The use of unmanned air systems from ships is growing as navies and maritime security agencies increasingly recognise the operational benefits they can bring. Richard Scott reports

The operation of remotely piloted air vehicles from naval ships is nothing new. It was back in December 1960 that the US Navy (USN) first recovered an unmanned Gyrodyne QH-50 Drone Anti-Submarine Helicopter (DASH) prototype to the destroyer USS Hazelwood: a milestone marking the beginning of vertical take-off and landing (VTOL) unmanned air system (UAS) operations at sea.

In the mid-1980s what was then Israel Aircraft Industries (IAI) RQ-2A Pioneer UASs were introduced to USN service on board Iowa-class battleships. Operating within line of sight (30 km) to provide spotting and battle damage assessment for naval gunfire support, the fixed-wing Pioneer vehicle - rocket-launched from a stand and recovered with a catch net - demonstrated its tactical utility in the 1991 Gulf War when operating from the battleships USS Missouri and USS Wisconsin.

However, it was the case for many years that maritime UAS operations were largely confined to a handful of larger US ships, or existed only in the realms of the esoteric and experimental. This was in stark contrast to the battlefield domain, where various UAS types have proliferated over the past three decades to deliver tactical and strategic intelligence, surveillance, and reconnaissance (ISR), target acquisition, and situational awareness. Several 'weaponised' UASs have entered service since about the turn of the century, which have added a capability for the remote prosecution of ground targets using precision-guided weapons.

That is not to say that navies had not recognised the potential contribution offered by organic unmanned air assets across a range of ISR tasks, plus other missions such as force protection and electronic warfare. Rather, a series of constraints and challenges conspired to hinder the operation and exploitation of UASs at sea.

Technical hurdles included the challenges of operational and functional integration (airspace de-confliction, integration of communications bearers, bandwidth limitations, and sensor data integration into the combat management system); the problems inherent in organic operation from shipborne platforms, specifically the issues of robustness and reliability attendant to the harsh maritime environment, plus the complexities and constraints associated with vehicle launch and recovery; and the inability of manufacturers and integrators to meet the range, endurance, and payload demands of the naval community with existing air vehicle technology.

The initial non-availability of heavy fuel engines was another factor. Naval users have always sought to exploit the existing shipboard infrastructure and logistics associated with fuel for manned aircraft. At the same time, heavy fuel offers the additional advantages of improved engine performance and endurance.
Technology has not been the only obstacle. Most navies have been working to fully understand the contribution of the UAS, to develop concepts of operations (CONOPS), and to understand how manned and unmanned aviation assets might best operate together. There are attendant debates on vehicle size, payload, and performance, and the potential advantages of optionally manned systems over purely uninhabited vehicles.

[Continued in full version…]

A ScanEagle unmanned aerial vehicle is recovered to the guided-missile destroyer USS Oscar Austin (DDG 79) using a capture net. (US Navy)

ISR focus

Insitu’s ScanEagle was introduced into USN service in July 2005 under a service-based contract, with the system subsequently being operated from a broad range of platforms to provide real-time ISR. Capable of flying above 16,000 ft and loitering in its area of operations for more than 24 hours at a time, the ScanEagle carries inertially stabilised electro-optical (EO) or imaging infrared (IR) cameras that allow the operator to track stationary and moving targets. The combination of a launch catapult and Insitu’s proprietary SkyHook retrieval system, which performs captures by way of a rope suspended from a 50 ft high tower, enables launch and recovery capture at sea, making it runway-independent and minimising its impact on shipboard operations.

The ScanEagle has subsequently been deployed by several other navies. The Royal Canadian Navy operated the system from the Halifax-class frigates HMCS Charlottetown, HMCS Toronto, and HMCS Regina between 2012-14 during Operation ‘Artemis’ (Canada’s participation in counter-terrorism and maritime security operations in the Gulf of Aden and the Indian Ocean).
Other users include the Republic of Singapore Navy, which has integrated the ScanEagle onto its Victory-class missile corvettes, and the UK Royal Navy, which has operated ScanEagles from Type 23 frigates since 2014 to meet an urgent operational requirement.

In October 2016 Insitu participated in the RN's 'Unmanned Warrior 2016' exercise with a ScanEagle UAS equipped with Sentient Vision Systems' ViDAR 'optical radar' payload. According to Insitu, a ScanEagle with ViDAR autonomously detected hundreds of large and small objects in Sea State 6 conditions despite sometimes challenging weather (ranging from clear sun to wind, rain, haze and, fog). These included spotting and positively identifying two mine countermeasures vessels by number, spotting smaller objects such as stationary jet skis and buoys at 5 n miles, and locating 28 contacts from one sortie in less than two hours.

Insitu was contracted by the Naval Air Systems Command in July 2010 to supply a variant of its Integrator UAS - a significant evolution of ScanEagle - to meet the USN/Marine Corps STUAS/Tier II requirement. Designated as the RQ-21A Blackjack, the system comprises five air vehicles, two ground control systems, and launch and recovery support equipment. The Integrator is a 36.7 kg, 4.9 m wingspan vehicle capable of 16 hours endurance and altitudes in excess of 20,000 ft. Sensors for the shipborne version include an EO/IR camera with laser rangefinder and illuminator, as well as an automatic identification system (AIS) capability.

An RQ-21A Blackjack UAS attached to Marine Medium Tiltrotor Squadron 365 (Reinforced) is launched from the flight deck of the amphibious transport dock ship USS Mesa Verde. (US Navy) 1693137

While Insitu has cornered a significant market share, it is by no means alone in the shipborne STUAS arena. AeroEnvironment developed the Puma AE UAS system to compete for, and win, a 2008 US Special Operations Command (USSOCOM) programme and subsequently supplied the system to the US Navy Expeditionary Combat Command Coastal Riverine Forces, as well as to the USMC. More recently the USN procured the Puma AE for use aboard patrol craft and also
deployed the system aboard an expeditionary fast transport (T-EPF) ship in support of operations to counter illicit trafficking in the Caribbean.

Hand-launched from its host vessel, the Puma AE features a gimballed payload that delivers high-quality EO and IR imagery via a secure digital datalink. Following completion of its mission the air vehicle can be captured using a precision recovery system; alternatively, because the Puma AE is designed to land and float in water, operators can recover it from the sea should mission requirements dictate.

[Continued in full version...]

**Skylark at sea**

In 2016 Israel's Elbit Systems publicly unveiled its Skylark C mini-UAS for naval and maritime applications. Based on the existing Skylark I system already in widespread international service, the C variant retains the electrical propulsion and dual EO/IR sensor payload of its progenitor, but adopts a waterproof and floating air vehicle that obviates the need for a ship-based recovery system.

![Elbit Systems' Skylark C seen being launched from a small patrol craft. (Elbit)](image)

Although Elbit offers a deck-mounted net recovery system as an option, the capability to land the air vehicle onto water allows persistent, over-the-horizon ISR operations to be performed from very small craft. Retrieval of the UAS in this mode is enabled through the use of fully autonomous, GPS-guided parachute-based recovery, allowing the air vehicle to safely glide, land, and float on water. The entire turnaround process - from recovery to next launch - takes no longer than 15 minutes, according to Elbit.
IAI’s Malat division is also addressing the maritime market. While the company has no dedicated shipborne UAS product, it argues that the range (up to 150 km) and endurance (over 15 hours) of its BirdEye 650D mini-UAS lends itself to launch at sea for subsequent recovery to land. Alternatively, a parachute recovery can be attempted at sea, albeit with the proviso that the vehicle may not be recoverable.

Thales is another entrant into the maritime mini-UAS market with its Fulmar X system. Using a small (1.2 m length and 3 m wingspan) fixed-wing, twin-tail UAV, the system is capable of operating out to a range of 80 km and offers an endurance in excess of eight hours. The Fulmar X has been purpose-designed for small ship operations, using a compact catapult system for launch and a net for recovery.

Vertical integration

Given the constraints of deck space common to most warships, VTOL operation is an attractive proposition as it enables an organic UAS to capitalise on the flight deck real estate and support footprint ordinarily provided on ships for manned rotorcraft operations. It also offers the flexibility to land on unprepared sites ashore, or cross-deck between suitably configured consort.

Intended as a complement to the manned MH-60 shipboard helicopter, the USN’s MQ-8 Fire Scout programme has been developed to provide the service’s new Littoral Combat Ship (LCS) with an autonomous vertical take-off UAV (VTUAV) to extend the range and endurance of ship-based operations. As such it has been designed to deliver situational awareness and precision
target support by means of its ability to detect, identify, track, and potentially engage threats at over-the-horizon ranges.

Powered by a Rolls-Royce 250-C20W turboshaft engine (using standard NATO heavy fuel), driving a four-bladed rotor to achieve a maximum take-off weight of 1,428 kg, the original MQ-8B version of the Fire Scout is based on the commercial-off-the-shelf Schweizer 333 manned helicopter. Interoperable through the Tactical Control System and compliant to STANAG 4586, the baseline modular mission payload comprises a FLIR Systems AN/AAQ-22D BriteStar II EO/IR/laser rangefinder/designator system and a voice/data communication relay. From 2016 deployed flight operations began with MQ-8B aircraft additionally configured with the AN/ZPY-4(V)1 maritime surveillance radar: a variant of Telephonics' RDR-1700B(V)1 system.

Under a Rapid Deployment Capability Weaponization Program contract awarded in September 2011, Northrop Grumman has integrated the BAE Systems Advanced Precision Kill Weapons System (APKWS) laser-guided 70mm rocket onto the MQ-8B.

The deployed Fire Scout UAS is comprised of up to three MQ-8B Fire Scout air vehicles, ground control stations, and associated control handling and support equipment. With vehicle endurance greater than eight hours, a full system is capable of 12 continuous hours of operations to provide coverage 110 n miles from the launch site, according to the USN.

Before deploying from the LCS, the USN performed flight testing and operational evaluation from FFG-7 frigates as a risk reduction. A number of frigate embarkations were undertaken to support military utility assessments and operational deployments.

First combined operations involving the MQ-8B Fire Scout and the MH-60 helicopter were performed on board USS Freedom in 2014. A first MQ-8B deployment on an LCS began in November that year on board USS Fort Worth.
US Navy flight deck personnel prepare an MQ-8B Fire Scout unmanned helicopter before performing ground turns aboard USS Coronado (LCS 4). As of December 2016 - the tenth anniversary of the MQ-8B's first flight - the Fire Scout fleet had accumulated more than 15,000 hours' flight time. (US Navy)

A total of 30 MQ-8B air vehicles have been delivered to the USN. As of December 2016 - the tenth anniversary of the MQ-8B's first flight - the Fire Scout fleet had accumulated more than 15,000 hours' flight time.

In 2011 the USN took the decision to migrate the Fire Scout to a larger and more powerful air vehicle, offering improvements in range, endurance, and payload. A first contract for this enlarged MQ-8C variant, which leverages from Northrop Grumman's private-venture Fire-X demonstration effort, was placed in late April 2012.

The MQ-8C marries the existing UAS architecture developed for the MQ-8B with the Bell 407 rotorcraft to create an autonomous four-bladed, single-engine unmanned ISR helicopter. The larger air vehicle provides longer endurance (eight hours on station), range (150 n miles), and greater payload capability (700 lb (318 kg)).

Camcopter at sea

In Europe Schiebel is continuing to press the merits of its multirole Camcopter S-100 rotary-wing UAS design for shipborne operations. The S-100 itself is already in series production for land-based operations and Schiebel has performed extensive shipborne trials and a host of at-sea demonstrations to interested navies, including those of Australia, Brazil, France, Germany, India, Italy, the Netherlands, Pakistan, and South Africa. The system also featured in last year's UK-hosted 'Unmanned Warrior 2016' (UW16) demonstration.

Compared with the Fire Scout, the Camcopter S-100 represents a very different class in terms of size and weight. Its maximum take-off weight is just 200 kg (versus more than 1,400 kg) and it has a rotor diameter of just 3.4 m (less than half the 8.4 m of the Fire Scout).

The Camcopter S-100 adopts a carbon-fibre monocoque airframe that, according to Schiebel, offers a superior strength/weight ratio and provides maximum capacity for a wide range of payload/endurance combinations. The air vehicle has a maximum speed of 120 kt (cruising at 55 kt for best endurance) and a ceiling of 18,000 ft.

With a maximum take-off weight of 200 kg, the S-100's gross payload (sensors and fuel) is about 100 kg, of which the maximum sensor payload is 55 kg. Typically, with a 25 kg sensor package, endurance exceeds six hours on internal fuel.

Two payload bays are incorporated into the design, together with side hardpoints and an internal auxiliary electronics/avionics bay. The primary payload bay, located directly beneath the main rotor shaft, is capable of mounting payloads weighing up to 50 kg; payload options include the Leonardo MW PicoSAR synthetic aperture radar (SAR); a gimbaled EO/IR sensor turret such as the L-3 Wescam MX-10, Thales AGILE2 or FLIR Systems' Microstar II; and Leonardo's SAGE electronic support measures (ESM) system.
According to Schiebel, the S-100 is well suited to maritime applications, pointing to its rugged design and robust tripod landing skid arrangement, which is able to survive impacts of almost 10 g. It is also capable of landing on ship flight decks without recourse to additional landing aids or entrapment equipment.

Schiebel’s Camcopter S-100 seen during a demonstration for the South African Navy. (Schiebel) 1693139

Recognising the needs of shipborne operators, in 2012 Schiebel certified a heavy fuel engine (developed in collaboration with Austro-Engines) offering the option to use JP-5 (F-44), Jet A-1 (F-35), and JP-8 (F-34) fuels. A second-generation heavy fuel engine completed testing in late 2015.

A major breakthrough for the S-100 came in early May 2012 when DCNS, on behalf of the French defence procurement agency (DGA), completed S-100 acceptance trials for operations from the OPV L’Adroit. Built by DCNS as a private venture, L’Adroit was transferred to the control of the French Navy in October 2011 for a three-year operational evaluation. This arrangement has subsequently been extended through to mid-2017.

The S-100 (given the name Serval by the French Navy) successfully completed a series of flights and trials on board L’Adroit at the beginning of November 2011 under the command and control of the French Navy. Final acceptance trials were completed in early May 2012.

In late 2016 Schiebel was awarded a contract by the Australian DoD for the supply of the Camcopter S-100 system to the Royal Australian Navy, plus three years of follow-on contractor logistic support.
The Skeldar V-200 rotary-wing UAV is fighting for the same market space as the Camcopter S-100. Developed by UMS Skeldar (a joint venture of UMS Aero Group AG and Saab), the Skeldar V-200 is a heavy fuel VTOL rotary-wing UAS offering an endurance of more than five hours, a ceiling altitude of 3,000 m, and a datalink range out to 90 km. The air vehicle has a maximum 235 kg take-off weight and can carry multiple payloads (EO/IR, SAR radar, LIDAR, or ESM) up to a weight of 40 kg.

In 2013 the Skeldar V-200 was embarked on Spanish Navy vessels operating with the European Union Naval Force Operation 'Atalanta' counter-piracy operation off Somalia.

Another Swedish company, CybAero, last year completed demonstrations of its APID One UAS from the Visby-class corvette HMS Karlstad. Under contract to the Swedish Defence Materiel Administration, working in collaboration with the Royal Swedish Navy, the company performed a series of tests over a period extending more than a year.

[Continued in full version…]
TAIL-SITTING TERN UAS TARGETS 2018 DEMONSTRATION

Under the Tern programme the US Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), and Northrop Grumman are continuing the development and manufacture of a tail-sitting medium-altitude long-endurance UAS suitable for launch and recovery from surface warship helicopter decks. Tern is an evolution of DARPA's Tactically Exploited Reconnaissance Node (TERN) programme, which culminated in successful Conceptual Design Reviews in mid-2014. In May 2014 DARPA and the ONR signed a memorandum of agreement making the programme a joint effort named Tern. According to DARPA, the Tern initiative is seeking to develop systems and technologies to enable a future air vehicle to provide persistent ISR and strike capabilities beyond the limited range and endurance provided by existing rotary-wing platforms. Specifically, the Tern system is foreseen to provide smaller ships with a flexible 'mission truck' able to transport ISR and strike payloads long distances from the host vessel without incurring the overheads associated with major ship modifications. In December 2015 DARPA awarded a Northrop Grumman-led team (including its Scaled Composites subsidiary as well as GE Aviation, AVX Aircraft Company, and Moog) a USD93 million Phase 3 contract to build a full-scale technology demonstration system (Northrop Grumman being downselected ahead of AeroEnvironment). The build of a second test vehicle was added to the programme in 2016. The Tern technical solution being developed by Northrop Grumman is a tail-sitting flying-wing UAS with a twin contra-rotating, nose-mounted propulsion system. The aircraft is designed to lift off like a helicopter and then perform a transition manoeuvre to achieve the correct orientation for wingborne flight for the duration of a mission.

[Continued in full version...]

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.
Leonardo used the EASA-certified SW-4 Solo optionally manned helicopter during RWUAS Phase 1. (Leonardo)

For the full version and more content:

IHS Jane’s Defence Industry and Markets Intelligence Centre

This analysis is taken from IHS Jane’s Defence Industry & Markets Intelligence Centre, which provides world-leading analysis of commercial, industrial and technological defence developments, budget and programme forecasts, and insight into new and emerging defence markets around the world.

IHS defence industry and markets news and analysis is also available within IHS Jane’s Defence Weekly. To learn more and to subscribe to IHS Jane’s Defence Weekly online, offline or print visit http://magazines.ihs.com/.

For advertising solutions contact the IHS Jane’s Advertising team