**UNMANNED VEHICLES**

Leading on from the previous section, the major progress in the world of unmanned air vehicles (UAVs) continues to threaten the future of manned aircraft. In particular, Dr Norman Friedman wonders whether, as the cost of JSF escalates, it will not even last to become the last manned attack bomber. He makes the case for the unmanned combat air vehicle (UCAV) and says that they will cost far less than manned aircraft.

Professor Keith Hayward concludes that Europe will have to play catch-up with a vengeance if it is to match the versatility and depth of commitment to UAV development shown by the US and others. But the military UAV market is largely dependent on the civil UAV market, as the CEO of the Canadian Centre for Unmanned Vehicle Systems points out. However, UAV platforms take the lion's share of development, but it is the sensors and sensor integration which is of greater moment, as Steve Roberts points out.

So much for the air. Unmanned ground vehicles will be discussed in the October issue, but in this one Keith Henderson examines the benefits of unmanned surface vessels which include surveillance, on-site automated analysis, vessel tracking and signature recognition.

# UCAVs: A New Kind of Air Power?

*by **Dr Norman Friedman***

*Norman Friedman is an internationally known strategist and naval historian, writing and lecturing widely on strategy, design and weapons. He will be publishing a book on UCAVs later this year. In this article, he discusses the automation of warfare, the need for an onboard pilot, and the economics of UCAVs.*

We often read about the use of unmanned but armed aircraft in the skies over Afghanistan and Iraq. Is this a specialised but limited extension of the Air Power with which we are familiar, or is it something new, something which may transform our traditional view of combat aviation? Clearly there is a widespread suspicion that at some point unmanned aircraft will supersede most manned ones. Many writers have, rightly or wrongly, referred to the Joint Strike Fighter (JSF) as the last manned attack airplane. As the cost of JSF escalates, some may wonder whether it will not even last to become the last manned attack bomber. A few years ago the British government, which has shown only limited interest in maintaining a conventional aviation industry, decided that unmanned aircraft were a strategic opportunity too vital to miss, and in the process financed a number of futuristic projects. They include the Taranis high-performance unmanned combat air vehicle (UCAV), in effect an unmanned strike airplane. The US Navy is about to test X-47B, intended as a demonstration carrier-based unmanned attack bomber.

UCAVs in current service are relatively slow long-endurance aircraft carrying limited numbers of guided weapons. Their greatest virtue is their endurance; they can loiter for hours, waiting for some human target to turn up. Once it does, the operator can lock on the weapon and attack. In effect the UCAV is a kind of sniper; like a sniper, it is intended to achieve a major impact by destroying a key enemy leader. Slow UCAVs have been effective in places like Afghanistan because they live in a very permissive environment. Presumably they would not survive for long in the face of any sort of air defence. They also tend to be direct extensions of manned aircraft. For example, when the Royal Air Force operated Reaper UCAVs over Afghanistan, each had a pilot assigned to it. The pilots might be far away (at a US air base in Nevada, in this case), but like all pilots they had to fly constantly to hone their skills. Perhaps the greatest virtue of the UCAV was that operating it over enemy territory did not risk the loss of a pilot. On the other hand, pilot fatigue must have been a factor during long UCAV missions.

Existing UCAVs, such as Reaper, gain their long endurance from their low performance. Higher-performance UCAVs must have much the same fuel endurance as a jet, but they need not cope with pilot fatigue. There are several current US programmes to demonstrate air-to-air refuelling of jet UCAVs. Results to date have been quite successful. If these programmes succeed as

expected, the limit on UCAV endurance will be parts reliability and, presumably, the supply of lubricants. It will then be possible for UCAVs to loiter for extended periods within range of possible targets, awaiting the command to attack – much as the current Tactical Tomahawk cruise missile loiters awaiting orders. The ability to maintain an air presence on a sustained basis far from a base would seem to have very interesting tactical potential. Pilot fatigue would make it impossible to provide manned aircraft with a similar potential.

### The Pilot's Contribution

The RAF's Reapers may be the model for future UCAV operations, but UCAVs may have a wider and more revolutionary potential. One way to understand this potential is to ask what the pilot contributes to an air operation. Obviously human initiative and creativity have a vital role in any military operation; the question is how and where they should best be used. Pilots only very rarely identify the targets they strike, and the less obvious the targets, the rarer the chance pilots have to recognise them as they fly in. More and more, targets are identified at data fusion centres or at intelligence centres. Pilots are sent to deliver their weapons, often GPS-guided, to coordinates provided to them. As a consequence, pilots sometimes cannot even see what they attack. The results are not always gratifying – the unfortunate US attack on the Chinese embassy in Belgrade was a case in point – but the process is inescapable. It is also the reason why modern strike aircraft are survivable at all in the face of sophisticated air defences. In the case of the UCAVs flying over Afghanistan, the target may be visible, but only because the UCAV is flying at such low speed that it would not survive serious air defence. Moreover, understanding that, say, a particular vehicle is the valid target (because it is believed to contain a particular human target) comes not from the pilot but from the source of intelligence. The human judgement that matters is made at the intelligence centre, not the pilot, level.

Aircraft have been key to ground warfare for a long time. If we imagine that UCAVs will change the rules, then first we have to ask exactly how aircraft contribute. Our own attack aircraft strike important targets, and other aircraft drive off the enemy's attack aircraft. The ability to identify targets by their coordinates so precisely that a weapon can be guided into those coordinates is new and revolutionary.

To the extent that it works, the place of the human in the system seems to have changed dramatically. The important judgement is now made at a data fusion or intelligence centre – or, alternatively, by a forward observer aware of how the dynamics of a battle have made a particular target temporarily important. In a world of precision-guided weapons, the pilot's role seems to reduce to making certain that the weapon is brought to the release point. The airplane is reduced to being the reuseable first stage of the guided air-to-surface weapon. However, unlike a guided weapon, a human pilot is subject to fatigue.

It will be objected that the description above omits an important class of attack missions: armed reconnaissance. For example, in Afghanistan the Taliban do not spend their time announcing their presence and inviting attack from the air. However, they are likely to fire at airplanes, particularly since they must fear air attack. Thus airplanes flying over Afghanistan can, in theory, identify targets when they are fired upon, and usefully return that fire. Unfortunately, not all ground fire encountered in Afghanistan is hostile. Afghans often fire into the air to celebrate, for example at a wedding. Friendly forces may conduct live-fire training. In theory, neither activity should cause problems with armed reconnaissance, because maps of no-fire zones are created and kept up-to-date.

Again, in theory a pilot should have to obtain clearance to attack, consulting those monitoring the situation. However, targets are always transient. Friendlies are attacked. A pilot who feels he is under fire may well fire back because he feels the situation is urgent. He is unlikely to have sufficient situational awareness to match the position on the ground with the map he saw at the morning briefing. That is best done in a data fusion or intelligence centre. It is, moreover, much easier for someone at that kind of centre to decide directly whether or not to attack than to have the pilot consult the centre indirectly.

### Eliminating the Onboard Pilot

Perhaps the appropriate future for attack aviation is to eliminate the pilot altogether. The key decision is whether and when to drop a weapon. If, as in the past, the great bulk of targets are designated before an airplane takes off, then in such cases there seems little point in placing a human onboard the airplane simply to insure that the airplane actually gets to the target area. Experience suggests that a UCAV can navigate there perfectly adequately. It may take a human to make sure that the UCAV does not get into trouble in airspace used by manned airplanes, but even then the human may not have to be aboard the vehicle; a lot of work has been done in recent years to develop collision avoidance for unmanned vehicles.

Most of the time much the same might be said for aircraft engaged in air-to-air combat. Pilots rarely have the time to identify their targets visually, which means that they rarely have the opportunity to inject their unique decision-making skills into air-to-air combat. The single great exception is air defence in difficult circumstances short of war, in which the key decision is whether to engage at all. It is the only case in which no data up-linked from the ground can possibly be good enough, and in which even the slight delay entailed in remote decision-making might not be tolerable.

For the rest of the time, the man onboard the airplane may well be in the wrong place, lacking the sort of information which decision-makers on the ground have. In that case it may be time to begin replacing attack aircraft and even fighters with their unmanned counterparts. Moreover, economics may soon be forcing us in that direction.

### UCAV Economics

The designer of a manned airplane clearly pays extra to keep a pilot alive, but it may be argued that unmanned flight can involve large expenditures on novel software which makes the unmanned airplane as autonomous as possible. The RAF may have liked to fly each Reaper separately, but surely the future lies with UCAVs capable of flying themselves along pre-planned routes to a target. Autonomous operation requires that the UCAV have at least some reflexes, to keep it from flying into a mountain or into the ground, for example. The software and hardware may perhaps cost as much as the life support system onboard a manned airplane. Imagine, then, that a high-performance UCAV costs about as much as a manned airplane.

What matters is not the single airplane, but the system of which it is a part. That system includes pilots and their training. Not only must pilots fly first-line airplanes as part of their training, they must fly constantly to remain proficient. Simulators apparently cannot provide anything like the same training. We often compare air forces based on how many hundred hours, on average, pilots fly each year, because we rightly equate pilot competence to such proficiency flying.

Again, how can we evaluate the air warfare system? The desired output is a given number of sorties; we might qualify that by some kind of evaluation of the effectiveness achieved on each sortie (which brings us back to proficiency flying). In effect, every flight hour is backed by X training hours using the same kind of airplane. Those X training hours impose the same sort of wear and tear that combat flying does (or at least they should impose it). Pilots actually fly relatively few combat hours, compared to training hours. The key to UCAV economics is that they may fly *only* on combat missions. Of course, that need not be true. Those RAF pilots in Nevada had to be trained to fly their Reapers; remote-control flying is nonetheless real flying. They needed live Reapers to fly on exercises.

### UCAVs and Cruise Missiles

However, UCAVs can be autonomous. They can fly themselves to their targets. They can autonomously release their weapons as planned, or they can act semi-autonomously and request new commands. For example, a UCAV forced off its planned path might request a new planned flight path – which still would not entail having a pilot control it directly. In the case of sniper UCAVs (as in Afghanistan), they can go to an assigned area and then begin sending back video to await the order to fire. There is now operational evidence, incidentally, that UCAVs operated autonomously are more reliable than those with human pilots, perhaps because the latter do not gain sufficient experience to fly them properly.

Making a UCAV autonomous emphasises its relationship to an existing class of unmanned weapons – cruise missiles. A re-targetable missile such as Tactical Tomahawk is not very different from a UCAV, except that it does not return for reuse. Because such missiles are not reuseable, no one would imagine buying large numbers for training. We do buy a considerable amount of test equipment, because we want to be sure that the missile will take off when the key is turned, but we are also compelled to buy considerable test equipment for airplanes.

Analysis suggests that much more than half the lifetime cost of a fleet of combat aircraft goes into training, including proficiency flying – including the cost of dedicated training aircraft.

The same amount would buy a great deal more combat flying by UCAVs or, alternatively, the cost of aircraft as a fraction of overall defence spending might be cut dramatically. For example, the ship cost of an aircraft carrier itself is less than half of the total system cost, the bulk of the ship's cost being her air wing. The carrier matters not because of the pilots, but because it is an excellent way to provide tactical Air Power where it is needed. Anything which makes it more efficient is probably well worthwhile. As it is, a carrier is the most efficient way to provide naval firepower against shore targets, simply because her magazines can easily be refilled and her aircraft are reuseable. The vertical and canister launchers which enable surface warships to strike land targets generally cannot be replenished at sea, whereas weapons can easily be transferred horizontally to a carrier. The carrier also benefits from her sheer size, which offers more volume into which weapons can be loaded.

### The Automation of Warfare

All of this may seem to be advocacy of an unpleasant form of robot warfare. In fact, it is in line with a trend going back centuries, in which warfare has gradually been automated. The connection with cruise missiles rather than with manned aircraft makes that obvious; cruise missiles are nothing new. A UCAV is a more efficient cruise missile. From their beginnings, missiles were seen as alternatives to piloted aircraft, but long-range types were limited by their sheer cost. Their payloads were limited because the missile itself had to be limited in size, and it flew a one-way mission.

An airplane-size UCAV is a different proposition. Moving pilots out of airplanes tends to emphasise the role of the user of air services, rather than the provider. This way of looking at air operations suggests that Air Power is largely an enabler for other operations, on land and sea, rather than a stand-alone form of power.

That was universally understood before the demonstrations of strategic bombing in the Second World War. No modern air force can mount the sorts of operations that were common in 1943-45; although their performance is much better, airplanes are far too few. Maybe it is time to go back to the earlier understanding, that land or sea operations were impossible without the assistance of aircraft, but also that aircraft by themselves were unlikely to be decisive in war. In the UCAV world, that is obvious when, for example, the US Army operates its Warrior UCAVs on an autonomous basis. ■