

# Straight from the forces' MOUT: UAVs enter urban environments

Unmanned aerial vehicle technology is developing to meet the challenges of operating in and around buildings, reports **Andrew White**

With military operations in urban terrain (MOUT) being fought with increased frequency by coalition forces in Afghanistan and Iraq, unmanned aerial vehicles (UAVs) are being called upon to build on their traditional surveillance and reconnaissance role to combat insurgents seeking refuge in and around buildings.

Traditional fixed-wing UAVs are able to track targets along main supply routes and open country, but reports from the front line suggest that insurgents are countering such tactics by 'disappearing' under and behind hard cover.

Short of providing troops with x-ray vision, the defence industry and world militaries have been deploying both fixed-wing and rotary-wing vertical take-off and landing (VTOL) systems for such urban operations. However, questions remain as to whether they can work in tandem and, more importantly, whether there is enough room in already busy airspace for both systems to operate at a tactical level.

## Tight corners

According to Russell Glenn, senior defence analyst with the RAND Corporation think-tank, VTOL UAVs are useful, but their efficiency, fuel consumption, time on station, payload carriage, endurance and speed are issues when compared to fixed-wing UAVs.

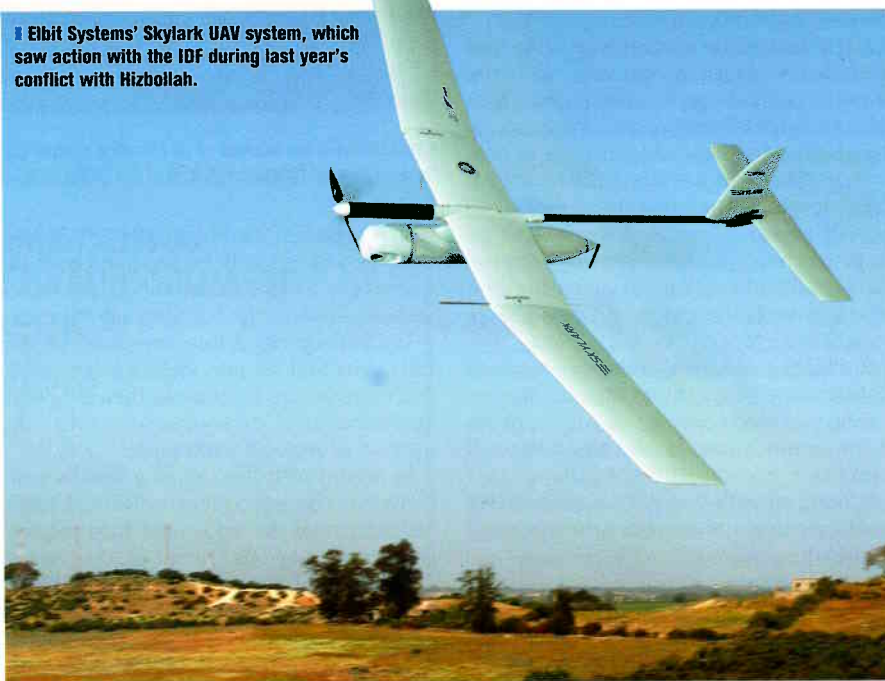
"Our forces need systems to get down tight corners, especially to conduct sensor-planting operations and drop off UGVs [unmanned ground vehicles]," he says.

Having worked in co-operation with UAV specialist AeroVironment and the US Army, US Marine Corps and Australian Defence Force, Glenn views UAVs as part of a larger system in the urban environment.

"They are less beneficial in urban areas than other environments because of their inability to see through cover, concealment and dead space [known as urban canyons]. This is still true to some extent. We cannot expect the same kind of success as in other environments but reports from the field say they are very valuable."

Glenn says UAVs should be used as the primary system to key other assets, whether they be artillery, close air support, UGVs or larger UAVs, although he expects them to remain the primary intelligence source for forces on the ground and in the air during an urban campaign.

Elbit Systems' Skylark UAV system, which saw action with the IDF during last year's conflict with Hizbollah.



Elbit Systems: 1191480

"They are very popular among ground forces but the limitations of UAVs are greater in the urban environment compared to other areas," he says, recalling the extensive operational use of UAVs over the past few years, including missions in Fallujah during 2004.

For MOUT roles, the modern-day UAV must be able to perform a number of tasks. These include traditional intelligence, surveillance, target acquisition and reconnaissance (ISTAR), offensive action, com-

munications relay and directing other unmanned systems.

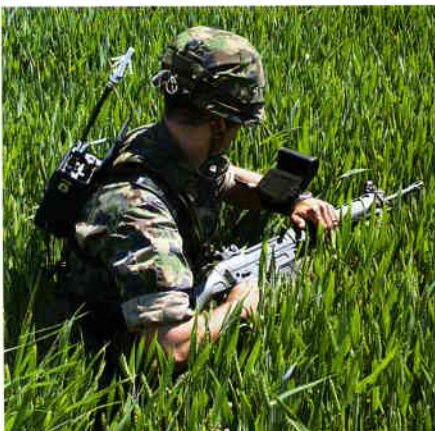
Following feedback from troops, Glenn tells *Jane's* that numerous individuals have expressed frustration at their inability to engage a target immediately after identifying it.

The threat of losing a target in built-up areas, according to Glenn, is very large when he or she takes refuge in a structure, unless supporting troops have overwatch of the specific building complex. However, with multiple access into buildings, forces cannot assume that the target's entry point will be the same as his or her exit point.

In addition, Glenn reports that soldiers have been frustrated by the amount of time needed to positively identify a target and engage it due to a prolonged decision-making process.

"The gap between the identification of a target and the ability to engage a threat in Iraq has led to high levels of frustrations for individuals interviewed. They need UAVs to reduce that gap and they need the right kind of engagement system or multiple systems," Glenn says.

A hunter-killer UAV, Glenn continues, can detect, identify and engage a target, thereby closing that gap to the minimum possible time. But he warns that specific offensive



Elbit's V-Rambo portable display system.

Elbit Systems: 1191481

action tasks require a UAV with the correct attack profile to deal with threats, whether they involve insurgents, civilians, chemicals or arms.

"If a hunter-killer does not have a suitable weapon system, then operators need to look at something else like artillery or other airframes [such as close air support]," he says.

In response to this trend, Glenn is confident that co-operation with other unmanned systems will also prove important in the future, with UAVs being capable of delivering UGVs and ground sensors into inaccessible urban environments.

## Lines of sight

Since the end of the Cold War in the early 1990s, which saw human observation positions (OPs) on international borders with lines of sight stretching for hundreds of metres, militaries have been unable to rely on human intelligence to the same extent.

This trend, according to Glenn, has seen a switch in tactics from manned OPs to more human-robotic co-operation with UAVs and sensor optic payloads.

"UAVs and sensors linked to a manned OP can cover dead ground where soldiers have no 'eyes on' [a view of the target]," he continues. "Information received can be passed on to quick-reaction forces to cover such approaches and the whole thing means less manpower and greater detection."

Similarly, he sees the collaboration of multiple UAVs working in a complementary fashion in a MOUT environment. With one airframe concentrating on a 'wide scope view' and a second airframe with a 'narrow' field of view for more detailed surveillance, the pair will be able to trigger each other on to targets, Glenn explains.

"Unless both systems can be developed, users will need complementary systems and high-altitude balloons to work together.

"UAVs are very valuable on their own and they are going to be more formally wrapped into larger systems, but UAVs remain poorly networked. If a UAV detects an anti-aircraft system, there is no way of communicating to all air assets interested in it," Glenn says.

Finally, he says UAV electro-optical (EO) payload operators require a capability to allow them to see through barriers such as walls and ceilings. As with the detection of explosives, Glenn tells *Jane's* that the theory works on the principle of a chemical probe, which can tell you whether a human is in an enclosure by their chemical signature.

Israel's Elbit Systems does not see VTOL systems as an affordable option and so has continued to concentrate on its fixed-wing family of UAVs.

The senior marketing director at Elbit UAV Systems Division, Yair Keren, tells *Jane's* that no technology yet exists for a suitable VTOL system without the shortcomings of a normal-sized helicopter, including noise, low endurance and high cost of use.

According to Keren, operators in MOUT

scenarios must choose between a UAV with high noise signature, flying at a high altitude with greater EO payload, and a UAV that can fly lower but with less noise thanks to electrical propulsion and a minimal EO payload.

Elbit's Skylark 1, which has been used operationally with the Israel Defence Force (IDF) in the recent conflict with Hizbollah, is a manpackable mini-UAV with an over-the-hill capability of up to 10 km. It is also fitted with a laser target marker to bring larger, armed UAVs on to a target.

Providing real-time imagery day or night



Schiebel: 1191482

■ Schiebel's latest Camcopter VTOL UAV system.



Schiebel: 1191483

■ DARPA's MAV UAV, a prototype for the FCS Class I UAV.

at a 'low' altitude of around 300 ft, Skylark's near inaudibility makes it ideal for MOUT operations in Afghanistan and Iraq. The Australians have been using an undisclosed number of Skylark 1 systems in Iraq's Al Muthanna province over the last couple of years.

Pointing to Skylark's minimal infrastructure, ease of deployability and small silhouette, Keren says the IDF is considering a "large procurement" very shortly with a view to equipping each mechanised brigade with a Skylark package. "With regards to MOUT, the IDF wants a bird's eye view and over-watch of the ground for SR [surveillance/reconnaissance] purposes as a forward scout to see what is ahead of troops. This is very useful," Keren says.

Elbit has nearly finished development of its Skylark II medium-sized UAV, extending its range up to 50 km. Flying at a higher altitude of around 3,000 ft, the updated system fits into Glenn's definition of a less detectable airframe with enhanced EO payload for day and night operations.

Weighing less than 8 kg and fitted with Elbit's Micro Compass payload system, the UAV is contained in a single ground vehicle and has two operators.

A three-way payload comprising day and night cameras, the Micro Compass system incorporates third-generation, mid-wave infrared technology and a laser suite including laser designator, rangefinder and illuminator.

Referring to a capability for UAVs to see through walls, Keren says: "We cannot look into buildings so far. If we had that capability, it would be classified, but consider the capability of watching a specific building. This is very important by itself."

Keren also sees a future for sniper detection systems aboard UAVs to detect enemy firers from building windows and apertures, with the airframe relaying information to troops on the ground for rapid response.

## Sharing the picture

Information can be disseminated via Elbit's new wrist-wearable video receiving system for ground combat forces, known as V-Rambo. Capable of receiving live video imagery from UAVs, it has been specifically designed for special operations forces in MOUT scenarios, according to Keren.

"It will extend vital UAV-generated intelligence to all ground combat forces, maximising the value and applicability of real-time video and telemetry data," he says.

Comprising a video receiver, rechargeable battery and foldable antenna, the system is worn in the operator's combat vest and has no limit to the number of users receiving information from the sourcing UAVs, including both Skylarks I and II.

Looking to the future, Keren believes all manoeuvring units will have their own UAV assets for MOUT operations, allowing them to be deployed where and when they want. But with more operators using up existing airspace, Keren would also like to see more regulation in this area, perhaps from NATO.

An advocate of VTOL UAVs is the managing director of Austrian company Schiebel, Stefan Vieweg. He says: "Troops have a requirement for patrolling in small units day and night with improved intelligence. They need to be non-routine, highly flexible and easy to use."

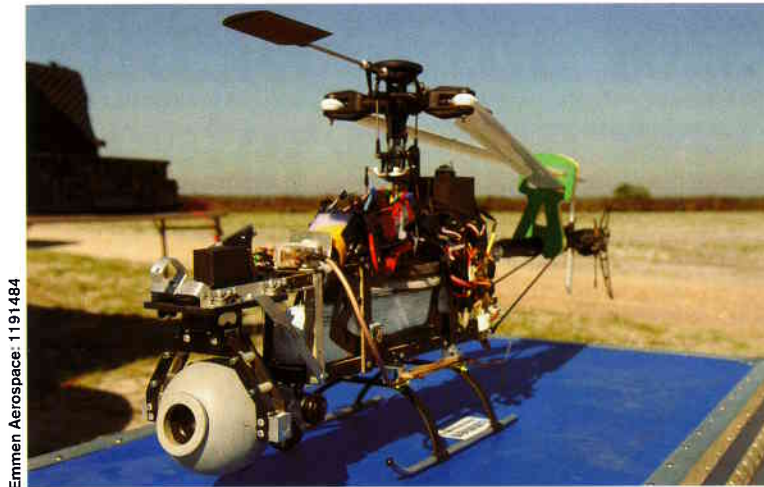
Referring to Schiebel's Camcopter system, Vieweg tells *Jane's*: "VTOL systems do not need runways as they start and land wherever you want. You need a 30 m<sup>2</sup> pad on a rooftop, for example."

Vieweg is in no doubt that Camcopter, with a rotor diameter of 3.5 m, six-hour endurance, 200 kg payload, a maximum speed of 240 km per hour and the ability to hover, provides a viable alternative to fixed-wing UAVs in urban combat scenarios.

"By hovering over a street, Camcopter can sit there high enough complete with day/night vision, infrared and real-time relay to control stations and troops on the ground."

With independent flight control, an operator can input a GPS grid and change

Emmen Aerospace's Condor UAV as used in the US Exercise 'Atlantic Strike V'. The rotors are foldable to ease space requirements.



Emmen Aerospace: 11 91484

speed settings en route via a rugged laptop with navigation points, waymarks and altitude restrictions.

"There is no need for a user to fly the system operationally and it is easy to use compared to real helicopters," Vieweg continues.

Schiebel has already sold 100 Camcopter UAVs around the world, in particular to the United Arab Emirates and users in Asia. The original 5.1 Camcopter prototype system is in use with the US Army but Vieweg concedes that Schiebel has learned a lot since the inception of this design.

## Greater payload

The latest design, known as the S-100, offers a greater payload, better communications set-up, more flexibility and reliability, according to Vieweg, as well as being faster and capable of travelling at higher altitudes while stabilised by an inertial navigation system.

"It eliminates the need for launch and recovery equipment and can be programmed to fly an autonomous mission profile via a simple point-and-click graphical user interface, or it can be directed manually." However, a full Camcopter system comprises two UAVs and a navigation system based in a small truck and needs three personnel to operate it. According to Vieweg, the system can be made operational within 20 minutes.

"We are trying to provide a flying platform with all the capabilities needed," he says. A generic plug-and-play interface makes it easy to integrate every payload with a minimum system size and weight, he adds.

On operations, the VTOL system cannot be heard while hovering at an altitude of 3,300-4,000 ft, although Vieweg concedes this is dependent on environmental noise levels and wind direction.

However, he says that by simply switching off the Camcopter's position lights and hovering at 1,000-2,000 ft at night, enemy and civilian populations will hear the system but will not be able to locate it.

Vieweg believes VTOL systems, currently capable of carrying FLIR (forward-looking infrared) cameras for night operations, will be used more in the future for jamming purposes.

"With the integration of radar payloads, including lidar, jammers and ground-penetrating radar, the future will see more and more applications and sensors, thus VTOLs will probably gain in importance," he says.

Vieweg sees UAVs hovering over buildings and streets while making sure nobody inside or in the vicinity can use mobile telephones, especially in order to cue improvised explosive devices (IEDs). They will also be able to provide a reconnaissance capability for mine identification and retrieval.

Schiebel is not considering mounting weapons on the Camcopter, saying it is not the company's "primary focus", but Vieweg suggests that the system would be capable of it. Similarly, Schiebel is not looking at developing a micro VTOL UAV system due to operational restrictions and endurance.

A similar VTOL concept, but based on fan technology, is the US Defense Advanced Research Projects Agency's (DARPA's) Micro Air Vehicle (MAV). A prototype for Honeywell's Class I UAV for the US Department of Defense's Future Combat Systems programme, the MAV is in its Advanced Concept Technology Demonstration (ACTD) stage and is due

for deployment with the US Army based at Schofield Barracks, Hawaii. The backpackable VTOL UAV with recovery system has a hover capability for persistent airborne staring in complex urban terrain and urban canyons, according to Dan Newman, ACTD programme manager for the MAV at DARPA.

## Semi-autonomous

An operator can provide the semi-autonomous UAV with waypoints so that no pilotage is required, allowing it to circle a target for up to 55 minutes at sea level and 45 minutes at high altitude.

Newman tells *Jane's* that following the completion of the ACTD, which started in October 2006, the US Army will receive 25 MAV systems, comprising 50 airframes as part of plans to kickstart a three-year training programme. Capable of storing up to 10 missions, with 100 waypoints each, the system is ideal for area searches in built-up areas and can be interrupted by an operator for manual control if necessary, says Newman.

With a dual payload, comprising either two EO cameras or two IR cameras, one to the front and the other to the rear of the system, the MAV has not yet been tested inside a building, although Newman says flying through a doorway or window would not be a problem.

Referring to the noise generated by high revolutions per minute, Newman says development of a heavy-fuel engine (HFE), as is being planned, would reduce engine noise by "significant" amounts.

"VTOL is ideal for looking at specific sites and targets, investigating urban canyons such as under bridges or providing a persistent view in complex terrain. Fixed-wing UAVs can complement this with a high-altitude perimeter overwatch capability."

With a pull start system, the MAV needs only one operator with a launch time of less than five minutes. Initial efforts, according to Newman, were designed to create a smaller

## UAVs help destroy insurgents in US exercise

A tri-service exercise comprising joint tactical air controllers (JTACs) from the US Air Force, Army and Marine Corps has demonstrated a way to defeat insurgents in an urban setting using live video streams from a variety of UAVs.

On 17 April at Avon Park Air Ground Training Complex, Florida, JTACs used Emmen Aerospace Condor rotary-wing and Swiper fixed-wing UAVs to co-ordinate simulated air attacks by a B-52 Stratofortress bomber and A-10 Warthog attack fighter to destroy insurgents during Exercise 'Atlantic Strike V'. Controlled by a rugged laptop, the 11.5-lb (5-kg) Condor UAV relayed live video footage from its 'webcam'-style zoom camera to an air support operations centre and JTACs in position to call in close-air support.

Compatible with ROVER – the US Army's Remotely Operated Video Enhanced Receiver – the Condor UAV travelled at speeds of up to 50 mph and needed to be recharged after an hour of operational use.

Directed by an integrated map at the operational base station, the Condor systems demonstrated automatic VTOL capabilities and landed within 7-15 ft (2.1-4.6 m) of its target landing site when required.

The exercise saw commanders using Condor to identify enemy positions on and around buildings, as well as targeting and combat rescue missions. Audible below 1,000 ft, the Condor travelled up to 3,000 ft above the target area before relaying real-time imagery to the operations room. The exercise included simulations of enemy forces trying to shoot down the UAV unsuccessfully.

A Swiper UAV was used for overwatch of the target area in order to provide detailed enemy locations or visible IED positions.

system but "physics" (the need for more than one camera, altitude capability and engine availability) drove DARPA towards a larger machine.

With control of the MAV capable of being handed to different ground control stations, the UAV can be passed from unit to unit on the ground as and when required. Newman believes this trend will prove popular in the future as a smaller number of airframes are allied with more ground control stations in order to reduce the number of UAVs in the skies at any time.

"The future benefits of unmanned systems are tremendous. VTOL and fixed-wing UAVs create a wide range of opportunity for 'dirty and dangerous' operations," Newman states.

"VTOLs can operate safely near soldiers and structures and are no more complex than fixed-wing UAVs, although they are less reliable than helicopters."

## Ultra-lightweight

In collaboration with MicroPropulsion Corporation, AeroVironment and Lockheed Martin Advanced Technology Laboratories, DARPA's Nano Air Vehicle (NAV) programme comprises an ultra-lightweight system with 7.5 cm wingspan, weighing less than 10 g.

However, DARPA's NAV project, which has been running for six months, has a promising future, according to Newman.

"The programme will explore novel, bio-inspired, conventional and unconventional configurations to provide the warfighter with unprecedented capability for urban mission operations," Newman continues.

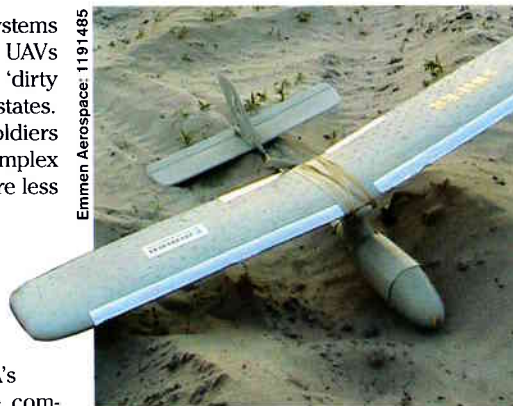
Meanwhile, AeroVironment is developing a remote-controlled NAV designed to look like a living creature such as a dragonfly. Its NAV design will use flapping-wing propulsion from an all-electric powertrain that is intended to propel the vehicle at 20 mph in dash mode and slow it down to 1 mph for precision navigation inside buildings. The vehicle will be designed to hover as well.

Northrop Grumman's HURT (Heterogeneous Unmanned Reconnaissance Team) system, also managed by DARPA, is designed to allow ground troops to receive video

surveillance imagery of enemy positions and targets in a portable touch-screen format.

Automatically processing multiple requests and directing suitable air assets for the task, HURT recently completed its third demonstration at Fort Hunter Liggett, California. Tests proved that HURT could use three tier combinations of manned and unmanned aircraft (ranging from 100 ft to 6,000 ft above the target area) to send essential tactical data in real time to soldiers with ruggedised hand-held computers.

Emmen Aerospace: 119 1485



Emmen Aerospace's Swiper UAV was also used in Exercise 'Atlantic Strike V'.

Aircraft used included the C-12, ScanEagle and Hunter, Pointer, Raven and Wasp UAVs.

However, Frank Schneider, the German-based chairman of the NATO Research Task Group for military applications for UGVs and chairman of European Robotics, warns that world infantries are already overloaded with equipment and may not be able to carry UAV systems.

"In France and Germany, there is no space in their armoured vehicles for such equipment. The Boxer vehicle has no space to squeeze in anything. Even if a unit has UAVs, the infantry cannot carry them," Schneider says.

He tells *Jane's* that a number of unnamed interested parties are looking at operating small UAVs within the confines of a building, but refers to the importance of having

a cover man for the operator, who cannot protect himself while operating the UAV.

The problem of operating UAVs within a building, according to Schneider, is one of situational awareness. With limited views from cameras, how do you know if the enemy is behind the UAV and what picture do you really get from a UAV in a building, he asks.

"How well a UAV operates inside a building is situation-dependent. In a non-collapsed building on the ground floor, UGVs have a slight advantage over UAVs. It would be more workload to fly a UAV than operate a UGV," Schneider states.

It would be better to use a UAV for stationary observation on the corner of the roof and transmit a live feed if a target moves from that location, he continues.

Schneider foresees a combination of UAVs and UGVs working together, especially in an interoperable communications environment. He confirms that the NATO working group is looking into communications between the two systems. "There is no uniformity for communications protocol between UAVs and UGVs," says Schneider, describing how a German UAV is unable to exchange data with US assets. Meanwhile, he expresses his desire for a NATO standard for Common Interface Protocol. "I expect a first draft in two years but we will be lucky to see it completed within five years," he warns.

Operations of UAVs in MOUT scenarios need to be made faster too, Schneider states, with aviation authorities needing to grant permission for UAVs to operate above an altitude of 30 m.

"Users expect SR capability with UAVs to be quick and provide a fast picture, but three hours is too long. By then, you could be out of the scenario you were in," criticises Schneider. He also believes some UAVs require too many personnel to get it in the air. "Some medium UAVs need 15 people to get them airborne. This negates the advantages you get from a UAV by introducing too many other variables," he warns.

**RELATED ARTICLE @janes.com**

● Mini UAVs - the next small thing, [idr.janes.com](http://idr.janes.com), 10.05.05

**Innovative Solutions for Surveillance and Reconnaissance**

Air/Ground/Maritime

*Turning Vision into Reality*



[www.contron.com](http://www.contron.com)

Please visit us at  
AUVSI 2007  
Unmanned Systems,  
August 6-9, in  
Washington, DC.



