A General Atomics MQ-1 Predator-A carrying Hellfires is positioned manually at Balad AB in Iraq

# Shift in Service Attitudes

**One of the most significant military developments of recent times has been the paradigm shift in service attitudes toward drone aircraft. Multi-national operations in Southwest Asia have demonstrated that such systems form part of the inventories of many major powers. It is also now clear that drones can perform usefully across a broad spectrum of missions, from over-the-hill scouting for a platoon of troops to wide-area ocean surveillance. Of particular interest is the fact that drones have been employed effectively in precision attacks on ground targets. The Teal Group has recently forecast a global market for almost 18,000 drones valued at over $ 12 billion in the period 2006 to 2015.**

Eric H. Biass
and Roy Braybrook

The Pentagon's «Unmanned Aircraft Systems Roadmap 2005–2030» states that since late 2001 some 20 different types of coalition unmanned aircraft have accumulated a total of more than 100,000 flight hours in the course of Operation Enduring Freedom (over Afghanistan) and Operation Iraqi Freedom. Taking a global view, the roadmap records 32 nations currently developing and/or manufacturing over 32 designs, and 41 countries operating 80 different drones, primarily for reconnaissance. What a few years ago represented only a niche market is evidently now growing exponentially.

## In-flight Refuelling

One of the current challenges is to develop a system that will allow one drone to autonomously refuel another, in order to extend the endurance of a sensor platform or to increase the strike radius of an unmanned combat air vehicle (Ucav). The US Air Force is reportedly attracted by the idea of a Ucav combining long radius and a persistence of 50 to 100 hours, far beyond the limits of human endurance. Such a drone could act either as a defensive shield or as a strike-capable deterrent during the build-up to war.

Both contenders for America's recently terminated J-Ucas (Joint Unmanned Combat Air System) were scheduled to have an air refuelling capability tested in the course of their programmes. Boeing has been contracted to develop an autonomous system to be first tested on a manned surrogate aircraft in 2007. The US Air Force also has a requirement to demonstrate in-flight refuelling of a drone from a boom-equipped manned aircraft by 2008. This will probably be accomplished with a Boeing X-45C and a KC-135.

In 2005 the Maryland-based UAV Refuelling unveiled a design for a weapons bay-housed drogue refuelling unit, with an optical sensor and drogue-mounted reaction controls to provide engagement with the probe of the receiver.

## EA and DE

One of the spinoffs of the J-Ucas programme was expected to be an electronic attack (EA) drone, which could operate closer to the target and thus require less power than a manned jamming aircraft. In the meantime it was proposed to begin a Joint Electronic Attack Unmanned Vehicle (Jeauv) advanced concept technology demonstration (ACTD) programme, using a mature drone as the platform.

One possible Jeauv mission payload is the 32-kg Rockwell Collins Rubicon II electronic warfare suite, which is designed to detect and jam frequencies in the 20 to 2500 MHz range. Conceived to meet a US Marine Corps requirement for communication jamming, it is to be further developed to counter improvised explosive devices (IED).

Drones may well dominate the market as platforms for directed energy weapons, soon to appear as high-power microwave (HPM) devices, lasers and Aesa (active electronically-scanned array) jamming radars. Such weapons offer the attraction of disrupting the enemy's computer and communication systems, and rendering useless his missiles and radars, without causing structural damage that would be expensive for the victor to reconstruct in the post-war period.

## Cover

This dramatic anticipation view of a Fire Scout from Northrop Grumman illustrates the future capabilities of the rotary-wing aircraft. Some of these already materialised in 2005 when such an aircraft flew a test mission that involved delivering items to someone in a simulated battlefield after flying a multiple waypoint course. Upon retrieving what had been delivered, the recipient punched a button upon which the helicopter took off again and returned home.

*The way ahead? Future combat drones will require in-flight refuelling. In this impression, a receptacle-equipped J-Ucas can be seen taking fuel from the boom of a KC-10A. (Northrop Grumman)*

In the case of a manned platform, directed energy weapons would require heavy screening for safe operation. It is anticipated that these drones may well need fly-by-light controls to eliminate inputs from the power spikes produced by the side- and back-lobes of directed energy weapons.

## Airships

The ability of a drone to provide persistent surveillance is taken to the extreme in the case of unmanned airships, which are attracting increasing attention, although their employment is restricted by their limited mobility and vulnerability to inclement weather.

One of the leaders in tethered lighter-than-air aircraft (aerostats) is North Carolina-based Tcom, which markets a range of four such products. An example of the company's truck-mounted 17M was delivered to the United Arab Emirates in August 2005. The 17M is normally operated at around 1000 ft. In the preceding month the US Army placed an order for 16 examples of the 71M for use in Iraq, to safeguard camp perimeters against intruders. Tcom also supplies the balloon for the SAIC Marine Airborne Re-Transmission System (Marts) communications relay, which carries a 225 kg payload, and operates at 3000 ft for up to 15 days at a time. One system has been delivered and six more are planned.

In Afghanistan the US Army has employed radars mounted on high towers and in aerostats, with Raytheon acting as prime contractor for this Rapid Aerostat Initial Deployment (Raid) programme. The Tcom-produced aerostat, which is far less expensive to operate than a fixed-wing drone, is flown for five days at heights of 350 to 900 ft, compared to the 110 ft of the tower. It carries a 90 kg payload, normally consisting of a Flir Systems Safire III EO/IR sensor. Three systems have been delivered and three more are planned.

In Iraq the US Army also employs the much smaller Lockheed Martin Rapidly Elevated Aerostat Platform (Reap), which is deployed from the back of a Hummer. It carries a 16-kg payload with Raytheon day/night cameras and operates at 300 ft, giving a horizon at 33 km. Two have been deployed to Iraq and two more are planned.

*America's southern approaches are watched by Lockheed Martin/US Air Force Tethered Aerostat Radar Systems (Tars), with tethered balloons carrying radars and beaming propaganda at Cuba. (Lockheed Martin)*

The Raid programme is seen as laying the foundations for the US Army-led Joint Land-Attack Elevated Netted Sensor (Jlens) for cruise missile defence. This will carry a 2270-kg payload to a height of up to 15,000 ft, and remain on station for 30 days. Raytheon is prime contractor, with Tcom providing the aerostats. A Jlens system consists of two aerostats; one with a surveillance radar and the other with a precision track illumination radar. Both aerostats are attached to mobile mooring stations and are linked to a processing station by a fibre optic/power tether. It is planned to acquire twelve Jlens systems.

Tcom also supplies the aerostat for the Israeli Airstar system, which has an Elta phased array radar in a ventral fairing. The drone will operate at around 3500 ft, providing airborne early warning of incursions by low flying objects, such as drones and cruise missiles.

Aerostats are already active in watching over America's southern border. In 2002 the US Air Force placed a contract with Lockheed Martin to provide L-88(V)3 radars for Air Combat Command's Tethered Aerostat Radar System (Tars), which employs 420K aerostats developed by the same company. The Tars is described as supporting aerospace sovereignty, border monitoring, counter-drug and psychological operations; the latter referring to beaming TV Marti to Cuba. It carries a 545-kg payload and remains at 15,000 ft for up to 30 days. At least ten systems have been delivered and ten more are planned.

Turning to free-flying unmanned airships, the US Navy plans to use a type produced by American Blimp as an Advanced Airship Flying Laboratory (AAFL) to test relevant avionics, heavy fuel engines and devices such as bow thrusters for low speed control. The AAFL is to carry a 450-kg payload to 20,000 ft and have an endurance of 48 hours.

In early 2006 the security contractor Blackwater USA, which is heavily involved in Iraq, announced the intention to develop a small remotely piloted surveillance airship. This is intended to operate between 5000 and 15,000 ft, staying airborne for up to four days, and carrying a 135- to 180-kg payload.

The Composite Hull High Altitude Powered Platform (Chhapp) programme is a collaborative effort by the US Army and US Air Force, the Southwest Research Institute and Aerostar International. Under this programme it is hoped to develop a family of long-endurance stratospheric airships, powered by batteries and solar panels, and able to lift pay-

*The Northrop Grumman RQ-4 Global Hawk currently dominates the high altitude long endurance (Hale) market. (Northrop Grumman)*

While lacking the stealth to penetrate defences, the Global Hawk has an assured future in maritime surveillance, as evidenced by interest from Australia, Germany, Japan and the United Kingdom. (Northrop Grumman)

loads of 44 to 440 kg to 'near-space' altitudes for over 30 days at a time.

The first product of Chhapp is the Aerostar International HiSentinel, which on 8 November 2005 reached an altitude of 74,000 ft in the course of a five-hour flight and whilst carrying a 27.2 kg payload.

At the top of the military scale, Lockheed Martin is being funded by the US Missile Defense Agency to develop a High Altitude Airship (HAA). The sub-scale prototype, now being built under a $ 149.2 million contract awarded in December 2005, is to carry a 220-kg payload to a height of 60,000 ft for a 30-day mission. Solar cells will produce 3.5 kW to power four 7.6-metre propellers. First flight is scheduled for 2009.

The US Air Force has a long-standing requirement for a stealthy penetration drone. Lockheed Martin's DarkStar had the necessary low observable characteristics, but was too small. (Lockheed Martin)

The full-scale 'objective HAA' version will be designed for a 180-day mission at 65,000 ft or more, carrying sensors to detect and track cruise and ballistic missiles. It is anticipated that the 1800-kg radar will employ an array of transmitter/receiver modules wrapped around the hull of the airship. It is planned to acquire up to twelve HAAs, which would self-deploy worldwide from the Continental US and remain on station for up to a year.

Aiming even higher, two small companies named CollaborX and Multimax have joined forces to develop a circular aerofoil-section airship, the MaXflyer, which will cruise at 100,000 ft for weeks at a time, providing civilian contractors with persistent surveillance and communications. Flying higher will almost double the distance to the radar horizon, but involves operating in higher winds, which require greater manoeuvrability. The MaXflyer will be transported to the theatre of operations in a container that can then be positioned by a CH-47. For development to go ahead the two companies need a well-heeled partner; one convinced of its commercial potential in television applications and cell phone communications.

## Hales

The leader in the High Altitude, Long Endurance (Hale) category is the Northrop Grumman RQ-4 Global Hawk. In a series of deployments to Southeast Asia following the 9/11 event, three RQ-4A technology demonstrators have accumulated over 5000 combat flight hours in more than 250 missions. The Global Hawk family has now exceeded 8000 flight hours. The US Air Force plans to acquire 51 production RQ-4A/Bs, which follow seven ACTD aircraft. The FY2007 budget request is for six aircraft and three ground stations.

In November 2005 Northrop Grumman was awarded a contract to start manufacturing the next five RQ-4Bs, following an earlier order for five. The stretched RQ-4B, which is the main production version, is heavier than the RQ-4A, grossing 14,628 kg instead of 12,111 kg. Payload is increased from 900 to 1350 kg, but endurance is reduced from 36 to 28 hours. Both versions have a single Rolls-Royce AE3007H of 34-kN thrust. The first of 44 production RQ-4Bs is scheduled to fly in November 2006 and the new-generation Raytheon MP-Rtip (Multi-Platform Radar Technology Insertion Program) sensor will be available from July 2007.

In January 2006 the RQ-4A received military airworthiness certification, which – in combination with its Federal Aviation Administration Certificate of Authorization – allows it to routinely fly within US airspace. Also in early 2006, the US Air Force deployed the first two production RQ-4As to an airbase in the United Arab Emirates (joining one of the ACTD aircraft), this to support operations in Iraq.

The Global Hawk is under consideration for acquisition by US Southern Command (Southcom) in its operations against Latin American drug smugglers. The US Navy's two RQ-4As, using new surface search radar modes and a Northrop Grumman (formerly Litton) LR100 signals intelligence sensor, are already being used in exercises to provide input to the service's Broad Area Maritime Surveillance (Bams) project.

The Predator-B is easily distinguished by its tail configuration. The centreline ventral fin of the –A is retained but the main surfaces are moved above the fuselage. (General Atomics)

The RQ-4 has been selected (alongside the Airbus A321) as a preferred platform for the Nato AGS (Alliance Ground Surveillance) programme. Additional RQ-4s are expected to be purchased for conversion by Eads to 'Euro-Hawk' standard for the German Navy, to replace its Atlantics in the signals

The principal alternative to the Predator is the IAI Heron, which is in a similar weight and power category. It is now in service with the Israeli Air Force and the Indian Navy. (Armada/RB)

intelligence mission. The Eurohawk joint venture was established by Eads and Northrop Grumman in November 2005.

Several other countries, including Australia, Japan, Saudi Arabia and South Korea, are interested in acquiring Global Hawks, but exports will be limited by the MTCR (Missile Technology Control Regime) agreement. Under MTCR rules, a Category I vehicle is defined as able to carry a 500-kg payload over a range of 300 km, which clearly applies to the Global Hawk and General Atomics Predator.

Encouraged by the potential value of the Hale market, the high unit cost of the Global Hawk, and the likely restrictions on US exports, other manufacturers are considering projects in this category. In its simplest form, the basic airframe-engine combination of a useful Hale drone represents only a powered glider. The more cerebrally challenging parts of the system are the sensor package and the processing of the data that it generates.

In late 2005 Grob proposed the G 600 Hale manned/unmanned derivative of its G 180 business jet, which is powered by two Williams FJ44 turbofans. Grossing 7750 kg, the G 600 would carry a 1200-kg payload to 65,000 ft for up to 17 hours.

Singapore Technologies Aerospace (ST Aero) is working with some French assistance on a twin-jet optionally-piloted Lalee (Low Altitude Long Enduring Endurance) project for AEW and ground/surface surveillance duties. In this case 'Low' appears to mean in comparison with satellites, as the aircraft would cruise at up to 65,000 ft.

*On current plans Eads Military Aircraft will be the prime contractor for the EuroMale project, which clearly owes a great deal in configuration terms to its Heron heritage. (Eads)*

As the years pass, progressive reductions in payload weights are encouraging some designers to think in terms of a much lighter Hale drone than the Global Hawk, which costs around $ 30 million. For example, General Atomics has for several years been planning a jet-powered Predator-C, which was due to fly in late 2005.

In early 2006 AeroVironment proposed a pair of Hale drones, which would not only be lighter than the RQ-4, but also offer much longer endurance by virtue of liquid hydrogen-powered fuel cells powering electric motors. The 1800-kg AeroVironment Global Observer GO-1 would combine a 160-kg payload and a seven-day endurance, while the 4100 kg GO-2 would increase these figures to 450 kg and eight days. Unit prices for the basic air vehicles are estimated as $ 14.2 and $ 18.5 million respectively. AeroVironment has US approval to market this drone family in Australia, Japan and Saudi Arabia.

*IAI Heron in multi-sensor configuration, with maritime search radar, a small side-looking radar array, two jammer pods, a multiplicity of elint antennas, an EO/IR ball and satcom tower. (IAI)*

## Males

In the same way that the Global Hawk dominates the potential Hale market, the General Atomics Aeronautical Systems Predator is the clear leader in the medium-altitude long endurance (Male) sector. Launched as the RQ-1 ACTD in 1994, the Predator-A transitioned to a US Air Force programme in 1997. The series has been used operationally over Bosnia, Kosovo, Iraq and Afghanistan, and was used as a Hellfire platform (designation MQ-1) from 2001. All US Air Force Predator-As are now designated MQ-1. The MQ-1 passed the 100,000 flight-hour mark in October 2004, and formally attained initial operational capability (IOC) status in March 2005.

The US Air Force currently operates twelve Predator systems as three squadrons, all based at Creech AFB, formerly Indian Springs Auxiliary Airfield, Nevada. In exercises it has proven possible for a single pilot to control up to four of these drones. More than 120 RQ/MQ-1s have been delivered and a further 77 are planned for procurement. The FY2007 budget request includes 24 MQ-1s.

In Iraq, MQ-1s are operated by the 46th Expeditionary Reconnaissance Squadron at Balad Air Force Base. The drones are launched (and later recovered) by the GCS at Balad but – once established in flight with the satellite link operational – control is handed to Nellis AFB, Nevada. The Predator is flown by a qualified pilot but the EO/IR sensors and laser ranger/designator are controlled by an enlisted airman. An improved GCS will shortly allow one pilot to control four MQ-1s simultaneously.

Britain's Royal Air Force has a personnel detachment (No 1115 Flight) assigned to one of the US squadrons in Nevada, assisting in operating Predators over Afghanistan and Iraq as part of the Combined Joint Predator Task Force. Under a special MTCR concession six unarmed Predators have been sold to Italy and five more have been ordered. Home-based at Amendola, three Italian Air Force Predators have been deployed to Tallil in Iraq since January 2005.

The MQ-1 is a 1043 kg drone with an 86 kW Rotax 914F engine and a 204-kg payload. It has a ceiling of 25,000 ft and an endurance of over 40 hours clean, or 14 hours with external stores. Each Hellfire carried reduces the time of flight by around 150 minutes; hence there is a strong motive to develop lighter precision weapons such as the APKWS-II (laser-guided Hydra-70 rocket).

The poor economics of current operations were illustrated by a mission in March 2006 in which a $ 96,500 Hellfire was used to kill three insurgents caught setting an improvised explosive device (IED).

In August 2005 the US Army announced that the General Atomics Warrior, a derivative of the Predator-A, had been selected as its new Extended Range/Multi-Purpose drone. The service plans to acquire eleven squadrons, each with twelve air vehicles and five ground stations, implying the purchase of at least 132 aircraft. The first 17 are due to be

*The baseline twin-engined Northrop Grumman RQ-5A Hunter traces its origins back to the IAI Impact project. At least 56 have been purchased by the US Army. (Northrop Grumman)*

*Unlike earlier Hunters, the Hunter II is single-engined. It makes extensive use of structural components from the IAI Heron for enhanced endurance and ceiling. (Northrop Grumman)*

delivered by mid-2009. The Pentagon is pressing the US Air Force and US Army to economise by rationalising their specifications for Predator-A and Warrior.

The Warrior is a 1360-kg aircraft with a 100-kW Thielert engine burning diesel or turbine fuel, a 260-kg internal payload and a 227-kg external warload; typically consisting of four Hellfire on four pylons. It will have a General Atomics Lynx synthetic aperture radar (Sar), a ceiling of 29,000 ft and an endurance of over 30 hours.

The current SDD (systems development and demonstration) phase of the Warrior programme is due to run until 2009 and includes the delivery and testing of 17 drones produced by GA-ASI, seven One System ground control stations (GCS) by AAI and logistics support by Sparta.

The turboprop-powered 4536-kg MQ-9 Predator-B was developed as a hunter-killer drone with a much heavier load-carrying capability. It first flew in February 2001. Equipped with a 670-kW Honeywell TPE331-10T engine, the MQ-9 can carry a 340-kg sensor payload and up to 1360 kg of stores on underwing pylons. Typical store configurations will be four 227-kg or up to ten 115-kg bombs, but a model of the Predator-B has been shown with a Sidewinder missile and four Hellfires on each of two underwing pylons. It has an endurance of 30 hours clean, falling to 16 to 20 hours with external stores.

The US Air Force has received six MQ-9s and plans to buy 60 more. In January 2006 General Atomics received a $ 41.6 million order for five MQ-9s and two more were included in the FY2007 budget request. The service plans nine squadrons but in the longer term hopes to increase its force to 15 squadrons, some of which would be Air National Guard and Reserve units. However, this plan is currently being frustrated by a shortage of suitably restricted airspace.

Two prototype US Air Force YQM-9As have already been deployed to Southeast Asia, with provisions for two 225-kg GBU-12 laser-guided bombs. From 2007 MQ-9s will also be cleared for 225-kg GBU-38 Jdams and 45 kg Hellfire missiles. Britain is hoping to extend its participation in US Predator operations to include the MQ-9, which (some reports indicate) Britain may attempt to purchase for use over Afghanistan. In February 2006 GA-ASI announced an agreement with General Dynamics Canada to jointly offer the Predator-B to meet Canadian surveillance needs.

The 4990-kg General Atomics Mariner or Predator-B-ER is a further development with increased fuel and a 360-degree radar, and is aimed at US Navy and Homeland Security applications. It first flew in March 2004. Lockheed Martin is partnered with General Atomics on the development and promotion of the Mariner. Like Northrop Grumman (promoting the Global Hawk), this team is under contract to perform the second phase of the US Navy's Persistent Unmanned Maritime Airborne Surveillance (Pumas) study, which is expected to lead to selection for the Bams programme (to operate alongside the manned Boeing P-8A) by the end of 2007.

## Analysis of Alternatives

The principal rival to the MQ-1 is the 1100-kg Israel Aircraft Industries (IAI) Heron, which has been tested with a 134-kW Volkswagen diesel in place of the standard 73.5 kW Rotax engine. Deliveries of Herons to the Israeli Air Force began in late 2005 under a $ 50 million contract, and a follow-up order is expected. In its first operational sortie in January 2006 the Heron (dubbed Machatz-1) achieved an endurance of 25 hours. Also in January, the Indian Navy commissioned its first drone squadron (Inas 342 'Flying Sentinels') with four Herons and eight 425-kg IAI Searcher IIs.

*The RQ-5B differs from the original RQ-5A in having more fuel capacity, an increased gross weight, a Mercedes-Benz heavy fuel engine and clearance for a 120-kg warload. (Northrop Grumman)*

The considerably heavier 1496-kg Elbit Hermes 1500 has two 75 kW Rotax 914 engines, and is reportedly the subject of a turnkey services contract with the Israeli defence ministry involving highly classi-

*The Sagem Sperwer has been one of Europe's few successes in drone marketing. Some Danish aircraft may be sold to Canada for use in Afghanistan. (Sagem)*

*Compared with the Sperwer and in spite of a similar configuration, the Sperwer B currently under final development shows more muscle. Its payload is doubled to 100 kg and could be a warrior, armed with ground-attack missiles like the Spike. (Sagem)*

*The German Army's KZO is produced by Rheinmetall Defence Electronics and is designed for stealthy day/night all-weather operation, with de-icing provisions. (Rheinmetall)*

fied sensors. Another manufacturer interested in the Male market is South Africa's Denel, which in 2004 unveiled its 1000-kg Bateleur; named after a local bird of prey. The engine choice between the Rotax 914 and Subaru EA-82T has not been made, but it appears that the car engine adapted by Denel is the more likely candidate.

*The Denel Aerospace Systems Seeker has the distinction of being cleared for operation in South African airspace, allowing Air Force drones to assist the police on a routine basis. (Denel)*

Turkey's Tusas Aerospace Industries (formed in April 2005) is scheduled to fly a Male project in 2008. The Abu Dhabi-based Adcom is due to fly a 1300-kg Male prototype, the Yabhon Excellency, derived from its Yabhon-R tactical drone, around mid-2006. Powered by an 85 kW piston engine, it will have a maximum payload of 500 kg and an endurance of up to 70 hours. Korea Aerospace Industries has begun work on a Male drone to satisfy a requirement generated by the South Korean Air Force.

The 3500-kg IAI Heron TP with an (unspecified) 895-kW turboprop engine first flew in late 2004 and reportedly has half the endurance of the basic Heron, but a 45,000 ft ceiling (up from 30,000 ft).

Several countries have requirements for Male surveillance drones. Canada wants to introduce such a system by 2010 and will be looking at proposals from General Atomics, IAI, Elbit and Eads. Nato is reportedly developing a Male requirement, but Germany is said to be going ahead independently to make sure that the reconnaissance capability that it needs is available in time. Germany is demanding the ability to track small targets such as infantry platoons, even below forest canopies, but it also wants a modular payload to be able to switch rapidly to electronic warfare or chemical, biological and radiological detection.

Eads Military Aircraft is proposing two Male projects: the Eagle-1 based on the IAI Heron, and the follow-on turboprop-powered EuroMale. The Eagle-1 was scheduled to be formally handed over to the French Air Force at the end of 2005.

The € 300 million EuroMale programme was 'launched' by France in June 2005, subject to other countries such as Germany, Italy, the Netherlands, Spain and Switzerland joining in. This would allow the French contribution to be limited to 25% (€ 75 million), covering the cost of the demonstrator programme. It was decided by the French Defence Ministry that Eads would be prime contractor, with Dassault providing the drone and Thales systems integration, although it has recently been suggested that Thales might become prime.

It currently appears that the EuroMale programme will have to be formally launched by France's DGA (Délégation Générale pour l'Armement), whose role would later be taken over by the six-nation Occar (Organisation Conjointe de Coopération en matière d'ARmement) or the newly-formed European Defence Agency, which is part of the European Union organisation.

The EuroMale demonstrator was originally due to be rolled out in 2008, to make possible full operational capability with a new European mission system by 2011. The drone is envisaged as a 3900-kg vehicle with a 500-kg payload and an endurance of twelve hours at 1575 km radius.

## Silver Medallers

The drone that came second in the US Army ER/MP contest was the 998-kg Northrop Grumman RQ-5C Hunter II, which flew in prototype form on 17 March 2005. Using the extended wing and tail surfaces of the IAI Heron the Hunter II has an endurance of 30 hours and a ceiling of 25,000 ft.

The ER/MP General Atomics Warrior (discussed above) will replace the US Army's Northrop Grumman RQ-5 Hunter, which has been employed in supporting Nato operations in the Balkans and US actions in Iraq. The Hunter fleet has accumulated almost 40,000 flight hours, of which approximately 10,000 have been over Iraq.

The 735 kg baseline RQ-5A has two 42.5-kW Moto Guzzi engines burning mogas. It carries an EO/IR sensor relaying real-time video to the ground via a C-band line-of-sight datalink. The RQ-5A has an endurance of 11.6 hours and a ceiling of 15,000 ft. Seven RQ-5A systems, each with eight drones, have been acquired by the US Army.

An additional 18 Hunters were ordered in FY2004 as weaponised MQ-5Bs, with provisions for Viper Strike and BLU-108 submunitions. The MQ-5B has a gross weight of 885 kg, and is stressed for external stores of 60 kg per wing. It first flew on 8 July 2005. Powered by two Mercedes-Benz heavy fuel engines burning JP-8 fuel, and fitted with a 'wet' wing

## Killer Bee

One of the latest newcomers on the unmanned aircraft scene is the Northrop Grumman family of KillerBees, the 2.74-metre wingspan version of which (KB-3) has been demonstrated to the US Air Force in March 2006. The major aim of blended wing design is to provide video streaming and act as a relay for communications. The design offers space and volume for a variety of payloads that include electro-optical, infrared and synthetic aperture radar sensors. According to the manufacturer, its ground station will be able to handle four aircraft simultaneously. The aircraft are pneumatic catapult-launched and can be recovered by conventional landing on skids or by net. The KillerBee is still under development but may enter initial operational service this year (continued next page).

## Killer Bee Specifications

| | KB-2 | KB-3 | KB-X |
|---|---|---|---|
| Wing Span | 2 metres | 2.74 metres | 5.2 metres |
| Max Endurance | 12 to 24 hrs | 12 to 24 hrs | 12 to 24 hrs |
| Payload | 3.2 to 6.8 kg | 7 to 14 kg | 27 to 54 kg |
| GTOW | 20 kg | 39 kg | 163 kg |
| Ceiling | 18,000 ft | 19,200 ft | 20,000 ft |
| Max Speed | 201 km/hr | 193 km/hr | 195 km/hr |
| Cruise Speed | 109 km/hr | 108 km/hr | 113 km/hr |
| Availability | 2nd qtr 2006 | 3rd qtr 2006 | 4th qtr 2006 |

centre section, the MQ-5B has a nominal endurance of 18 hours (although flights of 21 hours have been demonstrated), and a ceiling of 22,000 ft. Take-off and landing are automated. An MQ-5B system will consist of six drones and three One System GCS'.

The principal French company that failed to benefit from the EuroMale awards was Sagem, now part of the Safran group. Sagem has been highly successful in marketing its 250-kg Sperwer, which has been sold to Canada, Denmark, Greece, the Netherlands and Sweden. Over 100 of the series are in service in Europe and Sagem has recently received a repeat order from Canada for its operations in Afghanistan. A complete system with four drones and two GCS' costs in the region of Euro 100 million. Production has now switched to the long-span 350-kg Sperwer-B, which has an endurance of twelve hours (increased from eight). At the 2005 Paris air show Safran exhibited a Sperwer armed with Rafael Spike anti-armour missiles.

The Canadian Forces rushed the Sperwer into operational service in Afghanistan in 2003 and flew 107 sorties with six drones in eight months, but lost two in landing accidents, due at least in part to the mountainous terrain. Canada plans to redeploy to that theatre before the end of 2006. In the meantime, Mmist is developing a precision recovery system for the Sperwer, presumably derived from that of the company's 635 kg CQ-10A Snow Goose, and using a GPS-guided parafoil. The aim is to allow Sperwers to be used from small sites surrounded by minefields.

*The Thales Watchkeeper WK450 is basically an Elbit Hermes 450 drone equipped with a Thales I-Master radar and an Elop Compas IV EO/IR sensor. (Armada/RB)*

Another system heading for Afghanistan is the German Army's Rheinmetall Defense Electronics KZO (Kleinfluggerät Zielortung). The first KZO system, consisting of ten drones and two ground control stations, was handed over at the end of November 2005. Five more systems are due to be delivered by the end of 2007.

The KZO has a very advanced design, with stealth materials and de-icing provisions. However, there is some concern that it will probably need modifications to suit operations in Afghanistan, since it was designed specifically for a European war, to generate target co-ordinates for artillery and transmit them back to a fixed ground station using a highly directional aerial. It was also designed for a nominal maximum operating altitude of 11,500 ft, rather than mountainous conditions. The need in Afghanistan is more for a drone to relay ground imagery to a variety of receivers. In the longer term, the German Army wants to link the KZO to its Tiger helicopter, for the latter to control the drone's sensor payload.

In the United States the KZO is being marketed by Rheinmetall in co-operation with Teledyne Brown Engineering under the name Prospector. This has been offered as a follow-on to the AAI RQ-7B Shadow 200, which has been selected as the US Army's baseline Class III air vehicle. The service expects to buy 192 Class III drones, which are required to have a six-hour endurance and must be operable without a conventional airfield. The Class III will provide communication relay, NBC detection and meteorological data. The KZO has an endurance of more than 3.5 hours, is rocket-boosted from a vehicle-mounted container and is recovered with a parachute and two airbags.

The AAI RQ-7A/B Shadow 200 is employed by the US Army as a lighter complement to the twin-engined Hunter. The RQ-7B, which entered service in 2004, has a higher bandwidth tactical common datalink and increased wingspan. The RQ-7B has a gross weight of 170 kg, and is powered by a 28.3 kW UEL engine burning mogas. It has an endurance of seven hours and a ceiling at 15,000 ft. The RQ-7 uses multiple launch and recovery methods.

The US Army is funded to acquire 63 RQ-7 systems, each with four drones, but its longer-term objective is 88 systems. Over 30 systems have already been delivered. The Shadow has been deployed to Iraq and South Korea and has accumulated 50,000 flight hours, of which around 40,000 hours were over Iraq. AAI also markets the 201 kg Shadow 400, reportedly sold to the South Korea Navy, and the 265-kg Shadow 600, which has an endurance of 12 to 14 hours and has been sold to Romania and Turkey.


*Although cancelled by the US Navy in 2001, the Northrop Grumman RQ-8A Fire Scout provided the basis for the improved RQ-8B, now adopted for the US Navy and Army. (Armada/RB)*

## Tactical Developments

The latest important tactical drone selection is that of the 165 kg IAI I-View 250 by the Australian Army in late 2005 to meet its JP129 requirement. The principal reason given for its adoption was its fully automated take-off and landing system, with a catapult launch and a powered guided parafoil recovery. Coming roughly halfway between the RQ-5 and RQ-7 series, Britain's Watchkeeper WK450 is based on the 550-kg Elbit Hermes 450 drone. The prime contractor is Thales UK, but in late 2005 that company and Elbit Systems formed a joint venture to manage the programme. Based in Leicester and named UAV Tactical Systems (U-Tacs), the company received a 317 million pound (Sterling) subcontract from Thales in October 2005, covering development, production and eight years

## A160 Hummingbird

Frontier Systems/Boeing

| | | | | |
|---|---|---|---|---|
| 10.67<br>10.97<br>n/a | Piston engine 388 hp | 7.30<br>30<br>1950 | Sar, EO/IR | vtol |

## Aerolight

Aeronautics

| | | | | |
|---|---|---|---|---|
| 2.56<br>4.00<br>~0.50 | 8 hp (type undis-closed) | 4.00<br>10<br>40 | 8 kg Hi-resolution CCD or Night camera | cat/parafoil |

## Aerosky

Israel Aircraft Industries

| | | | | |
|---|---|---|---|---|
| n/a<br>4.48<br>n/a | (type undis-closed) | 5.0+<br>15<br>70.31 | Cots EO (manufacturer not determined) | conv/conv |

## Aerosonde Mk 1

Aerosonde

| | | | | |
|---|---|---|---|---|
| 1.71<br>2.90<br>n/a | H-Type | 30<br>21<br>13.61 | Various (FSI,various) | hand/belly |

## Aerostar

Aeronautics

| | | | | |
|---|---|---|---|---|
| 4.50<br>6.50<br>~0.50 | Zanzottera 2-piston 490ia 38 hp | 14.0<br>18.0<br>200 | 200 kg stabilised electro-optical | conv/conv |

## Aladin

EMT

| | | | | |
|---|---|---|---|---|
| 0.60<br>1.46<br>n/a | 1x electric | 0.75<br>low<br>~3.0 | Day or IR | hand/belly |

## Altair

General Atomics

| | | | | |
|---|---|---|---|---|
| 11.03<br>19.51<br>1.13 | 1 x Ase TPE331-10T | 32<br>52<br>3175 | 880 lb various EM/EO | conv/conv |

## Altus 2

General Atomics

| | | | | |
|---|---|---|---|---|
| 7.19<br>16.86<br>0.76 | 1x Rotax twin turbo | n/a<br>65<br>816 | Scientific (various manu-facturers) | conv/conv |

## Apid 55

Cybaero

| | | | | |
|---|---|---|---|---|
| 3.20<br>3.3 dia<br>n/a | 2-stroke 2-piston 55 hp | 6.00<br>9.00<br>105 | Stabilised electro-optical | vtol |

## ASN-206

Catic

| | | | | |
|---|---|---|---|---|
| 3.34<br>6.04<br>- | 1 x 37.3kw HS-700 | 8.00<br>5.50<br>222 | Day/night TV/IR | cat/para |

## Bateleur

Denel

| | | | | |
|---|---|---|---|---|
| ~10.0<br>15.0<br>~0.80 | 1x Rotax 914 or Subaru EA-82T | 24.0<br>25.0<br>1000 | Denel Argos or Goshawk/ Avitronics elint or Sar, 200 kg | conv/conv |

## Bekas

Granit - NPO Mash.

| | | | | |
|---|---|---|---|---|
| 2.97<br>3.20<br>n/a | not yet defined | 5.00<br>15.0<br>~250 | Project for target recce (imaging infrared) and RF jamming | conv/conv+para |

## BQM-145A

Northrop Grumman/Ryan Aero

| | | | | |
|---|---|---|---|---|
| 5.49<br>3.20<br>n/a | 1x tele-dyne CAE F480-CA 100lf | 2.00<br>40<br>980 | Programmable (TRA) | cat/para |

## Camcopter S-100

Schiebel

| | | | | |
|---|---|---|---|---|
| 3.09<br>3.40<br>~0.80 | 1x 55 hp Diamond | 6.00<br>18.0<br>200 | Day/IR/elint /comint | vtol |

## Carapas

Eads-Galileo

| | | | | |
|---|---|---|---|---|
| 4.07<br>2.30<br>0.40 | 16 daN Microturbo TRS 18-1 tf | 0.90<br>40.0<br>750 | 60 kg Eads passive esm-elint, stabilised e-o and infrared | cat+rato/para |

## Carolo P50

Mavionics/Eads

| | | | | |
|---|---|---|---|---|
| 0.47<br>0.49<br>n/a | 1x electric | 0.30<br>na<br>0.53 | Day | hand/belly |

## Changhong IC

People's Republic of China

| | | | | |
|---|---|---|---|---|
| 8.47<br>7.53<br>0.58 | 1x WP6 | 0.75<br>na<br>2450 | R/C (NAI) | acft/para |

## CL-289 Piver

Bombardier/Eads

| | | | | |
|---|---|---|---|---|
| 3.51<br>1.37<br>0.40 | 1x BMW RR T117 +s/b | 125<br>2.00<br>240 | Infrared line scanner | rato/para |

## CL-327 Guardian

Bombardier

| | | | | |
|---|---|---|---|---|
| 1.83<br>4.05<br>0.88 | 1x Williams WTS 117-5 | 6.5<br>18<br>349 | Various (FSI,various) | vtol |

## D-1A SR

Dara Aviation

| | | | | |
|---|---|---|---|---|
| 1.75<br>3.28<br>n/a | QA400, 37cc 2.5 hp | 4.00<br>na<br>25.0 | -1A recon or weather sample<br>-1D geophys. survey | car-top/conv |

## Eagle 1

Eads/IAI Malat

| | | | | |
|---|---|---|---|---|
| 4.00<br>16.3<br>n/a | 1x Rotax 914 | 24.0<br>25.0<br>1150 | 250 kg EO or EW | conv/conv |

## Eagle 2

Eads/IAI Malat

| | | | | |
|---|---|---|---|---|
| 13.0<br>22.0<br>n/a | 1x P+WC PT6A tp | 24.0<br>45.0<br>3600 | 600 kg EO, EW or Sar | conv/conv |

## Eagle Eye

Bell Helicopter Textron

| | | | | |
|---|---|---|---|---|
| 5.46<br>4.63<br>0.76 | 1x PW 200-55 | 8.00<br>20.0<br>1290 | Flir Safire III + Telephonics RDR-1700B radar | stovl |

## E-Hunter

IAI Malat

| | | | | |
|---|---|---|---|---|
| 7.53<br>15.39<br>n/a | 2x 64 hp dual | 25.0<br>20.0<br>953 | TV & IR, custom (IAI Tamam) | conv/conv |

**Exdrone**

**L-3 BAI Aerosystems**

| | | | | |
|---|---|---|---|---|
| 1.86<br>2.47<br>n/a | 1x 8 hp 2-stroke | 2.50<br>na<br>41.3 | Rangefinder TV, IR (various manufacturers) | cat/skid-para |

**Eyeview 1/2**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 2.93<br>3.96<br>n/a | 1x 25 hp | 6+<br>5.00<br>104 | Day/night imager (various manufacturers) | conv/conv |

**Falco**

**Galileo**

| | | | | |
|---|---|---|---|---|
| 5.20<br>7.20<br>0.74 | 75 hp AR682 | 14.0<br>na<br>350 | Flir, colour TV laser rangefinder | conv-cat/conv |

**Fantail**

**ST Aerospace**

| | | | | |
|---|---|---|---|---|
| 0.76<br>n/a<br>0.29 | 3.5 hp | na<br>na<br>5.50 | Day/night camera, chemical sensors | stovl |

**Fire Scout (RQ-8B)**

**Northrop Grumman**

| | | | | |
|---|---|---|---|---|
| 7.01<br>8.22<br>n/a | 1x R-R 250-C20W | 8.00<br>20.0<br>1430 | EO/IR, laser designator, Sar, GMTI | vtol |

**Global Hawk (RQ-4A Tier II plus)**

**Northrop Grumman**

| | | | | |
|---|---|---|---|---|
| 13.41<br>35.35<br>1.46 | 1x R-R AE3007 H tf | 36.0<br>65.0<br>12111 | Satcom + Sar, EO, IR | conv/conv |

**Global Hawk RQ-4B**

**Northrop Grumman/Eads**

| | | | | |
|---|---|---|---|---|
| 14.53<br>39.90<br>1.46 | 1x R-R AE3007 | 28.0<br>65.0<br>14628 | Sigint, MP Rtip plus extra power unit/Sar, E-O, IR, Satcom | conv/conv |

**Gnat-750 (Tier I)**

**General Atomics**

| | | | | |
|---|---|---|---|---|
| 5.49<br>10.67<br>0.76 | 1x Rotax 582 | 40.0<br>20.0<br>513 | Day TV, flir (Wescam) | conv/conv |

**GoldenEye 100**

**Aurora Flight Sciences**

| | | | | |
|---|---|---|---|---|
| 1.68<br>2.74<br>n/a | n/a | 4.00<br>10.0<br>70.0 | Comint, elint | vtol |

**GoldenEye 50**

**Aurora Flight Sciences**

| | | | | |
|---|---|---|---|---|
| 0.70<br>1.40<br>n/a | n/a | 1.00<br>5.00<br>11.0 | Day/IR 1 kg | vtol |

**Hermes 180**

**Elbit**

| | | | | |
|---|---|---|---|---|
| 4.43<br>6.00<br>~0.50 | 1x UEL 38 hp | 10.0<br>15.0<br>195 | EO, IR, laser designator, GMTI | conv, cat/para,ab,conv |

**Hermes 450**

**Elbit**

| | | | | |
|---|---|---|---|---|
| 6.10<br>10.52<br>0.52 | 1x UEL AR-80-1010 52 hp | 20.0<br>20.0<br>449 | Tesar Sar, DSP EO, compass flir and CCD | conv/conv |

**Hermes 1500**

**Elbit**

| | | | | |
|---|---|---|---|---|
| 9.39<br>15.0<br>~1.00 | 2x Rotax 914, 100 hp | 24.0<br>25.0<br>1496 | EM, TV, Sar (various manufacturers) | conv/conv |

**Heron**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 8.60<br>16.61<br>0.85 | 1x Rotax 914 115 hp | 50.0<br>30.0<br>1100 | TV and IR, custom (IAI Tamam) | conv/conv |

**Heron TP**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 12.01<br>23.01<br>n/a | 1x tp (type undisclosed) 1200 hp | 24.0<br>45.0<br>3502 | TV and IR, custom (IAI Tamam, various) 245 kg | conv/conv |

**Hunter**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 6.89<br>8.90<br>n/a | 2x 64 hp dual | 12.0<br>15.0<br>726 | TV and IR (IAI Tamam) | conv/conv |

**I-Gnat**

**General Atomics**

| | | | | |
|---|---|---|---|---|
| 6.34<br>12.86<br>0.76 | 1x Rotax 914 | 23.0<br>40.0<br>635 | EO, IR or Sar (Wescam) | conv/conv |

**I-See**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 1.82<br>2.90<br>n/a | 1x electric | 1.00<br>10.0<br>7.50 | Camera 0.8 kg | cat/belly |

**I-View**

**IAI Malat**

| | | | | |
|---|---|---|---|---|
| 4.10<br>5.70<br>~0.25 | (type undisclosed) | ~5<br>22.0<br>165 | 30 kg Mosp EO or EL/M-2055BSar | cat/para |

**Ka-137**

**Kamov Design Bureau**

| | | | | |
|---|---|---|---|---|
| 5.30<br>n/a<br>1.19 | 1x Hirth 2706 P05 65 hp | 4.00<br>16.4<br>279 | Various types (various manufacturers) | vtol |

**Drone Name**

**Dem**

**Manufacturer**

| Length<br>wingspan<br>⌀ payload bay<br>all sizes in meters | Electric engine | | Sensor packages, in many cases maximum sensor payload weight | launch/recovery |
|---|---|---|---|---|

turbine or t-prop engine | piston engine | Wankel engine

endurance [hours]

max altitude [feet x 1000]

take-off weight [kilograms]

Where no information is given, either the information was not made available or it has not been decided for that specific portion of the system. **Dem** signifies the drone is a demonstrator.

### Powerplant abbreviations

| | | | | | |
|---|---|---|---|---|---|
| 2-s | 2-stroke | elec | electric engine | tf | turbo fan |
| hp | horsepower | gas | gasoline engine | tj | turbo jet |
| tp | turboprop | s/b | solid booster | pj | pulse jet |
| Rx | Rotax engine | -cyl | -cylinder | | |

### Launch/Recovery abbreviations

| | | | |
|---|---|---|---|
| **conv** | conventional | **rato** | rocket-assisted take off |
| **cat** | catapult | **hand** | hand launched |
| **para** | parachute | **vtol** | vertical take-off and landing |
| **belly** | belly landing | **stovl** | short T/O vertical landing |

# Unmanned Aircraft

**KZO** — Rheinmetall

| | | | | |
|---|---|---|---|---|
| 2.26<br>3.41<br>0.37 | 1x 30 hp Schrick SF2-350S | 3.50<br>11.5<br>161 | Flir (Rheinmetall Defence Electronics) | rato/para |

**Orbiter** — Aeronautics

| | | | | |
|---|---|---|---|---|
| 1.00<br>2.20<br>~0.35 | brushless | 1.50<br>2.00<br>650 | Max. 1.2 kg<br>Hi-resolution CCD from Controp | hand/belly |

**Luna X-2000** — EMT

| | | | | |
|---|---|---|---|---|
| 2.26<br>4.24<br>n/a | 2-cyl 2-s 6.70 hp | 4.00<br>10.0<br>29.9 | CCD camera (various manufacturers) | cat/para |

**Pchela 1** — Yakovlev Design Bureau

| | | | | |
|---|---|---|---|---|
| 2.77<br>3.26<br>0.30 | Samana /Trud P-032 32 hp | 2.00<br>8.20<br>130 | TV or LLTV or elint | cat/conv |

**Mariner** — General Atomics

| | | | | |
|---|---|---|---|---|
| 10.97<br>26.21<br>n/a | 1x Ase TPE331-10T tp | 49+<br>52.0<br>4763 | internal 363 kg, external 1361 kg various | conv/conv |

**Pioneer** — IAI/AAI

| | | | | |
|---|---|---|---|---|
| 4.24<br>5.12<br>0.37 | 1x 27 hp Sachs SF2-350 | 6.50<br>15.0<br>210 | TV and flir (IAI Tamam, Versatron) | conv, rato/conv |

**Micro-V** — Elbit

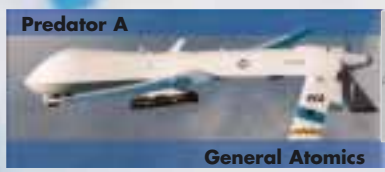
| | | | | |
|---|---|---|---|---|
| 2.74<br>3.66<br>0.70 | 2x 4 hp 2-stroke | 5.00<br>8.00<br>49.9 | CCD camera, flir (various manufacturers) | cat/para |

**Pointer** — AeroVironment

| | | | | |
|---|---|---|---|---|
| 1.80<br>2.70<br>~0.10 | 1x electric | 1.00<br>0.6+<br>3.60 | CCD camera or IR 0.9 kg | hand/belly |

**Mirach 20** — Galileo

| | | | | |
|---|---|---|---|---|
| 3.60<br>4.15<br>0.34 | 1x 26 hp | 4+<br>12.0<br>170 | TV or flir/elint (Meteor) | rato/para |

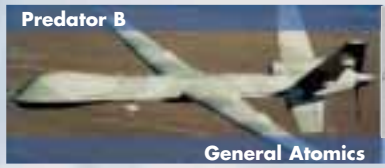


**Predator A** — General Atomics

| | | | | |
|---|---|---|---|---|
| 8.23<br>14.84<br>1.22 | 1x Rotax 914 100 hp | 40+<br>25.0<br>1043 | EO, IR, Sar (Northrop Grumman, Wescam) | conv/conv |

**Mirach 26** — Galileo

| | | | | |
|---|---|---|---|---|
| 3.78<br>4.72<br>0.37 | 1x 28 hp | 7.00<br>13.0<br>200 | TV, LLTV, flir, elint (various manufacturers) | rato/para |



**Predator B** — General Atomics

| | | | | |
|---|---|---|---|---|
| 10.36<br>20.12<br>n/a | 1x Ase TPE331-10T tp | 30+<br>50.0<br>4536 | Eo, IR, Sar (General Atomics, Wescam) | conv/conv |

**Mirach 150** — Galileo

| | | | | |
|---|---|---|---|---|
| 4.69<br>2.10<br>0.37 | 1x Micro-turbo TRS 18-1 tj | 1.30<br>30.0<br>345 | TV, IR, EW, Sar (various manufacturers) | rato/para |

**Prowler II** — General Atomics

| | | | | |
|---|---|---|---|---|
| 4.24<br>7.31<br>n/a | 1x 65 hp Rotax 582 | 18.0<br>20.0<br>340 | Eo/IR or Sar 50 kg | conv/conv |

**Model 395** — Northrop Grumman/Scaled Composites

| | | | | |
|---|---|---|---|---|
| 17.52<br>23.77<br>variable | 2x Williams FJ 44-2E tj | 16.0<br>40.0<br>5670 | Weapons or Sar/elint 1360 kg | conv/conv |

**R90** — Enics

| | | | | |
|---|---|---|---|---|
| 1.42<br>2.56<br>~0.25 | 1x Enics M44D pulse jet | 0.50 | Day/IR | rato/expend |

**Muas** — Irkut

| | | | | |
|---|---|---|---|---|
| 4.00<br>6.00<br>n/a | n/a | 14.0<br>20.0<br>200 | 50 kg IR and TV | conv/conv |

**Ranger** — Ruag

| | | | | |
|---|---|---|---|---|
| 4.60<br>5.70<br>n/a | 1x Goebler-Hirth 38 hp | 5.00<br>14.8<br>274 | EO/IR sensor (IAI Tamam) | cat/conv |

**Neptune** — DRS Technologies

| | | | | |
|---|---|---|---|---|
| 2.13<br>1.83<br>n/a | 1x 15 hp 2-stroke | 4.00<br>8.00<br>36.3 | IR or TV or 9 kg droppable | cat/belly, para |

**Raven** — AeroVironment

| | | | | |
|---|---|---|---|---|
| 0.92<br>1.34<br>0.01 | 1x Aveox 27 | 1.30<br>10.0<br>2.00 | IR/EO | hand/belly |

**Neuron** — Neuron

| | | | | |
|---|---|---|---|---|
| 9.30<br>12.5<br>n/a | 1x Adour | n/a<br>35.0<br>6000 | radar, IR + guided bombs in 2 internal bays | conv/conv |

**RemoEye 006** — Ucon

| | | | | |
|---|---|---|---|---|
| 1.55<br>2.72<br>~0.12 | 1x electric | 1.5+<br>na<br>6.00 | Day or IR | hand/belly |

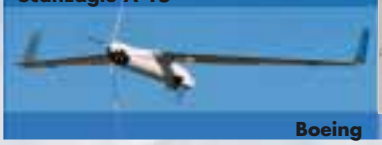
**Nibbio** — Galileo

| | | | | |
|---|---|---|---|---|
| 4.07<br>2.30<br>0.40 | Micro-turbo TRS18-1 tf | 0.90<br>40<br>740 | Flir, ESM, IR, TV, ECM 60 kg | cat/para |

**RemoEye 015** — Ucon

| | | | | |
|---|---|---|---|---|
| 1.80<br>3.20<br>~0.20 | 1x electric | 4.00<br>na<br>15.0 | Day or IR | conv/conv |

**ScanEagle A-15**



Boeing

1.19 / 3.05 / 0.18

1x 1.5 hp 2-stroke

15.0 / 16.0 / 18.0

Stabilised day or IR

cat/cable

**Scarab (Model 324)**

Northrop Grumman

6.16 / 3.35 / n/a

1x Teledyne CAE373 -8C

na / na / 1077

Program command (TRA)

rato/para

**SDTI**

Sagem

3.51 / 4.21 / n/a

1x 70 hp 2-stroke

8.50 / 17.0 / na

Sagem 410 TV + IR

cat/para

**Searcher II**

IAI Malat

5.85 / 8.56 / n/a

1x 73 hp

16.0 / 19.0 / 426

TV and flir (IAI Tamam)

conv/conv

**Seeker II**

Denel

n/a / 7.00 / n/a

1x 4-cyl 2-stroke 50 hp

10.0 / 18.0 / 280

colour camera, multi-sensor, electronic survey

conv/conv + arrestor

**Sentry**

DRS Technologies

2.57 / 1.90 / n/a

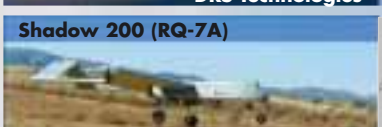
1x 2-stroke 28 hp

6.00 / 10.0 / 150

35 kg Varius

conv/conv-para

**Shadow 200 (RQ-7A)**



AAI

3.75 / 4.27 / 0.34

1x UEL AR 741

6+ / 15.0 / 170

Various (various manufacturers)

conv-cat-rato/para

**Shadow 400**

AAI

5.00 / 3.82 / n/a

1x UEL AR 741 38 hp

5.00 / 12.0 / 201

30 kg Various

conv/conv

**Shadow 600**

AAI

5.18 / 7.47 / 0.46

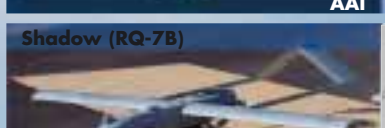
1x UEL AR 801 50 hp

12+ / 17.0 / 265

Micro-flir, CCTV (various manufacturers)

conv-cat-rato/para

**Shadow (RQ-7B)**



AAI

3.40 / 4.27 / 0.34

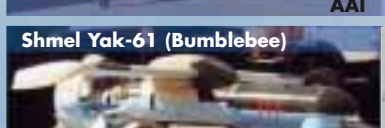
1x UEL AR 741 38 hp

7+ / 15.0 / 171

EO/IR, Tamam, 27.3 kg

rail/conv

**Shmel Yak-61 (Bumblebee)**



Yakovlev Design Bureau

2.77 / 3.26 / n/a

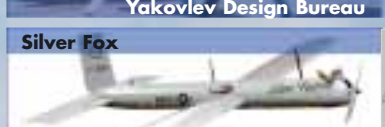
(type undis-closed)

2.00 / 10.0 / 129

Day/night imager (various manufacturers)

cat/conv

**Silver Fox**



ACR

1.80 / 2.40 / n/a

4-cycle JP5 or FP8

4.00 / 1.00 / 12.2

2.7 kg colour/CCD cameras, flir

cat/para

**Skylark**

Elbit Systems

2.20 / 5.50 / ~0.15

1x electric

2.00 / 6.00 / na

Day or IR

hand/belly

**Skylite**

Rafael

1.10 / 1.70 / 0.12

1x electric

1.0+ / low / 6.00

CCD camera

tube/belly

**Sky-X**

Alenia

~7.00 / ~6.00 / n/a

1 turbine

na / 30.0 / 1100

200 kg not defined

conv/conv

**Sniper**

Elbit

3.78 / 5.21 / 0.52

1x UEL AR 741 38 hp

6+ / 15.0 / 155

TV, flir (various manufacturers)

cat/para

**Sojka**

VTULaSTV

3.81 / 4.08 / n/a

2-cyl 2-stroke 29.5 hp

2.00 / 7.00 / 145

CCD camera, IR (various manufacturers)

cat/pata

**Sperwer B**

Sagem

3.50 / 6.20 / n/a

1x 70 hp 2-stroke

12.0 / 20.0 / 350

100 kg EO/IR, Sar Samir MWR + weapons (Spike)

cat/para

**Sperwer/Ugglan**

Sagem

3.51 / 4.21 / n/a

1x 70 hp 2-stroke

8.00 / 17 / 250

50 kg Sagem Olosp

cat/para

**Traker**

Eads

1.40 / 3.60 / ~0.10

1x electric

2.00 / 6.50 / 7.50

Day or IR, 1.8 kg

hand/belly

**Tu-243 (VR-3 Reys-D)**

Tupolev ANTK

8.21 / 2.26 / n/a

1x Izotov TR-3-117 tj

na / 17.0 / 1397

TV, IR, radiation detection

rato/para

**Vulture**

ATE

3.11 / 5.21 / 0.70

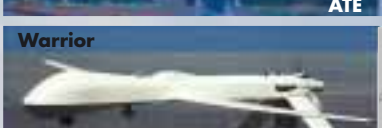
1x TTL-Wae 342

3.00 / 16.0 / 125

Optronic day sight (M-Tek)

cat/para

**Warrior**



General Atomics

10.36 / 20.12 / variable

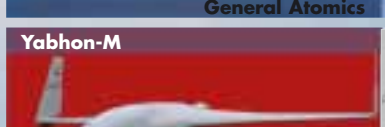
Thielert Centurion

30 / 29.0 / 1360

In development Lynx Sar, 8 Hellfire

conv/conv

**Yabhon-M**



ATS

4.30 / 5.70 / ~0.30

1x 60 hp ME 684

30.0 / na / 330

Day/IR

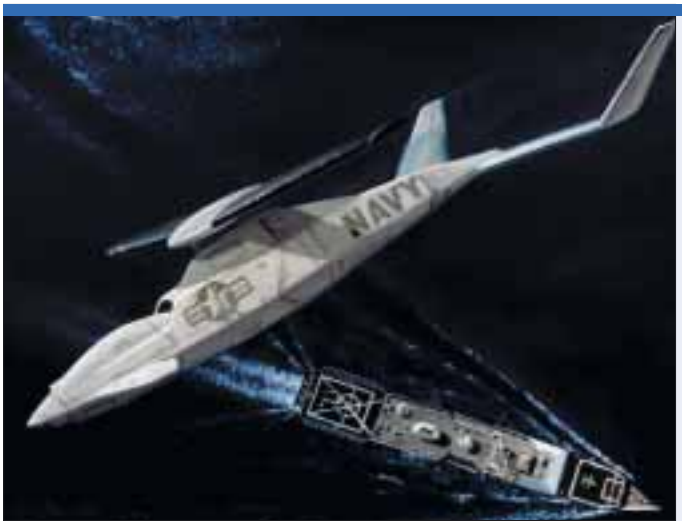
conv/conv

of support. Elbit is expected to receive around one-third of the total. The WK450 has an endurance of over 16 hours and a ceiling of 16,000 ft.

A British Army Watchkeeper regiment will consist of four batteries (systems), each with three aircraft. The baseline Watchkeeper is now due to enter service in 2010 (four years later than was planned in 2004), with a payload combining the Thales I-Master radar and the Elop Compass IV EO/IR sensor. It is understood that up to 94 WK450s will be procured for Britain, and Elbit and Thales will market the system worldwide.

The original plan for Watchkeeper was to combine two types of drone, in the winning (Thales) case the Hermes 450 and the lighter Hermes 180. The other combination shortlisted was the Northrop Grumman proposal to combine the Ruag Aerospace Ranger with its own RQ-8 Fire Scout helicopter.

The Ranger is a 275-kg drone with a 38 hp engine and an endurance of six hours. The Ranger is noteworthy for its automated recovery, known as Raps (Ranger Autoland Precision Sensor), which monitors the drone position by means of a TV camera and laser ranger transmitting corrective signals to the GCS.




*The Boeing X-50 Dragonfly canard rotor/wing technology demonstrator will investigate the feasibility of a high-speed operational drone using the stopped-rotor concept. (Boeing)*

*Tilt-rotor technology from the XV-15 and V-22 series is now being applied to drones. The first full-scale Bell TR918 Eagle Eye began hover trials in January 2006. (Bell)*

## Rotary Wings

The Northrop Grumman RQ-8A/B Fire Scout, based on the Schweizer 379, is still in the developmental stage. Five (three-blade) RQ-8As and four GCS' are currently under test. The first autonomous deck landings on a ship at sea were carried out in January 2006 with the amphibious assault ship USS Nashville off the east coast of the USA.

In 2003 the US Army selected the 1430-kg four-blade RQ-8B as its Class IV drone for its FCS (Future Combat System), representing a market for 1152 air vehicles. The RQ-8B is powered by a 315-kW Rolls-Royce 250-C20W turboshaft, and carries a 272 kg payload for a flight of six hours with a ceiling of 20,000 ft. Maximum speed is 230 km/hr.

The first of two RQ-8B prototypes is due to be delivered before the end of 2006, but formal service entry with the US Army is not scheduled until 2011. The RQ-8B has also been chosen for use on the US Navy's new Littoral Combat Ships. Northrop Grumman is currently under contract to deliver twelve aircraft: four for the Navy and eight for the Army. The company sees export prospects in Australia, Japan and South Korea.

There is a great deal of interest in the Vtol drone sector, because such vehicles suit navies and make armies independent of runways. Boeing is promoting the optionally-piloted Unmanned Little Bird (ULB) based on the MD Helicopters MD530F, which would give commonality with the US Special Operations Command AH/MH-6J. The ULB has a gross weight of 1400 kg and is powered (like the RQ-8) by a 315 kW Rolls-Royce Model 250 turboshaft. The ULB first flew on 8 September 2004, and is reportedly being tested with Hellfire missiles and a 12.7 mm GAU-19/A Gatling gun. It is planned to demonstrate remote control of the ULB from an UH-60 and possibly an AH-64.

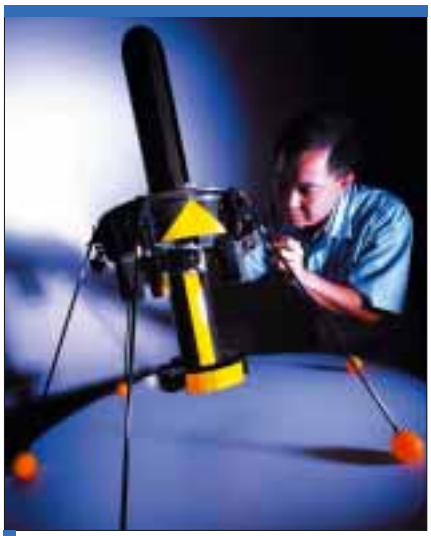
Boeing has a second iron in the fire, having taken over Frontier Systems which developed the 620 kg Maverick drone from the Robinson R22, which is powered by a 108-kW Lycoming engine burning avgas. The Maverick has a seven-hour endurance with a 180 kg payload, a ceiling of 10,800 ft and a maximum speed of 218 km/hr.

Another drone helicopter is the Science Applications International (Saic) Vigilante 502, based on the 512-kg two-seat American Sportscopter Ultrasport 496 powered by a turbocharged Rotax 914 engine. Maximum speed is 217 km/hr and ceiling is 13,000 ft. The Model 502 has been fitted with an NBC agent detection system, and has been tested as a platform for Hydra 70 rockets. The Vigilante 496 is an optionally-pilots variant with the original (larger) fuselage and consequently reduced performance.

Europe's principal de-manned helicopter is the 680-kg Vertivision, based on the manned Hélicoptères Guimbal Cabri G2, powered by a 112-kW Lycoming. The two companies have formed a joint venture named Vertivision to develop the Orka 1200, which is aimed at a joint French Army/Navy requirement. Eads, on the other hand is developing much smaller drone helicopters, the 13-kg Scorpio 6 and 38-kg Scorpio 30.

## Advanced Technologies

All the rotary-wing aircraft discussed so far have been conventional designs, aimed at exploiting existing airframe-en-



*Singapore Technologies Aerospace is developing the Fantail ducted fan Vtol drone. The current version is the 5.5-kg Fantail 5000, which began flight trials in May 2005. (ST Aero)*


*Sales of the S-100 with the United Arab Emirates as launch customer (followed by another three buying nations) being on a steep curve topping the near 200 mark have prompted Schiebel to build new facilities on the edge of the Wiener Neustadt airfield in Austria. (Armada/RB)*

gine combinations. However, America is also looking at advanced technologies to provide major improvements in helicopter performance.

The Boeing X-50 Dragonfly canard rotor/wing (CRW) is a fresh take on the old stopped-rotor concept, employing a relatively conventional straight wing as a two-blade rotor, powered by engine bleed-fed tip-jets for low-speed flight. The X-50 technology demonstrator is a 675-kg aircraft, with a 3.1-kN Williams F115 turbofan, and a design maximum speed of 408 km/hr. The operational CRW would be aimed for 740 km/hr. The first of two Darpa-funded X-50s began hover tests in late 2003 but was damaged in a hard landing in March 2004, later traced to control cross coupling. The second X-50 began hovering in December 2005. Two further prototypes are planned.

Another advanced Boeing helicopter drone is the A-160 Hummingbird, which

*Originally developed by the US Air Force Electronic Systems Center, the bungee-launched Desert Hawk is built under licence by Lockheed Martin. It is shown here at Ali Air Base in Iraq. (US Air Force)*

the company acquired on taking over Frontier Systems. A joint Darpa/Army/Navy programme, the A-160 is intended to demonstrate a major improvement in range and endurance through the use of a patented Optimum Speed Rotor (OSR). This is claimed to allow the rotor to operate over a wide rpm range and thus makes it possible for the blades to function at their optimum lift/drag ratio regardless of flight conditions. The first of four A-160 technology demonstrators had its maiden flight in January 2002. It is a 1950-kg drone, currently fitted with a 290-kW six-cylinder car engine providing a 7.3-hour endurance with an 18% fuel fraction. It is planned to progress to a turboshaft engine and ultimately a diesel, to give an endurance of over 24 hours, a ceiling of 30,000 ft and a maximum speed of 260 km/hr. However, the Darpa funding is due to end in 2007. Boeing is under contract to produce eight A-160s for Darpa and ten for US Naval Air Systems Command.

## Tilt-Rotor

The feasibility of the stopped-rotor and the OSR have yet to be demonstrated, but the tilt-rotor is known to work. Based on the technology demonstrated with the Bell XV-15, which first flew in 1977 and was further developed with the Bell-Boeing V-22 Osprey (1989) and the Bell/Agusta BA609 (2001), Bell is now developing its Model TR916/918 Eagle Eye tilt-rotor drone. The TR916 is specifically for the US Coast Guard and the TR918 is aimed at the broader military and commercial market. A seven-eighth-scale demonstrator (TR911X) flew in March 1998. A pre-production TR918 began hover trials on 26 January 2006.

The Eagle Eye will be operated from US Coast Guard cutters under the Deepwater programme. The procurement of 45 aircraft and 33 control stations is planned with service entry in 2011. It will have a Flir Systems Star Safire III thermal imager and a Telephonics RDR-1700B radar. In addition, the US Marine Corps plans to buy eight TR918s for evaluation as an armed escort for the MV-22. Bell is teamed with Lockheed Martin, AAI and Textron Systems on Eagle Eye development and marketing, and with Sagem and Rheinmetall on a European version.

The Eagle Eye is a 1290-kg drone powered by a 480 kW Pratt & Whitney Canada PW200-55 turboshaft. It is estimated to have an endurance of 5.5 hours, a ceiling of 20,000 ft and a maximum speed of 390 km/hr. It may be noted that the Korea Aerospace Research Institute has recently launched development of its Smart tilt-rotor drone.

*Like the Desert Hawk, the AeroVironment Dragon Eye is bungee-launched. The US Marine Corps plans to procure 342 three-drone systems under a five-year programme. (US Navy)*

## Marine Needs

One potential market for the Eagle Eye is the US Marine Corps, which, aside from needing a drone escort for the MV-22, has a requirement for a 'Vuas' (Vertical Unmanned Aircraft System) to replace the old RQ-2B Pioneer from 2015. The Pioneer can overcome the need for a long runway by using a rocket-assisted take-off and an arrested landing, but the service is now looking for Vtol operation from all its air-capable ships. Early reports spoke of demands for a 90-kg payload, an endurance of six to eight hours (threshold and objective figures) and a maximum cruise speed of 370 to 480 km/hr.

The obvious Vuas contenders are the Bell Eagle Eye and the Northrop Grumman Fire Scout, but it is anticipated that

*Sagem unveiled its Bertin-based electrically powered Odin at the 2005 Paris Air Show. (Armada/EHB)*

(in view of the relaxed timescale) Boeing may offer not only the ULB but also the A-160 and CRW. Another helicopter drone with maritime applications is Austria's 200-kg Schiebel Camcopter S-100, which has a dash speed of 220 km/hr. The launch customer for the S-100 version is the UAE Army, which has ordered 40 systems, each with two Al Sber drones, with an option on another 40 aircraft. Although no longer in production, the original and smaller Camcopter is employed by the Egyptian Navy.

The Pioneer/Vuas represents the US Marine Corp's longest-range system, the Tier 3. Tier 2 evidently refers to an intermediate-range drone, yet to be chosen. At the lower end, Tier 1 is represented by the bungee-launched, electrically powered 2.06-kg AeroVironment Dragon Eye. In February 2006 it was announced that AeroVironment is to produce 303 Dragon Eyes and 101 ground stations for the US Marine Corps under a $ ten million contract. The marines plan to buy 342 systems under a five-year programme. In the long term it is hoped the Dragon Eye will be replaced with a Joint Small UAS.

Another type in broadly the same category as the Dragon Eye is the 2.26 kg Lockheed Martin Desert Hawk, which was developed to meet a US Air Force requirement for overseas airbase protection. The service currently has 21 systems with 126 aircraft, all deployed in the Middle East. Other users of the Desert Hawk include the British Army, which has recently contracted Lockheed Martin to upgrade its existing systems and supply new ones to the improved standard.

In US Marine Corps plans there is scope for a close-range sub-Tier 1 in the micro air vehicle (Mav) category. This is exemplified by the AeroVironment Wasp, which weighs only 170 grams and has a span of only 33 cm but has demonstrated an endurance of 107 minutes. Several countries are experimenting with Mav-class drones. European interest is illustrated by the 530-gram 49-cm span Mavionics Carolo, funded by Rheinmetall.

## Ducted Fans

The US Army is encouraging the development of ducted fan mini-drones through its Class I requirement for a backpackable vtol weighing less than 6.8 kg with an endurance of 60 minutes. The Army foresees a need for a total of 624 such drones to perform 'hover-and-stare' duties. In 2005 Honeywell delivered to the US Army for assessment a 33-cm-diameter ducted fan vehicle that had been developed under Darpa funding. In 2006 the company is to deliver 25 improved drones for further evaluation by the 25th Infantry Division.

The Class I will operate in conjunction with a heavier Class II Organic Air Vehicle, which is to have a 'dry weight' of less than 50.8 kg and an endurance of two hours. In December 2004 Darpa awarded development contracts for Class II ducted fan vehicles to Aurora Flight Sciences, BAE Systems and Honeywell International. In July 2005 it was announced that Team GoldenEye, led by Aurora, is to develop the Class II. The GoldenEye-50 demonstrator weighs only 8.15 kg and the GoldenEye-100 will weigh 68 kg.

BAE Systems lost in both Class I and II, but is continuing to develop ducted fan drones. It plans to flight-test its 56.8-kg IAV2 vehicle with wings added, to increase maximum speed from 37 to 185 km/hr and extend endurance from one to perhaps five hours. It has also been demonstrated as a means to deploy a ten-kg WolfPack signals intelligence unattended ground station. The IAV2 is being offered to the US Marine Corps and Special Operations Command.

*AeroVironment Pointers are used by the US Air Force, Army and Marines. Here Air Force airmen from the 22nd and 23rd Tactics Squadrons are trialling use from an Ohio-class submarine. (US Navy)*

Other small ducted fan projects include ST Aero's Fantail-500, a 5.5-kg drone with a 2.6-kW engine, which was unveiled at Asian Aerospace in Singapore in February 2006.

Sagem, for its part, is developing an electrically powered ducted fan drone as part of the Felin soldier programme. Based on the HoverEye designed by Bertin, it is known as the Odin. In fact, Sagem is working on two derivatives one weighing 1.5 kg and the other 4.5 kg. Sagem had earlier envisaged a system based on the ST Aero Fantail but the project has been terminated.

## All-electric

The pathfinder for electrically powered, hand-launched mini-drones was the 3.76-kg AeroVironment FQM-151 Point-


*More than 100 Aerosonde drones have been completed. Work is proceeding on a precision maritime recovery system to automatically guide the drone into a net on a moving ship. (Armada/RB)*


*The Advanced Ceramics Research Silver Fox is a 12.2-kg modular drone burning mogas or avtur fuel. It is used by the US Marine Corps in Iraq and is being evaluated by the Canadian Forces. (US Navy)*

er, which has been used extensively by US services since 1989. The drone is known in the US military as the RQ-11A Raven and is a 1.8-kg development that exploits recent advances in battery and electric motor technologies. The US Army is buying 185 three-aircraft systems for use in Iraq and Afghanistan, the US Air Force 41 two-aircraft systems and Ussocom 70 three-aircraft systems. Total Raven sales have now reached the 3000 mark.

The Israel Defence Force is currently evaluating home-grown electric drones: the Aeronautical Defense Systems Orbiter, the Elbit Systems Skylark, the IAI I-View 50, the IMI Rainbow and the Rafael Skylite-B. This is hoped to lead to a selection by the end of 2006. The winner will carry a Controp EO payload.

*The Boeing/Insitu ScanEagle-B is aimed at a 48-hour endurance. Recovery at sea employs a 'Skyhook' system, the wing snagging a cable suspended from a 15-metre pole. (Insitu)*

The Elbit Skylark is reportedly in service with the Israel Defence Force and has been selected by the Australian Army, which is buying six three-drone systems. Four of these are to be deployed to Iraq. The original Rafael Skylite-A was shoulder-launched from a reusable canister, to facilitate urban use, but the -B version is catapulted and recovered by parachute and airbag for instant reusability.

Other electrically powered drones include the hand-launched ST Aero Skyblade series. In early 2006 the company handed over the first of four Skyblade IIs to the Republic of Singapore Army, and unveiled the improved Skyblade III.

AeroVironment has revealed that its AquaPuma, a marinised version of the Puma that was developed as a Pointer replacement, is in limited production for the US Navy. The AquaPuma is competing for a Royal Australian Navy order against the Schiebel S-100 and Australia's own Aerosonde series, now using a net recovery system.

Aerosonde has recently entered into a strategic alliance with Lockheed Martin on the development of small drones. Its current lightweight, long-endurance product (also named Aerosonde) is in broadly the same class as the 18-kg Boeing ScanEagle, which is already in use in the Iraq theatre by the US Air Force, Navy and Marine Corps.

## Targets

The current state of the art in regard to target drones was discussed in some detail in our last review (Armada International 2/2005). The most significant news in this context is that in February 2006 Orbital Sciences announced receipt of the first full-scale production order from the US Navy for 19 GQM-163A Coyote supersonic sea-skimming targets. This follows an earlier order for 20 low-rate initial production (Lrip) Coyotes. It employs a surplus Standard Missile Mk 70 tandem booster and a ducted rocket sustainer based on technology developed by Atlantic Research under the US Air Force Variable-Flow Ducted-Rocket programme. It has a range of approximately 90 km, flying extremely low at Mach 2.5.

In August 2005 the first flight took place of the Northrop Grumman BQM-74F, the latest version of the Navy subsonic drone series known in the export market as the Chukar. The new avionics from the –74F will be retrofitted to some Navy BQM-34 Firebees. The US Air Force is meanwhile seeking a replacement for its McDonnell Douglas QF-4s, which will probably lead to a drone development of the Lockheed Martin F-16.

## Ucavs

As indicated earlier, the future of Ucavs has been thrown into confusion by the US Air Force and Navy zeroing the J-Ucas programme in their FY2007 budget requests, although Lockheed Martin is reportedly already developing a J-Ucas-size penetrator drone. It may be noteworthy that the US Air Force estimated a $ 60 million unit cost for the J-Ucas production item, and allegedly saw it as a threat to the F-35.

According to press leaks, the Navy continues to need a carrier-based Ucav with design emphasis on stealth and long


*There remains a strong market for target drones for short-range air defences, as exemplified by this Meggitt Defence Systems Voodoo, a 210-kg vehicle with a 108-kW engine. (Armada/EHB)*

*Northrop Grumman has manufactured over 7500 examples of the BQM/MQM-74 target drone series. The straight-wing BQM-74E is now being superseded by the swept-wing BQM-74F. (Northrop Grumman)*

endurance. The service has requested $ 239 million in FY2007 for a Ucav carrier-suitability demonstration, presumably using an X-47B.

By 2018 the US Air Force wants to have a much heavier long-range strike drone to complement a new manned bomber, which will take a larger warload. The service may also have ICBMs with conventional warheads.

The future for European Ucavs is equally unpredictable. Hoping to collaborate with the US on a stealthy Ucav Britain cannot co-operate with its neighbours and so is working on a national technology demonstration programme. Germany is again making a solo effort: photographs of the Eads Barrakuda have been published, though not by Eads.

Italy and Sweden have flown their own Ucav research drones but have nevertheless joined in the multi-national Neuron programme, for which France's DGA signed a Euro 405 million contract with Dassault in February 2006. The Neuron is expected to be a six-tonne air vehicle, probably with a Rolls-Royce/Turbomeca Adour turbofan and weapon bays for two 250-kg bombs. Other companies involved include Alenia Aeronautica, Eads-Casa, Hellenic Aerospace Industries, Ruag Aerospace, Saab and Thales. The Neuron is to fly in 2011.

*If the J-Ucas project is to survive, it seems likely that the US Navy will have to fund its own improved version of the Northrop Grumman X-47B, as illustrated here. (Northrop Grumman)*

*Drones have special attractions in suppressing air defences and the use of directed energy weapons. The US Navy may well be the first service to field a directed-energy strike drone. (Northrop Grumman)*


*The planform of the Boeing X-45A is a typical configuration designed for radar stealth, with leading and trailing edges aligned to produce two narrow response spikes. (Nasa)*

## Ground Control Stations

Ground control stations are changing as service demands grow for ease of deployment and commonality between systems, and as drones develop to provide greater autonomy, requiring reduced manpower.

The Ryan (now Northrop Grumman) Firebees of the Vietnam era were hand-flown by professional pilots sitting in the Lockheed Martin Hercules that also served as their launch platforms. In contrast, the most advanced of modern drones have a relatively high degree of autonomy, flying pre-programmed missions from take-off to landing without the need for further human input, and monitoring the health of their own systems during flight. Nonetheless, they still require ground control stations (which may be carried on surface vessels or in other aircraft) to insert mission plans for the drone and its sensors, to modify those plans during flight and downlink and display the images generated by those sensors.

One of the major concerns voiced in the current Pentagon roadmap for drones is the relatively high cost of operation associated with the need for skilled manpower. For example, the pilot of a Northrop Grumman RQ-4 Global Hawk requires 26 weeks of specialist training, and it takes 17 weeks even in the context of a very basic drone such as the RQ-2 Pioneer. There is also concern that present-day ground stations are not designed to be used as training simulators.

One of the most important trends is toward greater drone autonomy, which will make it easier for one pilot to control several drones simultaneously. In addition, more data processing will be done onboard the drone, allowing the ground station to be simplified and require less power, thus becoming smaller and easier to deploy.

*Boeing's contender for the production J-Ucas was the considerably enlarged X-45C, shown here as a mock-up. The first of three demonstrators was to have flown in early 2007. (Boeing)*

*Germany is making a solo effort in developing various drone categories, including Ucavs. Photographs have appeared of a 'Barrakuda' prototype similar to this artist's impression. (Eads)*

In the longer term, quite sophisticated drones may be controlled from laptop computers, possibly using some degree of voice control to communicate basic instructions. Important advances are also taking place in communications, as illustrated by America's Link 16 encrypted jam-resistant digital datalink network. Like other Pentagon systems, drones are to be connected to the Department of Defense's own version of the Internet, the Global Information Grid.

It must be borne in mind, however, that mission duration largely governs the size and sophistication of a ground control station. The longer the mission the more data is amassed and processed and several recorders might be required. Typically, there will be at least two operators, the pilot and the payload operator. In principle a single person would suffice, but the operation would become very risky if a change of course has to be keyed in.

The laptop may not be the end of the trend to smaller ground stations. Elisra and several other manufacturers are offering wristwatch-like displays, which are better suited to the use of micro-drones and urban warfare.

At the opposite end of the spectrum, the long-range Global Hawk has a two-station Launch and Recovery Element (LRE) and a separate four-station Mission Control Element (MCE). The LRE controls the drone by UHF links but has no provisions for sensor control or the reception of images, which are the functions of the MCE. The latter employs UHF line-of-sight and UHF and Ku-band satellite links, with Inmarsat as backup.

In the case of Afghanistan, a forward-deployed MCE bounced the imagery to a collocated forward exploitation element or via a fibre-optic landline to a US-based facility, which could send the finished product to the in-country Combined Air Operations Center (CAOC) over Ku-band satcom. In the case of Global Hawk operations over Iraq, the LRE was again forward deployed, but the MCE was located at Beale AFB, California, communicating with the CAOC by landline and Ku-band satcom.

In between the extremes of the laptop and the twin-container RQ-4 system (with large satcom antenna) several companies have developed GCS that combine capability with mobility. One example is Elbit's backpackable system, applicable to all members of the Hermes family.

Another interesting system is available for the Denel Seeker II, using a truck-mounted Tactical Ground Station, which combines the functions of the home-based Mission Control Unit and the Tracking and Communication Unit, and maintains control beyond the UHF range of the mother station.

The multiplicity of drone systems developed for the US services have provided useful fallbacks when designs have failed, but only at high cost. There is a strong case for standardising ground control stations, as is now being done by the US Army. The new General Atomics Warrior will thus employ the AAI One System, as used for the Army's RQ-7 Shadow. It has also been employed to control the Army's RQ-5 Hunter, and a modified version is scheduled to fly the US Marine Corps RQ-2 Pioneer.

*The US Air Force is considering Long Range Strike (LSR) options, including ballistic missiles and large unmanned supersonic bombers, as illustrated here. (Northrop Grumman)*

## Payloads and Electronics

The prime payload of a drone is its eye(s), but from a mere observation vehicle, the drone is now increasingly being used for other operations like electronic warfare, comint and elint missions.

The traditional gimballed observation platform market is currently dominated by Flir Systems in the United States and Elbit in Israel. However, Denel, which had developed its own systems for South Africa's requirements, is now emerging as a world-wide supplier, and so is Sagem (who actually uses a Denel turret, but fills it with its owns sensors). Smaller drones, due to their weight and size restrictions, use fixed miniature cameras fitted in the nose or under the fuselage, although some may have a panning facility enabling the operator to remain manually focussed for a longer period of time on a point of interest.

*Dassault is leading a European effort on the Neuron Ucav demonstrator, to fly in 2011 under funding from France, Greece, Italy, Spain, Sweden and Switzerland. (Dassault)*

Although shaky due to the motion of the aircraft pictures from such fixed or panning payloads are good enough for short-range reconnaissance or spying over a hill. Such systems cannot provide position co-ordinates other than that of the aircraft. If the accurate position of what is actually been observed (which can be several kilometres from the aircraft) becomes mandatory then tracking and stabilisation and have to be coupled to an inertial measuring unit and/or to a GPS and managed by a computer. This steadily leads us to the gimballed platforms mentioned above, and to the larger tactical drones they are fitted to.

*The EL/K-7071 unit with its vertical aerials on the left is IAI-Elta's comint system that scans, analyzes and classifies highly mobile and frequency-agile ground, airborne and naval communication transmissions. The EL/M-2055 unit on the right, from the same company, is a synthetic aperture radar. (Armada/JK)*

## Optical Alchemy's KJ-640 Main Particulars

| | |
|---|---|
| Weight: | 2.7 kg plus electronics |
| Azimuth: | 360° continuous |
| Elevation Horizon: | to –75° |
| Azimuth & elevation speed: | to 60°/sec |
| IR Sensor: | 8 to 12 µm |
| Resolution: | 640 x 480 |
| HFOV x VFOV: | 350 x 260 |
| Video Format: | RS170; 12-bit digital |
| Visible Sensor: | 455 nm to 900 nm |
| HFOV x VFOV: | 480 x 310 |
| Zoom: | 18X |
| Laser Marker/Illuminator: | 830 nm |
| Power: | 100 mW |
| Beam Divergence: | 0.26 –0.30 mr |
| Beam Diameter: | 8 mm |

was to democratise the availability of information and bring military units the capability of using smaller reconnaissance drones that enable them to gather the type of information they require (including geolocation) at any time of the day or night and seven days a week. With its ability to reduce the weight of a 50-kilo unit down to 2.7 kilos, the term that best describes Optical Alchemy's activities in this domain is that of 'head shrinkers'. Alternatively, the reduced size and weight of such systems can bring substantial savings in fuel consumption and, as a corollary, much extended endurance. Also, if need be a single drone could be fitted with two turrets. According to the company, the two-axis KJ-640 unit is now entering production stage (The three-axis, 5.9-kilo KJ-800 series, on the other hand is still under development). The KJ-640 packs day and infrared cam-

These typically started life as helicopter-borne turrets used by police forces and TV crews, which require dead-steady pictures of the filmed scene whatever the upward/downward and lateral movements of the aircraft might be. This means that the ball (or its contents) has to be able to swerve in both the vertical and horizontal planes and be stabilised (this is effected in very much the same way as in armoured vehicle sights).

With the advent of the drone, more sophisticated elements have been developed: television cameras were soon accompanied by infrared sensors, laser rangefinders and even laser target pointers or designators and ladars. What makes the quality of such turrets is not only their reaction time, but also the ability of their tracking system to remain locked on the target, whatever its relative speed may be. All this has a cost, not only in terms of money but also size and weight. This is where a hitherto relatively unknown company – Optical Alchemy – cuts in. The company explained to Armada that its aim

*The Elisra AES-210/V elint and electronic support measures package weighs less than 22 kilos, operates in the 1 to 18 GHz band and has an RS422 interface. It uses interferometer and differential Doppler to provide fine direction finding. (Elisra)*

*The Thermo Vision Photon is approximately five centimetres long, weighs about 110 grams and is available with several lens options. (Flir Systems)*

eras and a laser illuminator/marker (night vision goggle compatible) in a six-inch ball. Its inertial measuring unit and GPS provide geo-referenced co-ordinates on the transmitted imagery. It is suitable for drones as light as 22 kilos on take-off.

Flir Systems has been on the market for many years and has a very comprehensive range of gimballed sensors with approximately 800 units used on 35 different types of aircraft (manned and unmanned). It claims that its Safire is the world's number one commercially developed military-qualified airborne thermal imaging system. The latest model of the Series is the Safire III, which can be seen under the chin of the Bell Eagle Eye tilt-rotor drone.

Developed from the Safire, and like it equipped with an embedded inertial measurement unit, the Brite Star is a multiple sensor laser designator/ranger unit that also houses a third-generation thermal imager and a television camera and can optionally receive an autotracker, a laser spot tracker and a choice of interfaces. This can be found on the Northrop Grumman Fire Scout.

As suggested by its name, the SeaFlir III is optimised for maritime applications and features on the DRS Sentry, the AAI Shadow 400 and 600, the Schiebel Camcopter and the Galileo Falco.

To cater to the needs of simpler requirements, Flir Systems has developed the Thermo Vision Photon, a high sensitivity uncooled long-wave thermal imager with a 320 × 240 array. It can be found on innumerable drones, amongst which are the Aerovironment Raven and the Boeing Scan Eagle.


*The Compass family includes payloads equipped with a third-generation Flir, eyesafe laser rangefinder/diode pumped advanced designator, and night vision goggle-compatible laser target illuminator. (Elbit)*

Turning to Sagem, this company is a long-standing producer of thermal cameras and binoculars and of stabilised sights for armoured vehicles and helicopters. Having put two and two together, Sagem now produces the Olosp payload for its own drone system, the Sperwer, although variants are used on maritime helicopters.

Pretty much the same could be said of Denel's experience, which has also been producing stabilised platforms for helicopters and now has the Goshawk 350 as its key system for drone applications. There are too many sensor options to describe them all in detail here, but typically this 14- to 16-kilo ball system offers a stabilisation accuracy of under 30 mradian and can typically house a thermal imager with two field-of-view optics or continuous zoom, colour television and laser rangefinder. A typical carrier is the South African Seeker II.

Elbit's current flagship is the Compass, a four-sensor package that has been used for some time now by the Hermes 450 flown by the United States Department of Defense as part of the Arizona Border Control Initiative to patrol along the Arizona–Mexico border. It scored relatively high in December 2005 by winning its ticket to board the British Watchkeeper, which, incidentally, also uses the Hermes 450 aircraft.

Drones are also increasingly being used for signals and communications intelligence (sigint and comint) but for manned aircraft, it is extremely difficult to gather detailed information from manufacturers (see «Osama, Don't Phone Home» in the core issue).

This is the main role that will be assigned to the EuroHawk in Germany but electronics integrators Eads are still very discrete about their gear.

Unsurprisingly, however, Israel is reputedly the first nation to see advantages of using drones to spy on terrorist electronics and communications. What is more surprising, on the other hand, is to see that a company like Elisra has been openly showing its wares at international exhibitions for a while now. The company has been producing the Emerald AES-210, which enables manned aircraft to detect, measure and identify all radars between .5 and 18 GHz and provide accurate direction-finding by digital interferometer. Elisra has since developed a lighter AES-210V version of this ESM/elint unit for drones. It weighs less than 22 kilos. ◘

*The elint package for the EuroHawk, featuring a belly omnidirectional aerial. The direction-finding sensors are located behind the black side plate. (Eads)*

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