Integrating remotely piloted air systems

Wing Commander Gordon Melville speaks to **Martin Temperley** about how remotely piloted air systems are heavily reliant on people, and explains that the pilot training is as rigorous as for manned aircraft

▲ A prototype unmanned combat aircraft system, Taranis, named after the Celtic god of thunder, was unveiled by the MoD on 12 July 2010

The Royal Air Force is undergoing the process of strengthening its force of remotely piloted air systems (RPAS), having formed its second operating unit, No 13 Squadron, in October 2012 at RAF Waddington in Lincolnshire. The Waddington squadron is remotely operating Reaper MQ-9 air vehicles flown from a base at Kandahar in Afghanistan.

Five more Reapers are now being delivered to join the fleet of five Reapers that have been acquired since 2007, and operated by No 39 Squadron. The primary role for the RAF Reaper force has been persistent theatre-wide surveillance, vital for the support of British and NATO ground forces in Afghanistan, where they have operated alongside RAF Tornado aircraft. The opportunity was taken in May 2008 to arm the Reapers with laser-guided GBU-12 bombs and Hellfire missiles. Both of these systems are classed as precision-guided weapons. Reaper's maximum weapon load is four Hellfire missiles and two GBU-12 bombs carried under the wings.

The RAF can claim to be the leading European air force for RPAS operations, and its operational experience is considerable, approaching 50,000 hours in Afghanistan. This high number of hours accumulated by a relatively small number of aircraft reflects the main operational strength of RPAS. Compared with aircraft flown by crews in the cockpit, they possess tremendous operational persistence.

▲ A Grob Tutor over Lincolnshire. UK RAF RPAS pilots have to complete full elementary training on the Tutor before qualifying as RPAS pilots

A single Reaper air vehicle has the ability to maintain observation over long periods, with exceptional endurance and unhindered by crew fatigue factors.

Although it is possible to trace the history of RPAS back by more than half a century to the operation of radio-controlled converted aircraft for airborne target purposes and later for reconnaissance, the modern generation of RPAS dates to around 1994, when forerunners of Reaper were deployed by the US over the Bosnian war zone and later over Kosovo. Now, a range of RPAS systems are operated by a number of European NATO nations, including France and Germany, sometimes by an army with tactical systems in support of land forces (as with the British Army and its Watchkeeper system). RPAS systems have been developed, purchased off the shelf or leased. In many cases, a major impetus behind RPAS acquisition for many operators has been the Afghanistan campaign, which started in 2001. As well as the RAF, the US Air Force and the Italian Air Force fly MQ-9s.

Learning from the Americans

From the start, the RAF worked closely with the US Air Force on the development of its RPAS capability. The key milestone was the creation of RAF No 1115 Flight starting in 2004 at Creech Air Force Base, Nevada. Some 45 British tri-service personnel were assigned to Creech, and they trained in UAV operations and tactics on US Air Force-owned MQ-1 Predators, a smaller, earlier version of Reaper powered by a piston engine. Experience was gained by the RAF in operations in Iraq and in early operations in Afghanistan. These Predators were never owned by the RAF, but No 1115 Flight became 'A' Flight of No 39 Squadron when it was reformed in January 2007, and 'B' Flight of No 39 Squadron received the General Atomics MQ-9 Reaper in 2007 to fulfil an urgent operational requirement. It was just 15 months between the drafting of the requirement and the arrival of the RAF Reaper in Afghanistan. With the establishment of No 13 Squadron, the number of Ground Control Stations will grow to seven. The Reapers were procured specifically for the Afghanistan operation, and the air vehicles have since been operated exclusively over Afghanistan.

Terminology has evolved over time. UAV – unmanned aerial vehicle – was once applied to the Reaper, but this fell short of an accurate description because the aircraft are anything but unmanned, being flown by highly trained crews on the ground, and it does not cover the existence of other components in the system. UAS – unmanned air system – was an improvement because it recognises

that a system is at work, but it fails to acknowledge the role of people. RPAS – remotely piloted air system – is now the preferred descriptor, used by the RAF, the United Nations Commission and the International Civil Aviation Organization.

Regardless of nomenclature, RPAS have generated considerable controversy over the past 10 years, mostly based on questions of control and responsibility and the suggestion that they operate as unsupervised 'drones' – a notion that RAF officers and Ministry of Defence (MoD) officials take great care to dispel. RAF Wing Commander Gordon Melville, of Air Staff Strategy, Intelligence Surveillance Reconnaissance at the MoD, says that the air vehicle is merely an element within a system, together with the Ground Control Station, but he emphasises: "People are the most important part of the system, people are the system. Reapers are flown by a crew of three at the Ground Control Station: pilot, sensor operator and a mission analyst." Supervised and scrutinised, the crews are subject to rigorous and meticulous weapons release procedures and the Reaper is under positive control at all times. "If a particular mission is better covered by other platforms such as a Tornado or an Apache helicopter, if those assets are better placed and considering the merits of the attack, then they may be deployed instead," says Wing Commander Melville.

During operations, the RPAS crews have access to experienced supervisors and, if required, the expertise of lawyers. RAF Reapers were specifically acquired for operations inside Afghanistan and do not fly over neighbouring nations. Three year-long tours of operation are typical for RAF RPAS crews and experience has been built up rapidly.

Training the RPAS pilots

The first generation of RAF Reaper pilots were trained pilots coming either from fast-jet backgrounds or from transport aircraft and helicopters. In December 2012, the RAF announced that a specialised flying branch for RPAS would be established, and in April 2013 the first four pilots to graduate under the scheme were awarded their wings at a ceremony at Creech Air Force Base. RPAS pilots have to complete full elementary pilot training on the Grob Tutor aircraft before four months of specialised RPAS training. The RPAS sensor operator's training is equally rigorous.

A word about the Reaper itself. The General Atomics Aeronautical Systems Inc GA-ASI MQ-9 is made entirely from carbon-fibre composites, with a rear-mounted Honeywell turboprop engine powering a pusher propeller. It possesses a long endurance, with the ability to stay airborne for more than 16 hours depending on payload, and has the ability to fly at altitudes up to 50,000 ft. Reaper is described as a medium-to-high altitude, long-endurance system, having a long-span wing of 66 ft and weighing under five tons at take-off loaded with fuel and weapons.

All RAF Reapers carry powerful built-in Lynx radar, which can provide images to photographic quality, and which can operate through cloud and smoke and in darkness. It works at long ranges and covers large areas of territory, and also operates in Ground Moving Target Indicator mode, which means that objects moving on the ground can be detected as they occur, in real time. This might be ground vehicles moving to mount an ambush, or a team at work planting improvised explosive devices.

Gathering imagery and cross-cueing

A second set of sensors is carried in the rotating turret under the front fuselage, enabling a closer look. This is the Raytheon multi-spectral targeting sensor suite, which gathers images and can project a laser marker onto targets to be attacked if required. Imagery is provided by an infrared (IR) sensor, a daylight TV and an image-intensified TV camera. The video from each of the imaging sensors can be viewed as separate video streams or fused with the IR sensor video. This process is known as fusion. A laser rangefinder or designator provides the capability to precisely designate targets for the guidance of laser-guided munitions, such as the GBU-12 bomb or the Hellfire missile, which can be the Reaper's own weapons or those launched from other platforms.

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The Reaper MQ-9, despite its wide wingspan and pusher configuration, is in many respects a conventional and simple airframe, having unswept wings and a propeller-turbine engine, and being designed for a top speed of no more than 250 knots, (just less than 300 mph). It is particularly well-suited to stability operations in the support of British and NATO forces in Afghanistan. In this theatre it has not been opposed by advanced surface-to-air missiles, or by fighter aircraft, and no enemy radars or advanced sensors have probed the skies to detect it. Air warfare specialists describe this as 'RPAS in uncontested airspace'. Any operations of RPAS in contested, highly hostile air environments are recognised as being a quite different proposition.

Former Chief of the Air Staff, the RAF's top-ranking position, Air Chief Marshal Sir Stephen Dalton GCB, acknowledged this, saying: "We must be absolutely

▲ A pilot from the RAF's No 39 Squadron remotely controls a Reaper MQ-9 RPAS during a training sortie over the west coast of America from Creech Air Force Base

clear that RPAS have weaknesses... they are relatively slow, vulnerable and inflexible. This means that the RAF must employ them to complement our Typhoon and Lightning combat ISTAR (intelligence, surveillance, target acquisition, reconnaissance) capability, not replace it entirely." All the signs are the RAF will not become an all-RPAS force in the foreseeable future, but in the words of the former Chief of the Air Staff, "the RAF will remain in the vanguard of RPAS tactics... My judgement is that if technology continues to develop as we expect, it will be possible to move to a mix of about one-third remotely based ISTAR platforms to two-thirds manned in the post-2030 era."

It is possible that a future air vehicle could be a straightforward successor to Reaper, or a more highly developed combat air vehicle, employing stealth, agility and speed. Such a design would be sleeker than Reaper, with less span and more propulsive power. Its fuselage contours and wings would possibly be blended to reduce radar reflectivity.

Taranis – a technology demonstrator

A pointer may lie in the shape of Taranis, an air vehicle built by BAE Systems for a first flight in 2013. Described as a technology demonstrator for a combat RPAS, this has the potential to offer high performance with multi-role capability, combining intelligence-gathering and attack capability. The contractor says the aim of the Taranis is to see if a stealthy RPAS capable of striking targets with real precision at a long range is possible. The Taranis will help make decisions on the future mix of RPAS and conventionally manned aircraft.

The UK and France signed an accord covering future RPAS for both nations in 2010 and aero-engine makers Rolls-Royce and Snecma have since agreed to jointly study future combat aircraft propulsion, with the possibility of a new turbine engine for RPAS.

The routine sight of an RAF RPAS in the skies over the UK, flying from UK bases, whether for training or in the course of deployment, is still some years away. So far, operations of large RPAS are mostly restricted to government-owned gunnery and missile test areas, in remote areas, or over water. RPAS cannot yet be flown in controlled airspace. Most authorities predict that this will at least require the development of advanced technologies to enable RPAS to 'sense and avoid' other aircraft and also technology to give the air vehicle a high degree of decision-making together with exceptional levels of independence and reliability. In the UK, progress in this direction has been made. The British Civil Aviation Authority in 2011 extended an overland corridor of airspace for RPAS testing in west Wales. At the same time, a British industrial group called ASTRAEA (Airborne Systems Technology Related Airborne Evaluation and Assessment), comprising seven leading aerospace companies, has completed a five-year research programme that was intended to promote the wider use of remotely piloted air systems, exploring the technical challenges involved.

There is no doubt that the RAF will continue to employ RPAS platforms in the future. And, whatever technical and operational advances emerge, the RAF will undoubtedly be eager to adopt them. ●