Unmanned Aerial Systems

Their Future
as
Australian Defence Force
Capabilities

A paper that

reviews Australian strategic guidance and

examines the role for unmanned aerial systems

in the defence of Australia and its interests

Brian Weston

For Submission to:

Senate Standing Committee on Defence, Foreign Affairs and Trade

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Introduction

The operational use of unmanned aerial systems (UAS) dates back to the Ryan Model 147 high altitude jet UAS, employed by the US over SE Asia and North Vietnam in the early sixties. But it is only in recent times that the use of UAS by the military has become wider and more commonplace.

One of the First Military UAS - Ryan Model 147 [i]

Given the vast dimensions of Australia's territories, maritime approaches and areas of interest, it is timely to overview Australia's defence requirements and to examine how UAS might contribute to improving Australia's national security capabilities.

UAS as a Defence Force Capability

The upsurge in the use of UAS by the military over the last decade has been a result of the increased sophistication of UAS, a technical maturing of their sub-systems, and a greater confidence by the military in UAS capability. There is also a greater recognition of the significant advantages that flow from not having defence personnel at risk as well as acquiring an increased military capability at less cost.

UAS can be categorised in many ways but one convenient way to understand UAS capabilities is to consider the altitude capability of the UAS, which broadly equates to large, medium and small. The high altitude long endurance (HALE) UAS is generally the largest and most sophisticated UAS. The medium altitude long endurance (MALE) UAS operates in the medium altitudes while the smaller, and generally tactical, UAS operates below 15,000 feet altitude. Some will include a further category of micro UAS – small and very small UAS operating at very low levels of altitude.

In the space of little more than a decade, UAS capabilities have advanced remarkably and some UAS have developed into mature capabilities. The HALE Global Hawk has been operating world-wide for more than a decade and the MALE Predator and its armed derivative the Reaper have accrued almost ten years of operational experience. The scope and maturity of UAS operations is best demonstrated by the ability of the US to operate both HALE and MALE UAS in operational theatres a half-a-world-away from where the pilots sit in their control cabins in the continental US.

At the tactical level, the increasing miniaturisation of lightweight, capable sensors and the development of advanced software-driven flight control systems have promoted a proliferation of small UAS which are increasingly commonplace.

But above all else, UAS, especially HALE and MALE, have brought a new dimension to the operational theatre, aerial persistence, previously achievable only by cycling multiple manned aircraft through an airborne task, and rapidly running down fleet and crew availability in the process. In one fell swoop, UAS have overcome the lack of an enduring aerial presence over the area of operations – so rectifying one of the long standing deficiencies of air power.

Medium Altitude UAS (Predator B) [ii] High Altitude UAS (Global Hawk) [iii]

Military planners are now beginning to grasp the scale and significance of the technological leap that long endurances of 24 hours and more bring to air operations, especially surveillance operations and operations at long range.

UAS do not put their controlling aircrew at risk. There are no ‘downed aircrew’ that can be used by an enemy for propaganda, political and negotiating purposes. Critical and essential missions that might not be flown because of risk of aircrew loss can be now undertaken.

Advances in aerial persistence when combined with advances in surveillance technology, make UAS an excellent platform for intelligence, surveillance and reconnaissance (ISR). And given that strategic awareness and successful military operations both depend for their success on intelligence, UAS must now be considered as an essential military capability.

But this does not mean that the manned aircraft has been superseded by UAS.

Many airborne operations, especially the complex, dynamic and interactive missions, require the immediate presence of human intelligence and human judgement. Hence a new paradigm is emerging; one of complementary manned and unmanned air capabilities which exploit the advantages of both manned and unmanned air capabilities. Typically this means that an unmanned but persistent ISR capability might be combined with a manned airborne response capability to provide a more capable and flexible defence force.

This new force structure paradigm – manned plus unmanned – is best illustrated by the decision of the US Navy to restructure its maritime patrol force of P-3 manned aircraft into a complementary airborne force of manned P-8A Poseidon aircraft and unmanned MQ-4C Triton

UAS thus gaining a persistent airborne ISR capability and a responsive flexible maritime warfighting capability.

Notwithstanding that Australia's Project JP2062 HALE Global Hawk and Project JP129 Tactical UAV were established more than a decade ago, Australia despite its compelling UAS friendly geography and environment has lagged in investing in UAS capability. But the deployment of the Heron MALE UAS into Afghanistan has generated momentum for change as the benefits of persistent airborne ISR become clear.

The experience of the ADF in Afghanistan with both the Heron MALE UAS and the Scan Eagle tactical UAS has considerably assisted the fostering of confidence in UAS, although questions still remain about what roles UAS might fill, and the pace at which UAS should be introduced into the ADF.

RAAF Heron (Afghanistan) [iv]

Scan Eagle UAS [v]

Certainly it would be misleading to simply extrapolate the lessons from this multinational expeditionary stabilisation operation to the making of decisions about where UAS should sit in the future force structure of the ADF. Australian defence planning demands wider considerations than those drawn from its most recent operational commitment. It is a process that needs to build from a foundation of strategic thought about why and what outcomes Australia needs from its military capabilities after which, an informed decision can be made on how and when, UAS capabilities might be introduced into the ADF.

Australian Defence Force Planning

For more than thirty years, Australia has sought to base its force structure decisions on a sound, conceptual strategic base. To this end Australian governments have issued a series of Defence White Papers and related policy documents. These policy papers date back to the mid-seventies and although some details remain classified, the logic base on which these papers have been drafted is generally understood.

The two most recent papers are the Defence White Paper "Defence 2000: Our Future Defence Force", and the Defence White Paper 2009 "Defending Australia in the Asia Pacific Century: Force 2030". A common theme in these and previous documents is that Australian defence planning builds on two key themes - Australia's geopolitical/geostrategic circumstances and Australia's strategic interests. A further Defence White Paper is expected in 2015 and almost certainly will continue to refine these themes.

More specifically, past papers have concluded broadly that the following are also influential factors in determining the nature of Australia's defence capabilities:

- Australia's enduring geographical disposition, especially Australia's island continent and her extensive maritime approaches.
- Australia's location dividing the extensive Pacific and Indian Oceans, adjacent South Asia but with an archipelagic band between the Australian land mass and Southeast Asia.
- Australia's wealth, education, technology, economic circumstances and dependence on world trade.
- Australia's small population, contrasted against the vastly superior populations of other regional nations.
- The rapid change in industrialisation, democratisation and wealth that is taking place in Southeast Asia, South Asia and Northeast Asia.
- The long established sources of tension that exist in the region.
- Australia's long standing alliance relationship with the US.
- Australia's growing economic dependence on China in an environment where China is seen as an emerging competitor to the US, Australia's key defence ally.

The papers have drawn judgements about Australia's strategic interests and objectives with "Defending Australia in the Asia Pacific Century: Force 2030" neatly expressing Australia's strategic interests and objectives as follows:

- A secure Australia.
- A secure immediate neighbourhood.
- Strategic stability in the Asia-Pacific region.
- A stable rules-based global security order.

The point of the above is not to engage in debate about past force planning guidance other than to note that much of the difference is subtle, with the major debating point being about how far Australia's defence capabilities should reach out in being able to operate in support of Australia's interests – this issue often being dumbed down to a semantic debate between advocates of a "defence of Australia" approach versus advocates for a more "expeditionary" approach.

The generally consistent conclusion over several White Papers is that Australia requires what is often referred to as a balanced military force – which is not a surprising outcome given the enduring geographic, geopolitical, regional and global factors that frame the deliberation. That balanced military force should enable the ADF to be able to conduct the following operational activities:

- Intelligence and surveillance operations to ensure that Australia is adequately warned of changes in the national security environment.
- Land, maritime and air operations in the direct defence of Australia, including operations in the maritime and archipelagic approaches to Australia.
- Influence over Australia's external trade routes and lines of communications.
- Expeditionary and coalition operations within Australia's adjacent region.
- The deployment and support of Australian defence force contingents in association with UN, allied or coalition global security operations.

The question is now, how can UAS best be used to ensure a capable ADF that can successfully operate in defence of Australia and its interests.

Why Go Unmanned?

An unmanned platform allows those support systems and human/machine interfaces necessary for the support of the crew and for control of the platform by the crew to be dispensed with. This means that unmanned platforms are significantly lighter and simpler than manned aircraft, which translates into UAS achieving large gains, indeed very large gains, in flight endurance over manned platforms.

UAS flight endurances well beyond 24 hours are common, with technology likely to advance endurances to 48 hours or more. Even if manned aircraft were to gain commensurate advances in flight endurance, aircrew fatigue considerations will limit the utility of these gains to a duty cycle of around 15 hours – around 10 to12 hours of flight.

But flight endurance is a poor measure of operational effectiveness as flight time to and from "on-station" is generally operationally ineffective. Effective time-on-station (ETOS) is the key operational performance parameter.

ETOS is easily determined. It is calculated by subtracting the transit time to and from the operational area from the flight endurance of the aerial platform, with the transit time being a function of the distance-from-base and the speed of the aerial platform.

Table 1 illustrates the relationship between distance-from-base and time-on-station. The data compares a UAS (endurance 24 hours, transit speed 300 knots) to a manned aircraft (endurance 12 hours, transit speed 400 knots) – the 100 knots speed difference approximating the speed advantage that a manned jet aircraft currently has over a jet UAS.

Distance to on-station (nm)	ETOS (hours) Manned	ETOS (hours) UAS
600	9	20
1200	6	16
1800	3	12

Table 1 - ETOS Comparison: Manned vs Unmanned

The step-change in time-on-station achieved by the UAS, even allowing for its slower transit speed, is obvious. UAS bring aerial persistence to airpower.

Table 2 compares the number of missions necessary to maintain a continuous time-on-station of 24 hours for a UAS (endurance 24 hours, transit speed 300 knots) and a manned aircraft (endurance 12 hours, transit speed 400 knots).

Distance to on-station (nm)	No of missions Manned	No of missions UAS
600	2.22	1.2
1200	4	1.5
1800	8	2

Table 2 - Total Missions Required: Manned vs Unmanned

Increased time-on-station also reduces mission rate-of-effort, hence UAS enable a 24/7 on-station presence with dramatically fewer missions.

This step-change in time-on-station and reduced mission rate-of-effort is compelling. UAS bring a new dimension to air power operational planning.

Apart from endurance, UAS transit speed is also important to UAS operations.

Table 3 illustrates the importance of transit speed in UAS operations, especially at distance. The table compares the time-on-station at on-station distances from 300 nm to 2,400 nm, for UAS with endurance of 24 hours, but with four different transit speeds – 100 knots, 200 knots, 300 knots and 400 knots.

Distance to on-station (nm)	ETOS (hours) Speed 100 kts	ETOS (hours) Speed 200 kts	ETOS (hours) Speed 300 kts	ETOS (hours) Speed 400 kts
300	18	21	22	22.5
600	12	18	20	21
1200	0	12	16	18
1800	n/a	6	12	15
2400	n/a	0	8	12

Table 2 - The Importance of Speed to Achieving Time-on-Station at Distance

In summary, the preceding examples amply demonstrate three characteristics of UAS:

- increases in endurance translate into large increases in time-on-station durations;
- increases in endurance dramatically decrease mission rates-of-effort; and
- UAS need a credibly fast transit speed otherwise their utility at distance is reduced.

Altitude capability is another consideration in determining UAS suitability for military applications.

Like manned aircraft, UAS benefit from an enhanced line-of-sight to the horizon. But HALE UAS gain further advantage by flying higher than manned aircraft, so gaining significant advantages in sensor coverage, provided they carry capable sensors. High altitude flight also allows:

- flight in a benign low wind speed environment, typically less than 40 knots compared to 80-120 knots when flying between 25,000 feet and 45,000 feet;
- flight above the weather;
- flight above other air traffic, both commercial and military; and
- increased clarity of electro-optical (EO) and infrared (IR) imaging by viewing more vertically through horizontal layers of haze.

Most ground based sensors are limited by line-of-sight considerations, so they greatly benefit by being carried aloft where radar horizons are extended. At 60,000 feet the horizon lies at 345 nm (690 km); at 30,000 feet the horizon lies at 245 nm (490 km). ISR operations greatly benefit from being able to carry both active and passive sensors to high altitude.

HALE UAS in many ways bring ISR advantages that were previously available only through the possession of a national low orbit surveillance satellite constellation including, being able to survey areas inside other national boundaries without penetrating the sovereign's airspace.

MALE UAS are simpler air platforms than HALE UAS. They lack the capacity for high altitude flight but still have the ability to "dwell" above complex, changing environments for extended periods of time. Their capability is determined by the performance of the on board sensor payload and the speed at which the MALE UAS can move from one area of interest to another.

MALE UAS operations might often be confined by the limits of their controlling communication links although if they have capable control and communication systems, MALE UAS can have their controlling crews located remotely from the theatre of operations; a significant advantage in not having to deploy, support and protect MALE UAS operatives.

MALE UAS are an essential ISR capability in air/land tactical operations, and when armed, might also provide fire support to deployed ground forces.

At sea the MALE UAS, operating from the deck of a warship as an organic airborne naval capability, is rapidly carving out a niche as an effective ISR capability. With its ability to operate at altitude for extended periods, the rotary-winged vertical take-off UAS (VTUAS) has greatly expanded the over-the-horizon vision of naval surface units.

Since the recent proving of unmanned VTUAS operations from the small flight decks typical of destroyer and frigate sized warships, the US Navy has moved quickly to explore the concept of warships operating a mix of both manned helicopters and unmanned warships.

In this way, the complementary advantages of both manned naval helicopters and unmanned VTUAS can be harnessed, with the unmanned VTUAS being optimised for the persistent ISR role and for the manned helicopter being optimised for responsive operations; be they carriage of boarding parties, delivering anti-shipping strikes, conducting anti-submarine operations, etc.

At lower altitudes, a host of small tactical UAS are now being employed by land forces for “over-the-hill” observational and other roles. These tactical UAS use small sensors (often EO/IR) and their operational use is generally integrated organically into the relevant defence force unit that the small UAS is supporting.

The rapidly advancing capabilities and innovation of small tactical UAS will see significant advances in the future use of small tactical UAS.

UAS Sensor Technology

Depending on the size and payload of the air vehicle and on the role of the unmanned air vehicle, UAS can carry a range of sensors. While sensor technology is advancing, a typical sensor mix might be a combination of radar, EO/IR and ESM.

Radar sensors are often multi-function, 360 degree, sidescan, and synthetic aperture employing an active electronically scanned array (AESA) thus providing all-weather coverage (day/night and through cloud). The more sophisticated radars have further capabilities that might classify, track and identify objects.

High resolution EO/IR sensors provide day monochrome/colour imaging; television intensified imaging; day/night IR imaging; and can include the blending of images. ESM packages provide all-weather passive detection, target classification and tracking of emitters of interest.

UAS, especially HALE UAS with their ability to carry substantial payloads to high altitudes, are a prime candidate for the electronic support and intelligence collection role.

Sensor technologies such as wide area stare arrays are advancing at a fast pace and UAS sensor capabilities can be expected to advance further. More capable micro-processors and new interpretive software will enhance the capabilities of UAS sensors while the maturing of inflight traffic avoidance systems will assist UAS to de-conflict from other aircraft. The fast pace of sensor development should see existing UAS capabilities enhanced by the periodic upgrading of their sensor packages.

UAS Combat Effectiveness and Cost

There is no doubt that UAS have delivered a step-change in aerial persistence and surveillance capability. Whether that has been achieved at a cheaper unit cost than manned aircraft might still be debated, but few will challenge the contention than when calculated on surveillance per-square-nm, or per-hour basis, the UAS with its advantages in persistence and lower mission rates-of-effort, is not only the platform of choice but the cheaper capability.

The product of surveillance is data, but raw data is of little use unless it can be filtered, assessed, analysed and disseminated to where it is most needed. Moreover raw ISR data is perishable, so unless the surveillance data can be transformed into a refined and deliverable intelligence product quickly, the full capabilities of ISR UAS will remain under-exploited.

An ADF ISR UAS capability will therefore need a commensurate increase in analytical and intelligence staffs to filter, assess, analyse and disseminate the refined intelligence product.

This task will be assisted by new and emerging technologies such as pixel recognition software. Notwithstanding such technological developments, it is likely that personnel efficiencies gained at the UAS “operational front end” will be offset by an increase in “back end data processing” personnel.

Potential Roles for UAS in the ADF

Previous Australian Defence White Papers and Capability Plans have long identified the maritime ISR role as appropriate for a HALE UAS and recently, the Prime Minister announced the intended acquisition of the MQ-4C Triton HALE ISR UAS to complement the already announced acquisition of P-8A Poseidon multi-mission maritime aircraft.

US Navy MQ-4C Triton and Poseidon P-8A [vi]

Taken together, both these projects replace and enhance the dated and limited capability resident in the RAAF AP-3C Orion maritime patrol aircraft and reflect the reality of Australia’s need to patrol the expansive Pacific and Indian Ocean regions; to monitor and control Australia’s maritime approaches, including key focal areas and strategic straits; to counter threatening maritime forces; and to neutralise submarine threats.

The operational logic behind these related force development decisions is compelling.

The manned P-8A Poseidon and unmanned MQ-4C Triton capabilities are ideally suited to Australia's geostrategic environment. The P-8A and MQ-4C are the most technologically advanced capabilities available. Both complementary capabilities are being developed to satisfy an operational requirement of the US Navy. Most of the development risk has already been mitigated by US Navy. The level of capability sought by Australia is modest and affordable. And the P-8A/MQ-4C solution offers operational interoperability between the ANZUS alliance allies, Australia and the US.

At the lower end of the UAS scale, Project JP129 has long aspired to acquire a tactical UAS for the Australian Army. But Project JP129 has a chequered history; largely, because of continuing uncertainty about the role and the level of capability, an institutional unfamiliarity with UAS and their capabilities, a lack of mature ADF doctrine on which to inform and base the tactical UAS requirement, and an inability to assess, with confidence, what might be realistically delivered by contractors.

Army Shadow 200 operating in Afghanistan [vii]

After a long and difficult gestation period, Project JP129 progressed to competitive tender and contract award. But when well into acquisition, the contract for Project JP129 was terminated signalling not just a failure by the contractor, but a failure of the requirements definition and acquisition process – a seminal lesson for all involved in capabilities development and acquisition. Since then, a new contract has been signed and the ADF is introducing the US Army RQ-7 Shadow UAS, procured through the US Foreign Military Sales program.

Apart from the introduction into service of the Shadow 200 and the foreshadowing of the acquisition of Triton, the ADF has acquired a further UAS –- the Heron MALE ISR UAS. But unlike the Shadow 200 and Triton which were subject to Defence's capability acquisition process, the acquisition of Heron arose from an urgent need to provide ISR support to air/land forces operating in Afghanistan.

The Heron MALE ISR UAS gathers intelligence, detects and identifies hostile elements, tracks prospective targets of interests, cues other military capabilities and facilitates fire support including close air support. It is a theatre level operational UAS supplied by a Canadian contractor but operated by the RAAF.

The Heron has proved invaluable in the conduct of operations in Afghanistan and while it was acquired purely on a need to provide theatre level UAS support, its success in the field has resulted in Heron being repatriated to Australia where it is assisting the ADF/RAAF to accrue more experience with UAS operations and to develop UAS operating doctrine and procedures.

Heron operations in both Afghanistan and Australia have highlighted the utility of the MALE UAS capability. They have also highlighted the need for a fast MALE UAS that can move quickly from one area of interest to another and for the UAS to carry appropriate high resolution sensors. Together with other lessons learnt from Heron operations, including from the associated ISR data management processes, Defence White Paper 2015 is likely to endorse the acquisition of a follow-on MALE UAS to the Heron.

Another role that should also be earmarked for consideration is the use of UAS as organic air operating from warships. The concept of naval helicopters operating from destroyer and frigates as organic naval air is well established. But helicopters are of short endurance and warships have a limited on-board aircrew complement, both of which limit the rate-of-effort that naval helicopters can sustain.

VTUAS capability with its step-change in endurance opens a new window for organic naval air capability.

VTUAS possess around four times the endurance of a manned helicopter, which translates into an ability to sustain long periods of over-the-horizon surveillance, a capability of immense value to a surface ship. Moreover, the unmanned VTUAS and the manned helicopter bring together an embarked complementary capability of enhanced unmanned surveillance, and manned helicopter tactical response.

Such a combination considerably enhances the operational effectiveness of destroyer and frigate-sized warships.

While the single aircraft hangar on the RAN's air warfare destroyer will limit the degree of exploitation of the VTUAS capability, the ANZAC frigate replacement would appear a prime candidate to operate both VTUAS and manned naval helicopters. Accordingly, two or more aircraft hangars should be mandated for the new ship.

Defence White Paper 2015 should also endorse an engagement program with the US Navy so as to facilitate the introduction into service of the VTUAS capability as the technology matures.

Defence White Paper 2015 might also flag VTUAS as a logistic resupply capability for embarkation on the two RAN Canberra Class Landing Helicopter Dock (LHD) ships, given the reasonable expectations that VTUAS will rapidly mature as a credible logistic resupply capability.

Should Australia Arm its UAS?

Less than a decade ago, the US commenced operations in Iraq and Afghanistan with armed UAS employing EO/IR/radar technologies to release precision laser-guided weapons and accurate Joint Direct Attack Munitions. Since then, the combination of precision attack and aerial persistence has further matured, raising the inevitable question as to whether such a capability is appropriate for Australia.

There appear two conceptual operational philosophies for the inclusion of an armed UAS capability in the ADF.

First, air power has long provided fire support to land forces through the tasking of tactical fighters and armed helicopters in “close air support” missions. The concept of close air support is well-established and prescribed in ADF operational doctrine. It is only a small step to add an armed UAS capability as a further element in the close air support delivery matrix where armed UAS with their long loiter capability add something to the more transient presence that “heavy hitting” manned close air support options bring.

Some questions remain regarding the survivability of armed UAS in certain operational theatres, although if downed by defensive fire, the armed UAS does not entail the loss of their piloting aircrew. So the question of acquiring armed UAS for fire support of land forces depends largely on whether they add operational value to an already existing capability, and merit the cost involved.

Armed UAS - Predator B "Reaper" [viii]

The second conceptual application for armed UAS involves their ability to travel long distances, loiter and strike otherwise difficult targets. The US has used armed UAS to target insurgents who have sought sanctuary across international borders or, outside a theatre of operations. While manned strike aircraft continue to be an option for such missions, the loiter capability of the armed UAS and its ability to execute such a mission without the risk of the combat loss/capture of aircrew, makes the capability attractive. Indeed many of these “pursuit-like” operations would probably not be countenanced if manned aircraft were to be used.

This second conceptual application for armed UAS also raises two other questions – questions that are not relevant when armed UAS are involved in close air support operations.

First, is the question of whether Australia is operating its armed UAS in accordance with the laws of war and other international conventions? Australia, unlike the US, cannot resort to the “might is right” argument which a superpower can use in making its own declarations of compliance with international laws and conventions.

Second, the existence of a long range armed UAS capability will have foreign policy implications as Australia’s neighbours are unlikely to agree with the notion that an armed UAS capability is no different from the long range F-111 strike capability that Australia possessed for 35 years. They might postulate that Australia’s manned F-111 aircraft were always constrained by the risks inherent in the combat loss/capture of aircrew. Hence warlike use of the F-111 strike force was always a constrained option of last resort only to be used when Australia's vital national interests were at stake. With no on-board aircrew at risk, an armed UAS capability might be seen as a relatively unconstrained capability, and a potentially more aggressive, destabilising capability.

With a long range armed UAS being seen as a less constrained capability and a capability that might run afoul of the emerging Missile Technology Control Regime, Defence White Paper 2015 will need to articulate a clear justification as to why it might endorse a long range armed UAS strike capability for Australia.

ADF Capabilities and UAS in National Support Operations

National support operations are those missions which do not require the exercise of warlike force but which are undertaken by the ADF in support of national interests. Such operations include search and rescue, border control, disaster relief both within Australia and overseas, fisheries surveillance, quarantine, etc.

These non-military and non-warlike operations are the role of constabulary forces and other government agencies using assets appropriate for their need. Examples include the aircraft, patrol boats and other vessels operated by the Australian Customs and Border Protection Service; the jet aircraft operated by an Australian Maritime Safety Authority; the fleet of aircraft and vessels operating in support of the Australian Antarctica Division; the heavy lift helicopters brought in seasonally to assist with Australian bushfire control; the vessels, aircraft and UAS supporting the Australian Fisheries Management Authority; etc. These assets are often supplied, maintained, and/or operated by contractors – a well-proven model.

Notwithstanding these national capabilities, ADF personnel and assets are tasked with national support activities, typically when the task is beyond the capabilities of the assets of the national agency. Examples include the use of RAN ships and RAAF aircraft to rescue yachtsmen in the Southern Ocean; the deployment of ADF capabilities in disaster support operations in Aceh and New Zealand; the employment of ADF capabilities in support of border patrol and control; etc.

So while there will always be legitimate calls for the ADF to be tasked with national support, such tasking comes at a cost as it involves the diversion of expensive assets, structured and trained for combat roles, to non-combat activities. Apart from the direct financial cost, there is the more debilitating consequence of the erosion of military skills flowing from the diversion of scarce military capabilities, such as AP-3C flying hours, to national support tasking – such is the "zero sum" nature of peacetime military training and resourcing.

Put simply, more peacetime search and rescue tasking for RAAF AP-3C aircraft means less training for essential defence roles such as anti-submarine warfare. Hence government needs to maintain the right balance between funding national agencies with economical and appropriate assets and resorting to the diversion of the ADF's expensive capabilities only when warranted.

To prevent the erosion of the ADF's combat capabilities, the following policy has generally been applied to national support operations:

- First, wherever possible, national non-combat roles are shed from the ADF to other more appropriate agencies, such as to the Australian Customs and Border Protection Service. Of note, the contractor managed Dash 8 fleet of aircraft flies more than 20,000 flying hours per annum, well over twice the rate-of-effort of the RAAF AP-3C force.

- Second, new ADF capabilities are justified and structured on the raison d'être of the ADF – combat operations and defence contingencies, not on potential national support roles. Consequently, the RAAF operates a fleet of highly capable AP-3C maritime patrol aircraft structured for maritime warfare, and not a fleet of Dash 8 maritime surveillance aircraft.

With the emergence of UAS, there is considerable scope for UAS to play an increasing role in national support tasks where their persistence, surveillance capabilities and economy of operation are advantageous. National support tasks such as border surveillance, fisheries surveillance, reconnaissance for emergency services operations, geographic and environmental survey, quarantine, bushfire assessment, bushfire response, etc, are prime candidates for UAS applications.

As a general observation, smaller and economical UAS will be increasingly seen in use by Australian constabulary forces and other government agencies – indeed a small contractor operated UAS has already being used in fisheries surveillance operations. Highly capable ADF UAS assets such as the MQ-4C Triton will be tasked to undertake national support operations, but only when the tasking is justified and beyond the capabilities already extant in Australian constabulary forces and other government agencies.

Future UAS Trends and Issues

There is no doubt that UAS will increasingly play a more prominent role in both military and non-military affairs. At the "high end" of the UAS spectrum, development will largely be driven by military needs especially those of the US military.

This is evidenced by continuing references in the US trade media to a range of classified military UAS initiatives that the US is developing as it seeks to maintain its long standing technological edge over global competitors.

At the policy level, the US continues to support the development of military UAS capabilities as noted in a recent report by the Center for Strategic and Budgetary Assessments (CSBA). Led by Deputy Defense Secretary Robert Work, the CSBA identified the need for a new family of US unmanned combat air systems (UCAS). These UCAS together with a stealthy long range strike bomber force and a submarine force are proposed as the three foundational elements of a new US defence force posture. These UCAS developments will no doubt have implications for the ADF as the technologies mature and are released by the US to close allies.

At a less sophisticated level, technological advances will see an increasing number of capable and economical UAS being marketed for wide range of potential uses. When combined with new miniaturised payloads and sensors, these UAS, of increasing flexibility and utility, will no doubt find their way into Australia's constabulary forces, government agencies and civilian enterprises.

The sheer number of UAS and their versatility will place considerable pressure on the current regulatory UAS environment to accommodate an expanding range of UAS applications.

While at the low and "micro end" of UAS, innovation and technology have combined to unleash a surge of uncertified and unregulated UAS into a marketplace which has an unsatisfied thirst for new technologies. Existing national UAS regulatory schemes have tried to contain these small UAS by approving unlicensed operations, generally at very low altitude, but whether such an approach can continue to be viable is unclear especially as these small affordable UAS gain flexibility and capability.

Concluding Observations

Australia has long sought to base its decisions on the future structuring of the ADF on a robust strategic base, guiding the process through the publication of regular Defence White Papers and related policy documents.

Apart from variations in style, presentation and emphasis, these policy documents have resulted in a fairly consistent result, with the ADF continuing to consist of a range of flexible capabilities well-suited to Australia's geographic, geopolitical and regional environment.

Perhaps the only substantive matter of debate is how far Australia should seek to extend its capability for expeditionary operations, especially autonomous expeditionary operations, these operations being complex, difficult, risky, and resource intensive.

Over recent years there has been an upsurge in the military use of UAS which reflects the increased sophistication and maturity of UAS, together with an emerging confidence by the military in UAS capability.

Certainly, UAS are a credible military capability and their impact will be as marked as such previous step-changes in aviation such as the all-metal monoplane, the swept-wing, the jet engine, the precision-guided-munition and the digital microprocessor.

UAS have already brought a new dimension to the operational theatre – aerial persistence. This step-change makes the UAS an excellent platform for ISR roles, as evident by the direction being currently taken by the ADF.

UAS will likely take on more operational roles although the manned aircraft has not been superseded by UAS. Many airborne operations, especially the complex, dynamic and interactive missions, still require the presence of human intelligence and human judgement.

Indeed, a new paradigm is emerging; one of complementary manned and unmanned air capabilities working together to exploit the advantages of both the manned and unmanned air capabilities, with the bonus of UAS not exposing aircrew to risk.

And UAS are certainly affordable; but they will require the acquisition of new support capabilities and personnel without which, the perishable product from UAS operations cannot be captured, processed or disseminated.

The emergence of new smaller UAS capabilities, generally sophisticated and capable, also foreshadows the increasing usage of these UAS in various national support tasks, especially in those constabulary forces and other government agencies that do not require a military or warlike capability.

But most significantly, the ADF is beginning to grasp and exploit the new opportunities that UAS will deliver – a result no doubt stimulated by the experience the ADF gained from operating the Heron MALE UAS in Afghanistan.

Canberra, Australia
12th December 2014

The Author - Brian Weston, AM, FRAeS

Brian Weston's air force career spanned 34 years, concluding in July 1997 when on completion of his appointment as Assistant Chief of Defence Force for Operations, he transferred to the RAAF Reserve.

Subsequently in 1998 following the Black Hawk mid-air collision, with John Faulkner - Deputy Chair of Air Services Australia, he conducted an *Independent Review of ADF Airworthiness*. In 1998 he joined *Australian Business Limited* as *Executive Director Defence Industries* and held the appointment of *Executive Director of the Association of Australian Aerospace Industries.*

He was the inaugural *"Industry Chair"* of the *Defence Capability Advisory Forum* from 1999 to 2003, and was a member of the *Defence and Industry Advisory Council* chaired by the *Minister for Defence* from 2001 to 2003.

From 2001 to 2004 Brian Weston was a non-executive director of National Air Support, operating the Coastwatch fleet of aircraft for the Australian Customs Service, and served as Chair of the SAI Global Certification Board from 2002 to 2014. He has been consulting to Northrop Grumman since 2004.

In 2003, he consulted to the Australian Strategic Policy Institute in drafting the ASPI paper "The Big Deal" - the decision to acquire the Joint Strike Fighter. Under the aegis of the RAAF Aerospace Centre he published a concise history of the Australian aviation industry and in 2013 he published a *"Coming of Age for Australia and its Air Force"* a commentary on the air operations at Darwin of No 1 Fighter Wing RAAF, in 1943.

His professional and related qualifications include a BSc, and MBA. He is a graduate of the USAF Air Warfare College, the Royal College of Defence Studies London, and served as a member of the Directing Staff of the Australian Joint Services Staff College.

He spent eight years as an honorary visiting fellow to the School of Aerospace, Mechanical and Civil Engineering and the School of Engineering, Information and Technology at the UNSW@ADFA.

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[i] Directory of U.S. Military Rockets and Missiles, 2002-2003, Reconnaissance RPVs (http://www.designation-systems.net/)
[ii] http://www.uasvision.com/2011/05/28/ dated May 28, 2011 by The Editor
[iii] Courtesy of Northrop Grumman
[iv] "The kill chain: Australia's drone war", ABC News, Wed Jun 27, 2012, http://www.abc.net.au/news/2012-06-08/australias-drone-war-in-afghanistan/4058058
[v] Australian Department of Defence WWW Site, Media Gallery
[vi] Courtesy of Northrop Grumman
[vii] Australian Department of Defence WWW Site, Media Gallery
[viii] Reaper exhibit opens at Air Force museum, Posted 1/26/2010 (http://www.af.mil/news/story.asp?id=123187210)