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Front cover: Indigenous UAV development programmes are gaining momentum in the Middle East and Asia. *(Image: TAI)*

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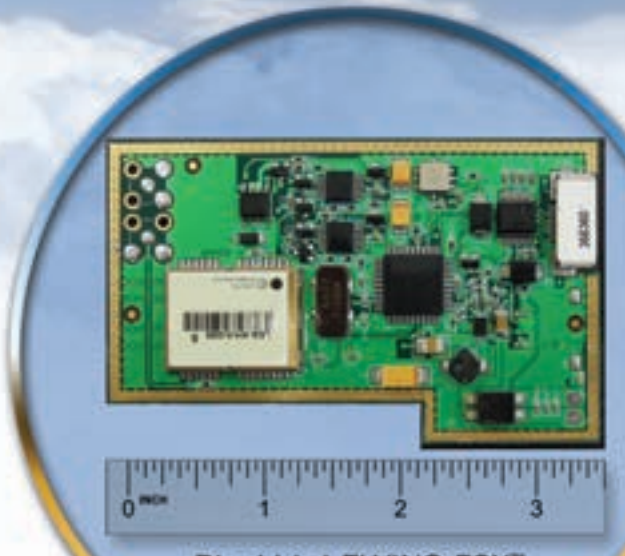

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Size matters

The UK MoD announced in early February that it had equipped troops in Afghanistan with a nano VTOL UAS called Black Hornet. The aircraft, which measures just 10cm in length, may look like a toy but it provides both full motion video and still images beamed to a handheld terminal.

However, any thought that the UAS is no different to the toy helicopters available in stores should be dismissed by the hefty price tag. The 160 units bought by the MoD cost a cool £20 million ($31 million) from prime contractor Marlborough Communications. The UAS was actually developed by Norwegian company Prox Dynamics, and much of the cost comes in from the sophistication of the flight control system needed to control such a small aircraft.

The use of this type of system in regular operations marks a further trend in the development of UAS involving a similar level of miniaturisation to what happened in the electronics industry.

Black Hornet appears to be able to give the same sort of 'over the hill' reconnaissance capability as was attempted in the past by much larger systems. There is no doubt that such a small aircraft will have limitations in terms of its endurance, range and stability in unsettled atmospheric conditions, but for looking over the wall of an Afghan compound or into the next room, it appears to be ideally suited.

The small size of the system and its lack of a logistics chain make it ideal for these kinds of infantry applications and may mark a shift in the paradigm for the use of UAS by the British Army.

There is no doubt that armies will continue to need high-level systems capable of wider area surveillance and, in some cases, undertaking strike missions. But if soldiers are able to carry their own organic assets, then there may be less demand at the lower end of the tactical UAS market and for some of the 'larger' small UAS.

Nano systems such as Black Hornet will not be a panacea, but they may disrupt the current UAS market. A number of US companies have been working on systems of a smaller size but seem to have not yet come up with a workable, deployable solution.

Prox Dynamics has been working on its technology for a number of years, and with the deployment of Black Hornet appear to have come up with a solution that is rugged enough to be used by the typical soldier. Of course, the average 18-year-old infantryman of today is comfortable with such technology in a way that his predecessors weren't, and this also helps with the acceptance of the equipment.

The current price tag probably keeps such systems out of the hands of the majority of civil users for the time being, but that can be expected to change. In the same way that soldiers can use it to 'look over the hill', police forces could use it as a tool to check out potentially volatile solutions. Such a small system would also be useful in inspecting tight spaces such as sewers or service conduits in buildings.

However, the size and sophistication of such systems may lead to further worries about civil liberties and the surveillance state – their use by paparazzi for example could become a problem. At some point this will need to be addressed by governments if they want to ensure the acceptance of such systems on the battlefield, with the social and commercial benefits that they potentially bring.

Darren Lake, Acting Editor

RESPONSE

Unmanned Vehicles' editorial team is always happy to receive comments on its articles and to hear readers' views on the issues raised in the magazine. Contact details can be found on p1.

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- US Army update
- Latin America
- Radar payloads
- Small UGVs

Turkey's indigenous MALE UAV has completed its acceptance trials. *(Photo: TAI)*

Anka trials completed for Turkish Air Force

Turkish Aerospace Industries (TAI) has announced that its Anka MALE UAV has successfully completed the final flight of its acceptance test campaign for the Turkish Air Force.

In progress since mid-2012, the trials have comprised some 130 mission-readiness ground and flight tests, which have been witnessed by Undersecretariat for Defence Industries (SSM) and air force representatives.

The final assessments were initially postponed due to bad weather conditions, but were eventually completed in January. The penultimate flight test commenced on 20 January and concluded with an automatic landing 18 hours later.

During the flight, the aircraft successfully demonstrated its full endurance and 200km-range data-link performance under winds reaching 45kt. Air traffic control (ATC) coordination was achieved through an onboard radio, which was relayed to a GCS over the data link, demonstrating Anka's capability to operate safely in an airspace managed by ATC.

In a separate test flight on 22 January, night take-offs and landings were demonstrated using an automatic take-off and landing system (ATOLS).

'During the summer, we started carrying out the acceptance tests for the prototype system for the Turkish Air Force,' Remzi Barlas, senior engineering manager for UAVs at TAI, explained to *Unmanned Vehicles*. 'We had a long testing period, including lots of ground testing, even some lab-level testing, and of course flight testing.'

A test and evaluation phase has also been defined between the government and TAI, which will involve placing the system at an operational base in Turkey on a service provision basis.

Since its first flight in December 2010, the Anka system has accumulated some 140 flight hours, during which flight control, data link, propulsion, fuel, landing gear, environmental control, ice protection and electrical systems, as well as EO/IR payloads, ATC radio and data recorders, were tested at altitudes of up to 26,000ft.

Autopilot, navigation, automatic loiter pattern and ATOLS capabilities were demonstrated throughout the flight envelope, including in severe weather conditions.

Contract negotiations are already under way with the SSM for the initial serial production of ten Anka systems for the Turkish Air Force, replacing its current Heron fleet manufactured by Israel's IAI. Low-rate initial production is expected to begin in mid-2013, with deliveries due from 2014-2015.

By Beth Stevenson, London

Camcopter integrated with hydrographic sensor

Schiebel has announced that its Camcopter S-100 UAS has been successfully integrated with the Riegl VQ-820-GU hydrographic airborne sensor. The UAV carried the payload during a flight test in Grossmittel, Austria, in December.

During the tests, the S-100 UAS carried a special Schiebel-made composite pod containing the sensor, IMU-GNSS unit, data recording and transfer unit and digital camera. The successful integration marked the first time that the new airborne sensor has flown on board a UAV.

The VQ-820-GU is specifically designed to survey sea, lake and river beds, and is well suited for combined land and hydrographic airborne survey. It enables acquisition of high-accuracy hydrographic and topographic data, even in critical operational areas, says the company.

According to Schiebel, fields of application include mapping of coastlines, lakesides and river banks, as well as archaeology and cultural heritage survey. These operations require repetitive surveying of inshore waters and are usually carried out by manned helicopters. The advantage of using UAS is that they are capable of penetrating areas that may be too dangerous for piloted aircraft or ground patrols, providing additional safety and security for their users.

Johannes Riegl, CEO of Riegl, noted: 'We are proud to have succeeded with this first integration of our bathymetric laser scanner with the Schiebel UAV.

Hans Georg Schiebel, chairman of Schiebel, added: 'The combination of the… laser scanner and S-100 allows swift and accurate mapping of remote areas, and will prove valuable in applications such as mining, exploration and construction.'

By Darren Lake, London

Australian Army receives General Dynamics D-VEX

The Australian Army has taken delivery of two Digital Video Exploitation (D-VEX) systems from General Dynamics Mediaware. The technology has been integrated into the AAI Shadow 200 TUAS operating in Afghanistan, enhancing the force's capacity to distribute mission-critical intelligence among Australian troops and coalition forces.

The D-VEX system helps manage large volumes of full-motion video (FMV) and turns data into real-time actionable intelligence for forward-deployed forces. Designed for in-theatre operations, it can capture and manage video feeds from airborne surveillance platforms.

According to the company, the system has the ability to record and index video with metadata, providing users with detailed forensic analysis through its comprehensive search and mark-up capabilities. D-VEX also supports open defence standards, including the Motion Imagery Standards Profile and STANAG 4609. The system also works with commercially available compact mobile hardware, such as a laptop.

Michael Manzo, director of General Dynamics Advanced Information Systems' Geospatial Solutions Imagery Systems division, said: 'D-VEX provides the Australian Army with next-generation tools for real-time and forensic analysis of airborne surveillance video. It will enhance and streamline the army's ability to derive timely, relevant and accurate geospatial intelligence from the Shadow TUAS.'

Kevin Moore, chief technology officer at General Dynamics Mediaware, added: 'Managing the thousands of hours of video collected by the Shadow 200 TUAS presented the army with a sizeable data processing and analytics challenge. With the D-VEX solution, the video archive is easily searchable, enabling analysts to identify, tag and analyse critical events in real time for consistent, reliable and standards-compliant results.'

By Claire Apthorp, London

AeroVironment announces new Wasp AE order

AeroVironment is supplying its Wasp AE small UAS (SUAS) to support an as yet unspecified USMC requirement under a contract announced on 23 January. The $12 million contract follows an award last September to Par Government Systems for the project, and will see the UAS handed over within the next four months.

The company will deliver Wasp AE SUAS, initial spares packages, training services and one year of logistics support under the contract. The system incorporates the smallest of AeroVironment's Mantis suite of miniature gimballed payloads, the 275g Mantis i22 AE, giving operators both colour and IR video imagery from a single sensor package.

Weighing 1.3kg, it is designed for ground and water landing, making it suitable for both land and maritime missions. The system is also capable of 20% greater flight duration than the Wasp III.

Roy Minson, SVP and general manager of AeroVironment's UAS business segment, said: 'We introduced the Wasp AE in May 2012 with the expectation that multiple customers would find its capabilities very compelling. These contracts supporting the USMC expand the adoption of Wasp AE beyond the air force, and support our view that this highly capable successor to the proven Wasp III system will help our customers operate more safely and effectively.'

The contract was awarded by Naval Air Systems Command's Program Office for Navy & Marine Corps Small Tactical Unmanned Aircraft Systems (PMA-263), working collaboratively with the US Army's Counter-IED Program Office.

By Beth Stevenson, London

Photo: Aerovironment

On the web

Northrop Grumman to continue Hunter UAV support
23 January 2013

US Army to receive new MetaVR VRSG systems
15 January 2013

Telephonics to provide MQ-8B Fire Scout radar
10 January 2013

Triton UAV demonstration platform under construction
8 January 2013

Innocon unveils Spider SUAS
7 January 2013

MRA supports sea-skimming UAV test flight
20 December 2012

Hood Technology unveils new Alticam Pod
18 December 2012

Gabbiano T-20 radar demonstrated on Hermes 459 UAS
14 December 2012

Unmanned Little Bird flies for RoK Army
13 December 2012

NAC UAV facilities expanded
12 December 2012

First Centaur OPA delivered to Swiss DoD
7 December 2012

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Germany's Euro Hawk has completed a successful flight demonstration. *(Photo: Northrop Grumman)*

SIGINT-equipped Euro Hawk achieves first successful flight demo...

Northrop Grumman has made a series of announcements regarding its UAV development, including the first full system flight of the Euro Hawk at Manching air base in Germany.

The eight-hour flight was conducted by the company and EADS Deutschland (operating through Cassidian) on 11 January, and the aircraft was equipped with advanced SIGINT sensors for detection of radar and communication emitters.

During the flight, the Euro Hawk climbed to a ceiling of 54,000ft within military-controlled airspace before landing safely back at the air base. The system had previously completed extensive ground testing, leading to final approval from the German airworthiness authority to flight test the functionalities of the integrated SIGINT payload.

Based on the RQ-4B Global Hawk HALE platform, the Euro Hawk includes a ground station consisting of mission control and launch and recovery elements provided by Northrop Grumman. It is equipped with a new SIGINT mission system developed by Cassidian, providing stand-off capability to detect electronic and communications emitters.

'This successful flight demonstrates the Euro Hawk programme's systems integration capabilities and cutting-edge technologies,' Bernhard Gerwert, CEO of Cassidian, said in a statement. 'The Cassidian-developed SIGINT sensor suite, conforming to the German Bundeswehr's requirements, showed excellent performance within the perfect interplay of the overall system.

'We therefore are proud to prove with these test flights the new Euro Hawk's mission capability of strategic SIGINT for the protection and security of the German armed forces.'

Tom Vice, corporate VP and president of Northrop Grumman's Aerospace Systems sector, said: 'Today's SIGINT sensor flight marks the start of the critical flight test phase of the Euro Hawk payload for the German Bundeswehr. Not only is it our first trans-Atlantic cooperation with Germany and Cassidian, but it is also the first international version of the RQ-4 Global Hawk produced by the company and the first high-altitude, long-endurance SIGINT UAS in Europe.'

By Beth Stevenson, London

...while USAF takes further Global Hawk deliveries

Northrop Grumman announced on 7 January that it had delivered two Global Hawks to the USAF. The aircraft, which were delivered ahead of schedule in late November, will allow commanders to receive high-resolution imagery, survey extensive geographic regions and pinpoint targets on the ground.

A total of three new aircraft were delivered to the service in 2012, bringing the total Global Hawk fleet to 37. Five previously delivered systems also underwent the installation of additional sensors, which will allow multiple types of intelligence data to be gathered during a single mission.

The Global Hawk carries a variety of ISR sensor payloads that allow commanders to gather imagery and use radar to detect moving or stationary targets on the ground.

'Global Hawk's ability to fly more than 30 hours at high altitudes while gathering multiple types of intelligence data makes it extremely valuable to field commanders who need near-real-time information,' George Guerra, VP of the Global Hawk programme, said in a statement. 'These new aircraft add to that capability.'

The company noted that the platform has logged some 80,000 flight hours and been used in Afghanistan, Iraq and Libya. It has also supported ISR efforts following the earthquakes in Haiti and Japan.

A NASA Global Hawk is now also conducting science missions to study the impact of atmospheric change on the Earth's climate, collecting data and helping scientists learn more about the humidity and chemical composition of air entering the tropical tropopause layer of the atmosphere and its impact on the planet's overall climate.

The Airborne Tropical Tropopause Experiment campaign, sponsored by NASA, began on 16 January at the agency's Dryden Flight Research Center at Edwards AFB, California, and will conclude on 15 March. In collaboration with NASA, Northrop Grumman is also providing engineering analysis, mission planning, maintenance, pilots and flight operations support for the science missions.

The manufacturer is also building a company-owned development and demonstration platform UAV for use on the USN's MQ-4C Triton programme. The aircraft will be used to perform testing efforts for the navy in preparation for Triton's expected operational date of 2015.

By Beth Stevenson, London

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Leading The Situational Awareness Revolution

Asian ascent

As international focus continues to shift to Asia-Pacific and US forces pivot towards the region, **Gordon Arthur** examines how its allies and potential adversaries are developing unmanned systems capabilities.

Zhuhai's Airshow China 2012 exemplified the rise of indigenous UAV programmes in the Asia-Pacific region. China's aerospace industry showed significant maturity compared to the same show two years earlier, with concepts maturing into workable designs. To a lesser extent, the same maturing process is occurring in places such as India, Pakistan, Singapore and South Korea, although Western-manufactured designs are still commonplace in many military inventories.

Latent hotspots such as the Korean peninsula, India-Pakistan and China-Taiwan, plus spiking tensions in the East and South China Seas, all point towards regional UAV orders taking off. While major US and Israeli players are hoping to capitalise, a number of Asian countries are pursuing domestic development and we are likely to see new players entering the international stage and even battling for market share.

In a region dominated by its oceans, the greatest interest is in platforms suitable for wide area surveillance so countries can keep an eye on their neighbours. HALE craft like Northrop Grumman's Global Hawk are being pitched to Australia, India, Japan and South Korea, for example, but US designs have generally made little headway here because they are too sophisticated or expensive. Furthermore, their technology or weapons content can preclude them from gaining export approval. This opens doors for Asian manufacturers to exploit by offering cheaper alternatives.

In 2011, $590 million was spent in Asia-Pacific on UAVs, second only to the US. Of acute interest is Frost & Sullivan's prediction of this regional market growing to $1.4 billion by 2017. Its importance will increase exponentially as the US and Europe endure defence budget cuts.

Tactical UAVs (TUAVs) will be the type most in demand, although MALE craft are also expected to attract significant orders. In general, the Asian market for armed UAS has not yet taken off because they are expensive to purchase and operate, plus they require complex weapon, radar, airfield and personnel infrastructure.

STRIDING AHEAD

However, this is one area where China is making strides, which may spur others to action. The AVIC Wing Loong was displayed as a scale model at Airshow China 2010 (then named Pterodactyl I). By 2012, it was a flyable airframe with a range of weaponry, and a spokesman suggested it had already achieved its first international sale. The Wing Loong has a 20-hour endurance and 4,000km range. The cost of a single craft is approximately $1 million, significantly cheaper than an MQ-1 Predator.

AVIC also exhibited a mini jet UAV christened Blue Fox. The company described its function as air-to-air combat training, but this does not seem to be the whole truth. The Blue Fox, resembling the Hongdu L-15 jet trainer, is surely a design to watch in coming years.

An interesting question is whether China will follow the US in developing UAVs for aircraft carrier operations. The PRC obviously lags behind Israel and the US, but some are warning it could become a formidable future global competitor. Budget-priced Chinese products could lure new militaries into acquiring UAVs, and many commentators are concerned about their proliferation to nations possessing dubious human rights records.

A Nishant multi-mission UAV of the Indian Army is positioned on an 8x8 Tatra hydro-pneumatic launcher truck.

The Wing Loong was proudly displayed at Airshow China. A spokesman from AVIC claimed one example had been exported to date. *(All photos: author)*

CASC was also promoting its new CH-4 UCAV at Zhuhai. It can carry four precision-guided bombs/missiles, and its maximum altitude is 26,000ft and range 3,500km. CASC freely admitted it was targeting Africa and Asia in its marketing efforts, and that medium- and short-range designs were popular because of their affordability and ease of use.

The People's Liberation Army uses the ASN-206 and improved ASN-207 TUAV from Xian ASN Technology, China's largest unmanned systems producer. The 7,000km-range Chengdu Xianglong HALE platform is likely destined for maritime surveillance, while the Harbin BZK-005 MALE with 40-hour endurance is thought to have been in service since 2009. One crashed in Hebei Province in 2011. CASIC offers the jet-powered WJ-600 UCAV, although it is unclear if it has entered service. Last June, Japan snapped a photo of a rotary-wing UAV operating from a Chinese frigate.

The State Oceanic Administration aims to develop UAV bases in 11 coastal provinces by 2015, including coverage of the disputed Diaoyu Islands. A pilot programme has been running from Dalian since November 2011

Meanwhile, in Pakistan military officials admit that surveillance capability gaps exist regarding counterinsurgency operations in the Federally Administered Tribal Areas, coastal surveillance and the Indian border region. The induction of capable UAVs is thus critical.

At the IDEAS exhibition in Karachi last November, state-run Global Industrial & Defence Solutions (GIDS) showed two new products – the Shahpar and Huma. The former is a 470kg TUAV, a development of the Uqab that has served the army since 2007. The Shahpar has completed testing and awaits production. Its most intriguing aspect is the canard pusher design, with some seeing technological similarities with the Chinese CH-3. It is feasible Pakistan is benefitting from design assistance from Beijing here, and the type could even be weaponised in future.

Destined for Pakistan Navy use, the Huma with 100km range is also Uqab-based. The aircraft is truck-launched and parachute-recovered, thus negating the need for coastal airfields. GIDS also makes the Scout mini-UAV, which the army is commissioning into service. The 4kg hand-launched craft has a 15km range.

SECURITY SOLUTIONS

Pakistan and India are expected to contribute a quarter of the annual global growth in UAVs for border security use through 2015. India, primarily through the Aeronautical Development Establishment within the Defence Research & Development Organisation, has extensive programmes.

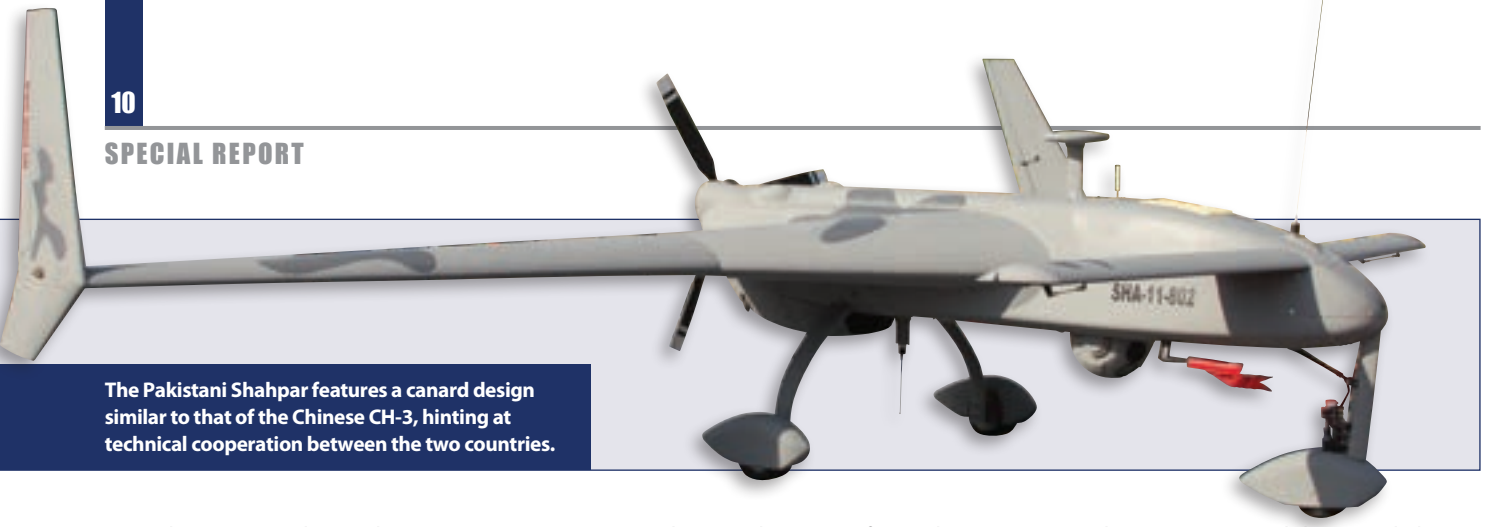
One indigenous design finally entering service in 2011 was the Nishant. The Indian Army should receive 12 systems (four craft per system) by next year. The army uses it for reconnaissance, border surveillance, target tracking and artillery spotting. A useful feature is its ability to launch and land without prepared runways thanks to a mobile launcher and parachute/landing bag. Nine Tatra 8x8 trucks transport a system to wherever needed, although its 12,800ft ceiling is inadequate for use along India's mountainous borders.

India was rocked by the 2008 Mumbai terrorist attacks, and coastal surveillance has since become a priority. An important programme is thus the tri-service Rustom MALE platform. The Rustom-1 prototype made its maiden flight in 2010, as a first step towards the Rustom-H, which will have a 15-hour endurance and 25,000ft ceiling for reconnaissance, surveillance, target acquisition, SIGINT, battle damage assessment and communications relay. A Rustom-2 combat version could begin flight trials next year.

DISASTER ALERT

The tsunami that wreaked havoc and precipitated a nuclear crisis in Japan demonstrates how military UAVs can be used for other roles. Within 48 hours, a Global Hawk from Guam was surveying damage. However, Japan had done surprisingly little to induct military UAVs, so the tsunami was a wake-up call. A commercial Fuji IMVAC B-II craft was used to overfly the Fukushima reactor and now the Japan Ground Self-Defence Force (JGSDF) will acquire two B-IIs plus two ScanEagles for operational evaluation.

Rotary-wing UAS have not gained much of a regional following except in Japan, with the JGSDF having flown the Forward Flying Observation System since 2004, while the Yamaha R-MAX was deployed to Iraq. Relaxed military export rules should boost UAV development and the Japanese market could be set to expand. Tokyo wishes to procure three Global Hawks by 2015, and will develop indigenous platforms capable of detecting ballistic-missile launches by 2020. ➤



The Pakistani Shahpar features a canard design similar to that of the Chinese CH-3, hinting at technical cooperation between the two countries.

South Korea warns that North Korea is developing 'kamikaze' drones to target its forces, although, ironically, Korea Aerospace Industries (KAI) exhibited precisely this kind of platform at the last Seoul Air Show. The explosive-filled Devil Killer is designed to perform 'swarm attacks' after being launched by bungee catapult. An electric motor gives 215kt speeds and an optimum 15km range. Operators guide the drones onto enemy targets, and in future they could even be launched by the M270 Multiple Launch Rocket System.

South Korea has huge potential as it invests in UAVs as an economic growth engine, although few designs have entered service yet, apart from the army's 120km-range KAI Night Intruder 300. Korean Air is developing the KUS-11 division-level TUAV, slated to enter service in 2015. Designed to army specifications that suit the peninsula's rugged topography, the 3.4m-long craft is catapult-launched and arrested by a ground net. The Korea Aerospace Research Institute has been working on a tiltrotor design capable of 215kt that would be suitable for navy use.

The Republic of Korea Air Force wants Global Hawks, but a doubling in price has quenched enthusiasm. A new competition will occur, and waiting in the wings are IAI and Elbit Systems with the Heron TP and Hermes 900 respectively. Certainly, a priority for South Korea's military is improving surveillance capabilities ahead of the 2015 transfer of wartime operational control from the US.

The KAI Devil Killer from South Korea is a low-cost flying bomb directed by an operator using a GCS.

MADE IN TAIWAN

Taiwan's army inducted the 454kg Chung Shyang II TUAV from the Chung-Shan Institute of Science and Technology (CSIST) in 2010. Thirty-two aircraft are on order and they are also earmarked for disaster relief. A CSIST spokesman told *Unmanned Vehicles* that Taiwan is not looking for overseas designs because craft can be developed 'more cheaply' at home. There is a HALE requirement, and again Taiwan is pursuing it domestically.

Another new CSIST craft is the 2.1kg Cardinal mini-UAV. It was tested by the army and marines and a production order subsequently placed. The Cardinal is hand-launched and has a 10km range. The camera nosecone can be exchanged for day or night-time use. CSIST has also displayed sleek UCAV concept models, but these remain paper designs only.

Singapore leads Southeast Asia in terms of fielding UAVs, although most platforms, like the Heron 1 and Hermes 450, are of Israeli origin. The Singapore Army has also operated the Skyblade III since 2010, a collaborative project of DSO National Laboratories and ST Aerospace. The 5kg craft has an 8km range. ST Aerospace is developing the much larger Skyblade, IV possessing a 100km range, while the hovering FanTail 5000 also exists.

NASCENT NEEDS

Other Asian countries are in their infancy in developing UAV fleets. In Indonesia, the Agency for Assessment and Application of Technology (BPPT) is promoting five home-grown designs: the Wulung, Pelatuk, Gagak, Sriti and Alap-Alap. The 40km-range Sriti will be manufactured by PT Dirgantara to help security forces monitor vulnerable coastline and territory.

Malaysia was not entirely happy with the Aludra from Unmanned Systems Technology (UST), which led to the improved Aludra Mk II that has been employed in East Malaysia. UST is also developing the 500kg Yabhon Aludra MALE platform alongside ADCOM Systems from Abu Dhabi. This has a 30-hour endurance and 500km range and Malaysia is to lease two such craft. Composite Technology Research Malaysia made the Aludra SR-08 micro-UAV used by army special forces.

To the north, Thailand wants UAVs for maritime patrol and internal security in light of a long-running Islamist insurgency. The Royal Thai Air Force (RTAF) wishes to create a UAV squadron with three different systems in the 15km, 30km and 100km range classes. Thailand is seeking to produce these domestically, although its fledgling industry will be dependent on foreign technology transfer. The country also imported three Malaysian Sapura Cyber Eye systems in 2009 for the RTAF Academy.

MARITIME TENSIONS

Another nation fighting Islamist militants is the Philippines. The cash-strapped military can rely on US-operated UAVs in Mindanao but, to beef up capabilities after sporadic maritime tensions with China, the government is looking at buying American UAVs. Domestically, OB Mapua and Partners has developed the 20km-range Assunta for the army.

Australia has not really developed indigenous craft, with the army using leased Insitu ScanEagles, replaced in Afghanistan by the RQ-7B Shadow 200 last year. Canberra has stated that the Cocos Islands in the Indian Ocean could be used as a base for US UAVs, although this would necessitate extensive infrastructure development. New Zealand has flown the 3kg Kahu Hawk mini-UAV in Afghanistan. Built by Skycam UAV, it has a 12km range and survivability was hugely increased by adding a parachute system. uv

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As UAS capabilities evolve, systems are becoming increasingly autonomous, reducing operator training requirements. Autopilots are at the heart of that change, and a number of companies are pushing the boundaries of the technology, reports **Claire Apthorp**.

Brains of the operation

If a UAV could be said to have a brain, it would be the autopilot, where all onboard elements and subsystems are brought together – including everything from navigation, vital and non-vital flight control procedures to communications and optical sensor systems – to allow the aircraft to fly and complete missions successfully.

Essentially, the autopilot is what transforms a simple RPV, in which the operator has control of every onboard system, into a complex UAV with a significant degree of autonomous function.

SIMPLIFYING COMPLEXITIES

In order to be effective, a reliable autopilot must simplify the onboard complexities of UAVs developed for numerous operational requirements, providing coordinated control of one or more vehicles, distributed control of onboard subsystems and disseminating collected data to a remote network.

In aiming to provide this, BlueBear Systems Research developed its Surveillance & Navigation Auto Pilot (SNAP), a scalable, modular vehicle management system that provides the capability to automate any UAV control, navigation and surveillance task.

The package has been designed to form the heart of a versatile flight management system, and is highly adaptable, with interface boards available to integrate with any platform. It has flown numerous UAS, ranging from small quadcopters and tactical platforms to lighter-than-air vehicles of various sizes.

According to the company, SNAP can be packaged according to the customer's environmental, size and weight requirements, and the software readily ported to alternative hardware cores, including ones certified to the highest levels. The system's logging facility also allows users to record any combination of flight data parameters or onboard sensor outputs, providing the ability to replay flight information and provide evidence of flight paths and vehicle performance.

'We have found that our customer requirements vary greatly according to the type and size of platform and defined modes of operation of the UAS – they also vary according to the intended operating environment, be it military or civilian, especially with respect to safety cases, failure handling and levels of automation required,' Mike Humphreys, military accounts manager at BlueBear, told *Unmanned Vehicles*. 'The ability to control a sensor payload in coordination with the platform is important, and we are seeing increasing demand for more sophisticated mission management, automated behaviours in take-off and landing and safe behaviours in cases of lost communications links.'

BRANCHING OUT

BlueBear comes from an R&D background, having undertaken work for the UK MoD's Defence Science & Technology Laboratory through which the IP and SNAP hardware/software/algorithms were developed, encompassing what the company calls 'entry-level certifiable autonomy'.

Using this technology, BlueBear has been able to move into international programmes, varying in scale from hand-launched bio-inspired morphing-wing small UAS (SUAS) up to 50t airships – the company also played a key role in automating the hybrid airship demonstrator as part of the Long-Endurance Multi-Intelligence Vehicle programme bid for the US Army, supplying key expertise and technologies, such as the algorithms controlling the airship when nobody is on board and mathematical models that predict how it will fly.

'Our work has taken us into the US, Europe and we are a significant partner on a major Anglo-French programme,' added Humphreys. 'We are now expanding into civil and maritime domains, and are breaking across domain barriers due to the innate flexibility of our technology. We have also designed and developed our own range of UAS, with several mature designs at near-production standard.'

One of the biggest challenges in creating SNAP was to ensure the system was flexible enough to be cost-effectively adapted to deliver an optimum solution to each customer, given that the needs vary from user to user.

'On the one hand, you want to be able to re-use proven core functionality from one requirement to the next, but on the other, you

(Main) Lockheed Martin's Kestral v3.0 autopilot has the ability to fly complex VTOL UAVs. (Above) The Procerus Virtual Cockpit can be integrated with Kestral. *(Photos: Lockheed Martin)*

want to be able to avoid any unused legacy functionality – burdening a customer with this reduces their future prospects for certification and introduces an instant through-life overhead in terms of upgradeability,' he continued.

'Customers want an autopilot that meets their needs, but that will grow with them if those needs change – for example, as they expand into using larger platforms or different types. UAS technology moves on apace, and customers want reassurance that their investment will keep pace too.'

MILITARY CAPABILITIES

The strongest demand for UAV autopilot technology is currently from the military sector. Lockheed Martin Procerus Technologies has developed its Kestrel autopilot largely for this market, providing intelligent, autonomous flight control of single or multiple UAVs, complete with GPS waypoint navigation and autonomous take-off, flight and auto-landing capabilities for mini- and micro-UAVs. When combined with its Virtual Cockpit ground control software, the system is an integrated avionics package for UAV applications.

Procerus is primarily focused on the SUAS market with this product, mainly working with hand-launched platforms with wingspans of between 1 and 6ft. 'Working in that SUAS space, from our point of view, it's been very important to develop technology that is very small, light and power-efficient,' Todd Titensor, senior manager at the company, told *UV*.

'Focusing on those SWaP requirements has done very well for us because now we have a product that can fit in small aircraft where other autopilots cannot, while still providing a product that is robust, reliable and able to deliver long flight hours.'

Kestrel uses an external GPS unit for inertial navigation and wireless modem communications between the ground station and autopilot. The system can guide mini- and micro-UAVs autonomously and receive user commands through the ground station, radio and gamepad controllers, while providing live video feeds to the user. It uses three-axis rate gyros and accelerometers for attitude estimation, as well as differential and absolute air-pressure sensors for airspeed and altitude measurement.

MAGIC NUMBER

The company's latest iteration of the product is Kestrel v3.0. 'In order to build into Kestrel v3.0 the ability to fly both complex VTOL and fixed-wing UAVs from the same autopilot and support additional customer software, among other things we had to increase the size of the onboard processor to make the system more capable,' explained Titensor.

'In terms of the technology itself, helicopter and hovering aircraft are much more difficult to fly – fixed-wing aircraft tend to want to fly, whereas VTOLs do not, so the algorithms required are much more complex.'

The Kestrel system has been installed on the Nighthawk and Desert Hawk UAVs, among others, as well as a number of very small lethal munitions that act as hovering ➤

SkyCircuits typically works with SUAS under 20kg, with the ultimate goal of also supporting airships. *(Photo: SkyCircuits)*

UAVs. The company is also working on developing advanced vision technologies to enhance onboard capabilities, which could also provide a framework for sense and avoid (S&A) in the future.

As national airspace regulations are formulated, the opening up of the commercial UAV sector over the coming decade will see a boom in the number of autopilot technologies developed for the civil market.

'As we start to see the commercial markets open up, it will bring certain challenges,' continued Titensor. 'What we are finding now is that there are some very simple low-end autopilots out there that are cheap and fly aircraft fairly well, and we're concerned that a lot of people won't understand that things such as reliability, robustness and thousands of flight hours actually matter.

'We're nine years into this autopilot technology and have a lot of great and very robust feature sets, and we need to help the commercial market understand the importance of those things.'

CIVIL DESIGNS

Another challenge for companies operating in the civil market will be that as regulations come into play, even SUAS may be required to have some form of certification and/or airworthiness standards applied – as this is expensive, it will be a challenge to apply this in a cost-effective manner to small systems.

However, there are a significant number of projects being carried out in the civil UAV autopilot market that provide opportunities for smaller companies unable to compete with more established players in the military sector.

'For the civil market, S&A is a key thing to have when it comes to looking at inserting UAVs into commercial airspace in the future,' Matt Bennett, managing director of SkyCircuits, told *UV*. 'But right now, our focus is building systems that can operate UAVs under current rules and restrictions, and there's an industry going along quite well in this space.'

SkyCircuits' leading autopilot system is the SC2, which is designed to provide a range of functionality, including selectable levels of flight automation. This feature allows the user to choose which functions the autopilot will be responsible for during flight – for example, the autopilot can be programmed to maintain a certain altitude, while the human pilot controls the remaining heading, bank angle and (within limits) airspeed.

Alternatively, the autopilot can look after everything except heading, allowing the human pilot to easily and safely steer the aircraft, or the autopilot can complete the mission alone with no human interaction.

The system is able to monitor a wide range of flight parameters in real time, such as airspeed, altitude, position and heading. Graphs are automatically plotted and the aircraft position shown on a moving map display, with all incoming data logged for post-flight inspection. The user also retains full access to the autopilot throughout the flight, so waypoints can be moved, controllers re-tuned and missions re-routed in flight.

The SC2 autopilot is also designed with a general payload interface connection, allowing a variety of extension modules to be plugged in. These include voltage monitors, camera interfaces and engine RPM sensors, and all payload data can be sent back to the ground station in real time for inflight monitoring – scripts can also interact with the payload modules, providing a powerful extension to flight operations.

SkyCircuits works on the most part with SUAS (under 20kg), across both fixed-wing and VTOL platforms, with the goal of also supporting airships in the future.

'Basically, the aim of the SC2 is to create a generic autopilot that supports as many platforms as possible,' continued Bennett. 'Most of our present customers are involved in aerial photography, so there is a big emphasis on being able to fly in accurate grids over a survey area, with the ability to operate a gimbal system to skew the camera into location.'

SkyCircuits is also working with customers from academic and scientific institutions, where the ability to add increased capabilities and options is a big draw card for the company's technology.

'SC2 itself is off-the-shelf technology, but we adapt and change it to meet customer requirements,' he added. 'There's always going to be something people want changed and new features to be added. We tend to have a close/open-source method in that any suggestions made by customers will be included in the product as a baseline capability from that point onwards, unless they want something added specifically for their own use to maintain competitor advantage.'

SWISS STYLE

This method of gradually adding to the product over time has developed into what Bennett calls a 'Swiss Army Knife' type of software for SC2. 'Whatever challenge we're faced with – for example, providing robust flight performance for a variety of airframes, particularly with regards to environmental factors such as high wind conditions – it comes down to designing algorithms over time.

'It's also about providing what our customers actually need – increased autonomy is a big trend right now, and will remain so… But there are pros and cons to everything – because of the lack of S&A and challenges of operating in rough terrain, things like automatic landing aren't always in the best interests of the UAV.

'The human eye is much better at bringing an aircraft down safely in difficult terrain, so the impetus then turns to a stabilisation fly-by-wire system rather than a fully autonomous landing system.'

While UAV technology remains largely dominated by bigger companies supplying the military sector, there are a healthy number of smaller manufacturers developing increasingly mature autopilot technologies ready to fuel expanding markets in the future. uv

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Staying up for longer

One way in which manufacturers are preparing for future requirements is by increasing the operational endurance of their platforms. **Beth Stevenson** examines some of the next-generation projects currently in development.

The Anka is due to replace the Turkish Air Force's Heron fleet. *(Photo: TAI)*

Despite UAVs often only needing to stay aloft for the specific time required to carry out their mission, increasing endurance can lead to shaping new requirements, and create fresh applications, boosting the utility of the platform.

Many companies are exploring and operating long-endurance (LE) platforms, openly attempting to push their aircraft to the next level of flight capability, although some efforts remain classified.

One well-known LE aircraft is the USAF's Global Hawk HALE UAV, which can fly at altitudes of up to 65,000ft for some 35 hours at speeds approaching 340kt.

On 7 January, the company announced that it had delivered two platforms to USAF. The aircraft, which arrived ahead of schedule in late November and bring the total Global Hawk fleet to 37, will allow military commanders to receive high-resolution imagery, survey vast geographic regions and pinpoint targets on the ground (for more, see p6).

The famed Predator and Reaper platforms have also led the way for LE aircraft, with the ability to fly for up to 40 hours at 25,000ft and 27 hours at 50,000ft respectively.

OPEN MARKET

However, it is not just the big players that are looking into this type of endurance. In July 2012, UAV Factory demonstrated a 54-hour, 27-minute flight for its Penguin B platform, which the company said was the longest recorded flight for a mini-UAV – the flight test only stopped because of a thunderstorm.

The flight apparently surpassed the previous record held by the AAI Aerosonde (38 hours), as well as Insitu's ScanEagle, which has a 24-hour-plus endurance capability.

The Penguin B used was a testbed, and some of these technologies will now be directly transferred to commercially available aircraft and available as a retrofit option for existing Penguin B UAVs, which currently have a 26.5-hour endurance with a 4kg payload.

The fully loaded Penguin B took off from a vehicle-based launcher on 5 July 2012 and belly landed more than two days later. It carried nearly 13kg of regular gas and oil premix, with fuel stored in the fuselage as well as an integral wing fuel tank, and the total take-off weight of the aircraft was 22.3kg. Air temperatures exceeded 30°C, with wind gusts reaching 20m/s.

During flight, the aircraft was controlled by a Piccolo flight control system, manufactured by Cloud Cap Technology, and also utilised Currawong's Electronic Fuel Injection system.

During the 2012 AUVSI conference in Las Vegas, a UAV Factory representative told *Unmanned Vehicles* that this type of endurance is not required for today's missions, but the company wanted to demonstrate the capability of its platform and engine, and is preparing for future requirements.

The manufacturer currently sells the system solely to the commercial market, with operators including institutions such as the University of Southampton in the UK and Greenpeace.

HYDROGEN FUTURE

Boeing is in the process of developing the hydrogen-powered Phantom Eye demonstrator LE UAV, which will eventually have a four-day endurance, while a ten-day capability is also in the works.

'We're focused on what we feel is a set of unmet customer needs that a number of customers have requested – long-term endurance,' Andrew Mallow, Phantom Eye programme manager, told *UV*.

In 2012, a first flight test lasted just short of 30 minutes, and highlighted problems with the landing gear, which have now been addressed. Mallow explained: 'We've completed all engineering work for returning the vehicle to flight. We've updated the software… which has been fully tested through both the functional tests we do and fully proven through our combined system tests, which is testing on the vehicle itself.

'This week [mid-January], we loaded the new landing gear, and the plane is fully ready for flight – in the next week we are going to test. Then it's just a matter of going through a few more tests to make sure that we're ready for flight.'

The undercarriage, primarily the nose element, has been totally redesigned, while some changes have also been made to the rear landing gear – Boeing's Military Aircraft business aided in the redesign.

'We've also done a number of tests, so the nose gear has been both structurally drop tested – in which we put it to the maximum load that it will see – and performed a spinning drop test to verify that it was good to go,' Mallow continued. 'We've also taken the nose gear out on a lake bed behind a truck and ran it round to make sure it doesn't shimmy when it lands.'

After the forthcoming evaluations will be a taxi run before the next flight test. 'Right now, we're really focused on flying the demonstrator vehicle,' added Mallow. 'We have continued to develop different configurations based on different customer requirements, but most of our work will be flying the demonstrator. We have active customer communications – we do have customers participating.'

The endurance of the platform will drive down operational costs because one system can replace what would previously take several others to do, according to Mallow.

'What we endeavour with Phantom Eye is that you really get coverage of almost any place in the world with just three vehicles in an operation, so that's a huge unmet capability that's out there,' he explained.

'Our eventual goal is a week to ten days vehicle, and that could go much longer depending on the altitude and amount of payload you want to carry. We're proving out the vehicle capabilities to have that kind of reliability, and now we're in

IAI's Heron is deployed with some 18 military operators, while the Heron Next Generation is currently under development. *(Photo: IAI Malat)*

discussion with the payload providers to make sure that the payloads can have that same type of capabilities.'

PAYLOAD PROGRESS

After the flight demonstrator has been completed, payload testing and flying is due to begin. Mallow said that a flight carrying a payload is in the development plan for 2013. Payload capacity is currently around 200kg, and is limited by weight alone, not the payload type. Increased payload capacity would in turn lead to less endurance if that is what the operator requires.

'The whole point of building a demonstrator was to show that we could overcome many of these challenges,' continued Mallow. 'I think from that perspective, we feel like we've overcome a lot of them – we just need a nice successful landing the next time. But we've worked through a lot of the challenges.'

Turkish Aerospace Industries (TAI) is in the process of finalising the design of the Anka LE UAV, which is due to replace the Turkish Air Force's (TAF's) Heron fleet. Remzi Barlas, engineering director for UAVs at the company, told *UV* that acceptance tests for the prototype system were carried out last summer for the TAF. This included a long testing period, with significant ground trials, alongside lab-level and flight testing. He confirmed to *UV* that acceptance testing was successfully completed in January, after a bout of bad weather pushed completion of the final test back (see p4).

A test and evaluation phase has also been defined between the government and TAI, which will involve placing the system at an operational base in Turkey on a service-provision basis.

'They [the air force] want to make sure that the systems in the field are doing the right job for them,' he noted. 'The TAF may operate the payloads, but we'll be doing all of the launch and recovery and maintenance of the air vehicle itself. Besides that, there is the initial low-rate initial production [LRIP] batch for the TAF. When they launched the programme… about seven years ago, they had already planned their procurement ahead.'

TAI is due to develop ten of the MALE airframes for the air force, with an option for another ten. The two sides are in final negotiations regarding the details of the contract, and LRIP is expected to begin in mid-2013.

'Of course, the acceptance testing that we've proved now is a good indication of the system's capabilities,' added Barlas. 'So, we are really progressing forward, but finishing off the contractual details does take some time. In the 2014-2015 timeframe, we'll be delivering the air vehicle.'

INTERNATIONAL INTEREST

A number of other nations have expressed interest in the platform, including countries in North Africa and the Middle East. Barlas said that ten potential customers are in discussions with TAI – it is believed that Egypt is one, with possible acquisition of ten platforms, although Barlas was unable to comment.

The Anka can reach an altitude of 23,000ft, and currently has an endurance of 18 hours, which is expected to be extended to 24 by the time development is completed. Payloads being explored include EO/IR, SAR, communications relay, electronic/communications intelligence and multi-spectral cameras. The current capacity allows up to a 200kg payload, with full endurance.

'Anka employs a heavy fuel engine and an electro-expulsive ice-protection system, which have certain advantages over their counterparts in Heron,' he continued. 'Anka data links have a radio relay function, which facilitates airspace coordination and improves safety through direct communication between the ground control station and local air traffic control/other manned aircraft.'

The cruise speed of the Anka is higher than Heron, providing better area coverage per flight hour and bad weather penetration capabilities, explained Barlas.

Commercial applications might be an option in the future, and the company is in contact with various organisations in Turkey to better understand their aerial surveillance needs. The endurance of the platform also lends itself to other uses, and could be a suitable platform for maritime operations, for example.

The Boeing Phantom Eye is planned to have both four-day and ten-day variants. *(Photo: Boeing)*

Meanwhile, as well as Turkey, the Heron is in operation with 18 military users, including Australia, Canada, France, Germany and Israel.

'The main issues are persistence and cost-effectiveness,' an IAI representative explained to *UV*. 'At the operational level, the long endurance provides the capability to maintain surveillance of a region of interest constantly without any need of replacement of the vehicle, and at ranges that can be extended.

'Cost-effectiveness goals are reached mainly because the number of UAVs required to provide full coverage of an area is reduced, and maintenance levels required are significantly reduced. The operating team can also be significantly reduced, since take-off and landing phases are not significant relative to mission time.'

COST VERSUS CAPABILITY

IAI states that the maximum time the Heron has flown is 51 hours, and higher figures are possible, although cost is factored into this.

'The main technological challenge is to provide a reliability level – based on redundancy of the critical systems – that achieves a mean time between critical failure high enough to complete LE missions,' the representative continued. 'The Heron has demonstrated during the last ten years an outstanding reliability level.'

The spokesperson claimed that the Heron is a very flexible system, and the only MALE UAV performing real multi-mission operations. 'The Heron system is slowly but surely replacing the manned aircraft for support missions,' he added. 'The MALE system – and the Heron especially – are maybe the most cost-effective systems. They are able to provide users with all the ISR, SIGINT [signals intelligence] and other missions capability for a fraction of the cost of manned mission aircraft.'

Of the billion-dollars-per-year MALE UAV sector, most applications are in the military market, the spokesperson continued, although civilian and parapublic markets have shown that they are 'growing significantly' in recent years.

The Heron New Generation is currently in development, and is a re-modelled variant that will integrate a new generation of mission payloads, such as larger EO sensors, as well as more precise and extended-range SAR and SIGINT systems. uv

The Cyberhawk RWS UAS conducts an inspection of an operational flare stack. *(Photo: Cyberhawk)*

Inspector gadgets?

Many companies are still reluctant to adopt UAS for inspection duties due to their perceived lack of added value, alongside questions of safety. However, such platforms should not simply be viewed as a novelty, argues **Angus Batey**.

Since the advent of unmanned aircraft, there has been considerable optimism about the possibility of using UAS to carry out various inspection roles required to protect and secure elements of a nation's critical infrastructure.

Checking vast stretches of power lines for defects, tracking gas and oil pipelines to detect and deter sabotage and aerial surveying of hard-to-reach parts of refineries or drilling installations all seem like jobs well suited to UAVs. If such an aircraft can monitor the integrity of flare stacks at an oil rig, inspections can be carried out without shutting down operations, which would be necessary for physical inspections.

Yet, what looks like an obvious market has been slow to establish itself. One significant impediment is the complicated regulatory picture regarding flights of civil unmanned aircraft in most nations' unsegregated airspace. Another may be that the same untapped potential UAS offer could be working against the technology – it is still new and remains unproven in the roles such companies may wish to deploy it.

RECOGNISING POTENTIAL

'The use of these platforms and technologies to do certain things is like a "greenfield opportunity",' said John Moreland, general secretary of the Unmanned Aerial Vehicle Systems Association, the UK trade group representing the unmanned industry. 'There are loads of people out there who, potentially, we feel could use these systems, and probably recognise they could use them. But most of them have established procedures for doing things.'

This has certainly been the experience of Cyberhawk Innovations, a company based in Livingston, Scotland, which supplies infrastructure inspection services using UAS to clients in the oil, gas and power-generation industries.

'Generally, it's getting our foot in with a particular company that is the trick you learn, because this is something new,' explained Mark Sickling, Cyberhawk's flight ➤

An inspection team uses the Cyberhawk RWS to inspect an electricity pylon. *(Photo: Cyberhawk)*

operations manager. 'These industries tend to stick with what they know – and what they know is sending people up on ropes when the kit's shut down.

'For them, risk is in a number of areas. There's the physical safety of the operators, but also there's the risk of if they commit to doing an inspection with a novel technique, if it is not successful, that can have major implications for them. So they have to have the confidence that what's going to be provided is good enough – and if the customer believes that is an unknown, he will always be very reticent to commit to that.'

However, according to Sky-Futures, another UK company offering UAS inspection facilities to infrastructure companies, that reticence is slowly but surely being broken down.

'Oil and gas is pretty modern these days, and they're always looking at new ways of doing things, especially when it comes to safety,' said company founder Chris Blackford. 'They're always interested in something which improves the safety of their work. They're less financially driven – safety and efficiency are the key ones for them. For these big companies to stay ahead, they've got to be efficient and innovate because if they don't, then they lose out to the competition.'

COST CONCERNS

Aerial inspection of facilities is far from unknown in infrastructure-related industries, and the cost savings UAS potentially offer over manned platforms ought to be another

'Oil and gas is pretty modern these days, and they're always looking at new ways of doing things, especially when it comes to safety.'

persuasive factor. However, Moreland argues that this too is an aspect that may be responsible for keeping the rate of uptake for UAS solutions relatively modest.

'In certain respects, we don't envisage UAVs being used for anything different that you could do with manned aviation,' he said. 'Power-line inspection, pipeline inspection, aerial photography, aerial surveying – these are all done by manned aircraft today. A lot of people turn around and say: "Yeah, I like the idea of using [UAS], but I only want to use it one day a month, or five days a year."

'You only have to have a look at the corporate jet market for a comparison. I know a number of companies that use corporate jets, and if you look at their utility, on a good month it's probably 10% – I think, in the current world, people can't really justify that. Even though UAV technology is much cheaper than buying a manned aircraft, people say: "Well, hang on a minute – do we really need this in the hangar just for the occasional use?""

On the face of it, this leaves the market wide open to companies such as Sky-Futures and Cyberhawk, which take the risk of systems investment out of the equation for the customer and can supply the technology and expertise on a case-by-case, inspection-by-inspection basis. Are they concerned that, in the longer term, their work may just end up enabling multinational energy companies to gain experience of conducting aerial inspections from UAS, and then choosing to buy their own unmanned fleets instead of replacing current corporate fixed-wing assets?

'That's always an issue, particularly when you look at organisations, such as some major oil companies, that have significant manned and, in some cases, unmanned aviation programmes in progress,' added Sickling. 'But what they have acknowledged is that our techniques and experience at doing this are probably far ahead of where their current research programmes are.

'We're working with these companies to share information that's mutually beneficial. In the current climate, there's far more interest in contracting this type of inspection than having an indigenous capability because of the cost, amount of training and level of expertise that's required.'

FULL REPORTS

For outsourced inspection providers, the business is not confined to operating the platforms and payloads – both Cyberhawk and Sky-Futures design each survey and supply their clients with fully annotated and illustrated inspection reports, not just the raw data.

'Using guys with specialist knowledge impacts how we do the operation,' continued Sickling. 'The guy out there operating the sensors on the job is a qualified engineer, so he knows what imagery needs to be captured. And when the job is actually in progress, he will see things that warrant closer investigation while the vehicle's airborne. That level of understanding and background is really required to make the data collection successful, so that the next step of production of the final report and the analysis is to its best possible level.'

Operational expertise with the aircraft systems is also a key factor. The need to inspire confidence in your operational capabilities is a

given in any industry, but is even more crucial when trying to persuade safety-conscious customers to allow 'novel' technologies to be deployed at locations where the risk of an accident is amplified by the presence of flammable and explosive materials.

Both Sky-Futures and Cyberhawk include members of staff whose experience in UAS operation has come via the military, although the companies differ subtly in the way they leverage that expertise.

'We don't always sell it in very overtly, but a lot of people have said to us that they really like the fact we use ex-military guys – they feel quite assured by that,' noted Blackford, who is one of many members of Sky-Futures' staff whose background is in operating British Army UAS.

'Our operators have a lot of experience flying in high-pressure situations, and that makes them fairly calm and robust in terms of how they operate. Anyone can fly a UAV, especially the modern ones – our consideration is actually the 3D picture. The crucial thing for us is that these guys have done extensive ground school, so they understand weather, airspace management and that they're operating an object in a 3D space.'

BUSINESS BACKGROUND

Cyberhawk, meanwhile, was established by professionals with experience in climbing tall industrial structures and carrying out inspections in person – its leveraging of UAS technology sought to ally the specific industrial expertise with the safety that remote operations provide, although it still has a strong ex-military UAS staff component.

'The company was founded by people who came from an industrial inspection background, but was formed to use the new technology,' explained Sickling, who is himself a former RAF Reaper pilot. 'It's certainly a huge advantage that people who've previously worked on the ropes have that relationship with the customer.'

To that end, Cyberhawk has created a fleet of bespoke UAS, specifically designed to cope with the particular challenges of aerial inspection work. Its Cyberhawk Rotary Wing System is the product of a years-long collaboration with German UAS manufacturer Ascending Technologies. The system has so far logged over 4,000 ➤

commercial flights, with no mishaps – a record Sickling says is 'an order of magnitude more than other operators'.

British airspace regulations, which enable the operation of small UAS for aerial work via a permissions procedure administered by the Civil Aviation Authority, mean that the country is well placed to enable new companies in the sector to build up their expertise and experience.

Both Cyberhawk and Sky-Futures have had success winning contracts outside the UK, suggesting that their capabilities are considered more desirable than other firms offering similar solutions in other territories. Neither company can afford to sit on its laurels however, and both have demonstrated unique and novel capabilities in recent months.

In 2012, Cyberhawk became the first company to fly a UAV from the deck of an offshore drilling platform. The work was a success, saving the client an estimated $7.9 million and winning the company, and a partner asset integrity management firm, the 'business efficiency' category in the 2012 Oil and Gas UK Awards. The contract took some time to deliver, as techniques and operating procedures were tested and validated.

'There are many technical issues with operating small equipment like we use in the offshore environment,' said Sickling. 'By doing a bunch of trials in a less critical area – operating off boats and in magnetic and GPS-denied environments to prove the equipment is safe – the customer was then able to say: "Yes, we've proven all that, let's give it a go."

'We started doing the above-deck flare inspection, and then progressed to underneath the deck. That meant flying in a totally GPS-denied, looking-down-on-the-vehicle scenario to carry out surveys of the underneath of the decking, which otherwise is very, very difficult to do.'

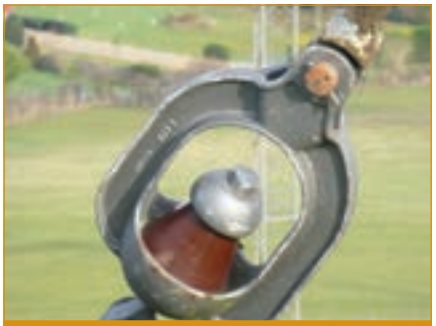
ELECTROMAGNETIC ENVIRONMENT

Sky-Futures spent a considerable amount of time on a project that saw it deploying a rotary-wing UAS in an unusual electromagnetic environment.

A Sky-Futures-operated Aeryon Scout platform conducts an inspection of a wind turbine. *(Photo: Sky-Futures)*

'We were asked to inspect a telecommunications mast, which had high RF output, so there was extensive work before we took on the job,' added Blackford. 'We did a lot of testing, spoke to the manufacturers and went to the site and did spin-up tests. We downloaded the log files at various distances, and then we analysed all the log files to see the impact of the energy on the modem and the GPS in the aircraft themselves. And it was only when we were satisfied that it was completely safe to fly that we did actually fly.

'It's the same with everything we do – there is a process. Whilst we can just turn up and fly for some things, if you're doing something new, that requires a level of investigation and preparation. One thing we're very honest about is what we can't do – we know what we can do, but we're still learning every day about the industry and markets.'



Imagery from a Sky-Futures UAS is able to provide sufficient detail to show the identification numbers on a cable. *(Photo: Sky-Futures)*

Developing the market remains a challenge, and will require co-operation and collaboration between contract UAS inspection providers and their industrial clients. Sickling points out that beyond-line-of-sight operations will remain a challenge for some time to come, and while UAS offer a number of key advantages, unmanned systems cannot be expected to solve every possible problem.

PIPELINE PROTECTION

'We're getting asked a lot of questions on pipeline protection, not so much in the UK, but certainly in more remote areas around the world,' said Sickling. 'That is very much a question of what the regulators will allow you to do, and what requirements does the customer have.

'We could probably use a very small, light unmanned system, if we were cleared to operate beyond line of sight, to fly down the route once a day to see if anything's changed. But if the requirement is for a reactive system, where you're looking for people approaching the pipeline and leaving – and we've been quoted: "Well, we'd need to know within a minute of anyone approaching that pipeline" – if you work it out, you probably need half a dozen Predator-type devices at 10,000ft with long-range cameras to do something like that.'

Moreland commented: 'If you were going to say: "I want to fly a Hermes 450 from Sizewell B [power station, on the Suffolk coast in the UK] over to Hinkley Point [in Somerset], and I want to follow the power lines from both, and through Oxford", for the aircraft to fly at 10,000ft to use its cameras at the optimum height, that would require a NOTAM [notice of temporary airspace management] and some pretty big intrusions into controlled airspace.

'If you were doing it as a one-off, it would be incredibly disruptive – if it was a scheduled flight, daily, like an airline, and it was incorporated into the flight system, it may be possible.' uv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The Gavia undergoing a customer trial in Lake Kleifarvatn, Iceland. *(Photo: Teledyne Gavia)*

Breaking through

The quality and quantity of underwater data collection by unmanned maritime systems has significantly improved over recent years, positioning them as a valuable information-gathering tool that can be deployed to otherwise inaccessible locations. **Beth Stevenson** reports.

One unmanned platform type that takes its legacy from a commercial application as opposed to a military requirement is the AUV. Developed as an oceanographic survey tool, the AUV remains true to its heritage, and is continually used by research organisations and academic institutes – as well as naval research laboratories – to undertake sub-sea scientific research.

Underwater surveillance can be both dull and dangerous, and unmanned platforms can now use an array of sensors to scan, identify and monitor what would otherwise have to be observed by humans underneath the surface.

'UUVs open up new areas for exploration,' David Kelly, president and CEO of Bluefin Robotics, explained to *Unmanned Vehicles*. 'They grant access to parts of our ocean where people or other technology cannot go, whether it be deep water, where distance and pressure pose problems; the Arctic, where there are vast areas covered in ice; or parts of the world where very harsh conditions and extreme topography prove too challenging to explore.'

UNMANNED ADVANTAGES

Kelly explained that AUVs are now a more efficient and lower cost option for underwater data collection. They also offer improved data quality, and take away the need for humans to carry out the mundane tasks that unmanned systems can now do instead.

'Another advantage of UUVs is the increased quality of the collected data,' he continued. 'Bluefin UUVs in particular are very stable platforms, which improves sonar resolution and image quality. Their accurate navigation allows the sensors to collect data at a constant altitude above the sea floor, resulting in greater image consistency.'

Bluefin offers a variety of AUV platforms, including its Spray Glider, which can be used to measure water quality.

As part of the Florida Shelf Edge Exploration II cruise, for example, two platforms operated by Harbor Branch's Ocean Visibility and Optics Laboratory, in collaboration with Bluefin, were deployed for several months at Pulley Ridge, Florida, which allowed large-scale measurement of water quality parameters above the coral reef and surrounding area.

Bluefin announced on 24 January that it is to produce and deliver the Knifefish UUV – a specialised Bluefin-21 developed for the Surface Mine Countermeasure UUV programme – to the US Naval Research Laboratory (NRL). It will be used to develop the NRL's low-frequency broadband (LFBB) payload technology to be used in a broader context for underwater research.

'This is just another example of how the UUV technology is maturing into a reliable, robust platform for advancing new science and capability,' noted Kelly in a statement.

'Science and defence programmes are now mutually benefitting from the investments made in UUV technology,' added Brian Houston, acting head of the NRL's Physical Acoustics Branch.

The NRL has been using another modified Bluefin-21 – the Reliant – as a science and technology platform for original LFBB development.

'Bluefin works closely with the world's leading sensor providers, and we aim to offer the most "state-of-the-art" sensor technology to our clients,' added Kelly. 'We have integrated over 80 sensors to date, and are currently integrating "cutting-edge" imaging sonars, advanced optical systems and sophisticated chemical sensors on the UUVs.'

Bluefin is continually in pursuit of smaller, more capable sensors that require less power. 'We are also interested in sensors that are specifically packaged for UUVs, versus those originally designed for other platforms, like ROVs or towed systems, but retrofitted to work in UUVs,' he noted.

The survey Bluefin-21 offers an endurance of 24 hours, with 'rapid turnaround between surveys'. Options to double this are available, and the company is working on approaches to triple or quadruple this capability. It has also successfully designed, built and tested a

docking station for in-sea charging to further extend endurance, and 'work continues in order to mature the technology to provide a practical solution for clients'.

Meanwhile, Bluefin is continuing its development of a hybrid ROV prototype with in-water testing. 'We believe that the Hawkes ROVs will be able to meet customer needs currently not being met by the equipment offered in the market place,' explained Kelly.

SLOW AND STEADY

Another such system that has come to people's attention is Liquid Robotics' Wave Glider. The vehicle is a dispatchable, self-fuelling USV designed to provide persistent performance over some 12 months, taking data for environmental monitoring, among other things. Its average speed is approximately 1.5kt, and it can monitor 65ft below the surface and be re-tasked at any time. The longest mission to date is two and a half years.

As part of the 'Pacific Crossing Challenge', four systems were launched to travel across the ocean – two were destined for Australia and two for Japan. They all departed from San Francisco in November 2011, and were subsequently launched in the two directions in May 2012 after reaching Hawaii.

It was announced in December that one of the two gliders destined for Australia had reached its target, setting a new world record after covering 16,700km.

The company said that the platform travelled through and measured some 1,900km of a chlorophyll bloom along the equatorial Pacific.

'These blooms indicate proliferation of phytoplankton that is fundamental to ocean life and climate regulation,' a company statement said. 'While typically monitored through satellite imagery, direct validation of chlorophyll blooms at this resolution provides a ground-breaking link between scientific modelling and in-situ measurement of the Pacific Ocean.'

The system can also be steered into hurricanes and collect data in real time, measuring the water temperature, a concept demonstrated in October 2012 when Hurricane Sandy hit the east coast of the US.

The company is working with the National Oceanic and Atmospheric Administration in a project to help understand how USVs can help predict extreme weather cycles. This involves one Wave Glider surveying the oceans, and although the particular USV used during Hurricane Sandy was not involved in the project, it was redirected to the area in order to carry out the data collection.

'We've been working on a project to work out how to improve our ability to forecast how strong hurricanes are either going to get or not get,' Edward Lu, chief of innovative applications at Liquid Robotics, told *Unmanned Vehicles* in November 2012.

He explained that some 72 hours is needed ahead of a hurricane hitting to ensure airports and ports are closed and people evacuated. Although hurricane prediction has got better over the past few years, not enough knowledge was known prior to Sandy to determine what weather state it would be – the prediction was not precise enough.

Lu continued: 'One of the key things we cannot measure is the thing that drives hurricanes. This is the water temperature in the upper 20-50ft of water, because hurricanes are driven by warm water.'

MONITORING APPLICATIONS

Teledyne Gavia has developed the Gavia AUV, which offers users the ability to monitor undersea regions previously hard – as well as more costly – to reach using manned platforms. 'The Gavia is distinguished by a modular architecture that truly enables "plug and play",' Justin Manley, a Teledyne Marine representative, explained to *UV*. 'Users can rapidly install extra batteries and new sensors to meet their operational requirements.'

He noted that cost is dependent on the modules purchased, but the system is 'priced favourably' against other AUVs.

'Our scientific customers use Gavia AUVs for environmental monitoring under ice and in estuarine regions like the Chesapeake Bay [the largest estuary in the US],' continued Manley. 'They also use them as educational tools to teach students the theory of AUVs and undersea robotics. Another application is to map the geophysical properties of the sea floor to better understand its geology.' ➤

The Bluefin-21 has an endurance of 24 hours, and its Knifefish variant will carry out scientific research for the NRL. *(Photo: Bluefin Robotics)*

With regard to the place of AUVs within scientific teaching, he identified that there is some use in this area, although due to limited budgets, they are only slowly growing into this application.

The Gavia can be launched from vessels, and is considered by the company to be a low-logistics platform, and therefore specialised launch equipment is not required. Military and commercial users are typically focused on mapping the sea floor, while those in the scientific community are often interested in the water column, or mapping under ice, according to Manley.

The vehicle can be fully autonomous, or if desired, acoustic modems can be used to communicate with it while active, and then once on the surface, data can be downloaded and new missions uploaded via systems such as WiFi.

POWER DRAIN

Endurance is dictated by the power demands of the payloads and number of battery modules installed, although the vehicles can typically operate from between four and 12 hours, depending on configuration, which Manley said is suitable for operational requirements. 'The rapid battery changes enabled by the modular architecture allow our customers to return their AUVs to operation very quickly,' he noted.

Payloads available include a variety of environmental and geophysical sensors, typically acquired from third-party companies and integrated by Teledyne. 'We are continuing to improve the number of sensors supported by our modular architecture,' explained Manley. 'We also focus on improving the positioning of our AUVs while undersea. Higher quality position information is of value to science and commercial users.'

The modular approach is also appealing to the scientific community because new modules can be added without additional integration costs, and therefore the platform is more cost-efficient and versatile. The low-logistics approach also allows 'science users to conduct operations with lower infrastructure costs'.

Saab, meanwhile, has developed its AUV62-MR platform with a modular and open architecture, which can be adapted to a variety of applications and requirements. 'We have a platform that has been designed for users to add their own payloads, so that is one reason why it is possible and quite easy to use it for different types of missions,' Michael Berg, director of marketing and sales at Saab, told *UV*.

Saab's AUV62-MR is designed with an open and modular architecture for a range of applications. *(Photo: Saab)*

The AUV62 also has a low signature within the water and a low radiated noise level, increasing its stealthiness. The Swedish Navy operates the platform for mine hunting, and it can be launched from a torpedo tube on a submarine.

RESEARCH TYPES

The platform is currently not on contract with any scientific customers, although Berg explained that naval research laboratories could use it for a variety of study types and investigations. 'That would be possible – they have their own research labs and can use it, but so far it hasn't been the case,' he said.

'They can purchase the generic vehicle and then decide what type of payloads they want to have for whatever mission they want to perform. The modular concept makes it possible for the customer to add modules that really fit their purpose.'

Scientific applications that it could be used for include bathymetric data gathering, sub-bottom profiling and environmental surveys. Endurance depends on the battery pack selected by the customer, although on average it is around two days, and the length of the vehicle is between 4 and 6m.

'If you're going to operate in a very severe environment where you have different temperature layers and different salinities, or close to things like big rivers, you can have modules to compensate the density of the system,' concluded Berg. **uv**

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Hotting up

Affluent countries in the Middle East have budgets to spare and requirements to meet, and unmanned systems manufacturers are eager to get their business. **Claire Apthorp** takes a look at developments.

With the build-up to this year's IDEX being more dynamic than ever, it is clear the event is becoming an important date in the calendar for UAV manufacturers worldwide, which are seeking new customer bases in the face of downsizing defence budgets in the West.

While the development and manufacturing of UAVs in the Middle East has long been dominated by Israeli companies, the region is home to a number of countries looking to challenge this stronghold. With the majority of nations having retained a good supply of funding throughout the wider economic downturn, companies from North America and Europe are now seeing the potential of this market.

WATCHING FROM ABOVE

The requirements of the region vary from nation to nation, but there is an overwhelming need for airborne surveillance for security purposes, both in the military and civil sectors. Recent events in Algeria have underlined the importance of keeping vulnerable and valuable infrastructure secure, and emphasised the complex challenges facing the region beyond the theatres of Iraq and Afghanistan.

The UAE is one of the more established markets in the region. At the Dubai International Air Chiefs Conference in 2011, military and government officials came together from across the region and the wider international community to discuss evolving strategic defence requirements, with a particular focus on air defence capabilities.

During the conference, the UAE's Deputy Air Force Chief Maj Gen Ibrahim Naser al-Alawi outlined the country's plans to acquire next-generation air defence assets, which included a UCAV between 2018 and 2025.

In the shorter term, al-Alawi confirmed at the time that the UAE would look to acquire a MALE UAV before 2013 – the country was believed to be considering General Atomics Aeronautical Systems' (GA-ASI's) Predator XP and Turkish Aerospace Industries' (TAI's) Anka to fulfil this requirement.

In February 2011, GA-ASI signed an agreement with International Golden Group to offer the Predator XP UAS for the surveillance needs of the UAE government. The platform is a variant of the company's Predator family that has been modified to meet US government export restrictions limiting certain technology transfers to select NATO and allied nations. Predator XP has been certified by the US government to be marketed within a broader customer base, including the Middle East and North Africa.

Predator XP has the same physical dimensions, altitude, speed and long endurance (up to 40 hours) as the RQ-1 Predator, originally developed for the USAF. It is also equipped with the same ISR capabilities, and the aircraft may be integrated with multiple exportable sensors, including state-of-the-art EO/IR cameras and GA-ASI's Lynx multi-mode radar.

TURKISH MALES

TAI is also believed to have an interest in the UAE's acquisition plans, with the company's Anka vehicle – the first MALE type developed by Turkish industry – the focus of its plans.

The Turkish Air Force is currently in contract negotiations with TAI for the purchase of ten Anka aircraft to replace its Elbit Heron fleet. In January, TAI announced that the aircraft had completed its acceptance test campaign, having successfully demonstrated its full endurance and 200km data-link range performance (for more, see p4).

The Shadow M2 is one UAS that Middle East customers could be interested in. *(Photo: Textron AAI)*

'If it was a platform that had not been fielded, many customers within the Middle East and elsewhere would be more sceptical and reluctant to buy.'

TAI is looking to increase its market share against Israeli companies beyond the Turkish Air Force, and although the Anka suffered a setback in late 2012 when a prototype aircraft crashed during a test flight, both Egypt and Saudi Arabia are understood to be looking at acquiring the platform in order to meet existing requirements. The UAE's interest in the system also bodes well for its prospects.

The UAE was also the launch customer for the VTOL Schiebel Camcopter S-100, where it is part of the Al Sabr programme managed by Abu Dhabi Autonomous Systems Investments on behalf of the UAE Armed Forces for ISR missions. The S-100 is also gaining attention elsewhere in the region, with two systems delivered under contract to the King Abdullah Design and Development Bureau (KADDB) of Jordan in 2011.

The system was acquired to form a key part of the Jordanian Armed Forces' (JAF's) Reconnaissance Squadron. The S-100 was selected following an evaluation process by KADDB on behalf of the JAF and Royal Jordanian Air Force, and will be equipped with the L-3 Wescam MX-10 EO/IR payload to perform ISR missions.

While TAI is seeing early positive results from the Anka, it will be interesting to see how well the system stands up against more mature systems, such as the AAI Shadow 200 – also being marketed heavily in the region – in a new market like the Middle East.

THE SAFE BET

'One of the key things that happens in the international marketplace is that customers look for low-risk solutions,' David Landis, VP of business development at AAI Unmanned Aircraft Systems, told *Unmanned Vehicles*. 'If you're looking for proven technologies, Shadow has surpassed 800,000 flight hours in combat, mostly in Afghanistan and Iraq. When you have that many flight hours in hand, most of the bugs and issues have been worked out, and the system has already seen great investment and improvement by the original customer [the US DoD].

'If it was a platform that had not been fielded or deployed, many customers within the Middle East and elsewhere would be more sceptical and reluctant to buy because there might be issues that they will end up paying the bill for.'

AAI is, according to Landis, looking at several prospects in the region, and expects to see some of these opportunities come to fruition within the coming 12 months. The company's UAS offerings are focused on the Shadow 200 and Aerosonde systems, as well as the as-yet unreleased Shadow M2 – a variant of the Shadow 200 able to carry larger payloads, complete longer missions and fly at higher altitudes. All of these systems offer a range of capabilities well suited to the requirements emerging from region.

'Almost every country in the Middle East is saying the same things in terms of their requirements: port security; infrastructure security; border protection – these are the things they are looking to UAV solutions for,' Landis continued. 'They are looking at UAVs to do those dull and dirty missions – why have an expensive manned aircraft out there flying around looking for things that might happen, when you can have a UAV conducting surveillance, costing less, putting less people in harm's way, and still get the same capability at the end?'

An export version of the Predator is being marketed in the region. *(Image: GA-ASI)*

INFRASTRUCTURE MONITORING

AAI is keen to match the Shadow 200/M2 with tactical border patrol mission requirements, while its Aerosonde is better suited to infrastructure surveillance, such as gas and oil pipeline monitoring.

'Infrastructure surveillance is a big deal in the Middle East – if you look at what happened recently in Algeria, concerns around kidnapping, and also on the commercial side there's a whole industry centred on tanker and freighter security as a result of the increased piracy threat,' added Landis.

The Camcopter S-100 was the first UAS sold in any numbers in the region. *(Photo: Schiebel)*

'We see this market expanding in many different directions, and customers are so much more educated today about the systems and their capabilities – you can't pick up a newspaper without seeing a UAV involved in some new mission, and that's exciting. We see that market continuing to grow, with the Middle East probably the biggest region for this capability for the next five years.'

Lockheed Martin is also zeroing in on the Middle East for the potential it sees in pipeline and supply line surveillance, for which it is marketing a number of its capabilities at IDEX. The company has made a number of acquisitions within the UAV space over the past few years, including Procerus Technologies, ChandlerMay and CDL Systems, which will enhance Lockheed Martin's offerings at IDEX.

'We're looking at the short and long term in this market with our expanding family of UAS solutions, and in particular we will be looking to open opportunities within the VTOL market for the region at IDEX,' Bill Daly, business development manager for small UAS at Lockheed Martin, told *UV*.

Lockheed Martin Procerus' VTOL offering – officially to be marketed as 'Indigo' – is a quad-rotor, man-packable system with dual-sensor EO/IR/laser illuminator gimbal and digital IP data link for video and communications. With vision-aided guidance and extended hover/perch/stare capability, the system has an endurance of 45-55 minutes and is a single unit that folds up for storage/transport.

Along with Lockheed Martin's legacy Desert Hawk system, which is used extensively by British forces, the company is keen to bring a new level of know-how and technology to bear in the Middle-East market.

'Being hand-launched, these systems are relevant for the needs of this market, particularly in the border security and monitoring space,' explained Daly. 'When integrated with other unmanned technologies, such as unattended ground sensors, these capabilities become very attractive to those organisations tasked with monitoring their borders against interlopers.'

MANNED VIABILITY

Critically, these systems bring the user flexibility in their response options to a potential border security incursion, particularly in situations where it is not always a viable option to deploy a manned aircraft or patrol vehicle to investigate suspicious activity.

'We tend to think of the Middle East region as being flat desert, but in reality it has a lot of challenging terrain that precludes people simply jumping in a car to go and investigate,' added Daly. 'So being able to quickly launch an SUAS without runways or launchers means you don't have to wait for a higher authority to cut loose a higher-value, already overtasked asset, be it manned or unmanned – they would have something organic which they can use on their own as and when they need it.'

The growth of the Middle East market over the coming years will in many ways owe a lot to the fact that the international UAS marketplace as a whole is approaching a critical crossroads. The large customer base that has developed over the past decade has been focused largely on combat operations in Afghanistan and Iraq. As those are scaled back, it brings UAS suppliers the opportunity to take lessons learned from those combat scenarios, refine their products and expand into new areas.

'We tend to think of the Middle East as being flat desert, but in reality it has a lot of challenging terrain.'

'If you look at the Desert Hawk programme, the UK MoD has called it one of the most successful UORs they've ever had,' noted Daly. 'Since we began flying Desert Hawk in 2006, we've been constantly taking feedback from the user and making recommended improvements that, as it turns out, make it ideal for high-elevation surveillance of power lines. So we've taken a combat system, and based on feedback from the user, it now has a commercial application.'

BURGEONING MARKETPLACE

While companies such as Lockheed Martin, AAI and GA-ASI continue working to gain a foothold in this sector, significant efforts are also being undertaken by domestic organisations looking to take advantage of the burgeoning UAV market.

One such example is UAE company Adcom, which unveiled the MALE prototype United 40 at the 2011 Dubai Airshow. The system is being designed for strategic missions such as near-real-time combat assessment, battle damage assessment and border surveillance and communications relay. With a wingspan of 20m, endurance of 120 hours and maximum altitude of 23,000ft, the United 40 can carry two gyro-stabilised platforms, and four pods located under the wings, with 100kg weight capability each plus SAR and sonar terrain avoidance.

Investing in a regional industrial base for UAV technologies is an important step in developing the capability to build and support a self-sustaining market, and it has positive consequences for the future of the market worldwide. As new developments emerge from within and Western companies continue to tap the new customer base of the Middle East, the future looks bright for maintaining innovation in the field for the long term and – vitally – beyond the limits of current combat theatres. **uv**


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Two of the MQ-8Bs embarked on board USS *Klakring* are seen here ranged on the frigate's flight deck. *(All photos: USN)*

Frigate birds

While the USN is still ascending a learning curve with the introduction of the VTOL MQ-8B Fire Scout, the deployment of HSL-42 Det 2 on the USS *Klakring* in 2012 broke much new ground, **Richard Scott** reports.

When the *Oliver Hazard Perry*-class frigate USS *Klakring* (FFG-42) returned to its home port of Mayport, Florida, on 1 December 2012, it marked not only the end of a successful five-month deployment in the US Africa Command area of responsibility, but also the completion of the USN's fourth and most ambitious MQ-8B Fire Scout UAS detachment to date.

During the course of *Klakring*'s deployment, which took the ship into pirate-infested waters off the horn of Africa, the quartet of VTOL UAVs (VTUAVs) embarked logged more than 500 flight hours supporting maritime security operations. In this role, the MQ-8B flight detachment – parented by Helicopter Anti-Submarine Squadron Light 42 (HSL-42) Det 2 – provided real-time ISR support to combatant commanders.

'These initial deployments demonstrated that the system offered the potential to provide a valuable ISR asset.'

Although the MQ-8B had previously completed detachments from the *Oliver Hazard Perry*-class frigates USS *McInerney*, *Halyburton* and *Simpson*, the deployment on *Klakring* – which had sailed east from Mayport on 29 June – was the first time that four Fire Scouts deployed operationally from a single platform. Moreover, it came in the aftermath of some intense media scrutiny after two unrelated mishaps had resulted in the decision to call a brief 'operational pause' in the Fire Scout programme in April 2012.

On 30 March, an MQ-8B operating off the USS *Simpson* was ditched at sea upon returning from a maritime surveillance mission. The air vehicle was unable to achieve lock-on with the shipborne recovery system, a requirement for landing aboard a ship at sea and, after several approaches and exhaustive troubleshooting by operators, was positioned a safe distance from *Simpson* and ditched. The Fire Scout was subsequently recovered from the sea.

The second incident occurred on 6 April when an MQ-8B operating in northern Afghanistan crashed while conducting a routine surveillance mission in support of Regional Command North. Following this incident, the USN took the decision to ground the 14 air vehicles in its inventory while system performance and operational procedures were reviewed. Flight operations were resumed later in April following two investigations, but the 'pause' had nevertheless given the Fire Scout programme an untimely and unwelcome jolt.

SYSTEM INCEPTION

Developed by Northrop Grumman, the MQ-8B is in fact a systems of systems comprising: a number of VTOL air vehicles (based on the Sikorsky S-333 manned helicopter and using a heavy fuel engine); an AN/AAQ-22D Brite Star II EO, IR and laser designator/rangefinder payload (one per air vehicle); a GCS; Tactical Control System software; a Tactical Common Data ➤

Link; the UAV Common Automatic Recovery System (UCARS) to support automatic take-off and landing operations; and associated spares and support equipment.

The VTUAV was conceived as a key mission enabler for the new Littoral Combat Ship (LCS), providing the host platform with an organic means to support ISR, mine countermeasures and surface warfare 'over the horizon'. However, in 2008 the USN decided that it would pre-empt integration on LCS by taking Fire Scout to sea on board *Oliver Hazard Perry*-class guided missile frigates, beginning with a military utility assessment (MUA) aboard the USS *McInerney* in October 2009. In the course of a six-month deployment to support counter-narcotics operations, the two MQ-8Bs embarked undertook 24 flights, totalling more than 60 flight hours.

A Fire Scout in flight near Naval Station Mayport during *Klakring*'s pre-deployment work-up in May 2012.

A second MUA was conducted from USS *Halyburton* from January to August 2011. In this case, the ship embarked HSL-42 Det 2 with two Fire Scouts and a single SH-60B helicopter for a seven-month deployment in the Mediterranean and Indian Ocean (operating in the 5th and 6th Fleet areas of responsibility). Fire Scout was used to provide ISR in support of anti-piracy operations off the horn of Africa, and during Operation *Unified Protector* over Libya (where one MQ-8B was lost to enemy fire).

These initial deployments demonstrated that the system offered the potential to provide the commander with a valuable ISR asset. However, they also exposed a number of deficiencies and shortcomings, including air vehicle and data link reliability, incomplete technical publications, spare parts issues, pre-deployment training, and the lack of spatial orientation data on payload imagery.

Work is ongoing to address and correct these reliability and sustainability matters, with initial operational capability now slated for June 2014. A decision on full-rate production has also been delayed until May 2014.

In the meantime, MQ-8B deployments have continued on board *Simpson*, *Klakring* and, most recently, the USS *Robert G Bradley* in response to operational commanders' urgent operational needs to support maritime ISR operations. In terms of tasking, that has seen Fire Scout contributing to maritime security missions in the Mediterranean and Indian Ocean, performing visual identification of surface contacts, developing the maritime recognised picture, and supporting visit, board and search operations.

GROUND BREAKING

Klakring's aviation detachment broke new ground in that it was the first to include the capability for dual air vehicle operations in order to sustain a 'half-orbit' capability – ie 12 hours' unbroken ISR support. Dual control requires an operator to provide commands to both air vehicles via a single control station, enabling the crew to replace aircraft low on fuel during a mission without losing sight of the target. The navy and Northrop Grumman had first demonstrated this capability in September 2011, with these methods subsequently honed and refined for use aboard *Klakring* and all future operations.

'The mission objective of the aviation detachment on *Klakring* was to have two Fire Scouts operating simultaneously during operations, allowing the ship's commander to keep a constant watch on a target of interest,'

'Having four MQ-8Bs embarked is essential to provide the necessary redundancy for sustained VTUAV operations.'

noted Capt Patrick Smith, programme manager for multi-mission tactical UAS (PMA-266) in Naval Air Systems Command (NAVAIR). 'By having four air vehicles aboard the ship and flying dual operations, we gained the ability to provide an increased maritime surveillance capability far greater than ever before with this unmanned helicopter.'

So how did this pan out in practice? According to Cdr Darrell Canady, *Klakring*'s commanding officer, the key to success lay in knitting together the ship and aviation teams. 'We went into week 1 work-up in March [2012] with zero [Fire Scout] experience. Yet just three to four months later we were doing a 13-hour flying day for 12 hours' continuous tactical ISR.

'What I found most gratifying was the way the aviation detachment, and the folks from Northrop Grumman, melded so well with the ship's team. It was a very smooth integration, and meant that we could immediately deliver dual air vehicle operations in an operational environment once on station.

'Fire Scout greatly expanded our horizon and ISR capability. We used the aircraft on several occasions to go and get a visual ID on a radar contact we had no other means of identifying.'

SUSTAINED OPS

While the requirement to maintain a half-orbit ISR watch can be met by two air vehicles, those familiar with naval aviation will recognise that having four MQ-8Bs embarked is essential to providing the necessary redundancy for sustained VTUAV operations. 'For the majority of the deployment, we typically had three out of the four on the flight line,' said Canady. 'That gave us two operational aircraft, plus a one as a ready spare.

'With this increased number of aircraft on board, HSL-42 routinely maintained 12-hour ➤

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days on station, regularly switching aircraft to provide continuous support. And our team perfected the art of managing maintenance requirements and crew rest in proving that 12-hour-a-day operations could be sustained almost indefinitely.'

Lt Cdr Jay Lambert, HSL-42's detachment officer in charge, added: 'The real achievement on this deployment was a surge we executed to provide just over 24 continuous hours of ISR coverage in late September. Completing this milestone required ten separate flights, refuelling aircraft eight times, and having the ship setting flight quarters for launch or recovery 20 times. It took everyone on the air detachment and ship working together to make it happen.'

In complementing the aviation detachment, HSL-42 Det 2 referenced itself against the existing H-60 helicopter. However, the operation and support of a VTUAV was quickly discovered to require a different balance of skills.

'Both the ship and the aviation detachment come from an H-60 background,' pointed out Lambert. 'But you have to change that mindset. For example, the Fire Scout brings a lot heavier workload for the electronics technicians.

'There was also a learning curve from the ship standpoint as to the number of people needed to support flight deck operations. We learned that we only needed about half the flight deck crew normally required by an H-60 detachment, because you no longer have the requirement for personnel to rescue aircrew in the event of a crash on the flight deck.

'That meant we could go to port and starboard flight deck crews. Splitting the team in half allowed us to better manage crew downtime, an important consideration when you're calling flight quarters up to 20 times a day.'

As regards the management of dual air vehicle operations, 'the actual flying and handover of the aircraft was not the most difficult part,' Lambert observed. 'It's more about the art of managing the flight deck, managing maintenance of the four aircraft on board and creating the flight plan – for example, determining when during the mission to plan a pilot turnover, and whether to do the exchange when the [UAV] is on the deck or in the air.'

But the most challenging part – and just as familiar to a manned ship's flight – remains the business of managing a single-spot flight deck with two aircraft in the cycle. Lambert noted: 'If you have a maintenance delay or a problem with one of [the UAVs] and, in particular, if you have an end user that is receiving your data on a specific target that does not want that interrupted… you have to judge when do you hold and when do you fold in terms of clearing the deck of an aircraft, or recovering another and refuelling it, or pulling one off station if things get delayed. That's the hard part that never goes away.'

ISR FEED

One consequence of the urgent mission need is the relatively low level of functional integration between the MQ-8B and the frigate's combat system. 'We do not have a complete integration into the FFG weapons system as we are meeting an urgent operational need,' said Smith. 'On LCS, we will see a more streamlined integration into the ship combat system.'

He continued: 'Raw feed ISR data from Fire Scout is piped into the FFG in several ways. Full motion video [FMV] is available to the CIC [combat information centre] watch, on the bridge and in the CO's cabin. We also have a reachback capability through satellite communications to make FMV available to different end users. And we have a capability to downlink to handheld ROVER [Remotely Operated Video Enhanced Receiver] units to provide in-situ video if [the crew] are doing a visit, board, search and seizure-type operation.

'In addition the AIS [Automatic Identification System] receiver payload on the air vehicle feeds the CIC and the bridge. That allows the ship to "see" any additional AIS pick-ups given the extended coverage of the MQ-8B at altitude.'

Klakring's five-month deployment has done much to grow confidence and develop understanding in the Fire Scout system at sea. However, as might be expected, there were still a few glitches to deal with.

'We had a couple of times when we suspended flight operations,' said Canady. 'On both occasions we had a component fail for the [GCS] for which we did not carry a spare on board. So the driver for the downtime was the immaturity of the pack-up kit on board, and the identification of specific single-point-of-failure items.'

Smith added: 'The primary issues with the GCS were due to sparing. It's an issue we're continuously monitoring… looking at the sparing posture, reliability and what we put in our pack-up kit.'

CRETAN RELIEF

The USS *Robert G Bradley* and Helicopter Sea Combat Squadron 22 (HSC-22) Det 5 relieved *Klakring* in the Mediterranean in mid-November, with three of the four embarked MQ-8Bs transferred at Souda Bay, Crete. 'We met the crew of *Robert G Bradley* in-theatre and did a

Sailors on board USS *Simpson* prepare to launch a Fire Scout during night flight operations.

***Klakring* departs Souda Bay, Crete, on 16 November, having transferred three of its four MQ-8Bs to HSC-22 Det 5 on the USS *Robert G Bradley*.**

face-to-face turnover between the COs and the aviation detachment leads,' said Canady.

Lambert also put together a number of briefs to impart 'lessons learned' to all interested parties. 'That was everything from tactical best practices to strategies for mission planning, maintenance and scheduling type activities,' he said. 'It's a continuous improvement process,' added Smith. 'We collect lessons learned from every deployment. We'll go through, analyse and see how the experience can make us better the next time.'

Fire Scout's growing pains are clearly not at an end. On 13 December, an MQ-8B operating from *Robert G Bradley* was returning from a routine maritime surveillance mission in the Mediterranean after encountering icing conditions. A navy spokesperson told *UV*: 'Prior to landing aboard ship, eyewitnesses reported seeing debris fall from the aircraft. The air vehicle then began to spin and impacted the water.

'NAVAIR is conducting an investigation. Commander, Destroyer Squadron 60 temporarily suspended operations but that suspension has been lifted.'

Such attrition should perhaps not come as any great surprise. These are still the early days of organic maritime UAS operations, and it is inevitable that there will be further bumps in the road accruing from technical fault, human error and a simple lack of empirical knowledge. The world's navies will watch with interest in the months and years ahead as to how the USN's Fire Scout programme negotiates these challenges. **uv**

Spreading the word

The National Aeronautical Centre (NAC) is pioneering UK UAV flying. **Ray Mann**, the organisation's architect, tells Beth Stevenson how his brainchild is expanding and teaming with other sites, both domestically and internationally.

The NAC was formed last year during the Farnborough Air Show following developments at West Wales Airport, and was designed to give an identity to the environment in which the facility was operating. Following on from that, in December it was announced that the centre had extended its operations and teamed up with Newquay Cornwall Airport, offering customers the choice of flying at either site.

'As an airfield we were of a particular size, and every airfield has its limitations,' Mann admitted. 'So we eventually got into discussions with Newquay, which also had a mission and aspiration to expand their operations into the UAS arena. It was a good fit – they knew nothing about UAS operations and we knew plenty, and it was an advantage for us to include them into the NAC as an extension to our capability and this is working really well.

'There's quite a lot of interest from companies looking to operate and they are enjoying having the choice of West Wales and the capabilities in that particular area, or Newquay Cornwall Airport.'

Mann explained that it is not the intention for aircraft to be able to fly from one site to another, but this is a possibility for the future if operations and customers require it.

'It's really an opportunity to transfer the West Wales Airport capability to fly UAS to Newquay and help them do the same thing under the same safety and regulatory auspices.'

OKLAHOMA ASSISTANCE

The NAC is also currently assisting Oklahoma State University with its bid to provide one of six dedicated test sites for UAVs as part of US efforts to integrate UAS into non-segregated airspace by 2015.

'Oklahoma State will be part of that development, and we will be supporting that,' Mann said. 'We found that they were a good fit for us. We've already started working on

that and we're hoping to be able to assist in a number of different areas. This will be an exchange of information, and will help us on this side of the Atlantic as well.

'The international effort is important. If you look at aviation in general at the moment, it is absolutely an international system and UAVs have to fit into that. That is fundamental.'

Alongside its efforts in the US, the NAC is also looking at European UAV development.

'It is important to break out of that segregated airspace, and that does not just apply to the UK,' Mann continued. 'In the not too distant future we will hopefully be delivering UAV services from one country to the next and vice versa.'

Mann explained that on a UK level 'we can always do more', and one concern at the moment is that, given the economic potential of the unmanned systems industry, it is surprising that it has taken such a long time to make government understand the contribution that it can bring.

'This is a high-tech growth area,' he added. 'My job is to maintain that communication as much as I can so that more people really understand what we can do today, understand what we need to do for tomorrow, and undertake sensible initiatives. Looking from a UK perspective, we are very well positioned to maximise the economic potential.

'We just talk to ourselves [within industry] and in that way we don't get answers. I think now is the time to start producing answers, which will help industry and government as well, because government aren't quite sure which way to go.'

ENDING SEGREGATION

He called for more communication across the aviation world to develop systems that adhere to international standards.

'We are now more than capable of delivering what is needed to break out of segregated airspace,' Mann asserted. 'I'm not saying that our segregated airspace will not be required in the future – quite the opposite. Development, test/evaluation and training activities will all have to be done in a subsidised, standardised area.'

Meanwhile the British Army's Watchkeeper UAV is based at West Wales while it is undergoing development, and the technology displayed by the platform is 'so worthwhile', according to Mann.

'The technology has to be harnessed into something that can participate in international aviation,' he concluded. 'We know we can fly with all sorts of payloads, and we know we can control them remotely, but we have to get them to a level that the regulator is completely satisfied and confident with.' uv

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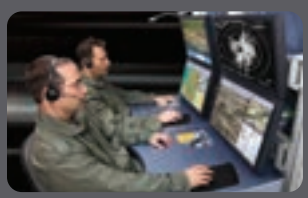

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