test and Evaluation Agency (OTEA) was established in September 1972 in response to congressional and DoD pressures to reform the OT&E process.[24] "By the late 1960s and early 1970s, the high cost of procurement, numerous system failures, and the need for extensive postproduction modifications were causing general dissatisfaction with the OT&E process.[25] Several DoD reports indicated weapon systems employed in Southeast Asia in the late 1960s were in production before undergoing adequate tests and they had a high rate of defects. In order to assuage the concerns of DoD and critics of the OT&E process, the Army implemented a few changes. A field exercise was added to the service testing process which increased objectivity and thoroughness of OT&E and policy changes were updated.[26] Additionally, an independent agency for OT&E was established.

There are two types of materiel testing and evaluation that the Army conducts. The first is Developmental Test and Evaluation (DT&E) and it is conducted by the developer to demonstrate that the engineering design is complete and that the system has minimum risks and will meet specifications of the military requirement.[27] The second test is User Test and Evaluation (UT&E) and it includes OT&E, Force Development Test and Evaluation (FDT&E), and Joint Test (JT).[28] Essentially, the OT&E is a series of tests conducted in a realistic environment by personnel familiar with operating and maintaining the system provides. In addition to providing operational effectiveness, suitability, and compatibility, it

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[24] Charles R. Shrader, "History of Operations Research in the United States Army," Volume III: 1973-1995, Office of the Deputy Under Secretary of the Army for Operations Research, Washington, D.C., 2009: 1-377.
[25] Ibid., 139.
[26] Ibid., 140.
[27] Ibid., 138.
[28] Ibid.

can also provide information on personnel requirements, doctrine and tactics.[29] FDT&E includes tests in a broader scope to examine the impact or effectiveness of a specific concept, tactic or doctrine, and JT is participating in a test with another service.[30] It is important to evaluate how systems will operate with another service's system to ensure interoperability before using the system in the field for the first time.

Similar to the Air Force, the Army OT&E organization went through several name changes, mission expansion, and organizational re-alignment from the 1970s to the 1990s. In 1990, the Operational Test and Evaluation Command (OPTEC) was established and folded OTEA into it. The intent was to streamline management and avoid duplication of efforts by consolidating Army testing and evaluation.[31] Then in 1999 the final stage of consolidation occurred with the new command of Army Test and Evaluation Command (ATE). Although the size of the command and its mission sets has varied throughout the years, its key mission of planning and conducting operational tests, evaluations, and assessments of systems has remained the same.

C. **MARINE CORPS**

Marine Corps experimentation has led to the "use of aircraft for close air support for ground troops during the 1920s, the development of amphibious warfare doctrine during the 1930s, the use of helicopters in combat during the 1950s, the development and use of vertical-capable jet aircraft during the 1970s, the development of very short takeoff and landing rotorcraft during the 1980s to building of Fleet Antiterrorism Security Teams and the

[29] Ibid.
[30] Ibid.
[31] Ibid., 151.

Chemical/Biological Incident Response Force of the 2000s."[32] The Marine Corps Operational Test and Evaluation Activity (MCOTEA) operates similarly to AFOTEC in that it monitors OT&E programs from operational organizations. Although the MCOTEA history is not as long compared to the other services, it works very closely with the defense acquisition process. It has long succeeded at operational test and now it ensures that the evaluation process is just as thorough.

MCOTEA's early involvement in the acquisition cycle includes early program reviews, demonstrations, working groups, selected testing, modeling and simulation and technical developmental work.[33] It also uses a System Evaluation Plan (SEP) that uses a three-part plan to analyze data from assessments and operational tests. Part I defines the system, Part II identifies questions that must be answered and Part III describes the evaluation methods used in evaluating the results.[34] The process makes for better integration with developmental efforts. Overall, MCOTEA, just like the other services, adheres to the basic processes of planning, testing, analyzing, evaluating, and reporting test results.

D. NAVY

The Navy "has experimented with new platforms (submarines in about 1901, carriers in about 1920, PT boats from about 1939 to 1941) and new propulsion systems and fuels from about 1904 to 1935. Experimentation conducted from about 1923 to 1940 with exercises was the key to the development of the U.S. carrier doctrine." [35] The Navy's

[32] *The Role of Experimentation in Building Future Naval Forces*, 76.
[33] Marine Corps Operational Test & Evaluation Activity, Validating Warfighting Systems, Volume III Issue I, March 2010: 1-28.
[34] Ibid., 4.
[35] *The Role of Experimentation in Building Future Naval Forces*, 48-49.

operational test and evaluation force dates back to 1945 in response to finding effective ways of combatting Japanese kamikaze attacks.[36] As a result, one of the first air development squadrons was formed as well as the Composite Task Force, "to develop tactics and evaluate equipment to counter kamikazes."[37] When World War II ended, the Composite Task Force was consolidated with other developmental fleet units and redesignated as Operational Development Force (OPDEVFOR).[38] Throughout the years the command's mission and tasks increased and in 1952 the Tactical Development Group was formed and became part of OPDEVFOR. By 1959, increased responsibilities caused the command to be renamed Operational Test and Evaluation Force (OPTEVFOR).[39]

As the Navy's independent agency for operational test and evaluation, its mission was the "fleet introduction of new weapon systems, operational test and evaluation and development of tactics."[40] Additionally, it makes independent assessments of operational suitability during the Research and Development (R&D) process. As such, OPTEVFOR closely follows all R&D programs of the Navy and its laboratories. Since testing and evaluation can be a lengthy process, being involved early in the R&D phase allows for input into the acquisition process and possibly cost savings. Overall, COMOPTEVFOR reports to the Chief of Naval Operations and is the principal advisor for Department of the Navy OT&E. COMOPTEVFOR receives support from aviation and submarine test and evaluation squadrons as well as surface units conducting operational testing.

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[36] COTF Command History. Accessed April 22, 2017. http://www.public.navy.mil/cotf/Pages/history.aspx
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] Ibid.

Each of the services has used experimentation as a tool in developing new systems and weapons. Although the structure of the organization may have minor differences, the fundamental principles remain the same. In order to improve capabilities of future naval forces, experimentation and innovation need to occur. As a result of experiments, concepts and technologies provide naval forces the ability to enhance their programs and strategies. This in turn allows the services to be more effective in accomplishing their missions. The next section describes the Department of Defense (DoD) acquisition process and how that is an important part of procuring weapon systems and new technologies.

CHAPTER 2: DEPARTMENT OF DEFENSE ACQUISITION PROCESS

The purpose of test and evaluation of a weapon system or new technology in the acquisition process is to identify any risks to design or estimate operational effectiveness and suitability. There are two principal types of test and evaluation – developmental test and evaluation (DT&E) and operational test and evaluation (OT&E). The differences between the two can be seen in the figure below.

DT	IOT&E
• Controlled by program office • One-on-one tests • Controlled environment • Contractor involvement • Trained, experienced operators • Precise Performance Objectives and Threshold Measurement • Test to Technical Specification • Development Test Article	• Controlled by independent agency • Many-on-many tests • Realistic environment with operational scenario • Restricted contractor involvement • User troops recently trained • Performance Measurement of Operational Effectiveness & Suitability • Test to operational requirements • Production representative test article

Figure 1. DT&E and OT&E Difference. Ref: Defense Acquisition University

DT&E is concerned with meeting the technical specifications while OT&E assesses how the system functions in a realistic environment. While both play integral parts in the acquisition process, OT&E is perhaps more important as it responds to the needs of the operational community.

To support military operations the DoD has an "acquisition process which encompasses the design, engineering, construction, testing, deployment, sustainment, and disposal of weapons or related items purchased from a contractor."[41] Because this process is complex, oftentimes the results don't match the estimated costs or meet the needs of a requested system. Additionally, there are statutory and regulatory requirements such as Title 10, which include sections for the service secretaries to "equip" the armed forces.[42]

BRIEF OVERVIEW OF ACQUISITION

"Every weapon system in the U.S. arsenal is intended to satisfy a specific military need, must be paid for by the federal budget, and is designed and built within an acquisition system."[43] The three-step process is as follows:

1) Identifying requirements through the Joint Capabilities and Development System (JCIDS)
2) Allocating resources and budgeting through the Planning, Programming, Budgeting, and Execution System (PPBE) and
3) Developing and buying the item through Defense Acquisition System

[41] Moshe Schwartz, "Defense Acquisitions: How DOD Acquires Weapon Systems and Recent Efforts to Reform the Process," *Congressional Research Service*, May 23, 2014, 1-21. Accessed May 21, 2017. https://fas.org/sgp/crs/natsec/RL34026.pdf
[42] Ibid., 2.
[43] Ibid.

To better understand the acquisition process, a brief description of each main step will be provided. Additionally, the figure below illustrates this process.

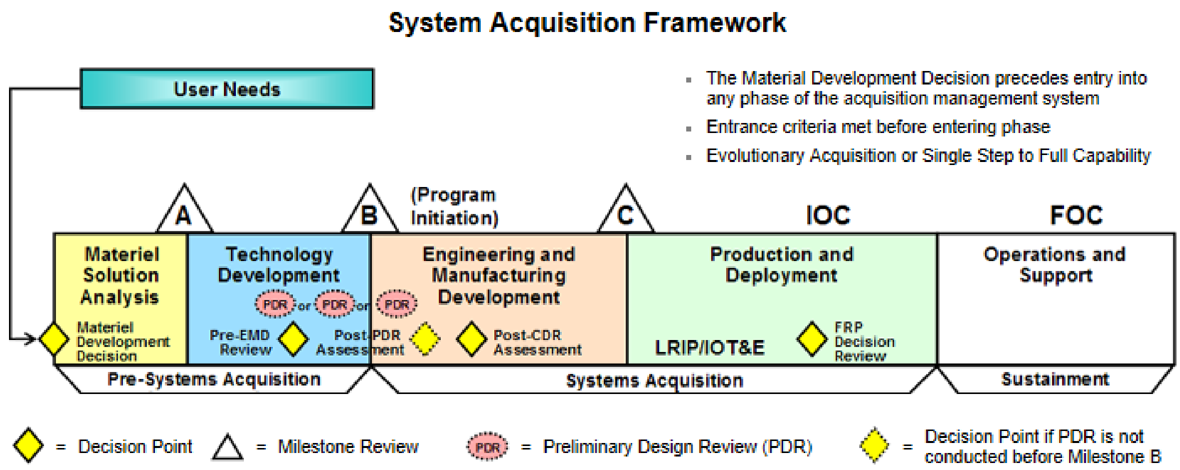

Figure 2. System Acquisition Framework. Ref: Defense Acquisition Guidebook

JCIDS addresses combatant commanders' capability shortfalls or gaps. In the past, the system focused on future threats. This led to each service independently assessing threats and developing their own weapons, at the risk of duplicating efforts. To ensure a more collaborative effort among the services, JCIDS provides a capabilities-based approach with the intent of weapon systems being developed jointly.

In Figure 2, within the three steps there are five phases of the acquisition process and three milestones that must be achieved in order to proceed to the next phase.

"To pass Milestone A:

- Milestone Decision Authority must approve the proposed materiel solution (based on Analysis of Alternatives) and the Acquisition Strategy,
- The lead component must submit a cost estimate for the proposed solution including life-cycle costs,

- The program must have full funding for the length of the Future Years Defense Program, and
- If technology maturation is to be contracted out, the program must have a Request for Proposal (RFP) that is approved by the MDA and ready for release." [44]

At Milestone B, the program becomes a program of record and must pass in order to proceed to Manufacturing Development Phase.

"To pass Milestone B:

- A program must have passed the Development RFP Release Decision Point;
- Requirements must be validated and approved;
- The program must have full funding for the length of the Future Years Defense Program;
- An independent cost estimate must be submitted to the MDA;
- All sources of risk must be sufficiently mitigated to justify fully committing to the development of the program; and
- The Milestone Decision Authority must approve an updated Acquisition Strategy."[45]

To continue to the Production and Deployment Phase a program must pass through Milestone C.

"To pass Milestone C:

- The production design must be stable,

[44] Ibid., 9-10.
[45] Ibid., 11.

- The system must pass developmental testing and operational assessment,
- Software must meet the predetermined maturity,
- The system must demonstrate that it is interoperable with other relevant systems and can be supported operationally,
- Estimated costs must be within the cost caps,
- The program must have full funding for the length of the Future Years Defense Program,
- The Capability Production Document must be approved, and
- The Milestone Decision Authority must approve the updated Acquisition Strategy."[46]

The Operations and Support is the final phase of a weapon system's life and it is when "the system is fully deployed, operated, supported, and ultimately retired."[47]

The overall acquisition process is complex and lengthy. Although there have been numerous DoD and Congressional reform efforts regarding the acquisition process, there is still concern regarding program over costs and schedule delays. Oftentimes the testing of a system occurs too late in the development stage limiting the ability to work issues. Regardless, it is still important to understand how the acquisition process functions in order to best support the warfighter in military operations.

The next section examines the evolution of the aviation squadron and how incorporating unmanned aerial aircraft such as the MQ-4 Triton, the Navy's variant of the Air Force Global Hawk (RQ-4), has made the establishment of an operational unmanned

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[46] Ibid., 12-13.
[47] Ibid., 13.

aviation squadron possible. While lessons learned from the aviation community may not directly apply to the surface community, it can provide valuable insights.

CHAPTER 3: AVIATION SQUADRONS AND UNMANNED AIRCRAFT

Naval aviation squadrons are highly successful in their ability to adapt quickly to new missions and requirements.[48] Each squadron has a different mission set and technological changes affecting aircraft capabilities have resulted in changes in operational capabilities and techniques.[49] As a result, they are good examples to learn how they are able to accept and incorporate new innovations in technology.

For example, the development of patrol aviation dates back as early as 1908. Successful "testing in Hampton Roads and the competitive interest of the U.S. Army in use of aircraft for scouting spurred the Navy to request $25,000 for aviation procurement."[50] The aviation patrol squadron was effective in the European theater during World War I. By the end of the war the squadron had grown in numbers. Since the 1960s the P-3 Orion has been the primary land-based maritime patrol aircraft.[51] However, as the P-3 Orion phases out, the P-8A Poseidon will take its place in conjunction with UAS, MQ-4 Triton.

[48] Roy A. Grossnick, "Dictionary of American Naval Aviation Squadron Volume I," *Naval Historical Center*, Department of the Navy, Washington D.C., 1995. Accessed May 23, 2017. https://archive.org/details/DictionaryOfAmericanNavalAviationSquadronsVolume1
[49] Ibid., 1.
[50] Ibid., 1.
[51] Navy Fact File. Accessed May 28, 2017. http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=1400&ct=1

Since 2001, there has been a great interest in unmanned aircraft vehicles. The origins of unmanned aircraft systems (UAS) can be traced back to World War I.[52] Since then, there has been an increase in the demand for UASs such that the Navy has made large investments in major UAS programs such as Broad Area Maritime Surveillance (BAMS) UAS, the Unmanned Combat Aircraft System Demonstrator (UCAS-D), the Fire Scout vertical takeoff/landing tactical UAS (VTUAS), and the Small Tactical/Tier II UAS (STUAS/Tier II UAS).[53] Examples of unmanned aircraft systems are listed below.

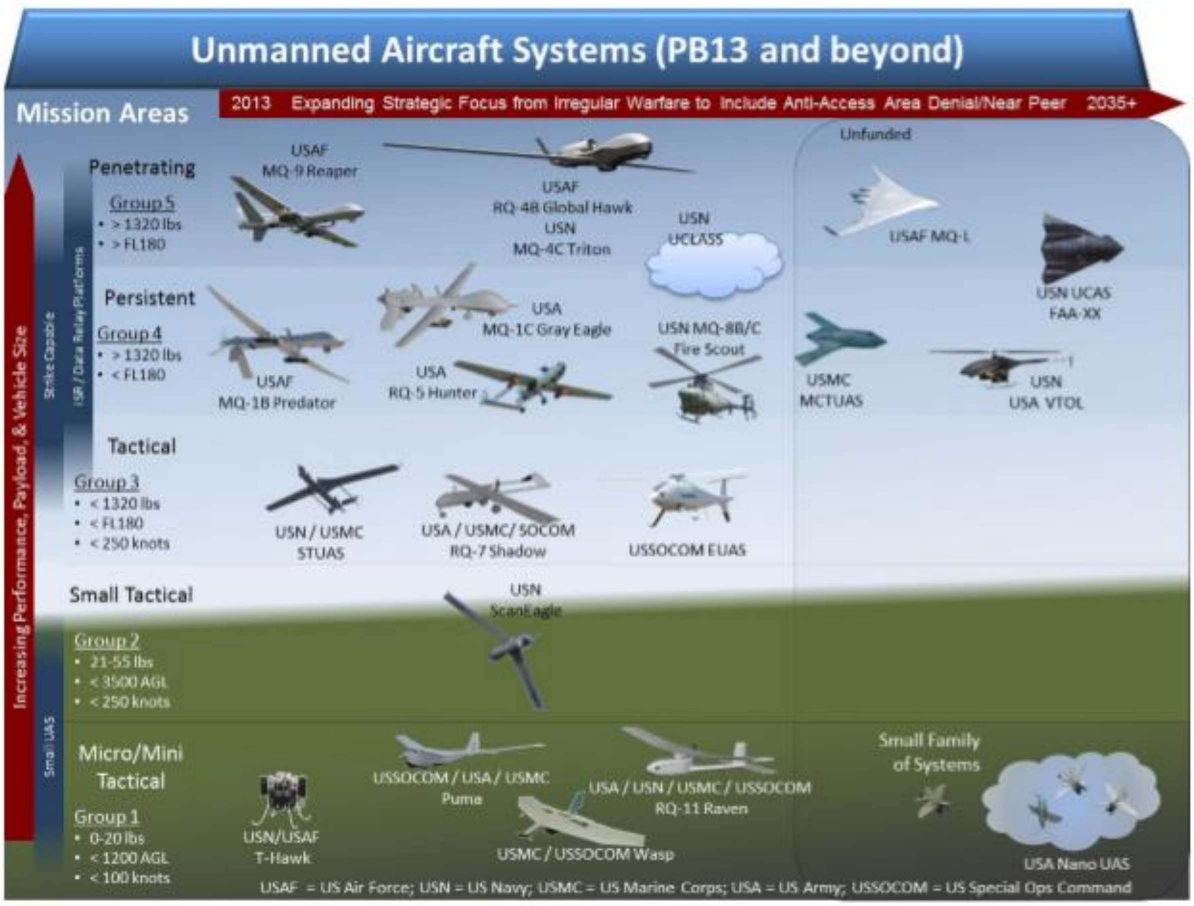

Figure 3. Unmanned Aircraft Systems. Ref: Unmanned Systems Integrated Roadmap FY2013-2038.

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[52] John F. Keane and Stephen S. Carr, "A Brief History of Early Unmanned Aircraft," *John Hopkins APL Technical Digest*, Volume 32, Number 3 (2013): 1-14. Accessed May 2, 2017. http://www.jhuapl.edu/techdigest/TD/td3203/32_03-Keane.pdf

[53] Brien Alkire, James G. Kallimani, Peter A. Wilson, and Louis R. Moore, "Applications for Navy Unmanned Aircraft Systems, *RAND*, 2010: 1-96.

In April 2008, the MQ-4 Triton, a Department of Defense acquisition category 1D program, received approval from the Under Secretary of Defense for Acquisition Technology and Logistics (USD (AT&L)) to enter System Development and Demonstration.[54] By 2012, Northrop Grumman unveiled the MQ-4C Triton, the unmanned aircraft version of the Air Force Global Hawk, a high altitude long endurance (HALE) UAS currently in use as a multisensory ISR platform. Although the Triton contains basic elements of the Global Hawk, enhancements were made to the Triton – de-icing capability that allows the aircraft to travel through icing conditions, 360-degree radar and electro-optical/infrared coverage and a longer wing span.[55] Testing of the Triton began in 2015 and in October 2016 the Navy established the first MQ-4C Triton operational squadron (Unmanned Patrol Squadron (VUP) 19) in Jacksonville, FL, to be co-located with manned P-8A Poseidon squadrons.

Although the squadron will not have vehicles until late 2017, squadron members have begun rotating through Naval Air Station Patuxent River to train with test pilots.[56] Furthermore, a mission systems trainer will be delivered to train air vehicle operators. The crew will collaborate with P-8 operators to develop tactics, techniques and procedures for operating the patrol/reconnaissance aircraft.[57] The Triton squadron was able to use the lessons learned from the command structure of the MQ-8 Fire Scout and the MH-60.[58]

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[54] MQ-4C Triton Naval Air System Command webpage. Accessed May 28, 2017. http://www.navair.navy.mil/index.cfm?fuseaction=home.displayplatform&key=f685f52a-dab8-43f4-b604-47425a4166f1

[55] Selected Acquisition Report (SAR) MQ-4C Triton Unmanned Aircraft System. December 2015. Accessed March 23, 2017. http://www.dod.mil/pubs/foi/Reading_Room/Selected_Acquisition_Reports/16-F-0402_DOC_71_MQ-4C%20Triton_DEC_2015_SAR.pdf

[56] Megan Eckstein. "Navy's First Operational MQ-4C Triton Squadron Stands Up This Week. USNI. October 25, 2016. Accessed May 28, 2017. https://news.usni.org/2016/10/25/navys-first-operational-mq-4c-triton-squadron-stands-up-this-week

[57] Ibid.

[58] Ibid.

The next section will discuss using the applicability of the aviation squadron applied to the surface community. It will also explain how the Navy is returning to sea control using the distributed lethality concept.

CHAPTER 4: APPLICABILITY TO SURFACE NAVY

An experimental squadron would not be a new concept for the surface Navy. In the mid-1880s Stephen Luce and Alfred Thayer Mahan advocated for a large, offensive oriented Navy.[59] The U.S. had begun production of the steel navy which had not been tested yet. As a result of seeking naval expansion, the Squadron of Evolution or the White Squadron, was formed. Its purpose was testing tactics and doctrine. While the squadron consisted of three cruisers and a gunboat,[60] they were limited in their abilities of simulating a battleship fleet. Additionally, the ships were of different designs, much more so than previous American warships.[61] However, based on the performance of the crews, further training led to ships being able to maneuver in formation and figuring out how the engines and other equipment onboard could be optimized.

In addition to testing tactics, the Squadron of Evolution provided the opportunity to achieve support of other naval programs. Interest and excitement grew of the idea of a large naval fleet – Mahan's advocacy of an offensive seagoing force. So much so that many young officers were applying for duty on the new cruisers.[62] The squadron was a projection of American power. As new inventions were introduced, such as searchlights on warships

[59] Daniel H. Wicks, "The First Cruise of the Squadron of Evolution," *Military Affairs*, Volume 44, No. 2. April 1980: 64-69.
[60] Ibid., 65.
[61] Ibid.
[62] Ibid.

which were made by a French company, the U.S. developed their own version and used the squadron to test them. It was evaluated to be just as good as the French version.[63] The squadron also tested U.S. designed torpedoes off the coast of France. The squadron existed until 1892 and up to that point it had participated in joint exercises, maneuvering, landings, gunnery and other drills.[64] The squadron greatly contributed to understanding the capabilities of American warships and naval power. However, fiscal constraints were relevant then as they are today. As Luce realized when he tried to conduct squadron exercises in the mid-1880s, there was hardly money or ships available.[65]

Return to Sea Control

As outlined by Chief of Naval Operations Admiral Richardson, in A Design for Maintaining Maritime Superiority, the design represents the initial steps articulated in CS-21R and addresses three major and interrelated global forces that are sources of contention: traffic on the oceans, seas, and waterways, including the sea floor, the global information system, and the rate of technological creation and adoption.[66] Currently, most of the discussion is focused on learning and adapting, as well as adopting emerging technology. The naval asymmetric advantage the U.S. Navy once enjoyed is being challenged by near peer competitors. As a result, the U.S. Navy realizes the operating environment has changed, specifically in the maritime domain, and needs to reassess its strategy going forward.

Since 2001 the surface fleet has been operating in a defense mode. Cruisers have shifted from their traditional scouting and commerce raiding missions to become air

[63] Ibid., 67.
[64] Ibid., 68.
[65] Ibid., 65.
[66] John M. Richardson *"A Design for Maintaining Maritime Superiority."* Washington D.C., January 2016.

defense platforms for carrier strike groups.[67] Additionally, destroyers, with multi-mission sets of surface warfare (SUW), anti-submarine warfare (ASW), anti-air warfare (AAW), ballistic missile defense (BMD), and strike, have also been placed in a defense mode whether protecting the carrier or not. In order to achieve a maritime strategy of sea control, a fundamental change in operation needs to take place. In response, Commander, Naval Surface Forces developed a strategy of Distributed Lethality. It is a return to sea control and using Distributed Lethality as an operational and organizational principle for achieving and sustaining sea control at will, by increasing the offensive and defensive capability of individual warships, employing them in dispersed formations across the world and generating distributed fires.[68]

Currently, presence and power projection has taken focus away from sea control. The U.S. national strategy of forward engagement and cooperation with other nations have kept naval forces forward based and forward deployed. The presence of U.S. military forces in other regions have been a constant feature in everyday life, assuring allies that the United States is committed to stay engaged through peacetime and conflict. Presence and power projection are factors in deterrence of adversaries. Conventional deterrence is maintaining an advantage in conventional military power, particularly with respect to a given potentially contested area.[69] However, because of the steady presence of Carrier Strike Groups, they no longer evoke the reaction of deterrence they once did. Carriers are

[67] Bryan Clark, "Commanding the Seas: A Plan to Reinvigorate U.S. Navy Surface Warfare," *Center for Strategic and Budgetary Assessments*, November 17, 2014: 1-78. Accessed January 10, 2017. http://csbaonline.org/research/publications/commanding-the-seas-a-plan-to-reinvigorate-u-s-navy-surface-warfare/publication

[68] Thomas S. Rowden, *"Surface Force Strategy: Return to Sea Control,"* San Diego, CA. Accessed January 10, 2017. http://www.public.navy.mil/surfor/Documents/Surface_Forces_Strategy.pdf

[69] Elbridge Colby and Jonathan F. Solomon, "Avoiding Becoming a Paper Tiger: Presence in a Warfighting Defense Strategy," *Joint Forces Quarterly*, Issue 82, 3rd Quarter 2016: 24-32.

increasingly vulnerable to potential Chinese attack capabilities, such as anti-ship ballistic missiles and anti-ship cruise missiles.[70]

It is imperative that the Navy utilize tools and concepts it already has and builds upon them.[71] Examples of such tools and concepts include utilizing current mission sets of SUW, ASW, AAW, MIW, and strike, in an offensive and defensive aspect.[72] Defeating enemy weapons is defensive sea control and defeating enemy platforms before they can attack is offensive sea control.[73] Because the U.S. Navy has been unmatched in capability for so long, sea control has been taken for granted as inherent to presence. More importantly now for the U.S Navy is to effectively maneuver within the same maritime environment as the adversary and counter them.

The Navy's Research and Development Plan

The Navy released its first 30 Year Research and Development Plan in January 2017 to "provide insight and guidance on DON RDT&E planning as it relates to developing future naval warfighting capabilities."[74] With the rise of more challenging threats there is greater need for innovation in exploring new technologies and concepts. However, an important factor is the budget. According to figure 4 below, funding in FY2021 will be at its lowest since FY2002.[75] However, Budget Activity (BA) increases in the Advance Component Division (BA-4), System Development and Demonstration (BA-5), and Operation System Development (BA-7) have "produced and fielded new weapon systems; command and

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[70] Ibid.
[71] Richardson, *"A Design for Maintaining Maritime Superiority."*
[72] Clark, "Commanding the Seas: A Plan to Reinvigorate U.S. Navy Surface Warfare."
[73] Ibid.
[74] The Department of the Navy Research, Development, Test and Evaluation 30 Year Plan. January 5, 2017. Accessed February 20, 2017.
[75] Ibid., 6.

control system; intelligence, surveillance and reconnaissance systems; and communication systems that provide the warfighting capabilities of today's naval forces."[76]

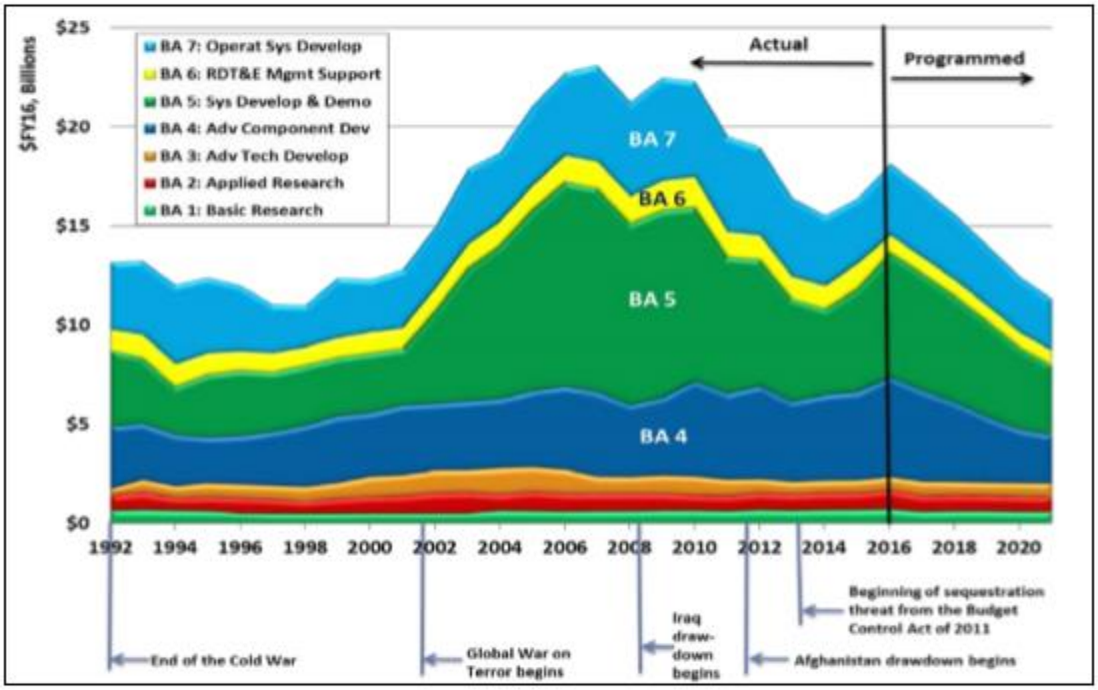


Figure 4. RDT&E Investment Trends, FY1992-2021. Ref: DON RDT&E 30 Year Research and Development Plan

Table 1 below highlights investments (BA-4, BA-5, and BA-7) to the next generation warfighting capabilities of the Navy and Marine Corps from the President's Budget 2017 (PB-17). Over decades of research and development have been invested in these systems. By 2035, in addition to unmanned aerial systems, the Navy anticipates unmanned surface, underwater, and ground systems to be included into the force structure. In order to accomplish this, prototyping, experimentation, and demonstration to fast-track the development and fielding of maturing technologies"[77] needs to occur. A surface experimental squadron along with industry collaboration can make this happen.

[76] Ibid., 7.
[77] Ibid., 13.

Table 1. Top BA 4, 5, 7 Investments (PB 17). Ref: DON RDT&E 30 Year Research and Development Plan

BA-4	BA 5	BA 7
- Ohio Replacement Nuclear Ballistic Submarine (SSBN) - Advanced nuclear power systems - Offensive anti-surface warfare weapon development - Surface and shallow water mine countermeasures - Littoral Combat Ship (LCS) mission modules - Marine Corps assault vehicles - Joint precision approach and landing systems - Advanced submarine system development - Surface ship torpedo defense - Frigate development - Advanced undersea prototyping - Gerald R Ford class aircraft carrier (CVN 78-80) - Advanced combat systems technology - Navy Energy Program	- Joint Strike Fighter - Next-Generation Jammer - CH-53K RDTE - Advanced Hawkeye - Executive helo development - Aegis Combatant combat system engineering - Multi-Mission Maritime Increment III - V-22A - Air and Missile Defense Radar System - Ship self-defense – engineering and manufacturing - Standard missile improvements - SSN-688 and Trident modernization - EA-18G - Ship self-defense (engage: hard kill) - Ship self-defense (engage: soft kill/electronic warfare)	- F/A-18 squadrons - RQ-4 modernization - Strategic sub & weapons system support - Tactical data links - Aviation improvements - MQ-4C Triton - Electronic warfare (EW) readiness support - Cooperative engagement capability - Ground/Air Task Oriented Radar (G/ATOR) - Marine Corps communications systems - Tomahawk and Tomahawk Missile Planning Center - Integrated surveillance system - Tactical aim missiles - Depot maintenance - HARM improvement

Unmanned Surface Vehicles

Unmanned maritime vehicles have been in use since after World War II and consist of unmanned surface vehicles (USVs) as well as unmanned undersea vehicles (UUVs). Figure 5 illustrates the different vehicles. They have been used for battle damage assessment (BDA), minesweeping, and in 2003, the SPARTAN Advanced Capability Technology

Demonstration (ACTD) USV deployed with USS GETTYSBURG (CG 64) to the Persian Gulf conducting ISR missions and fleet familiarization.[78]

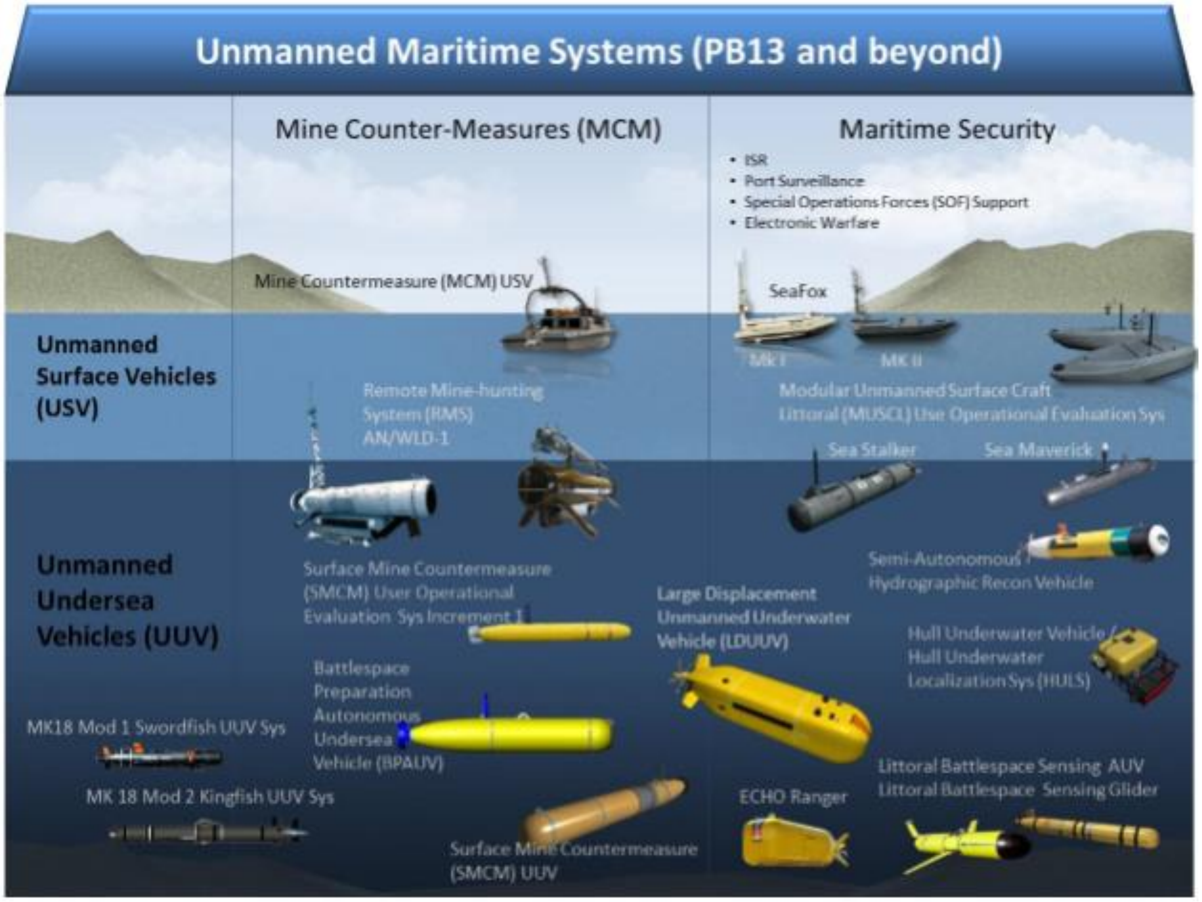


Figure 5. Unmanned Maritime Systems. Ref: Unmanned Systems Integrated Roadmap FY2013-2038

In 2007, the Navy released the Unmanned Surface Vehicle (USV) Master Plan. Taking into account the various documents such as the Quadrennial Defense Review, Sea Power 21, the National Strategy for Maritime Security, etc., the USV Master Plan was to support DoD guidance through integration of USVs. Why does the Navy need unmanned systems? In

[78] The Navy Unmanned Surface Vehicle (USV) Master Plan. July 23, 2007. Accessed May 22, 2017. http://www.navy.mil/navydata/technology/usvmppr.pdf

addition to reducing vulnerability and increasing effectiveness of manned platforms, the following are additional perspectives:

- "Cost – manned systems are far more expensive to operate than unmanned systems.
- Coverage – coverage rates and the ability to maintain constant awareness of the environment.
- Productivity – leveraging of unmanned systems for intelligence surveillance and reconnaissance (ISR) missions enables mission planners to focus manned platforms on other objectives.
- Persistence – persevering threat observation can provide military planners with an understanding of long-term threat behavior patterns and trends that are not apparent from short-term "spot" observations.
- Vulnerability – unmanned systems keep people and high-value manned platforms out of harm's way."[79]

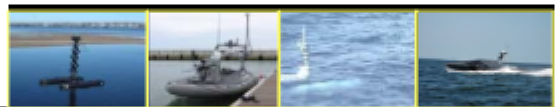
Based on selected USV missions the Master Plan reviewers identified four vehicles types and sizes that could be utilized by the Navy. From the Master Plan, they are:

1) "X-Class: about 3m, cheap, expendable, probably special purpose and purpose-built
2) Harbor Class (7m): size of boat carried on most/all Navy vessels, can be used in Maritime Security
3) Snorkeler Class (semi-submersible): MCM search requires: (1) ability to pull a tow body, (2) stability in sea states, up to and including/beyond Sea State 3, and (3) mission endurance

[79] Ibid., 4.

4) Fleet Class (11m): Required to provide (1) adequate power and payload for ASW, (2) power and tow force for MCM Sweep, and (3) endurance for these and other missions."[80]

The figure below illustrates the different mission sets along with the vehicle size.



USV MP Priority	Joint Capability Area (JCA)	Seapower Pillar	USV Mission	X-Class (small)	Harbor Class (7M)	Snorkeler Class (7M SS)	Fleet Class (11M)
1	Battle Space Awareness (BSA) / Access/ Littoral Control	Sea Shield	Mine Countermeasures (MCM)		MCM Delivery, Search / Neutralization	MCM Search, Towed, Delivery, Neutralization	MCM Sweep, Delivery, Neutralization
2	BSA / Access/ Littoral Control	Sea Shield	Anti-Submarine Warfare (ASW)			Maritime Shield	Protected Passage and Maritime Shield
3	BSA, HLD, Non-Trad Ops, 7 Others	FORCEnet	Maritime Security		ISR/ Gun Payloads		7M Payloads
4	BSA / Access/ Littoral Control	Sea Shield	Surface Warfare (SUW)		SUW, Gun	SUW (Torpedo), Option	SUW, Gun & Torpedo
5	BSA / Access/ Littoral Control/ Non-Trad Ops	Sea Strike	Special Operation Forces (SOF) Support	SOF Support	SOF Support		Other Delivery Missions (SOF)
6	BSA, C&C, Net Ops, IO, Non-Trad Ops, Access, Littoral Control	Sea Strike	Electronic Warfare		Other IO	High Power EW	High Power EW
7	BSA, Stability, Non-Trad Ops, Littoral Control	Sea Shield	Maritime Interdiction Operations (MIO) Support	MIO USV for 11M L&R	ISR/ Gun Payloads		

Figure 6. USV Classes and Missions. Ref: USV Master Plan

Although most of the technology used in the development of USVs is mature and available, DoD's acceptance and use of USVs is limited comparted to UAVs. There may be several reasons why such as compatibility, weapons release authority and vehicle launch and recovery from the host platform. According to the USV Master Plan, "the C4I communications profile of a USV lends itself to a "crawl-walk-run" development process:

- Crawl = Manual: USV in continuous, man in the loop, control and decision-making on host platform

[80] Ibid., 58.

- Walk = Semi-automatic: USV in periodic communication, many autonomous functions (piloting, collision avoidance), human permission required for major decisions (e.g. target pursuit, weapon release)
- Run = Automatic: USV in communications only as necessary to execute its mission profile. Completely independent, fully autonomous, independent USV operations."[81]

While USVs operate using Radio Frequency communication links, there must be a reduction in the bandwidth requirements for a fully autonomous vehicle.[82] Testing of systems should be conducted with acquisition efforts and in the crawl-walk-run approach.

Distributed lethality and an experimental test squadron

The shift towards Distributed Lethality within the last couple years is a change in mindset of the surface force. In response to strengthening naval power at and from the sea, in the Design for Maintaining Maritime Superiority, Distributed Lethality aims to accomplish this through tactics, talent, tools, training.[83] Warfare tactics are taught at various training centers for surface warfare officers but it is not a major component of day to day operations. Taking a lesson from the aviation community and their Naval Fighter Weapons School (Top Gun), the surface warfare community established the Naval Surface and Mine Warfighting Development Center (SMWDC) in 2015. The emphasis is to rededicate the force to training, developing, and teaching effective warfighting tactics, incorporating it into daily shipboard life.[84]

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[81] Ibid., 69-70.
[82] Ibid., 93.
[83] Rowden, *"Surface Force Strategy: Return to Sea Control."*
[84] Ibid.

SMWDC trains junior officers in several warfare areas – integrated air and missile defense (IAMD), anti-submarine warfare (ASW)/ surface warfare (SuW), and amphibious warfare with the intent of one WTI on every ship. WTIs can be assigned to ships in the experimental test squadron. Furthermore, the surface warfare community has implemented some changes to the division officer and department head tour career track. One change is the addition of the Plans and Tactics Officer. It adds another department head and enhances warfighting capability and operational readiness of the ship.

In addition to classroom training, use of synthetic trainers aid in training and provide an environment for proficiency. While trainers cannot fully replicate the real-world environment, they allow mistakes to be made without fear of actual damage to ships or weapon systems. The results promote critical feedback and analysis, essential to reinforcing the mindset of Distributed Lethality in the surface fleet.

Skillful management of the PPBE process is required to achieve sea control when implementing Distributed Lethality, according to the Surface Force Strategy.[85] With the United States fiscally constrained and the situation unlikely to get better, additional budget cuts or sequestration will increase levels of risk for some missions and limitations to warfighting advantages.[86] Therefore, the Navy needs to be innovative and develop systems that are ready to meet the challenges of the 21st century. The acquisition process is lengthy. As such, efforts should be made to start the process early when trying to field new weapons or systems.

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[85] Ibid.

[86] Dunford, Jonathan Greenert and Paul Zukunft, *"A Cooperative Strategy for 21st Century Seapower: Forward, Engaged, Ready."*

As the demand for missions such as maritime security, escort duties, and training with allies continues to increase, the surface navy will have less time to focus on offensive sea control. This is of great concern to Navy leaders and analysts. They assess today that the fleet's cruisers (CG) and destroyers (DDG) do not have the AAW capacity to defend against modern air and missile threats, such as those posed by China, and lack the reach to defeat submarines and surface ships before they can attack with sophisticated, long range anti-ship cruise missiles that can reach 800-1000nm.[87]

According to the Center for Strategic and Budgetary Assessments, in addition to modifying existing weapons, the Navy is addressing its vulnerability to only conducting defensive AAW, ASW, and SUW by developing the SM-6 interceptor, long range anti-ship missile (LRASM), and the next generation land attack weapon (NGLAW) to replace the current inventory of SM-2, harpoon, and Tomahawk.[88] While there are other weapon systems such as the laser deployed on USS PONCE in the Arabian Gulf in 2014, and the electromagnetic railgun on joint high speed vessel USNS Millinocket in 2016, it will not be feasible to implement on destroyers or Littoral Combat Ships. These advanced weapon systems require a large space at the expense of other shipboard systems as well as a significant amount of electrical generation.[89] Therefore, modifications to LCS weapons in AAW, SUW, and ASW should also be considered to support capabilities of offensive sea control.

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[87] Clark, "Commanding the Seas: A Plan to Reinvigorate U.S. Navy Surface Warfare."
[88] Ibid.
[89] Ibid.

Adaptive force packages are a method to meet mission demands in the maritime strategy.[90] Using the principle of Distributed Lethality, individual ships (cruisers, destroyers, LCS, and amphibious ships) can be employed in dispersed formations known as hunter-killer surface action groups (SAGs). They are able to perform screening operations for larger formations and hold adversary land targets at risk under a range of emission control conditions.[91] Hunter-killer SAGs can defend themselves against air and missile attack and by distributing their offensive power, they complicate adversary targeting and dilute the attack density.[92] The U.S. Navy demonstrated this Distributed Lethality concept in April 2016 with a three ship SAG deployed to the Pacific. The SAG operated forward in an offensive mindset, interacting with as many ships and service assets possible, to include naval partners and allies.[93]

Although the deployment was successful, there are a couple limitations to employing a SAG using Distributed Lethality. First, a ship is capable of destroying a target as far as its longest missile can go. From a logistical standpoint, reloading missiles at sea may not always be possible. Second, command and control issues may arise between ships when operating in a denied environment. As such, the U.S. Navy should continue refining their contingency planning in the event that situation occurs.

An experimental test squadron can assist with testing SAG tactics and procedures. Unlike aviation test squadrons where a squadron consists of multiple numbers of the same

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[90] Dunford, Jonathan Greenert and Paul Zukunft, *"A Cooperative Strategy for 21st Century Seapower: Forward, Engaged, Ready."*
[91] Thomas S. Rowden, Peter Gumataotao, and Peter Fanta, "Distributed Lethality," *Proceedings*, January 2015, Vol. 141. Accessed January 14, 2017. http://www.usni.org/magazines/proceedings/2015-01/distributed-lethality
[92] Ibid.
[93] Charles Johnson, "PACSAG Integrates, Strengthens Force," *Surface Warfare Magazine*, Winter 2017, Issue 53. Accessed January 17, 2017. http://www.public.navy.mil/surfor/swmag/Pages/PACSAG-Integrates-Strengthens-Force.aspx#.WH7PFoWcHIU

aircraft, the surface experimental squadron would be a mix of platforms. For example, the core of the squadron would be DDG 1000, LCS 1, LCS 2, 1x DDG, 1x CG, and an amphib (LSD or LHA). The squadron would report to SMWDC and be homeported in San Diego. Ships can be a part of the squadron on a rotational basis depending on the need.

CONCLUSION

The U.S. Navy can longer afford the luxury it enjoyed during the years following the collapse of the Soviet Union. It sailed the seas easily and unchallenged and reconciled the demands of warfighting prowess with the advantages of forward presence.[94] In the face of increasing anti-access / area denial threats, the Navy realized it had to change the way it operated while also being able to support missions of power projection, deterrence, and maritime security. As influenced by the maritime strategy, the surface force is regaining its ability to control the sea.

With budgetary constraints as an ongoing challenge, through innovation, creating the necessary weapons to counter threats from adversaries will aid in achieving offensive sea control. Flexibility in fleet architecture – dispersing ships in smaller groups (i.e. SAGs) to conduct operations will be more frequent. It will not be surprising to see more SAGs deploying consistently rather than a standard Carrier Strike Group. These SAG formations will continue to provide valuable information and stretch the limits of command and control. Through continued training, development of warfighting tactics, and testing of technology, using an experimental test squadron can best prepare the Navy against increasingly capable opponents.

[94] Colby and Jonathan F. Solomon, "Avoiding Becoming a Paper Tiger: Presence in a Warfighting Defense Strategy."

In approaching the challenges of today and in the future, Distributed Lethality is not an entirely new concept. It is a shift in the mindset of offense versus defense and a return to warfighting. It is also the most efficient and effective use of significant investments made in the surface force lethality over the past two decades.[95] As the Navy continues to defend freedom of navigation and deter aggression, the operational concept of Distributed Lethality is the most effective way to do so. As such, the surface navy needs to establish a formal experimental test squadron to further its efforts.

RECOMMENDATIONS

- Form a surface experimental test squadron. It can consist of DDG 1000, LCS 1, LCS 2, 1 x DDG, 1 x CG, 1 amphib (LPD or LHA).
- Oversight of the squadron would be SMWDC.
- Assign a WTI to the ships in the squadron
- Collaborate with industry on new technology to test on the ships.
- Work with acquisition process early to field new systems.
- Explore CONOPS with experimentation squadron.
- Incorporate use of USVs with the squadron.

[95] Rowden, Peter Gumataotao, and Peter Fanta, "Distributed Lethality."

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