NORTHROP GRUMMAN AUSTRALIA

USE OF UNMANNED SYSTEMS BY THE AUSTRALIAN DEFENCE FORCE

A Paper which examines the potential use by the Australian Defence Force of unmanned air, maritime and land platforms

Ken Crowe

2/1/2015

On 28 October 2014, the Australian Senate referred this issue to the Foreign Affairs, Defence and Trade References Committee for inquiry and report by 25 June 2015. This Paper examines the potential use by the Australian Defence Force of unmanned air, maritime and land platforms, with particular reference to their role in intelligence, reconnaissance and surveillance (ISR) operations. Unmanned Ground and Underwater Systems are examined in brief, however the majority of effort is focused on Unmanned Aircraft Systems (UAS) in terms of their cost, effectiveness and other important factors relevant to the Government's force structure review and defence capability planning.

USE OF UNMANNED SYSTEMS BY THE ADF

Roles for Unmanned Systems

Although in the Australian context, the term "unmanned systems" has generally applied to unmanned aircraft systems (UAS), dubbed “drones” by the media, the term unmanned systems encompasses all domains; air, land and maritime – a fact sometimes forgotten in Australia where unmanned technology has too often been seen as only an aerial technology. In other developed nations, unmanned technology has been long used in air, land, naval surface and subsurface warfare.

Figure 1 - Unmanned Systems Span Maritime, Air and Land Domains

The capabilities of unmanned systems are generally not unique, and there are few Australian Defence requirements that only unmanned systems can meet. However, unmanned systems provide persistence, versatility, survivability, and reduced risk to human life; and in many cases are the preferred alternatives especially for missions that are characterized as “Dull, Dirty, or Dangerous”.

Unmanned Systems are ideal for Dull, Dirty & Dangerous missions

- Dull: Long duration ISR, airborne search and rescue, and data collection
- Dirty: Chemical, biological, and nuclear detection
- Dangerous: High risk in potentially lethal air, underwater or ground environments

Dull missions might include lengthy intelligence, surveillance and reconnaissance (ISR) missions that involve prolonged periods of monitoring and observation. Dirty missions are those that might expose personnel to hazards, such as when undertaking chemical, biological, and nuclear detection operations. Dangerous missions are those that might be conducted in lethal operational environments. Unmanned systems perform all of these missions with far less risk to the operating personnel.

In a global context, use of unmanned systems continues to grow at a rapid pace – the last decade seeing an exponential increase especially in UAS, primarily performing ISR missions, and with increasing use in command and control, communications relay, battlespace awareness, force protection, ordnance delivery and logistics.

Unmanned systems expand military capabilities, improve situational awareness, reduce human workload, and minimize risk to civilian and military personnel. With further advances in technology, both the scope and capability of unmanned systems will increase, which represents both a challenge and opportunity for Australia in seeking out how best to incorporate these new technologies into the future force structure of the Australian Defence Force.

Unmanned Underwater Systems

Undersea warfare (USW) is one of the most demanding and dangerous operational environments, and one of the key domains where Australia needs to develop a decisive capability edge. The US Navy has long recognised the contribution unmanned underwater vehicles (UUV) can make to USW and has outlined an ambitious set of plans to develop the unmanned technologies that it needs in future USW.

In 2004, the US Navy released a UUV "master plan" that is still relevant. The master plan identifies nine USW missions: ISR; mine countermeasures (MCM); anti-submarine warfare (ASW); inspection and identification; oceanography; communication/navigation network nodes; payload delivery; information operations; and time-critical strike.

Closer to home, ASPI has produced an excellent paper which notes the need for Australia to develop unmanned underwater technologies:

> *"UUV already offer valuable functions for naval operations and the current interest in the US suggests these systems could become a higher priority for investment. While Australia should focus on UUV with proven capabilities in MCM and oceanography, we should also keep a keen eye on developments in ISR and ASW capabilities."*

A replacement fleet for the Collins Class submarine would consume a huge proportion of Australia's Defence budget and the complementary contribution that UUVs can make to overall USW mission effectiveness needs to be established as an integral part of the force development process.

Unmanned Underwater Vehicles or UUVs

- UUVs operate in the most extreme underwater environments.
- They are uniquely suited to Undersea Warfare and the technology has been targeted by the US for further development
- UUVs have the potential to complement a Submarine Force, making the overall capability more effective at significantly lower cost.

Unmanned Ground Systems

Unmanned Ground Systems (UGS) are defned as powered physical systems with no human operator aboard the principal platform, which can act remotely to accomplish assigned tasks. UGSs may be mobile or stationary, smart, learning and self-adaptive. UGSs include the commonly recognised Counter IED robots which perform a key role in protecting Australian and Colaition troops; unattended ground sensors which can detect enemy troops' movements and send a warning signal; and very soon, war-fighting unmanned vehicles.

Ground-based robots have proven their worth in Iraq and Afghanistan across a spectrum of mission areas and the US, as the leading developer of unmanned systems, will continue development of these systems. Over US$230m has been budgeted by the USDoD for UGS development and production over the next four years.

Figure 2 - Unmanned Ground Systems Perform a Variety of Critical Military Roles

There are a wide range of UGS applicable to Australian military operations. Their advantageous use has already been established by operational precedents, and their further development, especially for employment in Army, special forces and counter-terrorist agencies, should be pursued. Current UGS have tended to focus on smaller and easily deployable systems, but the adoption of larger UGS, on the same scale as existing vehicle types to be introduced under LAND 400, clearly needs to be further assessed and prioritized.

Unmanned Aircraft System

An Unmanned Aircraft System (UAS) is a "system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft". Of all the myriad types of unmanned systems, UAS tends to attract the greatest level of investment and development effort from both Military and Civil institutions. One industry analysis and forecasting group estimates worldwide UAS spending will almost double over the next 10 years to a total of US$89B. Interestingly though, a comparison of USDoD funding plans versus industry predictions indicates DoD will not be the bulk user within that market. However, the Military does tend to be the most innovative user of UAS, and the capability edge and cost savings delivered through the use of UAS are decisive for Defence applications.

Figure 3 - Global Investment in UAS Technology is estimated at greater than US$80 Billion over the next 10 years

UAS benefit greatly from not having to include those accommodation, life-support, human-machine interface and communication systems necessary in manned aircraft. As a result, UAS are much lighter than comparable manned aircraft and so gain a much enhanced endurance; around two, three of four times the endurance of comparable manned aircraft. Moreover, after subtracting those flight hours needed to transit to and from operational areas, UAS can stay "on station" many times longer than a manned aircraft. So with an "effective time on station" much longer than a manned aircraft, UAS have made aerial persistence an operational reality. When taken with the ability of UAS to elevate capable sensors to altitude, it is not surprising that UAS are seen as the ISR system of choice.

But while unmanned systems are making a considerable impact on the nature of military operations, it is important to recognise that they have not replaced manned aircraft which are still needed for a range of operational roles. Indeed, a new force structure paradigm has emerged which sees manned aircraft and unmanned aerial systems working in a complementary fashion, to maximise overall operational effectiveness, and to minimise the risk to aircrew. The US Navy has adopted this approach in the development of its future combat, surveillance and rotary wing capabilities. Analysis, combined with a significant amount of operational experience has proven that a "Hybrid Fleet" of manned and unmanned systems delivers a higher level of capability at significantly lower operating costs.

Cost and Combat Effectiveness of Unmanned Systems

Unmanned systems' unit capital costs largely depend on the size and complexity of the system. Structural and propulsion issues are generally proven and involve low risk technologies, although with UAS, airworthiness issues are often incompletely understood and underestimated.

Sensor fit and operational systems such as communications range from cheap and simplistic to the most technologically advanced and highly capable. Notwithstanding, up front capital comparisons with manned aircraft are often misleading as they are rarely based on a credible comparable operational metric, such as "surveillance product per square km"; rather simply being based on the "cost per flight hour" a measure that often bears little relationship to the "cost per unit of operational capability".

Unmanned Aircraft System or UAS

- Persistent Surveillance is one of the key advantages of Unmanned Systems.
- UAS' characteristics of persistence, endurance and altitude deliver lower surveillance costs per km^2, also reducing risk to human life.
- UAS complement, rather than replace manned aircraft.
- A hybrid fleet of manned and unmanned assets delivers significant advantages in terms of operating costs, and capability

The assertion that UAS are "cheaper" to buy or operate is overly simplistic and misleading. Operators of military aircraft systems may point out that a fleet of UAS requires a significant number of ground based operators to analyse the enormous amount of data collected by the systems, and to support missions spanning 24 hours or longer. However, this characteristic of UAS is their key strength: the capacity to generate prodigious amounts of extremely useful ISR data, at ranges far beyond the capability of normal manned aircraft, for durations that exceed human levels of endurance by an order of magnitude.

Persistence and range are critical factors in maintaining surveillance over Australia's enormous area of responsibility. The longer endurance of a UAS, and hence its greater effective time on station (or persistence), delivers far greater ISR value at lower overall operating cost per square km than the equivalent manned aircraft system attempting to perform the same mission.

Even with this inherent advantage, unmanned systems tend to be significantly cheaper to operate per hour as they involve fewer operating personnel, lower fuel costs and lesser maintenance costs; and these lower costs when measured on a credible operational metric such as "ISR product per square km", are invariably lower than for manned systems.

Implications of Unmanned Systems for the Force Structure Review

Australia's geostrategic circumstances, particularly its expanse, its vast sea/air approaches, its export/trading economy and its proximity to Southeast Asia stress the importance of range, endurance, surveillance and intelligence; all attributes well-suited to the use of unmanned systems. These factors point towards the use of UAS, especially in ISR operations, as exemplified by the logical decision to base Australia's future maritime air warfare capability around the complementary capabilities of the MQ-4C Triton UAS and the P-8A Poseidon manned aircraft – this combination building on the excellent ISR capabilities of the UAS while retaining the manned P-8A as the "maritime response" option.

Figure 4 - The Unmanned Triton ISR Aircraft is the perfect complement to the Manned Poseidon ASW Platform

A similar operational concept is emerging as the way forward for naval air operations which are presently restricted by the short endurance of manned naval helicopters. The US Navy has recognised this inherent limitation by funding the development of the MQ-8C Fire Scout vertical take-off UAS (VTUAS), a rotary winged unmanned air vehicle able to operate from the decks of warships and which has a flight endurance of greater than 12 hours, many hours more than embarked naval helicopters.

The addition of a small number of unmanned helicopters with significantly greater levels of persistence and range, to a highly specialized fleet of ASW helicopters such as the MH-60R creates a "system of systems" with an overall level of utility that far exceeds the capability of the individual components. The demanding ISR mission is offloaded to a robotic helicopter which is ideally suited to the task, while the complex response and combat mission is retained by the manned helicopter.

Studies show that the contribution of the unmanned aircraft significantly reduces the overall fleet cost, delivers higher levels of ISR and extends the life of the expensive manned assets by a considerable margin. It provides the warfighter with additional mission flexibility, and reduces risk to human life in an unforgiving and sometimes extremely hostile operating environment.

The Force Structure Review will no doubt be considering the endorsement of such a capability which combines the complementary capabilities of the MQ-8C Fire Scout VTUAS with the capabilities of the manned MH-60R Seahawk naval helicopter – both operating from the flight deck of the future ASW frigate (Project SEA 5000). The consideration of an unnamed adjunct to the MH-60R is under active consideration by the RAN and should be encouraged.

Maritime Unmanned Technology. Although "open source" data on UUVs is not readily available, the potential impact of this unmanned technology on maritime and submarine operations will, no doubt, cause the Force Structure Review to flag future developments in UUV as critical to Australia's future maritime warfare capabilities. At the very least, it should recommend that Australia, as a junior partner, seek to join with the US in the development of technologies that will be critical to Australia's future defence capabilities.

Land Unmanned Applications. Similarly, UGS can be expected to impact on future land operations; particularly for a nation that has a small manpower base and seeks to de-risk as much as possible, casualties from land operations. Indeed, it is timely that Australia places more emphasis on UGS than it has previously done.

Finally, in coming to cost versus capability judgements on unmanned systems, the Force Structure Review needs to be cognisant of using misleading costing models. "Cost per flight hour" is a misleading comparative basis when many of the flight hours are used for unproductive transit or for aircrew training. A more accurate comparison would use metrics such as "Cost of the ISR product generated per square km". Such a shift in perspective is essential and part of the cultural shift needed to ensure that Australian force structure reviews no longer simply focus on platforms, but systems.

Opportunities and Risks Regarding Unmanned Systems

As already indicated, unmanned systems provide an opportunity to greatly enhance Australia's ISR capabilities, which leads to improved strategic awareness and more accurate intelligence. Even in times of peace, these capabilities enable the early detection of shifts in geo-strategic capabilities, national policies and leadership attitudes.

But it is important to note that while unmanned systems greatly enhance Australia's ISR capabilities, such enhancement is dependent on a capable and sophisticated processing, exploitation and dissemination (PED) capability. The risk is that "front end" platform investment without the "back end" investment in supporting data processing and analysis systems will do little to improve national capabilities. ISR data is perishable; it must be processed and analysed quickly, then speedily passed to decision makers and end users. That is the role of a PED capability – without a co-investment in PED to match the platform procurement, the risk is that the value of the overall capability is diminished.

Research, Development and Industrial Issues Related to Unmanned Systems

While the Australian research organisations and industrial base lack the scope and depth to cover all areas of unmanned systems development, Australian research organisations and industry do have the skills to become significant players in niche areas related to unmanned systems development. And given that unmanned technology is a new industrial "mega-trend" Australian research, development and industrial organisations need to be given suitable incentives as a way of establishing themselves and exploiting opportunities in this new industry.

But the reality is that most major unmanned systems developments are likely to occur overseas, and especially, be driven by the US defence/industrial base. This should not be an impediment to Australian industrial involvement, as there is considerable scope for Australia, through its ANZUS defence alliance, to seek cooperation with the US regarding early Australian involvement in defence related unmanned system developments, especially those which may find their way into the ADF.

In particular, Australia should seek involvement in:

- unmanned systems co-operative development programs with US partners;
- unmanned systems research, trials and demonstration programs;
- the development of supporting unmanned systems technologies, such as software, communication or sensor technologies; and
- the development of the supporting PED systems and data processing technologies, without which unmanned systems will largely be ineffective.

Unmanned Systems Priorities

- Investment in Unmanned Programs is increasing rapidly in a globally competitive marketplace. This is especially true of UAS.
- Australia should seek opportunities to participate in development programs, leveraging the huge global investment
- The development of niche industries focused on better utilizing unmanned systems should be prioritized.

As well, there will always be scope for Australian in-country support of UAS operations, and for the involvement of certain Australian specialist and niche industries.

But realistically, as the range, pace and depth of unmanned technological developments will tax the capabilities of Australia's relatively small military/industrial base, the most sensible and cost effective approach is for Australia to seek to collaborate with the US and the other trusted allies, as a contributing junior partner, in selected and appropriate unmanned programs.

Policy and Legal Considerations

Unmanned systems bring few new international policy and legal considerations into play, as most defence and "warlike" capabilities are already governed by the laws of war and the conventions of conflict, such as: just cause; proportionality of response; minimisation of collateral damage; avoidance of civilian casualties; etc.

The main policy issues with unmanned systems are likely to arise in situations short of declared conflict when armed unmanned systems are used to strike targets which were previously beyond the technological capabilities of a military force, but which unmanned systems have now brought into range; such as the decapitation of a hostile leadership in situations short of war.

Airworthiness Issues Regarding UAS

One topical issue, especially with UAS, is the airworthiness of such systems. Current airworthiness standards, of which there are generally two – the NATO standard and the US military standard – treat UAS much the same as manned aircraft. There is a need to evolve these airworthiness standards to specifically address UAS and there is a need to achieve some rationalisation of the two current airworthiness standards, much of which relate to "safety of flight issues" when operating in airspaces used by manned aircraft.

Airworthiness is still a work in progress and will likely be impacted by new and emerging technologies that are applicable to UAS.

Conclusions

Unmanned systems have arrived, and will play an increasing part in Australia's defence capabilities.

In particular, Australia should:

- assess the future applicability of unmanned systems, not simply on a platform basis, but on their effectiveness in fulfilling Australian military roles and tasks;
- adopt an innovative and forward looking philosophy seeking to identify future applications for unmanned systems at the earliest stage in their development;
- foster the use of co-operative programs with the US, regarding demonstrations, trials, and the development of unmanned systems, with a view to not only exploiting those technologies in the ADF but of ensuring the earliest Australian research and industrial involvement in such programs; and
- identify specifically the VTUAS capability as a priority early development program for Australia, and seek substantive Australian involvement.

Bibliography:

1. US DoD Unmanned Systems Roadmap 2013 (Number:14-S-0553, 2013)
2. Underwater drone fleet’s budget nearly doubled by the Pentagon — RT USA. 2015. Underwater drone fleet’s budget nearly doubled by the Pentagon — RT USA. [ONLINE] Available at: http://rt.com/usa/underwater-drone-fleet-doubled-pentagon-698/. [Accessed 12 January 2015].
3. ASPI Strategist: "The unmanned underwater future" Apr 2014, Rosalyn Turner (The unmanned underwater future | The Strategist. 2015. The unmanned underwater future | The Strategist. [ONLINE] Available at: http://www.aspistrategist.org.au/the-unmanned-underwater-future/. [Accessed 12 January 2015].
4. A Survey of Missions for Unmanned Undersea Vehicles by Robert W. Button, John Kamp, Thomas B. Curtin, James Dryden
5. The United States' Center for Strategic and Budgetary Assessments (CSBA) strategy Publication "The US Navy: Charting a Course for Tomorrow’s Fleet", February 17, 2009, Robert Work (The US Navy: Charting a Course for Tomorrow’s Fleet | CSBA. 2015. The US Navy: Charting a Course for Tomorrow’s Fleet | CSBA. [ONLINE] Available at:http://www.csbaonline.org/publications/2009/02/us-navy-charting-a-course-for-tomorrows-fleet/. [Accessed 12 January 2015].)
6. DoD, D. o.-U. (2004). The Navy Unmanned Undersea Vehicle (UUV) Master Plan. US Navy.
7. Number:14-S-0553, U. D. (2013). Unmanned Systems Roadmap. US DoD.
8. USDoD Joint Publication (JP) 3-52, Joint Airspace Control, 20 May 2010