The Future of Naval Aviation

A CIMSEC Compendium

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Preface

By Matthew Hipple

Back in January of 2015, CAPT Jerry Hendrix (USN, Ret) and CDR Bryan McGrath (USN, Ret) had a stirring debate on the future of Aircraft Carriers. However, the debate quickly shifted from the carrier itself to the nature of the airwing it carried. Indeed, the carrier is nothing more than a host for the platforms provided by naval aviation – and only one of many ships that can carry aviation assets.

That discussion, driving into the world of the carrier air wing, was the inspiration for a CIMSEC Topic Week on the future of naval aviation. From the maritime patrol aircraft deployed from the reclaimed Chinese reefs in the South China Sea, to US Army Apaches operating from amphibious assault ships, to 3-D printed drones flown off a Royal Navy offshore patrol vessel, to manned and unmanned ideas for the carrier air wing - we sought ideas and observations on where global naval aviation will and can go next.

How will the littoral navies of the world change with new, lower-cost unmanned aviation assets? Are carriers armed with legions of long-range unmanned drones the future for global powers – will these technologies exponentially increase the importance of smaller carriers – or is unmanned technology a limited path that may be resisted (rightfully?) by pilots and their communities? Will surface fleets embrace the potential from easily produced drone swarms deployed from ships of the line...and should they? What is the future of land-based naval aviation? What innovations will be ignored, which will be embraced, and what will the air assets of future fleets around the world look like? What will the institutions, the leadership, and C2 structures that support all these assets of their varied nations look like?

The topic week's scope was purposefully broad to foment a variety of analyses. Read on to catch a glimpse of what the future may bring.

Matthew Hipple, President of CIMSEC, is a US Navy Surface Wafare Officer and graduate of Georgetown's School of Foreign Service.

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What's the Buzz: Ship-Based Unmanned Aviation & Its Influence on Littoral Navies

By Ben Ho Wan Beng

Introduction

"Unmanned aviation" has been a buzzword in the airpower community during recent years with the growing prevalence of unmanned systems to complement and in some cases replace peopled ones in key roles like intelligence, surveillance and reconnaissance (ISR). Insofar as unmanned aerial vehicles (UAVs) are increasingly used for strike, their dominant mission is still ISR because of the fledging state of pilotless technology. This is especially the case for sea-based drones, which are generally less capable than their brethren ashore. That said, several littoral navies have jumped on the shipborne UAV bandwagon owing to its relative utility and cost-effectiveness.[1] And with access to such platforms, how would these entities be affected during combat?

For littoral nations without an aerial maritime ISR capability in the form of maritime patrol aircraft (or only having a limited MPA capability), the sea-based drone can make up for this lacuna and improve battlespace/domain awareness. On the other hand, for littoral nations with a decent maritime ISR capability, the shipborne UAV can still play a valuable, albeit, complementary role. The naval drone also offers the prospect of coastal forces amassing more lethality as it refines the target-acquisition process, enabling its mother ship to attack the adversary more accurately.

The Littoral Combat Environment

Littoral operations are likely to be highly complex affairs. As esteemed naval commentator Geoffrey Till said: "The littoral is a congested place, full of neutral and allied shipping, oil-rigs, buoys, coastline clutter, islands, reefs and shallows, and complicated underwater profiles."[2] One key reason behind the labyrinthine nature of littoral warfare is that it involves clutter not only at sea, but also on land and in the air. Especially troublesome is the presence of numerous ships in the littorals. To illustrate, almost 78,000 ships transited the Malacca Strait, one of the world's busiest waterways, in 2013.[3]

Such a complex operating milieu would place a premium on the importance of battlespace awareness, which could make or break a

campaign. As fabled ancient Chinese military philosopher Sun Tzu asserted: "With advance information, costly mistakes can be avoided, destruction averted, and the way to lasting victory made clear." This statement was made over 2,000 years ago and is still as relevant today, especially when considered against the intricacies of littoral combat that hinder sensor usage. Indeed, shipborne radar performance during littoral operations can be significantly degraded by land clutter. For instance, the 1982 Falklands conflict manifested the problems sea-based sensors had in detecting and identifying low-flying aircraft with land clutter in the background.[4] Campaigning in congested coastal waters would also necessitate the detection and identification of hostile units in the midst of numerous other sea craft, which is by no means an easy task. All in all, the clutter common to littoral operations presents a confusing tactical picture to naval commanders, and the side with a better view of the situation – read greater battlespace awareness – would have a distinct edge over its adversary. Sea-based UAVs can provide multispectral disambiguation of threat contacts from commercial shipping by virtue of onboard sensor suites, yielding enhanced situational awareness to the warfare commander.

Improved Battlespace Awareness

Traditional manned maritime patrol aircraft (MPA) would be the platform of choice to perform maritime ISR that helps in raising battlespace awareness in a littoral campaign. However, not all coastal states own such assets, which can be relatively expensive,[5] or have enough of them to maintain persistent ISR over the battlespace, a condition critical to the outcome of a littoral operation. This is where the sea-based drone would come in handy. Unmanned aviation has a distinct advantage over its manned equivalent, as UAVs can stay airborne much longer than piloted aircraft. To illustrate, the ScanEagle naval drone, which is in service with littoral navies such as Singapore and Tunisia and is commonly used for ISR, can remain on station for some 28 hours.[6] In stark contrast, the corresponding figure for the P-3 Orion MPA is 14 hours.[7] The sensor capabilities of some of the naval drones currently in service make them credible aerial maritime ISR platforms. Indeed, they are equipped with sophisticated technologies such as electro-optical and infrared sensors, as well as synthetic aperture radar (SAR) systems.

To be sure, the shipborne UAV is incomparable to the MPA vis-à-vis most performance attributes, and the two platforms definitely cannot be used interchangeably. The utility of the naval drone lies in the fact that it can complement the MPA by taking over some of the latter's routine, less demanding surveillance duties. This would then free up the MPA to concentrate on other, more combat-intensive missions during a littoral campaign, such as attacking enemy ships. And for a littoral nation without MPAs, the shipborne UAV would be especially valuable as it can perform aerial ISR duties for a prolonged period.

The naval drone can contribute to information dominance in another way. In combat involving two littoral navies, the side with organic airpower tends to have better domain awareness over the other, ceteris paribus. However rudimentary it may be, the shipborne drone constitutes a form of organic sea-based airpower that extends the "eyes" of its mother platform. The curvature of the Earth limits the range of surface radars, but having an "eye in the sky" circumvents this and improves coverage significantly. Being able to "see" from altitude allows one to attain the naval equivalent of "high ground," that key advantage so prized by land-based forces. Indeed, the ScanEagle can operate at an altitude of almost 5,000 meters.[8] In the same vein, the Picador unmanned helicopter has a not inconsiderable service ceiling of over 3,600m.[9] In essence, the UAV allows its mother ship to detect threats that the latter

would generally be unable to using its own sensors.

All in all, shipborne drones enable littoral fleets to have a clearer tactical picture, translating into improved survivability by virtue of the greater cognizance of emerging threats that they offer to surface platforms. Having greater battlespace awareness also means that the naval force in question would be in a superior position to dish out punishment on its adversary.

Increased Lethality

Sea-based UAVs would enable a littoral navy to target the opposing side more accurately as they can carry out target acquisition, hence increasing their side's lethality. In this sense, the drone is reprising the role carried out by floatplanes deployed on battleships and cruisers in World War Two. During that conflict, these catapult-launched aircraft acted as spotters by directing fire for their mother ships during surface engagements. In more recent times, during Operation Desert Storm, Pioneer UAVs from the American battleship Wisconsin guided gunfire for their mother ship. Several current UAVs can fulfill this role. For instance, the Eagle Eye can be used as a guidance system for naval gunfire; ditto the Picador with its target-acquisition capabilities. There is also talk of drones carrying out over-the-horizon targeting so as to facilitate anti-ship missile strikes from the mother platforms.[10]

Though land-based UAVs are increasingly taking up strike missions, the same cannot be said for their sea-based counterparts as very few of the latter are even in service today in the first place due to their complexity and cost. The Fire Scout is one such armed naval UAV. This United States Navy rotorcraft can be armed with guided rockets and Hellfire air-to-surface missiles; however, with a unit cost of US$15-24 million,[11] it is not a low-end platform. All in all, unarmed shipborne drones are likely to be the order of the day for littoral navies, at least in the near term, and such platforms can only carry out what they have been doing all this while, tasks like ISR and target acquisition.

Conclusion

In summary, the sea-based drone can, to some extent, complement the maritime patrol aircraft in the aerial ISR portfolio at sea by helping to maintain the battlespace for awareness of the littoral navy during a conflict. The naval UAV's target-acquisition capability also means that it can improve its owner's striking power to some extent. These statements, however, must be qualified as current shipborne drones can only operate in low-threat environments – in contested airspace, their survivability and viability would be severely jeopardized, as they are simply unable to evade enemy fighters and anti-aircraft fire. In the final analysis, it can perhaps be maintained that the rise of sea-based UAVs constitutes incremental progress for littoral navies, as the platform does not offer game-changing capabilities to these entities.

Going forward, ISR is likely to remain the main mission for sea-based drones in the near future. Though the armed variant seems to offer a breakthrough in this state of affairs, it must be stressed that it is neither a simple nor cheap undertaking. If and when defense industrial players provide lower-cost solutions to this issue in the future, however, the striking power of coastal fleets would increase considerably and with that, the nature of littoral and naval warfare in general would profoundly change. Until then, the sea UAV-littoral navy nexus will be characterized by evolution, not revolution.

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Yan for his insightful comments on a draft of this article.

Endnotes

[1] For instance, the Scan Eagle drone has a unit cost of $100,000. See www.nytimes.com/2013/01/25/us/simple-scaneagle-drones-a-boost-for-us-military.html?_r=0.

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[3] Marcus Hand, "Malacca Straits transits hit all-time high in 2013, pass 2008 peak," Seatrade Maritime News, February 10, 2014, accessed September 4, 2015, www.seatrade-maritime.com/news/asia/malacca-straits-transits-hit-all-time-high-in-2013-pass-2008-peak.html.

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Parallax and Bullseye Buoys

By Jon Paris

It was Day 43 of the war everyone said would never happen: The war that assured mutual ruin and held little tangible benefit for either side. Yet, here he was, hurtling through the sky in the pitch black nothingness of the western Philippine Sea in mind-numbing turbulence and a driving rain. One wouldn't think that silence would be possible with the rain and the wind and the two howling General Electrics back aft, but it *was* silent. Eerily so. Lieutenant "Slider" Wilmore pondered this reality as he checked his instruments and reflected on the air wing's losses to date. They were not catastrophic, to be sure, but for a man on his third cruise, they were more than he had ever seen. They were also the first of his career that were credited to the enemy, rather than pilot error or malfunctions.

In this command and control denied environment with no GPS or voice communications, the challenge of getting the force from the Boat to the beach and back was infinitely exasperated. The Navy quickly innovated, the industrial base responded swiftly, and "bullseye" became a tangible object. The Navy thus required its ship drivers and pilots to execute precise maneuvers based on pre-planned maritime trigonometry and dead-reckoning. The concept was on the fringes, it had obvious weaknesses, but it was all they had. These thoughts – and many others – flickered through his brain like an insomniac flips through the channels of late-night TV. He snapped out of it when his newly-installed, low-tech WRN-100X waypoint tracker flashed three times, though. He sighed, looked down into the inky nothingness, took a deep breath, and hoped that his dead-reckoning had been correct. No Carrier Control Area, no GPS, no TACAN, no *nothing*, as far as he was concerned. All he had was another example of futuristic low-tech; a lonely, beeping ALQ-80 *Self-Correcting Bullseye Buoy* bobbing in the middle of nowhere, launched that day by the submarine *CHICAGO*. With this on his mind, he flipped down his night vision goggles, rolled his Rhino to port and pulled back hard. He was either in the Break, or he was bleeding speed over a watery grave – there was no way to be sure. His radios were silent, of course, as they had been for weeks. He slapped down his flaps, then his gear. After steadying up, he lowered his tailhook, eased off the power, and prayed that this blind-man's waltz would guide him to the Groove. No lights were visible – anywhere. Up until recently, this type of recovery – bastardized as it was – would never have been conducted at night. The mighty enemy hackers to the west had done their number, though. They had exploited the recovery methods specifically developed for just this type of denied environment to devastating effect. Now, he and his mates were looking for the

Boat in a slightly more advanced manner than Columbus had looked for the New World.

The sweat on his back made him shiver. *There* – another three flashes of his waypoint tracker, itself completely reliant upon the buoy's ability to self-correct for currents and his own trigonometric skills conducted at 500 knots some 2 hours in the past. Another pull to port, cutting some more power. As he settled onto his final course, he saw nothing. His heart sank along with his altitude. *Easy with it, easy with it*. The mantra pulsed through his brain. Then, rising and falling with the swells, he made out the impossible – a slightly blacker spot than the surrounding abyss. He puckered tight and squinted, just as a Chem-Light was broken and hurled into the middle of the blackness. He aimed for that spot and nearly closed his eyes as he sunk lower and lower towards the endless depths. *CRASH*! Though the sudden deceleration was welcome and expected, it never ceased to take his breath away. He retarded the throttles, raised his hook, and followed the ghostly Yellow Shirts across the lightless deck. Lieutenant Wilmore, soaked, jittery and tired, had not killed anyone tonight, for that was not his mission. The two jet-black ALQ-X99 pods under the wings were his mission and, many thought, the U.S. Navy's only hope.

LT Wilmore sized up his surroundings. He was in "Oz" – Flag Country. Not a Lieutenant's favorite place to be and certain to cause any junior officer additional anxiety – something he did not need as he stood there still trembling from his mission, cold in dripping flight suit. His CO stood in front of him and gave him a reassuring nod. He knocked and they both entered the space together.

The two aviators found themselves surrounded by the Strike Group Commander, Rear Admiral Patrick Aiken and his staff. "*Have a seat*," the admiral said after shaking the junior pilot's hand. *"Let us cut-to-the-chase. How did they respond to the ALQ-X99? Did they fall for it? We only lost two tonight so you must have had a pretty hairy time up there*. Iron Hand... *I never thought we would bring it back. Are you alright? Tell me what you saw*." The admiral spit out his comments rapid-fire as Lieutenant Wilmore sat there in a daze, thinking about his special cargo and of the terror he had felt only hours ago. He slowly blinked.

The adversary had the U.S. Navy in a corner. Their coastal defenses seemed impenetrable, extended out hundreds of miles, and appeared to have an endless inventory. They had more aircraft in theater than the Americans and were not afraid to lose a handful in pursuit of big gains. Their surface ships had been hit hard, but their submarines still roamed the seas hunting for targets. And their surveillance was top-notch. The U.S. Navy had to do its best to remain invisible while at the same time, launching highly-technical and heavily-laden Alpha Strikes from extreme ranges to hit both coastal and inland targets. Winning the war depended on the Navy's success. Unfortunately, this meant facing an angry swarm of fighter and attack aircraft, as well as a blinding throng of missiles reaching out like tentacles for F/A-18s, destroyers, and carriers, alike. While the enemy's inventory was deep and their supply lines were well-defended, no force could keep up their blistering pace of sorties and missile launches without the occasional pause for reloading, re-targeting, maintenance, and rest.

Operation Iron Hand was a Suppression of Enemy Air Defenses mission-set executed by both the Navy and Air Force during Vietnam. It focused on localizing Surface-to-Air gun and missile radars ahead of the strike package and then neutralizing the threats with anti-radiation missiles before they could cause the friendly formations harm. In today's war, localizing was less of a problem. The enemy was not being shy about using radars or their associated weapons, not to mention the fact that most of the launchers, and of course the ground-based aircraft, were

mobile. The Navy quickly realized that this was no Vietnam and that there would be no sneaking in to exploit the enemy's thirst for a kill prior to overwhelming them with a strike-force. The Hail-Mary solution had actually come from one of the most heart-pounding chapters of naval fiction ever to grace a Tom Clancy novel. "Dance of the Vampires" depicted a Soviet strike on a U.S. Carrier Battle Group. The strike was unique in that the Soviets led off with a massive launch of drones, duping the Americans into committing most of its anti-air missiles and its interceptors and leaving it nearly defenseless once the barrage of anti-ship missiles was loosed. Though modern surface-borne electronic decoys were nothing new, they were vulnerable to submarine attack, had limited capabilities, and did nothing to address a deceptive air battle – relatively useless in this scenario.

The ALQ-X99 attempted to solve this. It used extremely realistic electronic decoys – blips on the enemy radar – absorbed existing radar cross sections, and utilized a form of parallax to show a massive ghost-force that was sufficiently off-set from the aircraft carrying the pods. A number of F/A-18s now flew on the deck and carried these pods to the front, attempting to draw the enemy to a fight that did not exist while allowing strike packages to attack when the enemy was either exhausted or otherwise focused. Though the ploy was easy enough for the enemy to decipher after repeated use, they could not afford to ignore it. Thus, Naval Aviators like LT Wilmore were left to keep their critical packages intact, stay alive, and truly feel the mental exhaustion and strain of today's *Operation Iron Hand II*.

His blink seemed to last a year. He snapped to. "*I did what I had to do to stay alive, sir. Missiles exploded to my left and right. The bad guys were everywhere. They ate it up. The Alpha Strike got through. The ALQ-X99 works, sir, but I don't know if I'll ever stop shaking*."

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The Evolution of the Modern Carrier Air Wing

By Timothy Walton

The following article is adapted from a report produced by the Hudson Institute's Center for American Seapower titled "Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict.

In the period following World War II, the U.S. Navy sought to leverage its relatively uncontested sea control to develop the capability to conduct nuclear strike missions from carriers. Until the removal of carriers from the Single Integrated Operational Plan in 1976, the nuclear strike mission led to the development of heavy attack aircraft that could conduct long-range missions against Communist targets. Carrier aviation also played a crucial role in providing fighter, attack, and electronic warfare aircraft for employment in conflicts in Korea and Vietnam. Anti-Submarine Warfare (ASW) aircraft carriers were decommissioned in 1975, thus concentrating airborne ASW capability in the now multi-mission large deck carriers.

During the 1980s, a carrier air wing normally consisted of nine squadrons of various aircraft: two F-14 fighter squadrons, one E-2C AEW squadron, one EA-6B electronic warfare squadron, one S-3 ASW squadron, one A-6 medium-attack squadron, two A-7 light-attack squadrons, and one helicopter squadron, for a total of approximately 90 aircraft.[1] In the 1980s, the Navy decided to introduce the F-18 in order to replace the A-7. Trading range for speed in order to increase aircraft survivability, the F-18's 370 NM combat radius paled in comparison with the A-7's 608 NM combat radius, drawing significant criticism.[2] Test pilots decried: "Replacing the A-7 with the F-18 will constitute a reduction in battle group standoff range from the enemy and/or a reduction in ordnance delivered per aircraft on the target with no measurable increase in accuracy. [...] Our current ability to engage the Soviet fleet at ranges well beyond that of their newest surface-to-surface weapons will markedly diminish, and the vulnerability of our battle groups in war at sea will increase concomitantly."[3] The F-18 (and its successor Super Hornet) would replace the F-14 as well, continuing a trend of reduction of range in the air wing. Additionally, the air wing's medium-attack aircraft, the A-6 (with a combat radius of approximately 1,000 NM) was retired in the 1990s and the A-12, its envisioned long-range, stealthy replacement, was cancelled.

By 2015, a typical carrier air wing consists of two squadrons of F-18C/D Hornets strike aircraft (10-12 aircraft per squadron), two squadrons of F-18E/F Super Hornets strike aircraft (10-12 aircraft per squadron), one squadron of EA-18G Electronic Attack aircraft (5 aircraft per squadron), one squadron of E-2C/D AEW aircraft (4

aircraft), and varying numbers of SH-60 and MH-60 helicopters, for a total of approximately 64 aircraft.[4] The C-2 Carrier Onboard Delivery detachment aircraft do not fall under the CVW construct. The air wing eliminated S-3s that had provided organic open ocean ASW capabilities, replacing it with the short range SH-60 helicopter. Moreover, the carrier's dedicated organic aerial refueler, the KA-6D, had been replaced first with tanking from the S-3B following elimination of its ASW role, and then solely with buddy tanking from F-18Es and F-18F's. This significantly reduced the organic range of the air wing, made the air wing more reliant on Air Force tanking, and reduced the number of aircraft in the air wing available for combat missions.

Compared to the 1980s, the contemporary air wing is significantly smaller. In the 1980s a typical air wing had approximately 90 aircraft, 60 of which were fighter or strike aircraft; in contrast, contemporary air wings hold a mere 64 aircraft approximately, 44 of which are fighter or strike aircraft. Consequently, the fighter or attack portion of the air wing has been cut by more than a quarter and the total size of the air wing has diminished by approximately 30%. The planned introduction of the F-35C to the air wing is expected to further cut the size of squadrons by 2-4 aircraft.[5] The F-35C's low observable features, advanced sensors and networking, and approximate 613 NM combat radius will improve carrier fighter performance compared to the 390 NM combat radius of the F-18E/F.[6] Overall, though, the size of the air wing has been shrinking. Ironically, the Navy has gone on to procure the FORD Class carrier, capable of embarking more aircraft and conducting operations at a higher sortie rate than the NIMITZ Class.

In summary, contemporary and projected air wings display three key characteristics: they are shorter in range than Cold War predecessors, they host significantly fewer aircraft, and lack dedicated fixed-wing aircraft for ASW and aerial refueling. Differences between the current and projected air wing include the addition of the F-35C and potential incorporation of a carrier-launched unmanned aircraft system. Of note, Section 220 of the FY 2001 defense authorization act stated, "It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that by 2010, one-third of the aircraft in the operational deep strike force aircraft fleet are unmanned."[7] Clearly, the Joint Force has failed to meet Congress' 2010 goal.

On 8 October, 2015, the Hudson Institute's Center for American Seapower will release a report that will examine whether it is worthwhile to continue to build large, nuclear-powered aircraft carriers, given their considerable cost and mounting Anti-Access/Area Denial (A2/AD) threats to sea-based operations.[8] In our report, Seth Cropsey,[9] Bryan McGrath,[10] and I will systematically analyze the employment of the carrier air wing as an element of a Carrier Strike Group and as a component of the Joint Force. The report will examine the role that carrier strike groups (CSGs) play in current and projected concepts of operation, especially against mature and evolving A2/AD threats such as China.

We can say that the current air wing has inadequate capability, range, numbers, and qualitative superiority to adequately counter the most challenging threats, in particular the threat posed by China. Given the growing importance of carrier aviation in Joint CONOPS, as Chinese sea control threats and threats against land-based tactical aviation rise, the Navy should address the existing and projected capability gaps in the carrier air wing. In general, this requires the Navy to increase air wing striking range, develop sea control aircraft, and develop new weapons. Lastly, the Department of Defense and Congress should critically evaluate the naval aviation portfolio, including potential portfolio trades between land-based, permissive environment aircraft and sea-based, contested environment aircraft.

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Endnotes

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Trusting Autonomous Systems: It's More Than Technology

By Greg Smith

How will naval aviation employ unmanned aerial vehicles (UAVs) in the future? The answer is, of course, "it depends." It depends on technology, on the economy and budgets, on whether we are at war or peace, and on leadership. It also depends on less interesting things like how squadrons and air wings are organized. Given the rapid advances in unmanned systems technology and the success of unmanned platforms like Predator and BAMS-D,1 UAVs will certainly proliferate and significantly impact the future of naval aviation. If properly integrated, future manned-unmanned teams could deliver exponential increases in combat power, but integration of unmanned aircraft requires a level of trust in autonomous systems that does not yet exist in naval aviation. Building trust will require technical improvements that increase the "trustworthiness" of UAVs, but it will also require naval aviation to establish organizations that enhance trust in UAVs with the goal of fully integrating them into the fight. Indeed, organization will likely be the limiting factor with regard to the pace of integrating trusted UAVs. Therefore, naval aviation should consider the impact organization will have on the ability of aviators to trust UAVs and balance this among the competing requirements for introducing new unmanned platforms.

The Issue is Trust

Although naval aviators are perceived as natural risk-takers, they are trained to take no unnecessary risk and to mitigate risk throughout every evolution. Therefore, UAV integration will occur only when aviators trust UAVs to the same extent that they trust another aviator flying in close proximity as part of a strike package or during coordinated antisubmarine warfare sorties today.

The proliferation and success of UAVs in the past decade belies the fact that aviators still do not trust them. The vast majority of unmanned aircraft continue to fly only scheduled sorties in pre-established air space in order to ensure separation from manned aircraft. In addition, naval aviators operate with an abundance of caution around UAVs. Aircrews are briefed on planned UAV routes and orbits prior to a mission and routinely deviate from airspace assignments or coordinate new air space in flight to ensure safe separation from UAVs. Being notified that an operator has lost communications with a nearby UAV (i.e. it is autonomously executing a pre-programmed reacquisition profile) assists manned aircraft, but it also raises the hair on the back of an aviator's neck. In the terminal area it becomes

necessary to fly closer to UAVs, which is accomplished safely with the assistance of ground air traffic controllers. Still, as with any congestion, the threat to manned aircraft increases, especially in expeditionary locations. After several, near mid-air collisions with UAVs in 2010, one task force commander grounded his manned aircraft at a remote operating location until he was assured that the local control tower and UAV operators, who were physically located half-way around the world, would improve procedural compliance. Anecdotes like these abound, demonstrating both the adaptability and skepticism of aviators flying near UAVs. After nearly a decade of sharing the sky with UAVs, most naval aviators no longer believe that UAVs are trying to kill them, but one should not confuse this sentiment with trusting the platform, technology, or operators.

Building trust in autonomous systems should be a goal of those who will design the UAVs of the future as well as those who will employ them in the Fleet, because establishing trust in autonomous systems may be the tipping point that will unleash the revolutionary combat potential of UAVs. Naval aviation could fully integrate trusted UAVs into every mission area of every community. Unmanned tankers, wingmen (wingbots?), jammers, decoys, missile trucks, minesweepers, and communications relays could be launched from the decks of aircraft carriers, destroyers, support ships, from bases ashore, or from aircraft cargo bays, wing pylons and bomb bay stations in the coming decades, truly revolutionizing naval aviation. However, lack of trust is a critical obstacle which must be overcome before such a proliferation of UAVs can occur.

There are several technological improvements that can contribute to trust by enhancing situational awareness and safety of both manned and unmanned platforms. Improvements in see-and-avoid technology are needed to assist UAV operators when the UAV is flying in proximity of manned platforms. UAV command and control architectures and traffic collision avoidance systems (TCAS), as well as radars and data links, require improved reliability, security, and flexibility to ensure survivability in an anti-access environment or in the face of cyber or space attacks. Systems that provide manned platforms with increased situational awareness regarding the location of UAVs and the intended flight profile would also enhance trustworthiness. Today, the vast majority of naval aviation is not comfortable sharing an altitude block with a UAV in day, visual meteorological conditions (VMC), much less during war at sea in an anti-access environment. Technological improvements that make UAVs more trustworthy are necessary but not sufficient for establishing trust between an aviator and a machine. Sufficient trust will also require training, mission experience, and technical understanding of the system.

Organization Matters

Given the technological enhancements described above, it is not a stretch to imagine a manned F-35 establishing a CAP station with a UAV wingman, or a P-8 crew employing UAVs or unmanned undersea vehicles (UUVs) to search for a submarine, or an E-2D using a UAV to extend the range of its radar or data link, or an EA-18G commanding a UAV to jam air defenses or deliver an electromagnetic pulse. There remain challenges to fielding these capabilities, but the technology will soon exist to safely integrate UAVs into these naval aviation missions and many more. This level of integration raises numerous questions about UAV organizations and their personnel.

Who would be responsible for the success, failure, and the safety of the missions? Would each community operate UAVs that support its mission or would a UAV community operate all UAVs performing the full spectrum of naval aviation missions? How would a UAV operator develop the expertise

to execute complex tactical tasks in close coordination with manned platforms? What tactical and technical training will be required to integrate UAVs in this manner? How are the skills of pilots and UAV operators similar? How are they different? What portions of the unmanned sorties are accomplished autonomously and which require a link with a UAV operator? From where will UAVs launch and recover? From where will they be controlled and who will control them?

The answers to these questions depend on how squadrons of the future will be organized to command, operate and maintain the UAVs. In turn, each organizational model significantly influences the amount of additional training, coordination, and experience required to achieve the trust necessary to fully integrate UAVs. Consider the issue of who controls the UAVs. Some options include: control by the pilot of a manned aircraft themself; control by another aviator in the same aircraft or section; control by an aviator from the same naval aviation community outside the section; control by a UAV operator from a UAV community — aboard ship, ashore, or airborne; and fully autonomous operation. The amount of trust required to execute complex missions in close proximity to UAVs is the same regardless of how the UAV is controlled, but the amount of trust inherent in each scenario varies greatly. Decisions about these elements will significantly influence how quickly aviators will be able to trust, and therefore integrate, UAVs. As technology overcomes the challenges posed by the various capabilities implied above, organizational structures will determine how quickly UAVs can be integrated into the fight.

Beyond U-CLASS

Naval aviation's plans for its next UAV, the Unmanned Carrier Launched Airborne Surveillance System (U-CLASS), will prudently focus on ensuring the safe introduction of a novel platform in a budget constrained environment. Yet, looking beyond U-CLASS, there is the potential for naval aviation to exponentially increase its combat effectiveness by integrating UAVs in every mission area. Technological innovation is necessary to make UAVs more trustworthy, but naval aviation should also understand how organization will facilitate or impede the integration of trusted UAVs. The optimal structure of future UAV units will maximize trust between manned and unmanned platforms and allow for innovation and growth in integration.

Commander Smith is a Naval Flight Officer and the former Commanding Officer of VP-26. These are his views and do not reflect the views of the United States Navy.

Information Management and the Future of Naval Aviation

By Michael Glynn

Aviators and operators hitting the fleet today have reasons to be excited. Naval Aviation is in the process of recapitalizing the fleet with a stable of very capable platforms and sensors: the E-2D carrying the highly advanced APY-9 multifunction radar; the P-8A with a powerful acoustic system and the APS-154 Advanced Airborne Sensor radar; and the EA-18G armed with the very capable ALQ-218 electronic warfare system and Next Generation Jammer.

The advances are not restricted to manned platforms alone. The MQ-4C will enable wide area search and ISR operations, covering hundreds of thousands of square miles during 30 hour flights. The MQ-8C will bring impressive endurance to small deck surface ships. Longer dwell time promises to yield more collection opportunities and push more data to warfighters.

But observers should be cautioned that these new platforms, new sensors, and emerging autonomy won't necessarily yield higher quality intelligence or more information to commanders. Warfighters today are fighting not to generate enough information, but rather to manage the incredible amounts of data that today's sensors record and store. The fleet is struggling to keep from being drowned in a sea of data. The battle of the information age is to separate the useful information from the vast amount of meaningless noise.

Our sensors today already develop tremendous amounts of data. How do we store it, access it, make sense of it, and disseminate it? How will we manage this in the future with even more data as unmanned systems become more common? Can autonomy and data fusion be part of the answer? Will our training and intelligence analysis need to change? Let's examine these challenges in detail.

Large Data Sets, Autonomy, and Data Fusion

The increasing use of unmanned systems will bring longer mission profiles and hence longer windows of time where sensors can collect. This will generate extremely large amounts of information each flight. To put the challenge in perspective, consider a modern maritime patrol aircraft, the P-8A and its partner, the soon to be deployed MQ-4C UAV. On an eight hour mission, a Poseidon will generate up to 900 gigabytes of sensor information. How much more data will the unmanned Triton generate during its thirty hour flights?

Any operator in the fleet will admit that the amount of data gathered by our platforms

today far surpasses the bandwidth of our long range communication networks. What happens to data that can't be transferred off an aircraft during its mission? How best to manage information that may be over a day "time-late" when a UAV lands? What sensor information should be broadcast to operators ashore and what should be saved for post-flight access? These are challenging questions for program managers, requirements officers, and operators to solve.

In the same vein, the large data set generated by sensors today offers the possibility of using analytics to sift through them and draw conclusions. However, this will only happen if managers design suitable architectures to extract the data post-flight, store it, and make it available to customers. We will discuss this concept later.

A second broad trend worth mentioning is automation and the ability to use technology to parse the data. Algorithms in modern sensors allow these systems to automatically capture, store, and disseminate information. Legacy surface search radars required an operator to manually plot a contact, log its position on paper, and update the position as time went by. Modern surface search radars can automatically identify, assign track numbers, and update tracks of dozens, if not hundreds of contacts, and promote certain tracks to datalinks such as Link 16. The track information is also recorded on-board and available for post-mission download, analysis, and storage.

The benefits of automation and data storage don't end there. Today's platforms either already do or will soon employ data fusion engines that merge complimentary information from multiple sensors to produce a higher-fidelity view of the battlespace. These systems will identify a surface contact by radar and overlay an electronic line of bearing signal that arrives from the same direction as the radar contact. The fusion engine will recognize the radar signal is coming from that ship and by analyzing the parameters of the signal might be able to provide a possible identification of the type of vessel. The system will then merge the radar contact and the electronic emission into a single track and promote it automatically to a datalink.

The capability of our sensors and our ability to store the data they produce is improving rapidly. Unless we think about how we collect and process this data, we risk not being able to capitalize on the capability. Let's examine some actions we can take to prevent the technological advances from outpacing our ability to control them.

Recognizing the Challenge

Our warfighters and intelligence professionals need to examine the process by which they collect, store, process, and disseminate information. We need to match technology with roles a computer can accomplish and utilize our manpower where the skills of a human are most needed. Too often, our warfighters are employed in roles to which they are poorly suited.

In parts of the fleet, an observer can find operators plotting the locations of ships in paper logs when mission systems are recording the same information and storing it with far greater fidelity and fewer errors. These mission systems scale easily, plotting not one track history, but thousands. The same observer could find aviators submitting message traffic to meteorological commands listing environmental measurements at one location when the aircraft they just flew recorded similar measurements at dozens of locations spread over hundreds of miles. The observer could also find an intelligence officer spending their time preparing a PowerPoint brief for a commander instead of analyzing the information brought home by crew.

Humans are excellent at recognizing patterns and drawing conclusions from data. When it comes to tasks like plotting and updating

radar contacts or transcribing information in a log, a machine wins every time. Yet we can find numerous cases in which we ask humans to "beat the machine" and conduct a rote task when the technology exits to automate the process. We need to train our operators to adopt a "sensor supervisor" approach and use technology to automate post-mission product creation.

Action Ahead

Are we making wise use of the billions of dollars spent on collection platforms if we don't examine our own information processing requirements? When we bring new sensors to the fleet, are we process mapping to determine how best to analyze and disseminate the data they collect? Do we even know what types of information our systems are collecting? In all of these cases, Naval Aviation as an organization can get better.

Leaders in Naval Aviation and the Information Dominance Corps have several solutions that can be implemented. The first is to examine and implement a "pull" based system of information portals where collection platforms can post data and customers of all types can access it. Currently, the fleet relies on a "push" model where a unit is assigned to accomplish a collection task, and then information is reported back to stakeholders. Under a "pull" system, information would be posted to IP accessible portals where any authorized user can discover the information and utilize it for their analysis purpose. This is a far more efficient system, prevents stovepipes, and will enable next generation "big data" analytics efforts including applications in the Naval Tactical Cloud.

Next, information analysis and dissemination need to be viewed as a key part of the kill chain and performed so as to optimize mission effectiveness. Is a trained intelligence analyst better suited to sifting through ambiguous data and drawing conclusions about adversary behavior or best used building PowerPoint slides? Software today can be easily adopted to automatically generate post mission message traffic, briefing slides, and other products. This allows human capital to be reallocated into value-added efforts.

In a similar manner, Naval Aviation should examine how we can train our aviators and operators to best employ their sensors. We should expose our young aviators and sensor operators to concepts of information management early in their training. Understanding the strengths and weaknesses both of the human sitting in the seat and the sensor system will go far to optimize our collection platforms. This will allow operators to let machines do what they do best, and apply human minds to the analytical tasks they are best suited for.

Conclusion

The platforms and sensors being introduced to the fleet are very capable and will grow more so with intelligent management of the data they produce. Let us write and think about how best to manage the information our warfighters gather as they prepare to deter and win the conflicts of tomorrow.

Lieutenant Glynn is a naval aviator and member of the CNO's Rapid Innovation Cell. The views expressed in this article are entirely his own.

Transcript of Video Review of "Making Waves: Aiding India's Next Generation Aircraft Carrier"

By Peter Marino

Hi, welcome to Globalogues. This is a special extra edition of Globalogues done for the Center for International Maritime Security and this time, we are putting together a video for CIMSEC's Naval Aviation week, currently ongoing. We're going to be talking today about a paper that was released earlier this year in 2015 by the Carnegie Endowment for International Peace by their distinguished scholar Ashley Tellis, an international security expert, especially as it relates to subcontinental affairs. The paper is called "Making Waves," and it lays out in pretty definitive terms the case for a close collaboration between the United States and India on developing India's next-generation aircraft carrier and assisting with the further development of India's aircraft carrier program more broadly.

Now the paper is divided into sort of two basic chunks. One is a rather comprehensive enumeration of the various technical manifestations of how this collaboration could occur, and the second chunk which sort of pervades the rest of it and then sums it up in the end, is the broader strategic case for why this collaboration ought to happen and in a word, that reason is China. It's notable that in a paper on Indian security, the word 'Pakistan' appears only once and it is simply to name it as a regional rival of India and then it is quickly moved on from, whereas 'China' or 'Chinese' occurs fifty times. It's unambiguous here that the broader argument is that we're shifting strategic focus to a different kind of adversary. But, let's take a look at the technical components first and then sort of return to the rather strategic argument.

The sort of immediate argument within India for having to expand the aircraft carrier program, says Tellis, is pretty obvious from the limitations of its land-based air defense wing. As seen here, the sort of operational radius of its land-based Sekoy SU30NKIs is rather limited and doesn't give sufficient capacity to project force throughout much of the Indian Ocean where the Chinese in fact are already operating, especially in the programs near the Gulf of Aden where they've been active since 2012. So, the case for expanding the aircraft carrier program itself has even been obvious to Indian strategists and indeed they are working on their larger new aircraft carrier program the Vishal class to supplement, complement, and eventually replace the currently in service Vikramaditya and Vikrant, both of which are smaller size, only about 40, 45 thousand tons and the Vikramaditya is Russian-designed

Kiev class working with STOBAR launch recovery system. Tellis goes into a good deal of detail enumerating twenty-two specific categories of possible cooperation between the United States and India on developing the Vishal class of which he repeatedly emphasizes that technology transfer of the EMALS launch system is probably the most effective in improving the force projection capability of the Vishal class, but expands beyond this to explain that the energy demands of the new EMALS system are likely to require an upgrade of the class itself from diesel and gas to nuclear power, which of course then necessitates an additional layer of cooperation on top of it.

Dr. Tellis is not shy about indicating that there might be some additional complications involved in having to transfer those additional technologies which would have to go through the congressional process of transfer for military technology to foreign powers, including an EMALS system on the upgraded Vishal class would allow for higher tempo operations on the aircraft carrier and greater capabilities in any kind of combat or support role that it would undertake. But of course, using this launch system goes beyond the simple capacities that it brings the carrier, it also fits in with Dr. Tellis's additionally broader conceptual suggestion of greater integration between the US and Indian navies in Indian Ocean operations and using an American-designed launch and recovery system will certainly ease things on the path in that direction. Other capabilities that he explores but then suggests are not as immediately necessary are the modular building techniques pioneered by Newport News shipping and other kinds of basic hydrodynamics and naval engineering and naval architecture that the Indian naval design bureau is unlikely to seek out as they have a good deal of confidence in their own abilities in this area. However, all together this is a rather bold proposal given that this is not a kind of technology that the United States tends to design simply to sell to other countries, it's not an export product - and so suggesting its transfer to India is really part of a broader strategic reimagining of the relationship between New Delhi and Washington. Dr. Tellis himself of course points to the origins of this reimagining in the 2005 agreement between the Bush administration and the Indian government which has only deepened and strengthened under the new nationalist leadership of Narendra Modi.

It is possible that these kinds of bold ideas that would easily have been laughed out of both capitals as recently as two decades ago might find a broader reception as the PLAN continues additional operations throughout the western Indian Ocean and goes through additional efforts to resolve its Malacca Dilemma, of which of course the Indian Ocean is a major component. And indeed, some of the pieces already seem to be in place. Obama and Secretary Carter have both made visits to India this year in which this kind of cooperation was raised, and it may be that these programs are further along than is widely available to public knowledge, but at the very least it's a bold suggestion and it's interesting to see it taken as far as this already. So thank you all for watching, I look forward to producing more videos for CIMSEC, so, see you all next time. Bye.

Peter Marino holds an MSc in Global Politics from The London School of Economics and is a graduate of Norwich University. He lived in Shanghai from 2003 to 2008 and served as head of China development for London-based Aurigon, Ltd. He founded and sold Quaternion, a political risk startup, and is currently establishing a new Think Tank for International Affairs aimed at promoting engagement with the "Millennial Generation." He also produces Globalogues, a video blog with commentary on global politics and economics. The views expressed in this article are his own.

Naval Aviation Week: The Conclusion

By Wick Hobson

As a man who as spent entirely too much time flying in the immediate vicinity of the colloquial Death Star (and by that, I mean the aircraft carrier) over the last year, I know firsthand how forgone a conclusion naval aviation can seem. Naval aviation, as the world knows it, is a multibillion dollar power projection leviathan that literally catapults fire control solutions from mobile sovereign territory to the bad guys du jour, right? Kick the tires, light the fires, open and shut case… Or is it? From future capabilities to current funding limitations, reality is inescapably more complex.

While GCC allies transition toward hegemonic peacekeeping operations in the Middle East and posture their forces for a long term dichotomy with Iran, you can almost feel the deck of American air power at sea roll beneath your feet in new directions. Every day, the emphasis shifts incrementally away from permissive, asymmetric conflict in the Arabian Gulf and toward modern, access-denied conflict with technologically contemporary rivals. Although Operation Inherent Resolve may retain focus on surgical strikes flown overhead, our authors looked ahead to the next generation of challenges awaiting the proverbial fleet.

Speaking of ISR, how did an article summarizing the future of naval aviation go four full paragraphs without mentioning drones? Ben Ho Wan Beng arrived in time to keep my bitterness against unmanned aviation in check with a fantastic look at the rise of UAS proliferation among littoral states seeking bang for their maritime buck in his piece, “What’s the Buzz: Ship-Based Unmanned Aviation & Its Influence on Littoral Navies.”

Jon Paris gave us a taste of the war none of us want to fight in his article, “Parallax and Bullseye Buoys.” An edge-of-your-seat thriller, Jon straps you into the cockpit for an IMC, EMCON recovery onboard a lights-out carrier in hostile skies. I don’t want to live in that world, and fortunately we aren’t in that kind of extremis yet, but Jon prepares the reader. He articulated the complexities of navigating in GPS-denied airspace and the necessity of electromagnetic spectrum fluency for the modern A2/AD environment, an issue recently addressed by CAPT Mark

Glover at C4ISR.

Meanwhile, what good is a debate on the direction of military planning without a healthy dose of fiscal reality? Bridging the well funded past to the unaffordable future, Timothy Walton gave us a sneak peek from next month's report due from The Hudson Institute's Center for American Seapower. He reviewed the shrinking scale of the carrier air wing by the numbers and illustrated unmistakable mission gaps created along the way. From the salad days of the Tomcats to the uncertain future of the Joint Strike Fighter, Mr. Walton illuminated the reduced footprint of the current air wing and possible ramifications facing the CSG of the future in "The Evolution of the Modern Carrier Air Wing."

CDR Gregory Smith broadened the topic of integrated manned and unmanned operations with his article, "Trusting Autonomous Systems: It's More Than Technology." Beyond the short-term friction of terrified Djiboutian air traffic controllers, CDR Smith illustrated the essential progress required to instill the confidence required for fully integrated manned and unmanned combat operations. From C2 structures in flight to command structures in the Pentagon, the ground truth on drone warfare at sea has yet to reach IOC by any definition. CDR Smith's article provided clear context for the way ahead.

Michael Glynn delivered the cold, hard truth on data collection efforts in Naval Aviation: if a P-8A Poseidon collects 900GB of data on a sortie with no client for the information, does it validate its R&D costs? His article, "Information Management and the Future of Naval Aviation," provided a resounding YES while detailing the challenges facing efficient data extraction from maritime ISR operations.

Peter Marino adds international affairs into the mix by assessing the scope and implications of American technology transfer to India for the development of a powerful new carrier. Through a video review of "Making Waves: Aiding India's Next Generation Aircraft Carrier," he explores the unique value of naval aviation in foreign policy.

Our selections here delve into the challenges that lay ahead. I find the common thread unifying all of our authors to be the pursuit of value to the proverbial customer in an environment defined by change. What is it, exactly, that we are creating with all of this jet fuel?

The delivery of value to the stakeholder is incumbent on any military initiative from weapons safe to weapons free. On the one hand, that means providing maritime security and intelligence collection in the absence of conflict. Our authors speak from ground truth experience on the importance of developing and maintaining a cogent strategy for the proliferation of ISR and the subsequent decoding of the data collected.

On the other hand, delivering to the stakeholder requires a conscientious investment in fire control solutions against technologically advanced adversaries in denied airspace. There is no future without U-CLASS and there is no future without the JSF. These have to be integrated into the future of naval combat at least in the intermediate term. But what good is a fire control solution without C2 assurance? Are we ready for a GPS-denied environment? What will it take for tomorrow's navy to compete in the conflicts of the future?

Ultimately, the sting of sequestration and the pain of acquisitions make the road ahead formidable. The hardest question to answer may be the most simple. What ends are we attempting to achieve by the means of naval aviation? Once our days of busting bunkers in the Middle East with precision guided munitions no longer carry the bulk of our workload, how do we leverage the unique capabilities of naval aviation across the entire

spectrum of the rules of engagement to provide value to the theater commander?

It's an exciting time to be a part of naval aviation. With such seismic shifts in sensor capabilities, adversary technological acumen, and A2/AD threat proliferation cast against cutthroat funding and acquisitions, this is not a sport for the faint of heart. Vision, flexibility, and creativity will define the success or failure of our transition to the next war we fight. Please join me in congratulating our authors on a job well done for their contribution to the next step, and feel free to join the discussion with your own feedback at nextwar@cimsec.org!

LT W. W. Hobson is an MH-60R pilot. The views expressed in this article are entirely his own and are not endorsed by the US Navy.

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