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INNOVATION LOST: THE TRAGEDY OF UCLASS

SENIOR ACQUISITION COURSE

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"The U.S. military will invest as required to ensure its ability to operate effectively in anti-access and area denial (A2/AD) environments."

2012 Defense Strategic Guidance[1]

"At stake here is not just the operational relevance of the carrier air wing in the future, but, really, the strategic relevance of the aircraft carrier for decades to come."

Robert Martinage[2]

The stunning defeat of the superior and better-equipped French army at Agincourt 600 years ago by an exhausted and vastly outnumbered English force offers many lessons to military planners, not the least of which regards the adoption of innovation. For several weeks preceding the battle, the English army had endured a forced march across the contested French countryside and faced France's area denial measures. But when they finally met the French army on an October morning after a cold, sleepless night on an open muddy field, the English archers used their new longbow technology to devastating effect against the French. It was employment of the longbow--an innovation that permitted a faster firing rate at a longer range than the previously dominant cross bow--that proved crucial in the success of that few, that happy few, that band of brothers on the fields of Agincourt.

The Navy faces a challenge in the Pacific that would not be unfamiliar to Henry V in Normandy. US strategic guidance expects China to continue to invest in anti-access, area denial (A2/AD) technology that undermines the ability of the US Navy to project power in the Pacific.[3] The Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) system was conceived as a key next-generation capability to provide a means to penetrate and persist in A2/AD environments. However, despite 15 years of research and development (R&D), a well-funded transition path over the valley of death,[4] and clear guidance from the Secretary of Defense and Congress, the Navy is reluctant to embrace the innovation that a fully-capable unmanned strike aircraft could bring to naval forces. Consistent with common theories that bureaucracies have difficulty with innovating on their own, the Navy steadily diluted the requirements for UCLASS over the course of five years from a full-stealth combat system to a less stealthy surveillance platform before finally settling on an unmanned tanker largely confined to uncontested airspace. Shakespeare's Henry V boldly proclaimed before Agincourt that "All things are ready if our minds be so." When it comes to innovation via UCLASS, the Navy's mind is not yet ready.

This paper reviews the innovation life cycle, examines the origins and vision of the UCLASS program, describes the interaction between Congress, the Navy, and the Office of the Secretary of Defense (OSD), and then outlines and explores the natural resistance military services have against disruptive innovation. The Navy's failure to adopt the UCLASS innovation provides an opportunity to test the traditional theories on adoption of military innovation; namely, the theories associated with Barry Posen,[5] Stephen Rosen,[6] Owen Cote[7] and Harvey Sapolsky,[8] and Theo Farrell[9] and Elizabeth Kier.[10] Finally, this paper offers a general framework for success for those who seek to push innovation within the services.

We argue that the Navy needs a much stronger internal UCLASS advocate to lead the program through development and initial operational capability if the aircraft carrier is to avoid obsolescence in the coming decades. Further, the inability to successfully integrate this innovation with manned strike capabilities in a manner consistent with initial visions will delay the adoption of these technologies by other services and potentially further erode the lead that the US enjoys in capability relative to both allies and adversaries that are pushing to reap the benefits of unmanned combat air systems.

Note this paper analyzes an active program in the midst of ongoing change and undergoing continued scrutiny by a number of influential parties in the military, civil, and industrial communities. Previous case studies describing the requirements process for large systems development and acquisition have had the benefit of many years of reflection and are typically written after the system has been fielded. Examples include the 1987 Trident Study[11],[12] (written 15 years after the requirements were set) and the 2014 and 2015 CRS[13] and GAO[14] reviews of the F-35 program. These case studies and requirement reviews benefited from time in understanding the influences that guided the system through its development.

In search of the next Offset

The UCLASS program is widely considered a representative component of DoD's oft-touted Third Offset Strategy. Then Secretary of Defense Hagel's comments in 2014 that "Our long-term security will depend on whether we can address today's crises while also planning and preparing for tomorrow's threats" could have been made by President Eisenhower in 1953 when he initiated the New Look that focused on nuclear weapons as America's competitive advantage vis-à-vis the Soviet Union. Hagel continued that security under resource constraints "requires making disciplined choices and meeting all our nation's challenges with long-term vision."[15] The Eisenhower administration did exactly that in making the acquisition choices leading to the development of the nuclear triad. The Atlas intercontinental ballistic missile (ICBM) program became operational in 1959 after having been given the highest national priority in 1954.[16] The B-52 entered service in 1955,[17] and the Polaris submarine-launched ballistic missile (SLBM) followed in 1960 after only four years of development.[18] These technological advances and the strategic shift of Eisenhower's New Look would later be branded as the First Offset. The First

Offset is best characterized as requirements pulling technology development. In other words, the focused development and acquisition of major programs that built the nuclear triad began *after* the New Look strategy of nuclear deterrence was adopted.

In contrast, the Second Offset was more technology push than requirements pull. The Second Offset is used to describe the combination of stealth and precision that was developed in the 1970s and fielded in the 1980s. DARPA's Have Blue program, launched in 1974, would lead to the development of the F-117 Stealth Fighter (IOC 1983) and Tacit Blue, started in 1978, would lead to the B-2 Stealth Bomber (IOC 1997).[19,20] The precision-guided PAVEWAY II & III laser-guided bomb (LGB) systems begun development in the mid-70s, but the real *coup de grâce* for precision was the Global Positioning System (GPS) which had launched its first four test satellites by 1978.[21] Unlike the weapons systems that supported Eisenhower's New Look, the stealth and precision technologies of the 1970s emerged independently and only after they were proven did they become part of a coherent strategy under the Reagan administration to counter the Soviet's in Europe who by this point enjoyed parity in nuclear deterrence and a marked numerical advantage in conventional arms.

It is noteworthy and currently relevant that both of the first two strategic offsets occurred during periods of budget austerity as part of post-war budget reductions. After more than a decade of flush spending due to the wars in Afghanistan and Iraq, the Department of Defense is again facing budget reductions on the order of those in the post-Korean and post-Vietnam eras (Figure 1). As then Secretary of Defense Chuck Hagel observed, these reductions take place in the context of "countries like Russia and China… heavily investing in military modernization programs to blunt our military's technological edge, fielding advanced aircraft, submarines, and both longer range and more accurate missiles."[22] This motivates DoD's search for a Third Offset to increase "the competitive advantage of our American forces and our allies over the coming decades."[23] As such, the DoD is looking to technological advances in "robotics, autonomous operating guidance and control systems, visualization, biotechnology, miniaturization, advanced computing and big data, and additive manufacturing" to create a "technological overmatch against potential adversaries whenever or wherever we encounter them."[24]

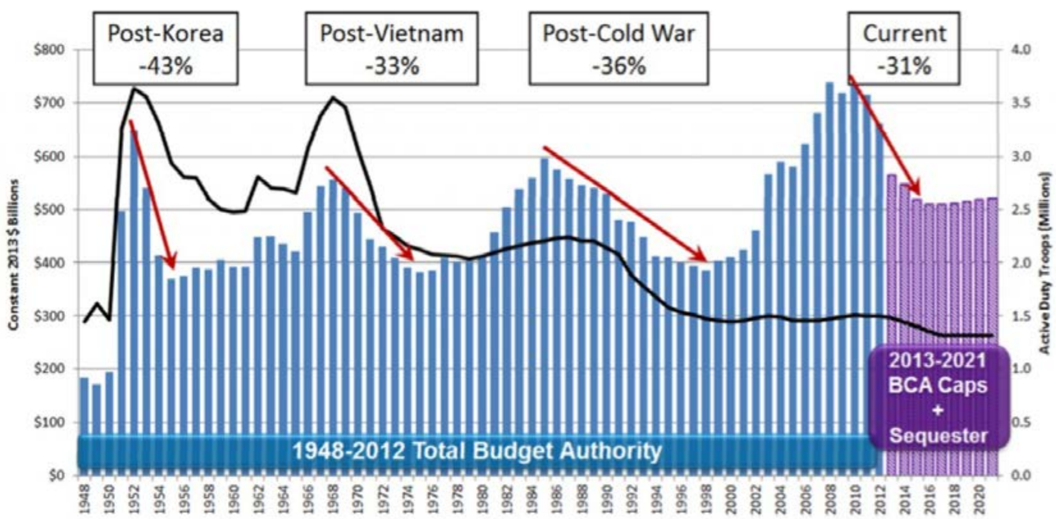

Figure 1. Historic post-war Defense Budget reductions.[25]

Former Undersecretary of the Navy Robert Martinage argues that "a new Offset Strategy must take account of America's fiscal circumstances but, at its core, it must address the most pressing military challenge that we face: maintaining our ability to project power globally to deter potential adversaries and reassure allies and friends despite the emergence of A2/AD threats."[26] This underscores the primary motivation behind the UCLASS system: a next-generation system designed to deliver a needed capability against an emerging a threat by a fiscally affordable means. In a white paper arguing for a new offset strategy, Martinage explains the potential for reduced life-cycle costs promised by UCLASS:

> Significantly reduced life-cycle costs are possible with unmanned systems by obviating the need to procure large numbers of platforms for a training "pipeline," as well as reduced operations and maintenance costs associated with training and maintaining combat readiness in peacetime and personnel savings…. With N-UCAS,[27] there would

> be no need to train pilots, so the Navy would only need to buy the number required to equip the maximum number of deployable carriers (typically 2-3 carriers are deployed on a steady-state basis and another 2-3 carriers can be "surged" in a crisis), and they would generally fly these aircraft only when deployed. As a result, compared to manned aircraft, the Navy could buy about half as many carrier-based UAS and fly them less than half as often, potentially generating billions of dollars in saving in procurement as well as operations and support.[28]

The UCLASS system was thus proposed as part of a deliberate strategy built around a requirement to project power in contested and denied airspace and in the context of expectations for continued constraints on future defense spending. In this sense, the Third Offset is reminiscent of the First: requirements preceded and defined the development of the major weapons programs which were deemed a more affordable force structure for countering expected threats. But in terms of technology maturity and readiness, the UAS systems of the Third Offset more closely resemble the Second Offset. As we shall see, the similarity between the Second and Third Offsets are stronger given the service's initial reluctance to embrace the innovation.

Technology Demonstrators: The Origins of UCLASS

The seeds of UCLASS are traced back to a flurry of UAV technology demonstration programs at the turn of the century. The 2000 and 2002 DoD UAV Roadmaps identified more than 20 UAV programs then in development and promised "profound opportunities to transform the manner in which this country conducts a wide array of military and military support operations."[29] DARPA and the Air Force began development of the Boeing X-45 as part of the Unmanned Combat Air Vehicle (UCAV) program in 1999. Soon thereafter, DARPA launched the UCAV-N program with the Navy which led to the demonstration of carrier-capable technology in the Boeing X-46 and Northrup-Grumman X-47A. These UCAV-N aircraft had their respective first flights in May 2002 and Feb 2003. In June 2003, the Undersecretary of Defense for Acquisition Technology and Logistics (USD AT&L) directed DARPA to merge the

UCAV and UCAV-N programs.[30] The consolidated Joint Unmanned Combat Air Systems (J-UCAS) technology demonstration program was a "joint DARPA-Air Force-Navy effort to demonstrate the technical feasibility, military utility and operational value of a networked system of high performance, weaponized unmanned air vehicles to effectively and affordably prosecute 21st century combat missions."[31]

Compared to the original UCAV timeline, the J-UCAS program timeline delayed the start of system development in order to provide more time to mature the technology, but innovation was still at the heart of the program with several new requirements and enhanced capabilities.[32] But almost from the beginning, J-UCAS met headwinds. Funding for J-UCAS was cut by more than $1 billion in early 2004 and leadership was transitioned to the Air Force with "Navy participation." The Department of Defense "restructured" the J-UCAS program again in the 2006 Quadrennial Defense Review (QDR).[33] The Air Force decided to shift focus to pursue an unmanned, penetrating, long-range bomber to modernize its bomber force. (The contract for the B-21, née Next-Gen Bomber before designation as the Long Range Strike Bomber (LRS-B), was finally awarded in October 2015.[34])

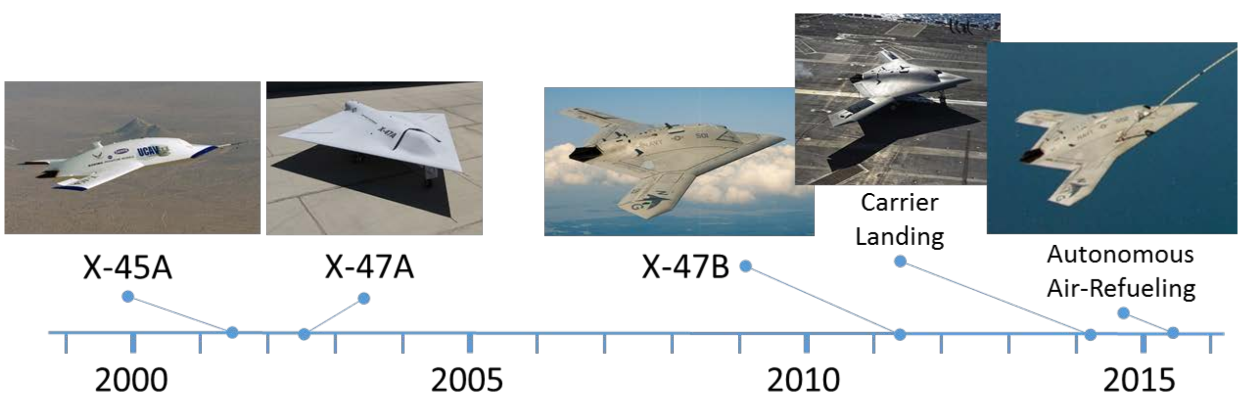

Figure 2. Demonstration systems contributing to the development of the UCLASS system concept. Beginning with the DARPA UCAV X-45A, the Air Force and Navy were partnered for a short period under J-UCAS. The Navy took up the reigns under N-UCAS which led to the development UCAV-D X-47B that served it well through an impressive series of demonstrations that included carrier take-off and landing and autonomous aerial refueling.

On the Navy side, J-UCAS became N-UCAS and the Navy was directed to develop an "unmanned longer-range carrier-based aircraft capable of being air-refueled to provide greater standoff capability, to expand payload and launch options, and to increase naval reach and persistence."[35] In 2007, the Navy awarded the Unmanned Combat Air System Demonstration (UCAS-D) contract to Northrup Grumman for development of the X-47B which first flew in 2011 and made the first carrier-based arrested landing in July 2013.[36]

On the basis of more than a decade of technology development (see Figure 1) and the experience gained from the UCAS-D program, the Navy was ready to begin formal acquisition of a carrier-based unmanned aircraft system in 2011. The Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) system was born with great promise for innovation. But soon thereafter, turmoil and debate over the UCLASS requirements plagued the pre-acquisition phase of the program.

To Strike or Not to Strike: The UCLASS Requirements Maelstrom

The Navy's original 2011 UCLASS request for information (RFI) conceived UCLASS as an unmanned vehicle designed "to address a capability gap in sea-based surveillance and to enhance the Navy's ability to operate in highly contested environments defended by measures such as integrated air defenses or anti-ship missiles."[37] This initial vision was consistent with the 2006 and 2010 QDRs that both called for developing power projection capability in A2/AD environments. The Joint Requirements Oversight Council (JROC) approved the Navy's Initial Capabilities Document (ICD) in June 2011 which included penetration of A2/AD airspace and a robust strike capability, but disagreement over the initial capabilities started shortly thereafter. The Navy, concerned about the price tag accompanying the capabilities in the ICD, developed an acquisition strategy with a reduced initial capability for UCLASS that could be improved later. Among the reported Key Performance Parameters (KPP) for the program was a cost cap on the resulting system of $150 million per 24-hour orbit developed within a constrained 2013-2017 budget of $2.3 billion.[38] There was likely significant concern over the degree to which the program could meet the objectives of endurance, payload capacity, stealth, and aerial refueling in an autonomous, carrier-compatible configuration within these constraints. Back of the envelope estimates for a pair of platforms derived from the UCAV-D configuration that would be needed to cover a 24-hour orbit would cap the cost at $75 million apiece. They would have the signature performance characteristics similar to current 5th-generation manned platforms costing substantially more[39] and benefit from other development efforts in excess of several hundred billion dollars.[40]

The Navy sought and received approval from the JROC for the diluted requirements in a 2012 memorandum that approved the Navy's desire to reduce strike capacity from approximately 6000 pounds to 1000 pounds of payload and only operate in permissive airspace (vice penetrating A2/AD airspace).[41] The Navy had some, though not universal, support in OSD. The ISR Director in the office of USD (AT&L) defended the JROC decision to reduce initial capability on the basis of fiscal constraints: "we can't afford to start programs that we can't finish."[42]

Congress disagreed. In his opening remarks at a hearing of the House Armed Services Committee (HASC) Subcommittee on Seapower and Projection, Chairman Randy Forbes stated unequivocally that "I believe strongly that the Nation needs to procure a UCAV platform that can operate as a long-range surveillance and strike asset in the contested and denied A2/AD environments of the future." [43] Congressman Forbes continued, "this committee has concluded the UCLASS air system segment requirements will not address the emerging anti-access/area-denial challenges to U.S. power projection that originally motivated creation of the Navy Unmanned Combat Air System program."[44] Senator John McCain, Chairman of the Senate Armed Services Committee (SASC), is of the same mind. In an open letter to Secretary of Defense Ashton Carter, Senator McCain expressed his concern over the Navy's "strategically misguided" approach and that the Navy's UCLASS requirement "would result in an aircraft design with serious deficiencies in both long-term survivability and internal weapons payload capacity."[45]

Several prominent strategists and national security experts agree with McCain and Forbes. Robert Martinage, a former Undersecretary of the Navy and now a Senior Fellow at the Center for Strategic and Budgetary Assessments (CSBA), testified that "UCLASS should be the next step in the evolution of the carrier air wing and must be able to provide sea-based surveillance and strike capacity in anticipated anti-access and area-denial environments."[46] Martinage went even further arguing that "a truly capable UCLASS" is essential to maintaining the strategic relevance of the aircraft carrier for decades. Shawn Brimley from the Center for a New American Security expressed his concern that Navy's UCLASS "program does not fully exploit the opportunity the Navy has… to lock in what could be a decisive advantage in future warfare, the ability to employ long-range, stealthy, unmanned strike platforms from the aircraft carrier."[47] Another defense strategist and retired naval officer, Bryan McGrath, argued that "If the air wing of the future does not evolve in a way that enables the kind of unmanned strike that a truly capable UCLASS would bring, the aircraft carrier might indeed become obsolescent."[48]

For its part, the Navy does not disagree outright, but thinks it can initially field a less-capable UCLASS and then upgrade it to a more capable UCLASS system over time. Secretary of the Navy Ray Mabus claims that "the [UCLASS] end state is an autonomous aircraft capable of precision strike in a contested environment, and it is expected to grow and expand its missions."[49] Several experts dispute this, arguing that achieving affordability and endurance by trading off stealth, payload, and survivability results in design changes that cannot be altered later. For example, the Navy set a threshold requirement (key performance parameter) for UCLASS unrefueled endurance of at least 14 hours in order to bridge the canonical 12-hour deck day on the carrier. In the view of Martinage, "Meeting the threshold requirement of 14 hours of unrefueled endurance necessarily results in sacrificing survivability, weapons carriage/flexibility and the number of weapons you can carry, and growth margins for future mission payloads."[50]

The draft UCLASS capability development document (CDD) with the reduced capability was signed in April 2013 by the Chief of Naval Operations (CNO) and the Navy's acquisition strategy was approved in June 2013.[51] The Navy released a formal draft of the RFP a year later in April 2014. Though classified, the Chief of Naval Research explained the draft RFP required operations in an *uncontested* environment without precluding the option to grow capability to achieve operations in contested airspace.[52] Four companies received the draft RFP and were expected to offer competing UCLASS designs: Boeing, General Atomics, Lockheed Martin and Northrop Grumman.[53] Release of the final RFP was repeatedly delayed from the summer of 2014, to the spring of 2015, to the fall of 2015, and finally early 2016. The delays were explained in the context of ongoing ISR portfolio reviews, but were more likely intended to solidify Congressional support behind the Navy's less-capable UCLASS design. The support in Congress never materialized.

Congress exerted its influence over the process and attempted to force its UCLASS vision in the only way that it could, through authorizations and appropriations. As discussed above, the Navy had successfully used the Joint Capabilities Integration and Development System (JCIDS) process to gain approval for a reduced ICD and had developed a spiral acquisition strategy in an attempt to placate Congress, but Congress continued to press the Navy for a more capable platform. The 2016 National Defense Authorization Act (NDAA) more than doubled the Navy's budget request for UCLASS and gave the Navy strict direction to "develop penetrating, air-refuelable, UCLASS air vehicles capable of performing a broad range of missions in a non-permissive environment."[54] Additionally, Congress continued to authorize funding for the Navy's X-47B UCAS-D program--funding the Navy explicitly did not want--as a means of continuing R&D for a penetrating UCLASS system.[55]

The Office of the Secretary of Defense (OSD) finally settled matters in February 2016 with the President's 2017 budget submission which zeroed out funding for UCLASS replacing it with a Carrier Based Aerial Refueling System (CBARS). UCLASS appeared to be dead. The penetrating combat system that was originally conceived to provide deep strike capability in A2/AD airspace, but was subsequently reduced to a surveillance and light strike mission in uncontested airspace, was now going to become an unmanned tanker.

Transformed to a Tanker: UCLASS becomes CBARS

The long steady degradation of the Navy's next-generation combat vehicle became final in OSD's FY2017 budget submission: the Carrier Based Aerial Refueling System (CBARS) became the newest incarnation of the UCLASS system. Along with the demise of UCLASS went any hope of real innovation in the manner by which the Navy conducts power projection. It is perhaps telling that the change from UCLASS to CBARS was made in conjunction with the Navy's plan to buy additional F-18E/F Super Hornets and an accelerated purchase of F-35 Joint

Strike Fighters (JSF).[56] That is, when choosing between innovation and traditional mission sets, *i.e*. strikes by manned fighters, the Navy chose to continued existing missions rather than seek innovation. It is also noteworthy that OSD's acquiescence to the Navy's steady erosion of UCLASS requirements takes place in the context of the final months of the current administration. Some have speculated that this is may be the best deal that those who wish to innovate the Navy with unmanned systems could get before their tenure in OSD is over when the current administration leaves office.[57]

Mind the Gaps: Technology Maturity and the Valley of Death

The failure for a truly innovative, fully-capable unmanned combat system to emerge in the form of UCLASS as part of the Third Offset is surprising at the outset. All three corners of the military-industrial iron triangle—Congress, services, and industry—were aligned behind UCLASS when it was first conceived in 2011. Additionally, the requirements were square: the original JROC memorandum and ICD endorsed the warfighter requirement for an innovative approach to operating in A2/AD airspace. Support for UCLASS from both the Senate and House Armed Services Committees was unequivocal. Industry was excited with four potential prime contractors eager to bid for the lucrative UCLASS contract. With fair winds and smooth seas, how did an innovative UCLASS system designed for the emerging A2/AD environment get turned into a non-stealthy tanker whose only real function is to support traditional missions?

Explanations for the failure of innovation to be adopted by organizations or enterprises generally fall into three categories:

1. **The technology/innovation does not work**
   (the "technology gap"; the technology is not ready, does not satisfy a genuine need, or it arrives too late)

2. **Lack of transition path**
   (the acquisition "valley of death"; lack of process for implementing the innovation; no transition plan from technology development to operational employment)
3. **The deep gravity of the *status quo***
   (the "gap of vision" to bridge the natural resistance to change; lack of key stakeholders or the failure to communicate the reason for change; disagreement that a particular innovation is desired/needed; self-interest in preserving the status quo)

The first gap is the gap of requirement or the gap of technology readiness. The innovation offered by a fully-capable UCLASS satisfies a genuine capability gap by fulfilling the challenge of the aircraft carrier to project power in A2/AD environments. Additionally, after more than fifteen years of concept study and technology development, plus more than $1 billion in direct UCAS-D R&D investment through FY 2016, the technology needed for UCLASS was proven and mature. Thus, neither technology readiness nor requirements explains the failure of UCLASS to flourish.

The second gap is the infamous "valley of death" metaphor between the S&T or R&D phases of a program and its formal acquisition. The valley of death is where promising new technologies die from lack of funding, sponsorship, warfighter commitment, or other forms of bureaucratic neglect. Scores of studies and papers offer recommendations on bridging the valley.[58] Most recommendations for DoD include early engagement of the requirements community (through the JCIDS process) and the planning community (through the POM process). Initially, UCLASS made all the right moves to build a bridge over the valley of death from the UCAS-D demonstration program to an operational UCLASS system. The R&D funding for UCAS-D that continued throughout development of the UCLASS RFP established an abutment on the left-hand side of the S&T/R&D bridge. The JROC approval of the 2011 UCLASS ICD clearly defined the right-hand bridge abutment. Congress's unequivocal and unwavering support for UCLASS provided assurance that resources for building the bridge were available. Thus, we may eliminate neglect in the valley of death as a causal factor in the failure for an innovative UCLASS system to emerge.

Eliminating the first two explanations for the lost opportunity of an innovative UCLASS leaves the third: bureaucratic resistance. As Congressman Forbes observed in his remarks that opened the HASC hearing on UCLASS requirements:

> Like with the shift from cavalry to mechanized forces, sailing ships to steam-powered vessels, the battleship to naval aviation, or adopting unmanned aerial vehicles in the late 1990s, ideas that initiate difficult changes and disrupt current practices are often first opposed by organizations and bureaucracies that are inclined to preserve the status quo.[59]

Sadly then, UCLASS's failure is just the latest example in a long saga of failed military innovation.

<u>Failure to Innovate: Blame the Bureaucracy</u>

In his seminal and classic examination of bureaucracies, James Q Wilson argues that organizations readily accept innovations that support the *status quo*. "It is striking, however, how many technical inventions whose value seems self-evident to an outsider are resisted to varying degrees because their use changes operator tasks and managerial controls."[60] As an alternate option to outright resistance, innovations are sometimes misapplied to maintain existing mission sets without realizing their full potential for new ways of accomplishing missions. Wilson offers several examples:

> Many navies purchased airplanes before World War II bust most viewed them simply as an improved means of reconnaissance. Thus the first naval planes were launched by catapults from battleships in order to extend the vision of the battleship's captain. The organizational innovation occurred when aviation was recognized as a new form of naval warfare and the aircraft were massed on carriers deployed in fast-moving task forces.[61]

The parallel with the Navy's refusal to embrace the innovation offered by UCLASS is striking. Rather than accept a UCLASS system that would extend the operational reach of the carrier and permit combat operations in contested and denied airspace, the Navy has chosen CBARS, an unmanned system whose only real function is to refuel manned aircraft. Furthermore, the Super Hornet and JSF systems do not have the signature of the original UCLASS requirement to permit persistence in A2/AD airspace.

According to Wilson, "real innovations are those that alter core tasks."[62] He further argues, "The longer an agency exists the more likely that its core tasks will be defined in ways that minimize the costs to operators performing them, and thus in ways that maximize the costs of changing them."[63] One can see the parallels in the evolution of UCLASS into CBARS as the former threatened to disrupt or potentially displace manned strike platforms from their most coveted roles and the latter enhances their effectiveness further solidifying their status in the hierarchy. The alignment of the CBARS role with the *status quo* as a sustaining innovation follow's Wilson's argument and may benefit from reduced organizational resistance. One can only speculate as to whether this more benign introduction of unmanned capabilities into naval forces will be akin to the Camel's nose[64] that initiates the broader changes necessary to realize the disruptive potential of these systems.

There is little doubt that the enthusiasm that accompanied the original introduction of the UCAV concepts that extended the mission set for strike platforms beyond the initial successes seen by the armed Reaper drones in the late 1990's has been tempered as the services have proceeded further into the development. Figure 3 shows the anticipated rate of adoption of these technologies as envisioned in the Unmanned Aerial Systems Roadmap[65] published by the Secretary of Defense in 2005 that projected a rapid increase in sophistication of the supported missions from the remotely piloted vehicles through the semi-autonomous surveillance missions of Global Hawk to the multi-platform coordinated missions of the J-UCAS.

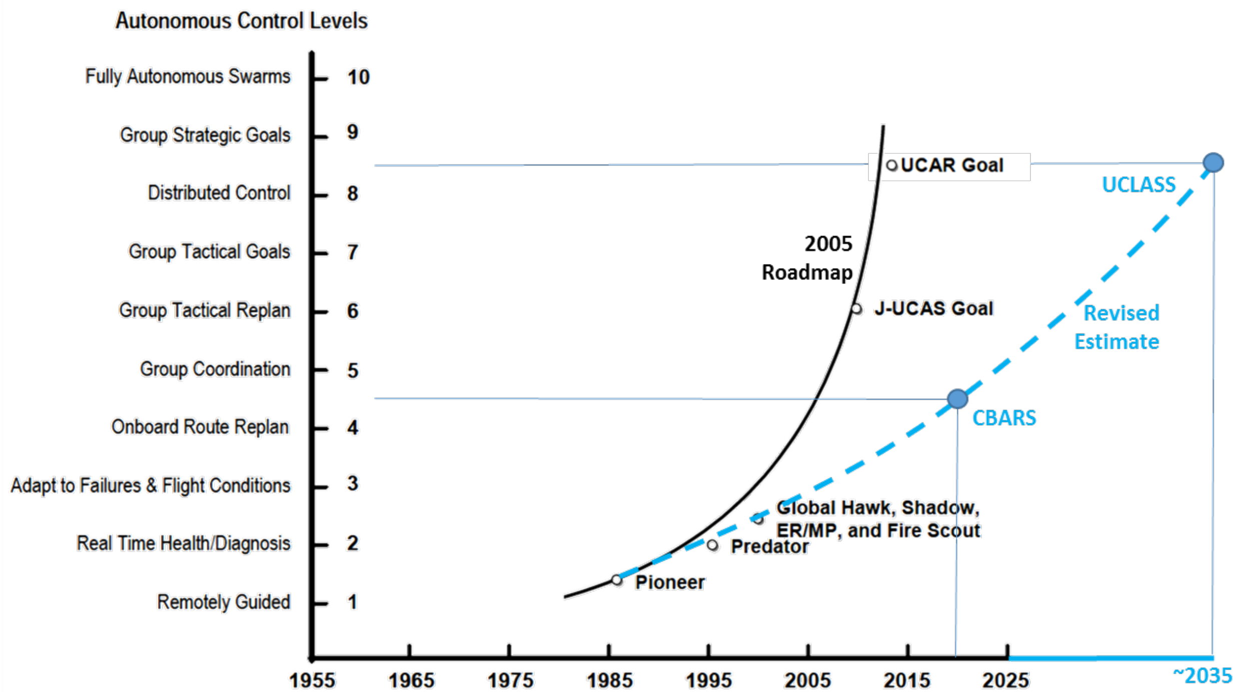

Figure 3. Unmanned Aerial System (UAS) developers had high hopes for the maturation and adoption of new unmanned capabilities in the 2005 Unmanned Systems Roadmap (solid black line) [66] *and anticipated it would follow the rapid growth in processing capability upon which early demonstrations depended. The 2013 Roadmap noted the harsh realities new efforts would face to competing with current priorities to be "appropriately integrated into Military Department programs of record (POR)"* [67] *in a time of declining budgets and a significant shift in focus to supporting missions in anti-access/area denial (A2/AD) areas. Revising the anticipated maturation date of UAS capabilities (blue line) to align with the somewhat less ambitious goals of CBARS, one can project the more demanding objectives of UCLASS may lay within reach of the coming next two decades. The rate of maturation may benefit from any number of accelerants including breakthroughs in processing technology, overcoming the hurdles of regulation and public acceptance of autonomous systems, especially in the ground vehicle domain.*

A decade later, the accompanying narrative of the 2013 UAS Roadmap made clear the positive influences of constrained budgets and the normative restraints of the JCIDS process in which emerging unmanned systems would have to compete in order to transition into Programs of Record (POR). Although the anticipated rate of adoption projected in 2005 did not come to pass, the degree of progress realized in the interim has been impressive nonetheless. Significant hurdles have been cleared supporting their employment in complex naval environments including successful demonstration of autonomous carrier landings, aerial refueling, and the resolution of a host of command, control, and safety issues.[68] A potential revision to this UAS Roadmap is posited in Figure 3 that incorporates the CBARS concept in its current form and projects a more modest rate of growth leading to the fully autonomous strike capability originally envisioned in UCLASS. Future increases in performance will continue to benefit from advances in processing driven by gains in both hardware and software sophistication as well as benefits from complimentary commercial investments in autonomous systems control that are seeking broader acceptance in a wide range of applications.

Theories of Innovation

Describing how and when military forces adopt innovation is a long-honored academic pursuit that continues today. Adam Grisson, RAND Corporation, summarized four of the leading theories on sources of military innovation.[69] The first, owing to Barry Posen, holds that military innovation must be imposed by civilians because military leaders are wedded to existing doctrine. The second, offered by Stephen Rosen, holds that military innovation comes from within, but is slow since it relies on a generation of young officers with new ideas to assume leadership positions (intra-service competition). The third theory, from Owen Cote and Harvey Sapolsky, argues that inter-service competition is the primary force leading to military innovation. The final and most recent theory argues that military innovation must be considered within the context of organizational culture and how services react to opportunities. As will be discussed in regard to the UCLASS case, the first three theories rely upon conflicts between parties to drive disruptive change and the last argues the best way to incorporate sustaining innovation is to suppress these rivalries.[70]

Common to all four theories of innovation is the idea that it is a top-down process that has to be forced by leadership: "military organizations must be goaded into innovating."[71] Further, the first three of these theories also draw upon the conflict between key centers of power as the catalyst for change.[72] Congressman Randy Forbes would agree with this overriding imperative for external intervention: "I believe the Congress has a unique role to help push the Department and the services in directions that, while challenging, will ultimately benefit our national security and defense policy."[73] Forbes clearly claims a responsibility "in cultivating, supporting, and protecting military innovation" in the context of UCLASS. [74] Similarly, Secretary of Defense Hagel argued that "the demand for innovation must be Department-wide and come from the top."[75]

Criteria for Innovation

The criterion outlined by Grissom begins with a determination as to whether the innovation changes the manner in which the military functions in the field. The current missions under consideration for UCLASS that employ the system for surveillance, strike and, more recently, in the role as an aerial refueler, are all capabilities that replicate or augment well-defined manned systems capabilities in the field today. The potential flexibility to employ the unmanned systems in threat environments that would be considered unacceptable to manned systems will, however, allow the Navy to dramatically alter both manned and unmanned mission profiles. These could include extending the ranges and persistence of manned systems, pushing the boundaries of threat defense systems with unmanned platforms, and the consideration of one-way or sacrificial penetrations deep into the adversary's territory to yield critical intelligence or elicit responses for subsequent waves of attack to name but a few. These would certainly qualify as a change in the manner by which the military functions in the field. The calculus of options will be determined in large measure by the cost and availability of the unmanned systems as they are weighed against that of threat. The experiences gained in the employment of cruise missiles for missions outside the “simple” precision delivery of ordnance will provide guidance here along with those being drawn from employment of other unmanned, though unarmed, naval air systems such as the MQ-8B Firescout in less contested environments.

The second criteria for consideration as a military innovation is that it is of significant scope and impact. The initial concepts for UCLASS employment would have easily met this criteria, but the impact associated with their use in an aerial refueling role will depend upon the degree to which the systems are embraced and used to change the roles of the platforms they support. Thinking along these lines was reflected in the recent comments of Rear Admiral Michael Manazi, Director, Air Warfare, who posited multi-platform teams under the control of a JSF would extend their role into Fusion Warfare and described a potential instantiation as:

> “The unmanned system coming off the carrier, in the instantiation that I think about, is three (drone) wingmen and an F-35. A single pilot. Combat spread now is 25 miles apart in Fifth Generation tactics. Imagine a single aviator owning a 100-mile front of air dominance or air superiority—because that pilot is talking to the extended unmanned systems.” [76]

The nod to JSF’s air dominance role that would extend its reach is particularly intriguing as nearly all previous commentary on the offensive capabilities had been restricted to strike missions such as air-to-ground Suppression of Enemy Air Defenses (SEAD). The surveillance role of the CBARS may prove to have significant impact under more independent conditions where the threats lie within range of its sensors and how well the data feeds are integrated into the larger network. Longer term, the largest impacts will not be realized until some form of strike capability is included as presaged by the Admiral’s comments. These impacts will be not unlike that seen by the USAF with the advent of the armed Predator and Reaper Remotely Piloted Aircraft (RPA) systems. The Navy stands to benefit from both the tangible aspects of understanding how to employ these systems in combat as well as the intangible gains in resolving the thorny political and ethical issues associated with their employment. Ultimately, the Navy systems will need to be produced in sufficient numbers to create the impact and benefits envisioned with their development and these may only be realized after this initial generation of systems makes their way into the force.

The final criteria for consideration is the degree to which the new capability equates with greater military effectiveness. Taken in the broader context of the increased effectiveness of the carrier battle group, this is where the integration of a new class of air combat systems that have the greatest potential to increase military effectiveness. As envisioned by its Congressional and naval supporters, the UCLASS systems have the potential to extend the reach of US forces into hostile air environments and counter the adversary's ability to effectively deny access to routes of navigation or project power around the globe. Even in the somewhat diminished role of the CBARS configuration, the advantages of removing the support systems required for manned operation from an aircraft design have the potential to significantly affect the available mass for the carrying fuel and mission systems. These advantages translate directly into extending the range and/or persistence of the manned-strike platforms that they service. The development and implementation of new tactics that take advantage of this range-extending capability for manned or even other unmanned platforms will require time and effort to realize, and, as noted by Congressman Forbes,[77] it will at least introduce unmanned, fixed-wing operations in the carrier community. With this introduction comes the potential to normalize UAS operations over the coming years. As will be discussed later, this gradual introduction of a new capability has the potential to create a more disruptive impact and may be a reasonable approach to overcoming some of the barriers to adoption of innovation by the service.

Contest of Wills

The struggle between Congress and the Navy aligns precisely with Posen's Civil-Military model of military innovation. The debate over how to respond to an external threat to the international balance of power occurs at a time when the threat to security is perceived as high.[78] The external threat of China as a near-peer competitor in Asia and the Pacific portends challenges to open access to trade routes and communication in this part of the world and potentially upsets the balance of power in the region. Although the level of near-term threat posed by China's actions in the Pacific may be perceived by the public as low compared to that of the daily news of terrorist events around the globe, Congressional members appreciate both the scope of the military transformation necessary to meet this threat and the changes necessary for the Services to embrace the advantages of unmanned air combat systems in this domain. The successful development and demonstration of capabilities with the objective range, stealth, and lethality promised by a fully-capable UCLASS would serve as a significant deterrent to Chinese ambitions in the Pacific theater.

Posen's theory notes that in order to achieve the greatest degree of success in adopting such disruptive forms of innovation that it needs to be supported by 'mavericks:' uniformed officers within the service that are willing to champion these new capabilities and bring about the transformation.[79] To date, in the case of UCLASS, it does not appear that these mavericks have risen to the level of influence necessary to sustain this next-generation capability for the aircraft carrier. UCLASS's disappearance from DoD's 2017 budget request after some $818 million in funding during 2015-16 underscores the absence of high-level support within the Navy. (The much more modest CBARS development effort starts with $89 million in 2017.[80]) The GAO-reported budget profile in Figure 4 shows total sums to approximate value anticipated in 2011, but with substantially revised technical objectives associated with the tanker mission.[81]

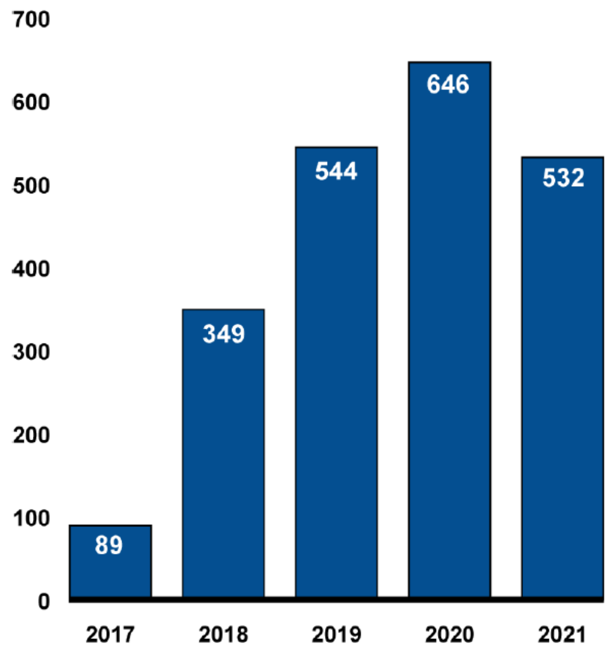

Figure 4. CBARS budget profile submitted in DoD's 2017 budget request as noted in GAO Report 16-389R. This profile largely reflects the plans dating back to 2011 but with much revised technical objectives.

Details remain forthcoming, but recent reporting points to a non-stealthy configuration that leverages the technical advancements in aircraft control developed under UCLASS and an iterative airframe development approach[82] that pushes the completion date past 2020 (see Figure 4). Longer term, supporting strike functions could be incorporated, but the hard choices to retain manned systems as centerpiece of airpower concepts were made back in 2006. 2006 was a critical year for the Joint Strike Fighter and the decision was made to "pour hundreds of billions of dollars into a complex, decades-long effort to build thousands of stealthy F-35 Joint Strike Fighters to replace most of the Cold-War vintage warplanes then in service for the Air Force, Navy, and Marine Corps."[83] This context provides insight to the departure from the innovation pathway envisioned in the 2005 UAS Roadmap in Figure 3 as the underlying assumptions were that the scale of investment for UAS would be comparable to those made JSF. Maturing the technologies and winning support of the manned-fighter community through a slower, more deliberate development may eventually create a stronger case for unmanned system, and thus more support within the service. In an interview with Congressman Forbes shortly after the announcement that CBARS would replace UCLASS, Forbes appeared to acquiesce commenting that "current cost constraints preclude [us] from making the investments for now."[84] The Navy ultimately proved to be the dominant apex in the iron triangle fight over UCLASS.

Posen notes in his theories of innovation the need for internal support within the affected services to achieve success in transition.[85] Grissom discusses the lack of documented studies that bring this aspect of innovation into clear focus. These may indicate the importance of 'bottoms-up' innovation as a counterbalance to the dominant theories of 'top-down' approaches.[86] More recent efforts by Tom Pierce[87] to fill this void have provided the observation that the style of this internal support can have a significant impact on their success as well. In particular, distinguishing between the types of innovation and the complimentary style of internal support were central to the success in the naval innovation case studies presented. Innovations were categorized as either sustaining or disruptive, the former occurring in well-established military roles and the latter placing the organization on *a new performance trajectory*.[88] Misaligning the type of innovation with the wrong style of internal leadership was cited as equally important as recognizing the type of external forces of innovation at work. The transformation of UCLASS from a classic top-down, civil-military, disruptive innovation approach to CBARS, which may turn out to have better internal, bottoms-up support. By making carrier-based refueling more efficient and returning F-18's used for this purpose to their normal strike missions, CBARs has the potential to achieve success where UCLASS did not. Revisiting the CBARS development from this perspective in a few years will be an interesting exercise for innovation theorists going forward.

Intraservice Rivalry Muted

Intraservice competitive theories of innovation as proposed by Steve Rosen do not appear to be applicable to the UCLASS/CBARS saga except for similarities in the potential cultural conflict between manned and unmanned flight systems. Each of the armed services have faced this deeper cultural issue when wrestling with the integration of robotic systems into air, ground, surface and even subsurface communities. As of yet, the Navy has not attempted to spur this type of competition internally by creating independent organizations that would focus on unmanned air systems and placing them in competitive positions with manned platforms. The current approach of focusing CBARS on a mission set that compliments and extends the capability of the current and emerging set of manned fighter capabilities on the carrier was proffered by the Navy as far back as 2013 when the Rear Admiral Manazir commented in his vision of the UCLASS and a Tomcat-sized, 70,000- to 80,000-lb platform that could give gas to "extend the range of the tactical fighter fleet—particularly the Lockheed Martin F35C Joint Strike Fighter."[89] Thus, if anything, intraservice rivalry regarding UCLASS has been minimized as the Navy plans to integrate the advantages of unmanned systems by shifting the less glamorous roles to them.

USAF Avoided the Fight

The third top-down means of driving innovation depends on interservice competition. Owen Cote has made clear cases for large-scale change being driven by the potential access to new missions and their associated fiscal support and dominance between the services. Early in the armed UAS history, forced marriages of J-UCAS sought to temper some of these conflicts, but the USAF abandoned this approach early to focus resources on the effort that eventually became Long-Range Strike Bomber (LRS-B).[90] If anything, the USAF sought to let the Navy take on the responsibility and expense of maturing the technology and, since the Navy was in the midst of a self-identity crisis on the relevance of the carrier in the face of emerging A2/AD threats, they likely had more motivation to take up the charge. The USAF retained its position of supporting the strategic long-range strike mission while providing an opening to future reinvestment and harvesting a more mature technology base through a reference in the fiscal year 2016 budget request for LRS-B that included the potential for it to be *optionally-manned.*[91] There remains the potential for legitimate interservice rivalry over the unmanned combat mission to emerge and help drive the innovation and adoption of the fully-capable UAS technology.

<u>Which Service Culture is better Aligned with UCLASS?</u>

Cultural aspects within the services have a significant impact on the viability of changes imposed through technological innovation and a host of theorists have outlined the discussion of how internal forces shape these changes. Theo Farrell argues that "culture sets the context for military innovation, fundamentally shaping organizations' reactions to technological and strategic opportunities"[92] and suggests that the change can be imposed either by strong senior leaders in the service who shape culture, by external shocks, or even by international competition to keep up with allies or adversaries.[93] James Hasik cites a particularly apt example for the adoption of new methods of air power as seen through the lens of the USAF and Navy cultures:

> Consider how the US Air Force's acceptance of armed drones took much longer than the US Navy's embrace of cruise missiles. The surface admirals wanted an offensive

> weapon, but the fighter generals were not interested in flying missions from a cubicle. Serious adoption took direction from Defense Secretary Gates and his appointment of Norton Schwartz, a transport pilot, as chief of staff.[94]

Finally, Elizabeth Kier *rejects external security threats as the prime driver of innovation*[95] and argues that the cultural frame of the organization and even the countries involved shape their ability to incorporate new ways of fighting, as in the historic example of the failure of British and French forces to foresee and prepare to face the new German *Blitzkrieg* developed during the interwar period.[96] The cultural influences of the Navy may be well-suited to incorporating the UCLASS/CBARS system into their way of fighting, especially since it offers a reasonably-clear path to cutting their dependence on land-based refueling systems and meshes well with their *independence of spirit that leads the service to favor standalone capabilities*.[97] This capability grows in importance with the push to support more complex engagements in distant arenas associated with the A2/AD environment of the Pacific. The Navy also stands to benefit from the millennial culture of young aviators who grew up as digital natives of the computer revolution and may overtime develop alternate employment methods for the proposed unmanned systems as they are integrated into the carrier air wing. This younger generation of naval officers may be more sympathetic to the potential gains that can be harvested from advanced technologies than their seniors. This organic, bottom-up source of innovation will need some nourishment from above if it is to make real progress beyond the initial CBARS demonstrations.

Competing cultural influences, at least within the USAF, may also serve to dampen enthusiasm within the officer corps for more rapid adoption as the composition of the airmen engaged in the operation of RPA's changes to include those from the enlisted ranks. Driven by the demands of growing mission sets and limits to available cadre, the Air Force is embarking on this cultural shift.[98] Although this aligns the Air Force with the Navy and Army who have longemployed warrant officers and enlisted in airborne combat roles, it represents a significant change for the USAF. The new policy is being focused initially on the ISR mission of the RQ-4, but "there are not limitations on enlisted members employing weapons" [99] potentially signaling their incorporation in the armed Predator and Reaper roles in the future. It is uncertain how this potential change in pilot status (and fighter pilot status in particular) will impact future adoption of UAS technologies by the Air Force. Longer term, the cultural imperative within the USAF to maintain its technical lead over other services as well as our adversaries will overcome these impediments to adoption of these new capabilities.

In summary, each of the theories of innovation provide insights into the ongoing struggle to incorporate the UCLASS capabilities into the Navy's force structure. Posen's Civil-Military model provides an accurate template through which to view the public debate between Congress and their Naval counterparts. Although actively engaged in the development, the Navy has been reluctant to adopt the technology as aggressively as Congress has advised to meet what they view as growing threats in future A2/AD environments. Intra- and interservice rivalry theories of innovation have only seen minor degrees of alignment with the Navy pushing UCLASS into the more limited tanker role and the USAF largely avoiding entanglement in the discussion. Cultural influences on the process of innovation, as explored by Farrell and Kier, have not seen much exposure in the public debate so far, but may have longer term and more profound effects on the degree of adoption within all the services. The Navy's UCLASS struggle is only the latest in a larger set of cultural challenges associated with unmanned combat systems being addressed by the services. Given the tepid approach the Navy is now taking with CBARS, the Secretary of Defense and Congress may find it necessary to purposefully instigate rivalry between or within the services to create a greater sense of urgency to incorporate these new technologies to support power projection in the A2/AD airspace.

<u>Tis better to have loved and lost…?</u>

Secretary of Defense Chuck Hagel clearly directed the DoD to the pursue innovation in a 2014 memo: "We are entering an era where American dominance in key warfighting domains is eroding, and we must find new and creative ways to sustain, and in some areas expand, our advantages even as we deal with more limited resources. This will require a focus on new capabilities and becoming more efficient in their development and fielding."[100] UCLASS could have been the crown jewel in the development of next-generation naval combat capability and the first component of DoD's Third Offset. The UCAS technology development program that preceded UCLASS was well-funded and the required technology was proven ready for engineering and manufacturing development. At initiation of the UCLASS program, all corners of the iron triangle, to include the Navy, were firmly behind a fully-capable UCLASS that stood to transform the Navy's power projection from manned to unmanned systems in A2/AD airspace.

From such a promising start at innovation, UCLASS ran into resistance in the Navy that offers proof for an oft-cited claim that bureaucracies resist innovation that threaten the *status quo*. Over the course of five years, the Navy systematically eroded the requirements for UCLASS until they finally succeeded in converting the next-generation unmanned combat system into a tanker that supports traditional manned missions. Without an advocate from within the Navy leadership to champion transformation, further attempts at innovation will likely suffer the same fate as UCLASS. It seems clear through history that, due to bureaucratic inertia, the services will not deliver innovation without vision and leadership. Even in the midst of calls for a Third Offset strategy and generous support from Congress, the Navy suppressed the best promise for innovation in this generation. Inspiring and visionary leadership as well as the adoption of the innovative longbow were essential for Henry V's conquest of Northern France and his victory at Agincourt. Similarly, strong, visionary leadership is necessary if the Navy is going to adopt technologies that are essential for the next-generation of naval power projection. We might well ask: wherefore is our Prince Hal that will bring us innovation?

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