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14. ABSTRACT
The Future of Vertical Lift (FVL) is the first joint rotary wing acquisition program for the Department of Defense. Rotary wing aviation has limited programs to model its first joint initiative after. Complicating joint acquisition strategy further are the decisions the FVL program leadership is making, specifically the unique performance requirements and requirement for current weapon systems and sensors. The FVL program emphasizes Army and Marine Corps missions to the detriment of the Navy and Coast Guard. The Navy needs to take the lead of the naval variant of the FVL and advantage of technology

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MASTER OF MILITARY STUDIES

The Future of Naval Vertical Lift Systems
Departing the Pattern of Joint Acquisitions Syndrome

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Executive Summary

Title: The Future of Naval Vertical Lift Warfare: Departing the Pattern of Joint Acquisitions Syndrome

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Thesis: In order to ensure its superiority operating on the high seas and littorals, save on overall life cycle cost and reduce risk to the warfighter, the Navy needs to initiate a maritime-specific acquisition program for its future vertical lift platforms.

Discussion: The Future of Vertical Lift (FVL) is the first joint rotary wing acquisition program for the Department of Defense. Rotary wing aviation has limited programs to model its first joint initiative after, and the historical record of genuinely joint fixed-wing aircraft acquisition programs does not provide a promising record for FVL. Complicating joint acquisition strategy further are the decisions the FVL program leadership is making, specifically the unique performance requirements and requirement for current weapon systems and sensors.

The FVL program emphasizes Army and Marine Corps missions to the detriment of the Navy and Coast Guard. The Navy needs to take the lead of the naval variant of the FVL and advantage of technology maturation from the Joint Multi-Role FVL initiative to apply to its own vertical lift acquisition program. While the basic structure of the FVL program takes advantage of a family of subsystems concept to save cost, the overarching performance requirements for FVL are at odds with the performance requirements to operate in the maritime and littoral domains.

Conclusion: If the Navy continues toward the joint acquisition of FVL without a strategic vision for how it will employ its vertical lift aircraft of the future, the naval variant of FVL will fall short of the Navy's expectations. It behooves the Navy to recognize that the Army's current and proposed future requirements for vertical lift aircraft are diverging rapidly from its own, and should therefore adjust its future vertical lift platform acquisition strategy in order to maintain naval capability superiority.

DISCLAIMER

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List of Acronyms

A2/AD	Anti-Access/Area Denial
AO	Area of Operations
APKWS	Advanced Precision Kill Weapon System
ASW	Anti-Submarine Warfare
CapSet	Capability Set
CAS	Close Air Support
CBA	Capabilities Based Assessment
CCA	Close Combat Attack
CGF	Cost Growth Factor
CJCS	Chairman of the Joint Chiefs of Staff
CRM	Crew Resource Management
CRUDES	Cruiser/Destroyer
CSAR	Combat Search and Rescue
DHS	Department of Homeland Security
DICASS	Directional Command Activated Sonobuoy System
DIFAR	DIrectional Frequency Analysis and Recording
DoD	Department of Defense
DRL	Digital Rocket Launcher
F2T2EA	Find, Fix, Track, Target, Engage, Assess
FAC	Fast Attack Craft
FACE	Future Airborne Capability Environment
FIAC	Fast Inshore Attack Craft
FoS	Family of Systems
FVL	Future of Vertical Lift
FY	Fiscal Year
HA/DR	Humanitarian Assistance/Disaster Relief
HELLFIRE	Helicopter-borne Fire and Forget
HIGE	Hover In Ground Effect
HOGE	Hover Out of Ground Effect
IDA	Institute for Defense Analysis
IOC	Initial Operating Capability

JAGM	Joint Air-to-Ground Missile
JAST	Joint Advanced Strike Technology
JCA	Joint Common Architecture
JCIDS	Joint Capabilities Integration and Development
JFTL	Joint Future Theater Lift
JMR	Joint Multi-Role
JROC	Joint Requirements Oversight Council
JSF	Joints Strike Fighter
LCS	Littoral Combat Ship
MCM	Mine Countermeasures
MEDEVAC	Medical Evacuation
MIO	Maritime Interdiction Operations
MUM-T	Manned-UnManned Teaming
NAE	Naval Aviation Enterprise
NEO	Non-combatant Evacuation Operations
NCEA	Non-Combat Expenditure Allowance
O&M	Operation and Maintenance
O&S	Operation and Support
OAMCM	Organic Airborne Mine Countermeasures
OEF	Operation Enduring Freedom
OIF	Operations Iraqi Freedom
OSD	Office of the Secretary of Defense
PAF	Project Air Force
PPBE	Planning Programming, Budgeting and Execution
RDT&E	Research, Design, Test and Evaluation
RESCORT	Rescue Escort
RFI	Request for Information
RMP	Recognized Maritime Picture
SAR	Search and Rescue
S&T	Science and Technology
TD	Technology Demonstrator
USAF	United States Air Force
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology and Logistics)
UTTAS	Utility Tactical Transport Aircraft System
UONS	Urgent Operational Needs Statement
VERTREP	Vertical Replenishment
VOD	Vertical Onboard Deliver

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Preface

This project was conceived in response to frustrations borne from fighting multiple missions with minimal training, new equipment, no manuals and instructors who had the same level of familiarity with the aircraft as myself. I grew up with the Helicopter Master Plan, watching it evolve and continue to grow, which has been very rewarding. Learning from the past is one of the most powerful enablers of personal growth, and the power of learning from one's personal experience is only surpassed by the knowledge gained from other's mistakes. I hope to make a difference in the Navy's future acquisition of vertical lift platforms, to keep future vertical lift pilots from dealing with the same frustrations I endured.

I would like to thank Dr. "S" Streusand for personally taking an interest in my topic and guiding me through the research and writing processes. I owe a deal of gratitude to Lt Col McMellon for taking the time to point me in the right direction while navigating through a field in which I have little experience. I would like to thank LtCol Glathar for inspiring me to continue in the program, LtCol Chesarek for near daily support as my conference group MILFAC and CDR Evans for his support through this endeavor.

Finally, I would like to thank my patient wife Kimberly, who persevered through the long nights of research, proofreading, public speaking practice and walking the dogs. I could not have completed this without your enduring support for my work.

Introduction

Fiscal year 2016 will see delivery of the last MH-60R completing the acquisition of the United States Navy's MH-60R and MH-60S helicopter fleet. Although the Navy expects this fleet of MH-60R/S helicopters to remain in service through 2030, the joint development of the next generation of vertical lift platforms is nevertheless well underway.[1] (**Note:** A joint aircraft acquisition program is defined as "an aircraft program in which two or more services are significantly involved in all stages of the acquisition and operational phases – that is, in the design development, procurement, and operations and support (O&S) of the aircraft."[2]) Now, eight years after inception, the joint Future of Vertical Lift (FVL) program is showing signs that it will not meet the needs of the Navy and is another example of the Department of Defense's (DoD) reflexive preference for joint acquisitions.[3] To ensure its superiority operating on the high seas and littorals, save on overall life cycle cost and reduce risk to the warfighter, the Navy needs to opt out of FVL and initiate a maritime-specific vertical lift acquisition program.

Several programmatic decisions that FVL leadership have made combined with the findings from an analysis of the outcome and cost of historical joint programs has led to this conclusion. Current requirements for the FVL program primarily support Army and Marine Corps mission sets, and are significantly at odds with the Navy and Coast Guards performance requirements. The technology selected for maturation encompasses enhanced troop carrying capacity, high speed and high altitude performance that will be demonstrated by the flight of two technology demonstrators (TDs) in 2017. Any aircraft engineered to meet the Army's high speed, high altitude performance requirements will inevitably fall short of the naval requirements for low speed, low altitude performance.[4] The United States Air Force (USAF) is abstaining from participation in the FVL program, deciding instead to purchase new HH-60W Combat

Rescue Helicopters.[5] The current state of the FVL indicates that the program is a joint program in name only.

Historically joint programs have failed to meet all of the individual service goals because of the need to compromise design for one service. This inevitably leads to one service accepting a less capable design than originally conceived. Since the tenure of Robert McNamara, the DoD has preferred joint acquisition programs because joint programs, in theory, save money. The theory has rarely worked out in practice. Historical data suggest that if the Navy purchases aircraft that fit the FVL requirements and attempts to adapt them for Navy missions, the result will be increased cost compared to multiple single-service programs and degraded mission capability. Joint aircraft programs historically fail to achieve cost savings revealing a complex and multi-faceted problem.

The Army, as the lead service on requirements and development of the two TDs, has clearly demonstrated minimal regard for the mission requirements of the naval services. The Navy being the most impacted needs to generate naval FVL requirements that take advantage of technology maturation and TD proof of concepts, and then initiate a maritime specific acquisition program.

FVL Background

The process that led to the FVL program began in 2008 when the Congressional Rotorcraft Caucus expressed concern "about the lack of a strategic plan for improving the state of vertical lift aircraft in the United States."[6] The Congressional Rotorcraft Caucus called for an assessment of DoD's future vertical lift requirements in response to the helicopter and tilt-rotor industry's concern over the uncertainty of future DoD requirements for helicopter technology.

At that time, the DoD had recently completed a Fleet-wide helicopter modernization program consisting of various upgrades to airframes and avionics, purchasing newly manufactured airframes from existing production lines, and consolidating models. The modernization plan extended the Fleet's life until 2020; however, there was no strategic vision for vertical lift platforms beyond that time.

The Congressional Rotorcraft Caucus and the helicopter and tilt-rotor industry both understood how time intensive it is to field new technologies. In response, Secretary of Defense Robert Gates "directed the Joint Advanced Concepts Directorate to lead the development of a capabilities based assessment [CBA] that will outline a joint approach to the future development of vertical lift aircraft for all the Military Services."[7] The CBA was tasked "to determine what new and better rotary-wing and other vertical-lift aircraft the armed services will need."[8] Created in 2008, the law establishing the CBA also directed that the Pentagon create a detailed plan for a joint vertical lift office, modeled on the Joint Advanced Strike Technology (JAST) office (the program responsible for the creation of the F-35 Joint Strike Fighter (JSF)).[9] Like JAST, the FVL program is designed to mature technologies, compose requirements and exhibit capabilities that will eventually demonstrate the future potential of vertical lift warfare. Similarly, the FVL program was never intended to solely replace current aircraft models, or find more efficient solutions for current missions.[10]

The U.S. Army was selected to lead the FVL technology and development program because they own and operate 80% of current DoD vertical lift aircraft.[11] They developed requirements for FVL based on the lessons identified from fifteen years of combat operations in Iraq and Afghanistan, and the probability that future operations would face sophisticated anti-access/area denial (A2/AD) capabilities extending over larger areas.[12] These reflect neither experience at sea nor anticipated future naval vertical lift requirements. LtCol David Bristol, US Army Aviation Program Executive Officer for FVL activities, described the strategic plan for FVL as "a family of future vertical lift platforms – the light, the medium, the heavy, and the ultra", which will share common systems and subsystems across the fleet.[13] Each of these platforms will have increased efficiencies in speed, range, payload, endurance, reliability, survivability, situational awareness, sustainability, and common systems (open architecture).[14] The technology to achieve these capabilities will be exhibited in fiscal year 2017 by the flight of two Technology Demonstrators (TD). These TDs are required to fly at 250 knots and hover out of ground effect (HOGE) at 6,000 feet and 95 degrees Fahrenheit, an extraordinary achievement currently unavailable in today's DoD vertical lift platforms.[15] Missing from consideration are Navy requirements seeking to optimize sensor and weapons employment in the low speed, hover endurance and salty maritime environments.[16] The performance of these TDs will showcase engineering solutions that overcame the challenges borne by the Army and Marine Corps during Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), and demonstrate the capability to transport and supply troops further and faster.[17] However, the TDs will not demonstrate technological solutions to those vertical lift challenges the Navy and Coast Guard have endured during the last decade.

Leadership at the Naval Aviation Enterprise (NAE) insists that Naval Aviation "will continue to play key roles in the rebalancing of our nation's global posture and presence to an emphasis on the Pacific and sustaining support for our partners in the Middle East."[18] The Commander of Naval Air Forces plans to achieve this goal through implementing three parts of a strategic vision, the first of which is through maintaining capability superiority.[19] Preliminary designs for the TDs prioritize the demonstration of high-speed, high-altitude performance and troop-carrying capacity. None of these capabilities improve the Navy's ability to execute its vertical lift missions in the low altitude, low speed, and salt spray maritime environment. The only naval consideration for the FVL program is the requirement for shipboard suitability, essentially to take off and land on ships.[20] However, the FVL program's primary cost saving principle is to achieve economy of scale through the incorporation of common subsystems across multiple platforms.[21]

"When FVL was initiated, it was envisioned that the Family of Systems would be based on four general [aircraft] weight classes: Light, Medium, Heavy, and Ultra."[22] The USAF absorbed the ultra heavy lift class under the Joint Future Theater Lift (JFTL) program; however, JFTL was shelved in 2011 completely removing the USAF from involvement in the FVL program.[23] The Army was charged with developing the light, medium, and heavy class family of aircraft. For each weight class, the program defined specific requirements called capabilities sets (CapSets). See Figure 1: FVL Family of Systems Capability Sets. The CapSets are composed of mission sets performed by each of the services.

The FVL program envisions that "solutions for each CapSet requirements will be highly common on the subsystem level—e.g., engines, avionics, software, etc.—but may be very different vehicles.[24] Comparing the mission sets of the CapSet's in Figure 1, it appears that CapSet #1 represents the missions performed by the MH-6 Little Bird and those of CapSet #2 and #3 representative of the missions of the H-60 variants. There appears to be an overlap of missions between CapSets #1 and #2 when considering the AH-64 Apache or UH-1Y Venom. Although the CapSets appear to suggest linear replacements for legacy platforms, e.g. that CapSet 1 seeks to replace the MH-6 Little Bird, that alignment is coincidental.[25] The new medium weight aircraft will replace no less than 4500 UH-60L, MH-60M/R/S, and AH-64E helicopters. The program originally had two medium-weight CapSets. The incompatibility between the Army's requirements for a Blackhawk replacement and the Navy's need for an

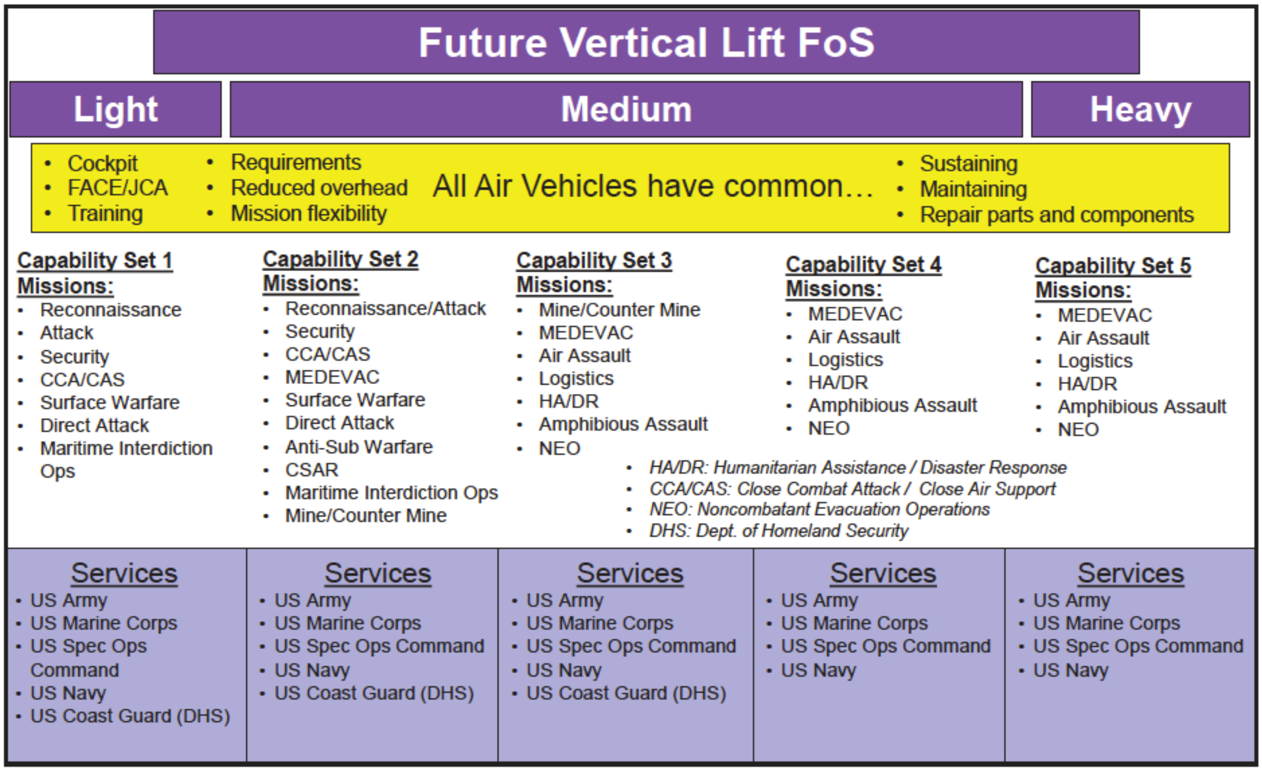

Figure 1: FVL Family of Systems Capability Sets[26]

Aircraft that could operate off of destroyer flight decks led to the separation of CapSet 2, which reflects the Navy requirements from CapSet 3, which reflects the Army requirements.[27] This mitosis of CapSets mirrors previous experiences with joint programs. Modifications needed to meet the service requirements consistently reduce the savings anticipated from the joint acquisition, as discussed in the history of joint acquisitions below demonstrates.

<u>Joint Aircraft Acquisitions: A Historical Context</u>

The defense buildup under President Ronald Regan in the early 1980s led directly to the skyrocketing price of DoD spending, highlighted by claims of $600 toilet seats, $7,000 coffee pots and "bungled [joint] military operations."[28] Legislative investigation and reform was initiated to reduce the corruption and inefficiencies in acquisitions and put in place a plan for the responsible management of defense spending.[29] The Blue Ribbon Commission on National Defense and ensuing Goldwater-Nichols Department of Defense Reorganization Act addressed this "perfect storm" of issues and codified today's obligatory preference for joint acquisition that began in the sixties.[30] Joint aircraft programs have, however, consistently fallen short of the savings anticipated.

No historical precedent for a genuine, joint rotary-wing acquisition program exists. Although the services have employed similar helicopter and tilt-rotor aircraft, the overall 'big-A' acquisition programs for those platforms were not conducted jointly.[31] For example, the Navy has been operating the SH-60B since 1983 but it was not involved in developing the original requirements, nor the research, design, testing and evaluation (RDT&E) for the Army's Utility Tactical Transport Aircraft System (UTTAS) program, which eventually became the UH-60A, in the late 1960s.[32] The Navy chose to procure Sikorsky's SH-60B in 1978, the same year the Army started receiving production models of the UH-60A, "because [the SH-60B] offered significantly lower life-cycle cost as a result of parts commonality with UTTAS."[33] Similar threads can be followed in the acquisition of the Army led UH-1 and other service led programs.[34] Throughout these 'big-A' acquisition programs, one service led the program to successful initial operating capability (IOC), after which sister services acquired the aircraft and modified it.[35] These programs are not genuinely *joint* in nature because all participating services were not actively involved throughout the entire process. When sister services procure another service's platform, they accept trade-offs in performance for financial gains.

There is no precedent for joint rotary wing programs; the precedent from joint fixed wing programs is not encouraging. Historically, "joint aircraft programs, in which two or more services participate in the development, procurement and sustainment of a single baseline design, are thought to save life-cycle cost by eliminating duplicate RDT&E efforts and by achieving economies of scale in procurement and operations and support (O&S)."[36] This assertion would be true if each service had requirements that were 100% identical, yet "the need to accommodate different service requirements in a single design or common design family leads to greater program complexity, increased technical risk, and common functionality or increased weight in excess of that needed."[37]

Mark Lorell of the RAND Corporations studied eleven aircraft programs to determine if they actually cost less than multiple single-service programs.[38] Lorell's analysis indicates that the cost for joint programs rises significantly after milestone B.[39] This point is significant because it is well past the initial advanced technology development, advanced component development, and prototype RDT&E phases where joint programs theoretically save cost.

On average, five years after milestone B, joint programs cost 44% above baseline while single service averages were only 12% above baseline.[40] Nine years after milestone B, joint programs continued to increase, averaging 65% cost growth over baseline while single service programs averaged just 24% above baseline. Using algebra to determine the maximum potential savings that a notional "ideal" joint program could, in theory achieve, Lorell calculates that at most, a joint program could save 20% in overall costs compared to two single service programs.

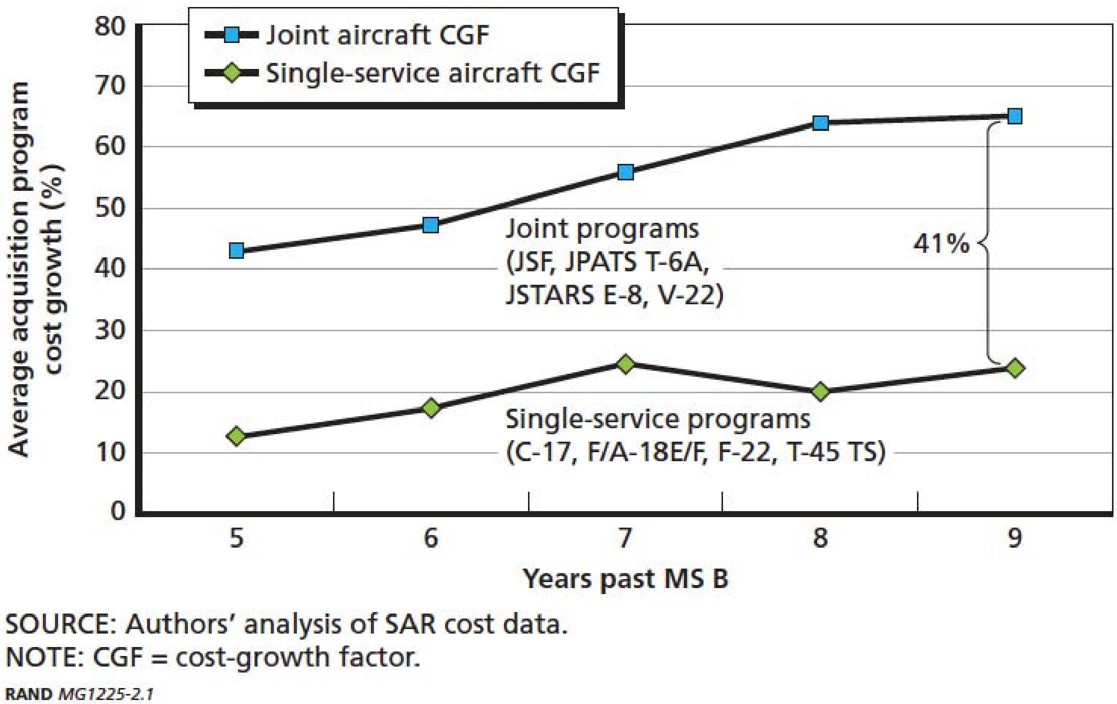

Figure 2: Average Acquisition Program Cost Growth versus Years Past Milestone B[41]

However, using the historical data from Figure 2, Lorell determines that despite savings in RDT&E, the joint program will cost 6% more than two single-service programs because of the 41% increase in cost growth of joint programs indicated in Figure 2.[42] Lorell included an uncertainty factor to account for the range of cost-growth premiums from five to nine years past milestone B, covering both data sets. His findings clearly indicate that joint programs would not save acquisition costs versus two single service programs.[43] Of note, the model for his "ideal" joint program maintains 100% commonality between services, which has never been observed. All indicators point towards lack of commonality as the leading factor contributing to this cost difference.[44]

Commonality refers to subsystems of a weapon platform that meet the requirements of all services involved. For example, all aircraft need engines, and if an engine meets the requirements for all services, then it is a common part and contributes positively to commonality. Naval aircraft are required to use existing aircraft carrier catapults and arresting gear to take off and land, but Air Force fighters are not. While the core engines may be the same, the naval variant will require a heavier landing gear, folding wing tips and tailhook to facilitate flight operations from the carrier. The specificity of the naval requirements reduces commonality and contributes to overall cost growth.

In 2006, David McNicol analyzed the failure modes of joint acquisition programs using the TFX (F-111A/B) as a case study for the Institute for Defense Analysis (IDA). Air Force requirements for the TFX called for a multi-mission aircraft capable of providing air superiority to defeat advanced Soviet fighters, the ability to conduct long-range penetration into Soviet airspace to deliver nuclear warheads, and to provide close air support (CAS) to troops on the ground.[45] The Navy shared these requirements, but most importantly needed an interceptor capable of defending carrier groups against long-range air-to-surface anti-ship missiles. The Navy needed an aircraft that could fly patrols with a long loiter, and then return.[46] Swing-wing technology offered the hope of combining these capabilities in a single aircraft, but was unproven.

McNicol cites the trade off of weight for speed as the primary example of the TFXs conflicting service requirements. The Navy’s requirements for carrier suitability required increased structural support, and therefore increased weight. Yet, the Air Force requirement for supersonic speed at sea level required that aircraft weight be limited. Secretary of Defense Robert McNamara directed that the program go ahead on the assumption that the technology would produce an aircraft capable of all these missions.[47] Specifically, he assumed that state of the art technology was capable of satisfying the Air Force requirements within the limits imposed by the Navy.[48] The decision was made to commence a joint program despite discovering that "the Mach 1.2 dash speed at sea level imposed stringent structural strength requirements, [meaning] weight, which worked against carrier suitability."[49] Lorell assessed that the weight penalty for the F-111B was approximately 2,000-3,000 pounds.[50] Eventually the Navy withdrew from the F-111 program, but not until initiating a replacement program.

The VFX program shared similar swing-wing technology, eventually becoming the highly successful F-14. In this case, initiating separate service programs that shared technology could have produced aircraft with enough commonality to make them cost effective. The Navy's decision to withdraw from participation in TFX was due to design penalties that negatively affected performance and increased risk while operating at the carrier.[51] The failure of the F-111 program to satisfy the needs of both services shows the basic weakness of joint programs: the technical impossibility of overcoming contradictory requirements.

Figure 3 shows the evolution of four programs that started as joint initiatives with the goal of 100% commonality. The ACF program is another example that highlights how differences in the service's presumed requirements did not pass flight test and caused one service to diverge from directed weapons system procurement. The Air Force favored the single engine YF-16 over the twin engine YF-17. Despite being directed by Congress to jointly purchase the YF-16, the Navy favored the multi-engine aircraft for carrier operations and proceeded to procure the F/A-18.[52] Of critical significance is the lack of any commonality between the F/A-18 and the F-16 in Figure 3.

With 20/20 hindsight, Brookings Institute military analyst Michael O'hanlon suggests that as a rule of thumb, joint aircraft acquisitions should have at least 90% commonality to effectively save costs.[53] The lack of a required percentage of commonality still plagues the

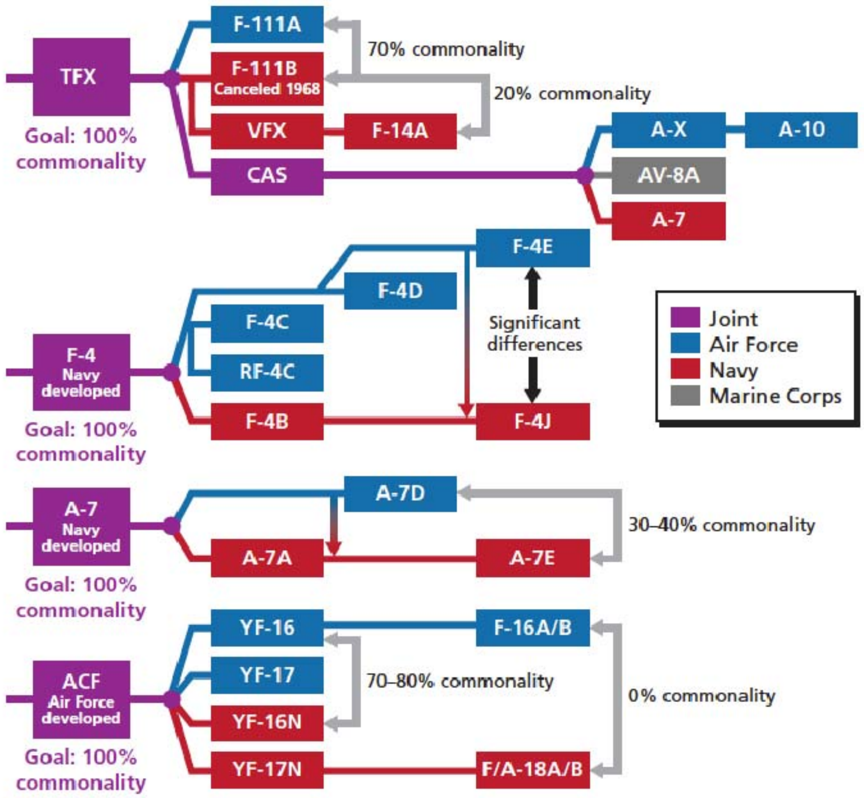

Figure 3: Service Requirements and Commonality[54]

joint acquisition process, evidenced by the absence of a required commonality metric for the FVL FoS.

While the Army is charged with the responsibility of managing the overall FVL program, the Navy's primary interests are focused within CapSet 2. The desire to condense all naval vertical lift missions into one platform warrants further scrutiny since its motivation is similar to that driving a joint program, namely reducing cost. The Navy's recent experience with the acquisition of the MH-60R/S, the keystone of the Helicopter Master Plan, experienced several difficulties associated with joint programs, specifically that of trying to squeeze too much capability into one platform.

While not a joint program, the Helicopter Master Plan experienced problems associated with joint programs because its underlying objective was consolidating seven community mission sets and associated capabilities into two aircraft.[55] The appendix of this paper describes how the Navy's Helicopter Master Plan was executed and should be referred to for details on the lessons learned. The lessons were identified while evaluating the evolution of the Navy's Helicopter Master Plan:

1. Naval Aviation leadership needs to define an overarching strategic vision for future vertical lift employment.

2. Build in excess human and material capacity in anticipation of the assignment of new missions and systems.

3. Clearly define backup plans when program goals rely on unproven technology.

4. Define the limit of acceptable risk and capability consolidation when compared to cost savings anticipated.

Applying these lessons learned to the recommendations from Lorell and McNicol's findings from historical joint acquisition programs, a path forward can be crafted and recommended for the Navy's interests in the FVL program.

Applying Lessons Learned From the Past To The Future of Vertical Lift

The FVL program has several problems for the Navy as it is currently implemented. First, the programs requirements reflect Army and Marine Corps missions and operating environments that ignore naval missions and constraints. Second, attempts to meet both Army and Navy requirements will both reduce the performance of the rotorcraft and the level of commonality and thus cost savings. Lastly, the concentration of all navy requirements into

CapSet 2 will force the Navy to rely on a single airframe for all missions. This consolidation will have second order manning effects if not properly managed.

From a Navy perspective, the Army's management of the FVL program resembles the Air Force's management of the TFX. Mary J. Miller, Deputy Assistant Secretary of the Army for Research and Technology, stated to the Intelligence, Emerging Threats, and Capabilities Subcommittee of the House Armed Services Committee on the United States Army's science and technology program for fiscal year 2014, that the "vision for army aviation S&T is to provide the best possible aviation technology enabled capabilities to deliver soldiers, weapons, supplies and equipment where they are needed, when they are needed."[56] The Army's proposal for the FVL requirements also included a potential future near peer adversary threat with extensive A2/AD capability covering an area of operation (AO) that is sixteen times larger than current AOs.[57] These geographic expanses and the proposed threat capability has led FVL leadership to require increased performance in speed, range, and capacity to meet the Army's mission of supporting ground troops. The FVL requirements should produce a superior assault support helicopter, but ignore both the mission requirements of the Navy and the environmental constraints of maritime operations. Now published, these metrics can be compared to the Navy's current and expected future requirements to expose naval specific capability gaps in the Army's requirements for the FVL.

As of this research effort, only the requirements for CapSet 1 (light) and CapSet 3 (medium) are available, published in Request for Information (RFI) documents updated on the American Helicopter Society International webpage.[58] (**Note:** the use of RFI in the FVL program is not within standard military usage; instead it refers to the list of detailed requirements for each CapSet that specifies comprehensive capabilities far beyond mission sets) As indicated above, these two CapSets, which have been chosen as the baselines for the two TDs scheduled to fly in FY 17, primarily represent Army and Marine Corps missions. The RFIs for CapSet 3 are similar to missions that the AH-64 and UH-60L/M aircraft fly. Additionally, the following capabilities are required: to achieve 230-310 knots, carry 12 troops weighing 335 pounds each, and hover out of ground effect at 6,000 feet and 95 degrees Fahrenheit.[59] The only naval requirements listed are to have amphibious (LHD/LPD) and CRUDES (DDG/CG) ship capability, the ability to conduct maritime interdiction operations (MIO) (i.e.; the ability to fast rope troops to a ship), and include a description of the folding mechanisms for ship operations.[60] RFIs for CapSet 1 have fewer maritime requirements than RFIs for CapSet 3, but include the need to conduct an "auto approach to a ship deck and coupled hover hold/precise position hold over [the] water."[61] Although these minimal naval requirements exist in the CapSet RFIs, they exist to support Army and Marine Corps operations and do not address commonality between all services. The lack of comprehensive naval requirements in the RFIs is indicative of program decisions made by FVL leadership, which will eventually lead to design compromises for the Navy.

Another requirement for the FVL program is to dynamically communicate with other service and joint assets, and the ability to transmit and receive full motion video (FMV) and sensor data. The RFIs for both CapSet #1 and #3 list specific Army systems that are currently fielded, e.g., Manned-Unmanned Teaming (MUM-T), an Army specific program to transmit and receive FMV and control similarly capable vehicles sensors.[62] This is problematic because Navy ships, aircraft, Unmanned Aerial Systems (UAS), and ground units currently use ROVER and HAWKLINK for FMV transfer, not MUM-T technology.[63] There is no joint FMV standard in use by all services. This would necessitate duplicate technology to be incorporated across the whole Naval fleet of ships, aircraft and UAS, or the development of interoperable software to allow units to transmit and receive data to both naval, air, and ground units. The requirement for MUM-T negatively influences commonality because it creates additional requirements for the Navy, Marine Corps, and Coast Guard.

The Navy has not disclosed its specific inputs to the FVL programs.[64] Navy mission profiles differ vastly from those of the Army and Marine Corps and require improved performance in different areas. The Navy's current missions require performance in a variety of flight regimes ranging from slow, controlled and methodical hover at sea level for anti-submarine warfare (ASW), search and rescue (SAR) and mine countermeasures (MCM), then dashing to employ weapons on Fast Attack Craft (FAC) and Fast Inshore Attack Craft (FIAC). Other naval missions can be short induration or encompass long range armed Rescue Escort (RESCORT) supporting organic Combat Search and Rescue (CSAR) at low altitudes over salt water. Yet these mission profiles are conspicuously absent from the FVL RFI discussion.

The Army currently has detailed requirements to develop at least five CapSets and has created CapSet 2 because their medium lift vehicle is anticipated to be too large and heavy for shipboard operations.[65] The Navy's requirements are consolidated within CapSet 2. It was recently reported that the Navy desires to keep the missions of the MH-60R/S in one airframe of aircraft.[66] The separation of CapSet 2 from CapSet 3 improves the probability of acquiring an aircraft suitable for Navy missions, but creates a different risk: the need to adapt a single airframe for all Navy missions. Such a decision could increase the risk to mission effectiveness, given the diversity of naval missions listed above. In contrast to the Army, by consolidating all its missions within CapSet #2, the Navy appears to be prioritizing anticipated costs savings over performance. This decision should be made after defining the limit of acceptable risk due to capability consolidation and comparing it to anticipated cost savings. The Swiss Army knife has many features, however it executes all of them marginally. The variety of mission requirements for CapSet 2 means that a single aircraft may perform those missions marginally. The Navy cannot accept marginal performance of essential missions.

This same principal can be applied to the manning aspect of equipment and unit consolidation. Even if a single airframe could perform all the Navy's missions—that a hypothetical MH-XX could accomplish everything the MH-60R, MH-60S, MH-53E, and HH-60H do and do it well—that it would be impossible for a single squadron to adequately train and qualify crews to the required level of proficiency required accomplish those missions successfully. Thus, despite flying and maintaining identical aircraft, two squadrons in an Air Wing would still need to train to different mission sets. The difficulty in training to all mission sets is time to train. Not only are Navy crews bound to deployment cycles, but also requirements for career progression through sea and shore tour rotations. Unlike the Army's Warrant Officer pilots who are expected only to fly, the Navy's Unrestricted Line Officer's are required to take on management positions and leadership roles while on flying tours, in addition to academic and staff non-flying shore tours. These personnel requirements further limit the Navy pilots ability to become an expert at the skills required to execute a variety of missions sets throughout a career.

The Navy's strategic vision appears to encapsulate manning structures and training plans that consolidate all naval vertical lift missions into a single platform. This plan betrays the lessons learned from historically joint aircraft programs and the Helicopter Master Plan. The Navy needs to take over as the lead service for CapSet 2 in order to ensure that the aircraft meets the requirements of maritime operations and naval missions. Second, the Navy should evaluate whether a single airframe can meet all of its requirements with adequate growth capability, and, if not develop a second airframe for some Navy missions. Finally, the Navy needs to determine the limit of human performance within the confines of an unrestricted line officer's career progression.

Recommended RFI Requirements For The Navy's FVL

Several critical naval requirements are missing from the FVL TD CapSets. The Navy should define its visionary operational concept for the future vertical lift tying together ends, ways and means to achieve its strategic goals. The vision for the Navy's future vertical lift concept should invoke the NAEs three tenants for Naval Aviation's Vision: Sustain capability superiority, ensure wholeness and affordability, and maintaining capacity. This vision would be resourced with two models of vertical lift aircraft. The first would be adapted to fly controlled, low speed, hover operations for ASW, SAR, MCM, Logistics and VERTREP while the second model would be light, lethal, and agile for SUW, CSAR, MIO, and SOF support missions. Having this vision clearly defined would allow the Navy to leverage technology maturation from the JMR FVL TDs, and then commit to a Navy led acquisition program optimized to execute naval missions. While the opportunity to get naval technology interests into the JMR FVL TDs may be waning, the following list, though not all-inclusive, provides a start for naval planners to develop the CapSet RFIs that would support the NAEs Strategic Vision for future vertical lift aircraft.

Mitigate Salt Encrustation of Turbine Engines. Salt encrustation of turbine engines occurs when helicopters hovering over the ocean or body of salt water ingest salt spray blown up by the rotor downwash. This salt spray crystalizes on the engine turbine blades, consequently disrupting the airflow through the engines, decreasing power available and in extremis causes compressor stalls that negatively affect hover performance. Current techniques to address this condition are conducted by maintenance crews after shutdown on the flight deck. In order to perform SAR, ASW, MCM, and MIO missions adequately, naval helicopters must be equipped with technology that minimizes the effect of salt encrustation without landing and shutting down.

Effects based integration of naval FVL weapons. Effects based weaponeering of naval targets should be addressed by analysis of subsurface, surface and airborne targets. Instead of requiring the ability to mount current weapon systems onto the FVL platform that will embody CapSet 3, calling them out by name, *e.g.*, APKWS, JAGM and AGM-114 HELLFIRE (semi-active laser (SAL), millimeter wave (mm)), the desired effects on the target should be optimized through the FVL platform.[67] One of the principles of weaponeering is to start analysis with the desired effects on a specific target and then determine what weapon is appropriate and how to employ it. From that point of view, aircraft are merely a weapons delivery platform in the weaponeerng process.

Subsurface threat. The new aircraft must have the capacity to accommodate a new generation of ASW weapons and sensors. The basic design of current systems, such as the Mk-46 torpedo, AN/SSQ-53 DIFAR and AN/SSQ-62 DICASS sonobuoys, dates back to the 1960s.

Surface threat. The capacity and operating method of current and future surface threats, specifically, FAC and FIAC, require a genuine ‘fire and forget’ weapon systems. This weapon system needs to have the ability to adjust fuzing, select warhead type, and simultaneously designate and attack multiple fast-moving and agile maritime targets during the day and night, and in all weather.

Airborne threat. Current naval rotary wing aircraft do not have a dedicated Air-to-Air weapon to accurately employ against Low Slow Flyer (LSF) and UAS. This capability gap was clearly revealed to the USS Carl Vinson Strike Group in March of 2015 when a Y-12 approached the carrier strike group unchallenged, made several low passes, then departed.[68] This gap needs to be addressed in the FVL planning in order to defend the Strike Group when no strike fighter aircraft are airborne to intercept.

Appropriate weapons carrying capacity. The naval FVL platform should have the ability to carry and store all adequate weapons and sensors required to perform the assigned mission.

Aircraft Plane Guard SAR Endurance as a Function of Cycle and Mission Times. Plane Guard/SAR FVL platforms should have sufficient fuel to loiter for the primary mission profiles married to the expected cycle times of the carrier air wing strike package to optimize fuel efficiency.

Ensure self-defense capability. The FVL platform configuration should ensure that self-defense capability is not compromised with configuration changes. This lesson was gleaned from the Helicopter Master Plan Armed Helicopter Weapon System (AHWS) that could not mount .50 caliber machine guns, used for self-defense, with APKWS. The Navy needs to understand that helicopter weapons are generally always employed within the enemy's Weapons Engagement Zone (WEZ), and therefore self-defense capability and capacity cannot be compromised in order to employ a new weapon.

Embedded training mode. All FVL weapon systems need to have an embedded training mode that accurately represents employment and facilitates shot validation. This training mode capability would extend life cycle cost saving to the expenditure of Non-Combat Expenditure Allowance (NCEA) for routine proficiency training.

Intuitive User Interface. Much training time is spent learning how to interface with an aircraft. With the explosive proliferation of video games and gamers, clearly understandable graphical user interfaces should be used to utilized to maximize performance and minimize time to train. The man-machine interface should be designed with the holistic approach of operating the aircraft in all mission sets and aspects of combat.

Joint Interoperable Communications. FVL TDs should demonstrate the ability to receive and send encrypted communications across all formats facilitated by open source architecture. Standardizing encrypted sensor data, voice, and FMV with all joint assets (surface, subsurface, and air assets) would complement the naval SUW recognized maritime picture (RMP) and enhance in the execution of ASW, SAR, CSAR, and SOF missions.

Conclusion

Tomorrow's enemy combatant and battle space environment is unknown. The Army's operational concept for vertical lift warfare is implemented through CapSets shared over a FoS to support the soldier in achieving superiority in the land battle.[69] The Navy must be prepared to dominate challenges presented through warfare on the seas and in the littorals. It can only achieve this through superior capability. The very nature of joint aircraft programs encumbers each service's ability to attain superior capability in their mission sets due to design compromises. While the estimated savings in RDT&E may be appealing, historically joint programs have proven to cost more than single service programs over the total life cycle and fail to provide equally capable performance for all services. The lessons learned from past programs needs to be addressed in the FVL program to ensure that the appeal of consolidation does not limit superior capability.

Yet, and despite recommendations to conduct service specific acquisitions, the services continue marching toward a joint FVL program optimized for Army requirements in a projected overland operating environment. It is imperative that the Navy critically assesses the risks of participating in a joint program for its vision of future vertical lift platforms. The Navy must weigh the capability and capacity required to maintain superiority in the future maritime and littorals against the perceived benefits of cost savings, interoperability and commonality. The direction the FVL program is being steered will force the Navy to compromise on design and challenge its ability to maintain superior capability in the conduct of naval warfare. In order to safeguard its superiority operating on the high seas and littorals, save on overall life cycle cost and reduce risk to the warfighter, the Navy needs to take the lead on CapSet 2 to advance a maritime specific acquisition program for its future vertical lift platforms. This would enable naval vertical lift units to implement the Commander Naval Air Force's strategy in the Pacific.[70]

Areas for further investigation that were revealed during research for this paper were extensive. The Navy needs to promulgate a vision for the operational future concept of vertical lift to answer the question, "what will naval vertical lift air warfare look like in 2030." If the Navy anticipates in fifteen to twenty years its vertical lift squadrons will be conducting the same sets of missions (SAR, ASW, SUW, CSAR, SOF support, logistics, VERTREP, and MCM) with a single platform as they are now, then its vision is narrow in scope. However, at the introduction ceremony for the MH-60S in 2002 it was understood that "leaders in naval aviation anticipate that the [MH-60S] Knighthawk will not only replace most existing Navy helicopters, but will be instrumental in the development of entirely new helicopter missions."[71] This capability growth was not tempered by the limits of individual human capacity to conduct multiple missions in a combat environment. Specifically, the Navy's unrestricted line officer career path for pilots develops officers to be well-rounded fleet leaders, which is in stark contrast to the Army's cadre of experienced warrant officer pilots who progress through their careers from flying tour to flying tour. If the Navy only operated one type of vertical lift platform from one type of squadron, commonality would be 100% and acquisition cost models would indicate on cost and schedule. However, expecting a first tour pilot to master all the current and future missions in three years under fiscally austere budgets that limit training flight hours is unrealistic and dangerous. A clearly delineated operational vision for the Navy's future vertical lift would drive capability and equipment requirements, and create an appropriate manning construct balanced with career progression and training metrics. Until that vision is made known, lessons from the past will help steer the Navy on a course towards a vertical lift platform that will meet its future strategy.

Other areas for further study include how to better integrate the weapons school experts with weapon system acquisition personnel. Operational planning–connecting ends, ways and means—for future conflict, is a gray area within Naval Aviation. The limits of human performance in multi-mission aircraft are also at issue–should a pilot and crew be multi-mission capable? What is the cost/benefit risk analysis of employing fewer model/series of aircraft less effectively across more mission sets? While not specific to the FVL program, exploring the expansion of contractor supported mission sets to cover all aspects of VERTREP, logistics and plane guard SAR would allow the Navy to focus FVL requirements solely on those dedicated to naval combat missions. These approaches can have manpower savings that, in the long run, outweigh savings in equipment acquisitions and allow the naval version of FVL to be more effective at combat missions through specialization.

There are many opinions on the path forward for right-sizing the future military force structure. Broad stroke budget cuts across all departments due to sequestration is the punishment for lack of fiscal oversight and management. The Navy must maintain superior war-fighting capability as its own center of gravity as it continues to advance towards a truly joint fighting force.

APPENDIX: Lessons Learned From The Helicopter Master Plan

While not a joint endeavor, a review of the Navy's Helicopter Master Plan exposes clearly the difficulties faced by attempting to consolidate diverse requirements into a single platform. The challenge of finding commonality among diversity resulted in design compromises that negatively impacted tactical employment and ultimately resulted in capability gaps remaining unfulfilled. The Navy conceived of a plan in the 1990s to modernize its aging fleet. This plan had a stated goal, which was to reduce the variety of aircraft in the Navy's inventory through a "neck down strategy", intended to achieve large manpower and cost savings.[72] The core concept would trim the number of operational helicopter models from seven to three and streamline the type of units from five to three.[73] Reducing the variety of helicopter units forced structural changes in the plans for manning, training, and equipping squadrons. This redistribution of mission sets amongst the new multi-mission squadrons was a new concept that had no historical precedent.[74] In the early 2000's, the Department of Defense initiated a helicopter modernization program to address the excessive aging of airframes brought on by a decade of higher than expected use supporting operations in Iraq and Afghanistan.[75] The Navy, in particular, was in need of replacement aircraft for nearly half of its fleet and required major modernization for the remainder. The CH-46Ds, UH-1s, SH-3s, SH-60Bs, SH-60F, and HH-60Hs were rapidly reaching their service life limits. At this time, "three general approaches [could have been] taken to modernize DODs helicopter force: upgrading current platforms, rebuilding current helicopters (often called recapitalization), or procuring new models."[76] Initially, the Navy planned to recapitalize the SH-60Bs and procure a single aircraft to replace the other five airframes. The Helicopter Master Plan took advantage of a chance to consolidate five of its models into one platform, the CH-60S (eventually becoming the MH-60S), and reap the benefits of a projected $18 to $20 billion in operations & maintenance (O&M) savings over a twenty-year period.[77] The procurement also included a modular upgrade feature that replaced the armed helicopter capability of the HH-60H and migrated the mine counter measures (MCM) mission from the CH-53E to the MH-60S. However, the $17 million cost to recapitalize each SH-60B was already earmarked for a new aircraft acquisition, the MH-60R, at a price of $21 million each.[78] Despite this initial Nunn-McCurddy breach, the program met the metrics to re-baseline its cost according to prior criteria, bringing the program within costs.[79] The reduction in O&M costs through managing two new aircraft in lieu of an aging fleet of seven, and the absorption of the MCM mission from the CH-53E, laid the foundation for the Navy Helicopter Master Plan.

Now, almost twenty years after inception, an assessment can be made of the Helicopter Master Plan in order to learn from the past. Lessons learned can be applied to future vertical lift platform acquisitions that will support the NAE's strategy of implementing the joint concept for access and maneuver in global commons (JAM-GC). In 2004, Christian F. M. Liles and Christopher Bolkcom proposed five major issues for Congress to consider for modernizing the helicopter fleet: (1) budgetary concerns; (2) force structure; (3) coordination of modernization efforts; (4) industrial base issues; and (5) operational issues.[80] The Navy expected to save money by replacing seven platforms with two, the MH-60R/S.[81] The decision to reduce the number of platforms adjusted the force structure by reducing the variety of maintenance training pipelines, pilot and aircrew training pipelines and reduced the assortment of parts in inventory. Leadership did not regard the loss of the heavy-lift capability of the CH-53 as an issue because its need for the service was in question and they anticipated that the MH-60S would take over the MCM mission. The plan had no backup if the MCM package for the MH-60S failed and no excess reserve to handle mission creep.

The lack of a backup plan exposed a flaw in the Helicopter Master Plan when three of the five organic airborne mine countermeasures (OAMCM) modules failed to pass flight tests. In 2012, the Chief of Naval Operations responded by cancelling the three modules, citing safety reasons and delaying the expected date of IOC of the littoral combat ship (LCS) MCM module.[82] The Navy was so confident that the MH-60S OAMCM module for the LCS would succeed that they never invested in the development of the Marine Corps' MH-53K, scheduled to debut in 2019. The Navy's MH-53E's will still remain in service to provide a MCM capability until at least 2025.[83] However, the navy is currently evaluating whether the requirement for a heavy-lift helicopter to conduct vertical onboard delivery (VOD) and MCM missions will exist after that date.[84] The Navy faces a critical shortfall in OAMCM capability, with no planned replacement for the MH-53Es, an incomplete MH-60S MCM package and failures in the LCS MCM program. Until these issues are resolved, the Navy may face a significant gap in the MCM capability in the near future. Along with this potential future capability gap, mission creep to the surface warfare (SUW) mission of the armed helicopter module has further complicated the progress of the MH-60R/S program.

The original plan for the armed helicopter module was composed of three weapon systems that had already been fielded on DoD helicopters: The AGM-114 series of Helicopter Launched Fire and Forget (HELLFIRE) laser-guided anti-tank missiles, the .50 caliber GAU-21 machine gun and the M240D 7.62mm machine gun. The addition of fixed forward firing weapon systems to both the MH-60R/S aircraft was "in response to an U.S. Central Command Urgent Operational Needs Statement (UONS) for enhanced surface warfare capability against threat representative small boat targets."[85] The UONS was addressed in a modular three-step approach, again incorporating weapon systems previously fielded on other helicopters to save RDT&E costs. The first weapon added to the MH-60S was the M-197 20mm forward firing cannon followed by the LAU-61 C/A 2.75" Hydra rocket pod. The LAU-61 G/A Digital Rocket Launcher (DRL), firing the Advanced Precision Kill Weapon System (APKWS), was the ultimate answer to the UONS and was incorporated last, requiring the most time to migrate the technology to the MH-60R/S platform. Using previously fielded weapon systems resulted in considerable savings in RDT&E. However, results from developmental flight tests, conducted under laboratory-like conditions, gave a false sense of ease of employing the weapon system when compared to employment in a combat training environment. Flight tests ultimately assessed that APKWS had "demonstrated marginal surface warfare capability" due primarily to conflicts in doctrinal employment.[86] This additional mission creep was justified because the UONS was in support of a geographic combatant commander, however these additional weapons continued to increase the overall cost from the original acquisition program baseline (APB).

The legacy HH-60Hs and SH-60Bs configured with AGM-114 HELLFIRE for anti-surface warfare capability were employed at long ranges, which provided adequate standoff from surface fires. The M197 20mm and LAU-61 C/A would be employed at close ranges, while APKWS was meant to bridge the gap between the anti-tank missiles and the 20mm munitions and unguided rockets. Because these weapon systems were modular upgrades, added at a much later date than the MH-60R/S IOC, their execution of the find, fix, track, target, engage, assess (F2T2EA) kill chain was not thoroughly envisioned. The issues discovered implementing this plan were two-fold. First, both the MH-60R/S aircraft had only two pylons each for weapon stores limiting configurations to only two types of weapons per aircraft. The MH-60R can be equipped with either the AGM-114 HELLFIRE or APKWS, while the MH-60S can be equipped with the AGM-114 HELLFIRE, APKWS DRL, LAU-61 C/A or M197 20mm. Both aircraft can mount the M-240D 7.62mm crew-served weapon for defensive measures, however further complicating configuration management was the inability to install GAU-21 .50 cal machine guns on an APKWS configured MH-60S. The MH-60R/S primary SUW role is ship defense and consequently, the need to bring all weapons to the fight against an unknown enemy is highly desirable. However, due to configuration limitation, this is not possible without accepting increased risk attributed to the inability to mount crew served GAU-21s for self-protection. Since a single aircraft could not be armed with the four weapon systems for a single sortie, two aircraft could bridge the lethality gap by flying together with a mixed load-out of weapons. Historically, MH-60R/S crews did not operate together in mixed section formation flight. This want of experience was resolved through the addition of training sorties specifically for qualified crews flying in mixed formation of MH-60R/S. Meeting this objective required more training sorties and further increased O&M costs.

In addition to limitations on mounting weapons, the second issue encountered was the dearth of latent experience amongst the cadre of skilled Navy helicopter pilots with the techniques of employing these new weapon systems. Due to the lack if institutional knowledge amongst navy pilots, adopting these weapon systems required the Navy to embrace techniques of the Marine Corps and Army, who previously employed these weapons. The diving profiles necessary for employing the M197 and LAU-61 C/A were new for Navy crews. Executing these techniques required crews to point the nose of their aircraft at the water and place the aircraft near the edge of its operating limits, an unnerving experience at night over water. A robust plan for training instructors and building their confidence was therefore implemented, further increasing O&M costs. These two operational issues were unplanned for but not difficult to predict. In contrast, APKWS was selected for the MH-60R/S due to its predictable performance for the Marine Corps in combat.

The M197 and LAU-61 C/A, while employed at close ranges, were stepping stone advances toward a precision-guided munitions that would be employed at mid-ranges. Employment at close ranges increases risk due to proximity to the enemy target, yet mitigates it through the same measure. By decreasing the distance to the target, firing accuracy is improved. Using guided APKWS rockets at close range increases accuracy substantially and contributed to the Marine Corps success with the weapon in combat. However, this benefit did not translate to the Navy's selection of the APKWS for the MH-60R/S. While the Marine Corps employs APKWS in the same manner as M197 and unguided LAU-61 C/A rockets, at close ranges, the Navy intended to employ APKWS at mid-ranges. Using the success the Marine Corps had with APKWS to partially justify selecting it for the MH-60R/S is not a sufficient rationale since, among other reasons, they were employed in vastly different manners. The effects of employment at mid-ranges not only manifested in reduced accuracy, but also required new and intricate crew resource management (CRM) skills between the two pilots. This disconnect in doctrinal employment is directly attributed to the lack of an operational concept for the Navy's vertical lift platforms combined with mission creep and a 'can do' attitude at any risk. Establishing a formal relationship between the acquisition community, test community, and centers of excellence could have identified this disconnect earlier.[87] The M197 and LAU-61 C/A were to be discarded after APKWS achieved IOC, yet ironically they were praised as successful in the close fight. Command decisions extended the M197 and LAU-61 C/A programs indefinitely and also increased the number of weapons purchased in order to equip all carrier-based MH-60S squadrons, again adding to the overall costs of the program.[88]

While it was not a joint acquisition program, reviewing the lessons learned from the Helicopter Master Plan reveals problems associated with planning an acquisition program based on the consolidation of many competing missions into one type of platform implemented through modular block upgrades. The failure of three MCM modules revealed the Helicopter Master Plans vulnerability from gambling on technology that had yet to fully mature. The mission creep from the central command UONS demonstrates how competing interests for capability from a single platform can delay delivery times, result in massive increases in costs and increase the risk at the tactical level. These significant schedule and O&S cost breaches from acquisition program baseline (APB) took the form of a year delay in IOC of the LCS MCM capability and a 41.08% increase in unit cost for each MH-60S, projected at totaling $1.67 billion.[89] Despite consolidating seven platforms into two, the Navy's Helicopter Master Plan failed to have robust contingency plans for each modular upgrade, excess capacity to handle unexpected mission creep and did not anticipate the additional O&M costs required to operate weapons systems that are doctrinally at odds with current employment. As the Honorable Norman R. Augustine, retired Chair and CEO of Lockheed-Martin, stated for a 2014 staff report on acquisitions for the Permanent Subcommittee on Investigations, "in acquisitions, one size does not fit all."[90]

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