Closing the gap: tactical UASs set to muscle in on MALE mission space

As their capabilities have grown, tactical UASs have found themselves in a position to undertake some of the missions previously reserved for larger platforms. Huw Williams examines the enabling factors.

Tactical unmanned aircraft systems (UASs) generally operate away from the limelight, rarely gaining the attention afforded to their larger medium-altitude, long-endurance (MALE) cousins. However, while MALE systems are often presented as the face of UAS technology, it is fair to say that Group 3, tactical-level systems are the workhorses of most militaries’ fleets.

These aircraft are providing an increasingly sophisticated range of intelligence, surveillance, and reconnaissance (ISR) capabilities and are a far cry from the systems in service 15-20 years ago, when they were for the most part employed by specialist artillery units in battle damage assessment and reconnaissance roles. Nowadays the most advanced tactical UASs can take on a number of missions that were previously the preserve of MALE platforms.

Elbit Systems’ Hermes 450 is an operationally proven platform, having gained extensive experience with the Israel Defense Forces and the British Army in Afghanistan, among others. (Elbit Systems)

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Engine issues
Much of the focus in developing UASs has been on payloads and operational capability, with relatively little attention paid to powerplants. In many cases engines on board tactical UASs have been ported across from other applications rather than being designed specifically for this purpose. This has resulted in a gap between available and required performance; furthermore, many aircraft losses have been attributed to powerplant issues. As such, a number of notable efforts are under way to re-engine platforms, as well as to develop new units.

Insitu has worked with Australia-based Orbital UAVE to develop a bespoke unit for its ScanEagle platform. The specifications for the new heavy-fuel engine - which Orbital claims is the first reciprocating internal combustion propulsion system to be engineered from the ground up for UASs - were based on experience from 800,000-plus flight hours undertaken by ScanEagle.

_Orbital UAVE and Insitu have developed a bespoke engine for the latter’s ScanEagle - more UAS-specific powerplants are set to come to market. (Insitu)_

The engine is fitted with Orbital’s Argon engine control unit (ECU) and control system and its FlexDI technology.

Advanced features of the ECU, which has been developed specifically for UAS applications, include real-time monitoring and diagnostics of all critical systems, redundancy in the sensors and actuators, and a black box recording capability.

The FlexDI technology is designed to provide advanced spark ignition for heavy-fuel engines along with air-assisted direct injection. Further capabilities include automatic altitude compensation, improved fuel efficiency (up to 30%), a cold start capability that has been demonstrated at -35°C Celsius, low combustion noise, and the ability to work with two- and four-stroke engines. The engine is also designed to have low vibration and noise suppression.
The unit will be fitted to Insitu's new ScanEagle 2 as standard and be available as a retrofit for existing models.

A prime example of how improvements to engines have been introduced in this class of UAS is embodied in Textron Systems' (formerly AAI's) RQ-7 Shadow, which is employed by the US Army and Marine Corps (USMC), as well as branches of the Australian, Italian, and Swedish armed forces.

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**Onboard power**

The latest operational Shadow variant - the RQ-7B V2 - is significantly more capable than earlier models. The V2 is representative of the changes made by manufacturers to react to operational requirements. (Textron Systems)

Capable powerplants are not only required to support flight performance but are essential if enough onboard power is to be provided for the payloads that operators expect on the latest platforms, "It's a two-sided sword, we are trying to maximise the amount of power we can provide, and payload manufacturers have to do their best to reduce the amount of power they require," Henry Finneral, Textron Systems' vice-president of tactical UAS, explained, adding, "We're taking a significant step forward, right now we offer 2,000 W of power on the Shadow [RQ-7B V2]. It enables us to introduce capabilities like the L-3 Wescam MX-10 HD payload."

How to address increasing onboard power requirements is a challenge across industry. "Although we are making the UAVs [unmanned aerial vehicles] bigger, we still have more demand regarding power consumption, volume, and most significantly, weight," explained Elad Aharonson, executive vice-president and general manager of Elbit Systems' ISTAR Division, "so we are now struggling [to work out] how to put several sensors and antenna arrays on the same platform ... the customer
wants more than one payload - sometimes more than two - simultaneously. There are some limitations with the power consumption, but mainly with the weight, because the weight affects endurance."

Few companies have the pedigree in the UAS field that Elbit Systems has with its Hermes 450 platform, which is billed as a long-endurance tactical UAS. The system has accrued extensive operational experience with a number of customers, notably the Israel Defense Forces and the British Army in Afghanistan; the platform forms the basis of the latter's Watchkeeper.

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Schiebel's Camcopter S-100 has carved a niche as the leading rotary-wing tactical UAS, and has found particular utility in the maritime domain. (Schiebel)

**Multiple payloads**

Developments in payload technology that have reduced size, weight, and power (SWaP) requirements are a key enabler for a much wider range of capabilities now available to operators of tactical-level UASs, such as advanced electro-optical/infrared (EO/IR) payloads, a range of electronic warfare (EW) and intelligence-gathering systems, and communications relays, along with small synthetic aperture radar (SAR) - many of which incorporate ground-moving target indicator (GMTI) technology - munitions, and others.

Missions that emerged in Afghanistan in particular have driven a number of payload developments, such as the introduction of SAR technology to assist in counter-improvised explosive device (C-IED) work. For example, the Copperhead system was developed under a US Joint Improvised Explosive Device Defeat Organization (JIEDDO) programme, aimed at providing
a C-IED capability principally by detecting soil disturbance: often symptomatic of the emplacement of IEDs.

The US Navy’s (USN’s) Naval Air Systems Command (NAVAIR) had responsibility for the development of the system and US Naval Reserve elements for its operation. The system takes the form of a MiniSAR to provide the change detection capability, primarily for the detection of IED command wires positioned alongside roads. In Afghanistan the payload - which is now in its Copperhead II iteration - was integrated on the TigerShark UAS.

The US Army is also pursuing this technology and contracted ImSAR to conduct research and development into the integration of SAR on small UASs in 2014 and previously undertook work examining the use of a downsized version of Northrop Grumman's AN/ZPY-1 STARLite radar on board Shadow. Sandia National Laboratories has transferred the technology from the Copperhead to the US Army. Thales’ I-Master ground surveillance SAR equips the British Army’s Watchkeeper.

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**Modular designs**

Modularity and the ability to integrate multiple payloads simultaneously have emerged as design aspects that are necessary to meet the demands of operators. Through its Shadow M2, Textron is looking to provide greater flexibility to customers.

The M2 is set to feature two different core configurations, one of which introduces a satellite communications (SATCOM) capability. The aircraft has a blended-wing design and a larger fuselage and tail than the RQ-7B V2. The fuselage incorporates an internal payload area that can accommodate either extra sensors or a fuel bladder. It can also be fitted with payloads on wing hardpoints. These enhancements will enable the M2 to take on a wider range of mission sets and ultimately some of those currently undertaken by MALE UASs.

The under-nose payload space remains in both configurations, as does the ability to fit systems to wing hard points, however, the SATCOM configuration introduces a bulge to the nose of the aircraft and does not utilise the second payload bay. The standard, non-SATCOM configuration has a greater payload capacity as it can take advantage of the extra space.

The dual bays can accommodate a range of payloads including EO/IR packages with various laser-based ‘tools’, and SAR/GMTI, among others. Previously, Textron officials confirmed that they had worked with Northrop Grumman to examine the integration of the AN/ZPY-1 STARLite payload on board the M2, but had not flown the aircraft with that system.
The M2 Shadow has a modular design with multiple payload bays and hard points. It can also be configured with a satellite communications system. (Textron Systems)

Wing-mounted payloads are set to include SIGINT and COMINT systems, EW packages, chemical, biological, radiological, nuclear and explosive (CBRNE) detection devices, and even munitions: the M2 has been used as a launch platform to test Textron's Fury free-fall munition. The M2 will also feature the TCDL.

Even the smaller members of the tactical class have introduced designs that enable them to be equipped with multiple payloads that can be swapped in and out with relative ease. The USMC's Insitu RQ-21A Blackjack is described as being a small tactical UAS (STUAS) and provides a land and maritime ISR capability. The aircraft's primary payload is carried in a nose bay, but systems can also be integrated in the centre-of-gravity bay (which has the highest capacity), wing/winglet bays (each wing contains two payload spaces: one on the wing and one on the winglet), and a single hardpoint on each wing. All have power and ethernet connections.

In addition to the EO/IR systems, the baseline payload includes a mid-wave IR imager, an IR marker, and a laser rangefinder.
One advantage brought by the likes of the RQ-21A is its ability to deploy and be recovered within a limited footprint and independent of a runway. (US Navy)

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Survivability

Fabrizio Boggiani, director of marketing and sales for Finmeccanica's Airborne and Space Systems Division, points to an emerging design concern for tactical UASs that Finmeccanica is looking to address - survivability. "These assets are a target from ground-based countermeasures, so this means they have to be protected against threats, including electronic attack … electronic protection is a much more significant [issue] now on these types of air vehicles."

According to Boggiani, threats that have to be addressed include kinetic effects and various forms of EW, such as jamming datalinks and GPS. He added that the use of SATCOM systems can go some way to countering certain methods of electronic attack.

Falco is arguably Europe's most advanced fielded tactical system and has seen service in a variety of environments, including in support of UN operations in the Democratic Republic of Congo. (Finmeccanica)

The integration of traditional defensive aids suites on tactical UASs will be a challenge, principally due to their SWaP requirements. It is likely that unless these packages are miniaturised, tactical platforms will have to rely on their physical characteristics - relatively small size and thermal signatures - to evade kinetic effects.

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Offensive roles

Weaponising UASs continues to be a contentious issue and few platforms have deployed munitions in anger. In the past, this may not have been of concern for tactical systems, as they were unable to carry the munitions that are employed by larger UASs - such as the Hellfire missile.

However, as has been the case with payloads, manufacturers have developed small munitions that can be fitted to tactical systems, with both modified and entirely new weapons produced.

Boggiani said that Finmeccanica has recognised the demand for arming this class of UAS, but are aware of the SWaP issues that this presents and the potential impact on the primary mission set of the aircraft. As such, he believes that there may be the case for mixed fleets of UAS, with base...
platforms configured for the ISR and strike roles separately, but operating with the same ground control elements and support infrastructure.

Finneral believes that it is more a case of 'when' rather than 'if' tactical UASs will be armed, "I hear from many of the users that they would love to have that immediate response capability. I think it's ready, we have done a lot of work via internal funding to prepare that capability and we are ready for when our customer says they want it. I think that investment represents where we believe it is heading."

In the case of the Shadow UAS, the focus for arming the platform at present is on the integration of Textron's Fury, which has been developed in co-operation with Thales UK, where it is known as the Free Fall Lightweight Multirole Missile (FFLMM).

Fury is among a new crop of munitions that are being aimed at use on board tactical-level UASs.

The push for the development of smaller munitions has come from a number of factors; notably the recognition that on operations in Afghanistan, these aircraft often came upon potential targets during their ISR missions that at the time, they were unable to prosecute. Furthermore, many of the targets being engaged do not require the effect offered by the likes of Hellfire. Therefore, a smaller and lighter munition - which can routinely be carried by a tactical UAS alongside its ISR payload - could be deployed on the battlefield.

Textron and Thales are among a number of established manufacturers that have entered the UAS munitions fray. Notable efforts are under way in the United States at Raytheon and Lockheed Martin, and by South Africa's Denel. Elsewhere, China's defence industry has been quick to provide weapons for its burgeoning crop of UASs, while Pakistani and Turkish companies have also made progress. Israel remains guarded about its UAS weaponisation efforts, with neither the military nor industry confirming which platforms have been weaponised or which munitions they deploy.

The Textron/Thales programme is one such system that draws on technology developed for other weapons, bringing together parts of Thales' Lightweight Multirole Missile and Textron's G-CLAW, which is a semi-active laser (SAL) precision-guided weapon.

According to Textron, Fury offers 1 m precision on static and moving targets and uses a mature warhead that was made for Thales' LMM; it is effective against soft targets up to lightly armoured vehicles.

Fury is a compact, free-fall munition that is 68 cm long and has an all-up weight of 5.8 kg, including a 1.8 kg blast fragment, shaped charge warhead. Furthermore, in addition to the SAL it features Selective Availability Anti-spoofing Module GPS/INS terminal guidance. It is also fitted with a Textron-developed operator selectable tri-mode fuze, with options of impact, height-of-burst, and delay detonation. Sources state that it has a range of around 4.5 km at a launch altitude of 10,000 ft.

The variant marketed by Thales UK, the FFLMM, is non-International Traffic in Arms Regulations (ITAR) compliant.

Successful tests of the munition have taken place at the Yuma Proving Ground in Arizona, with Shadow M2 and RQ-7B used as testbeds. The first set of trials struck within 2 m of the target, while the second achieved a circular error probable of around 1 m, according to Textron. The
company is now focusing on the development of a multi-pack rail that will be able to carry three Fury rounds and be fitted to a Hellfire launcher.

A number of munitions under development are in much the same guise as Fury, with Raytheon's Pyros (formerly Small Tactical Munition) and Lockheed Martin's Shadow Hawk targeting the same mission set and being of a similar configuration.

According to Raytheon sources, Pyros has been integrated on the Navmar Tigershark for the USN, Insitu's Blackjack for the USMC and the RQ-7B Shadow for the US Army.

Significant progress in arming tactical UASs has been made in Turkey, with Roketsan's Smart Micro Munition (SMM) being successfully launched from a Bayraktar TB2 UAS in December 2015. SMM leverages technology developed for Roketsan's UMTAS and Çirit missiles, using the seeker from the latter and most components of the former, save the motor unit and modified control surfaces.

According to the Bayraktar's manufacturer, Baykar Makina, the weapon release was conducted from 16,000 ft, with the munition hitting the central 1x1 m area of a roughly 3x3 m target board from a distance of 8 km.

SMM can feature a fragmentation warhead - with a blast radius of 25 m - optimised for use against soft targets and in an anti-personnel role. A tandem warhead for engaging heavily armoured targets is also said to be available.

Teaming

Tactical systems are central to the US Army's burgeoning manned-unmanned teaming (MUM-T) concept of operations, and Shadow aircraft have already demonstrated interoperability with Apache attack helicopters. At its most basic level, MUM-T offers aircrew the ability to access data from the UAS’ payloads, but grows in complexity to provide them with control over the payload and navigation of the aircraft, through to total command of the UAS's flight profile and mission. The service is also looking at introducing teaming with Black Hawk helicopters.

"I think one of the inherent aspects of a tactical UAS is that normally they are owned and controlled by the organic ground asset [that they support]," Finneral said, "To really have that close co-ordination [between UAS and manned helicopters] at combat aviation brigades makes the tactical UAS ideal for that unit and to maximise the combination of the unmanned forward scout with the manned lethal capability. I think that if you took a group 4 MALE [system] it's going to be harder. The Gray Eagle [MALE UAS] is doing a great job as well as Shadow in integrating into the manned-unmanned teaming [concept] I think Shadow provides the unique capability of having multiple platforms flying with the Apache."

Airspace integration
As is the case with MALE platforms, the consensus that the full benefits of UASs will not be felt until they are able to integrate into civilian airspace, pervades the tactical domain. This presents manufacturers with a number of challenges, which are not just technical in nature.

"The robustness of the UASs has not been demonstrated at a level that aviation authorities will allow them to fly in significantly populated areas," Boggiani said, adding "Sure, the technologies are there, the point is that for the time being military UASs are paying more attention to performing certain types of mission, knowing that they are working in areas [where they have control of the airspace]."

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**Newcomers**

The tactical UAS sector is highly competitive and a number of systems are emerging to compete with the established platforms.

The Turkish Land Forces' requirement for tactical systems has seen two indigenous platforms developed - Vestel's Karayel and Baykar Makina's Bayraktar.

As noted, the Bayraktar has gained notoriety by demonstrating the ability to deploy munitions; the Karayel, however, has already commenced operations.

It is being provided on a service basis, with Vestel employees acting as aircrew and maintainers, as Turkish Land Forces wanted the capability fielded as soon as possible. Three aircraft have been deployed and can be operated by a small team, consisting of a pilot and payload operator, and with just two maintainers/support crew.

Around 1,000 flight hours have been amassed to date across the three airframes, with the missions focused on ISR duties via the aircraft's EO/IR sensors. The aircraft are working at extended ranges from its forward-deployed location, using ground data terminals to relay command information to the platform and receive ISR imagery from the area of operations.
Vestel’s Karayel has commenced operations in support of the Turkish Land Forces. It is one of a crop of advanced systems that are emerging to compete with established manufacturers. (Vestel)

Vestel has built-in a number of features that many UASs do not possess, notably triple redundancy in key systems and a deicing capability.

Pakistan has also emerged as a developer of advanced tactical UASs, with the indigenously manufactured Shahpar and Burraq systems inducted into service with the army and air force respectively in late November 2013.

The design of the aircraft seemingly borrows heavily from CASC’s CH-3 UAS, of which 20 were to be delivered to Pakistan in 2011, *IHS Jane’s* reported in 2010. However, representatives from Global Industrial and Defence Solutions’ (GIDS) - manufacturer of the Shahpar - told *IHS Jane’s* that there has been no collaboration with CASC in the development of its platform and that the Shahpar and Burraq programmes were independent of one another.

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