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Next-Gen Hawk

TRAINING TO FIGHT

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Mark Broadbent reports from RAF Valley on how the Royal Air Force's new Hawk T2s are providing a quantum leap in fast-jet training

All images Paul Heasman unless otherwise stated

The Hawk is so familiar in Royal Air Force service it may seem unworthy of attention. No longer. At RAF Valley in North Wales, the home of UK fast-jet pilot training, there is now in service the next generation of the long-lived BAE Systems advanced jet trainer – the Hawk T2, which is significantly changing the training of RAF and Royal Navy combat pilots.

Background

The fast-jet pilot of today flying an aircraft with an advanced cockpit is a manager of systems, expected to comfortably handle and interact with large amounts of information about his or her aircraft, mission and wider battlespace. Countries have realised they need to update their fast-jet training to prepare their pilots more effectively for these demands.

The UK was no different. With the wide gap between the analogue cockpits of the 30-year-old Hawk T1s used for fast-jet training at Valley and the sophistication of the Typhoon, Tornado GR4 and now-retired Harrier, the Ministry of Defence (MoD) recognised it had to act. Although the T1, with its sports-car handling and sparkling performance, was still giving sterling service, it was far removed from the technologies pilots encountered when leaving Valley on postings to the Typhoon, Tornado and Harrier Operational Conversion Units (OCUs).

In response, the MoD in July 2003 selected the BAE Systems Hawk Mk128 AJT (Advanced Jet Trainer), with its modern glass cockpit, as its preferred successor to the T1. A design and development contract followed in December 2004 before BAE Systems was

1 Students and instructor pilots walk to their awaiting Hawk T2s on the flight line at RAF Valley. **2** Pilots and lineys (the colloquial term for a flight line operative) conduct flying control checks. **3** A student pilot prepares to get in the cockpit as his liney looks on. *Paul Ridgway* **4** Panoramic view of the full motion simulator display. **5** The Hawk T2 full mission simulator. *Paul Ridgway* **6** The instructor operating station for the Hawk T2 full mission simulator. **7** Ascent lineys pull Hawk T2 ZK026/'Q' onto the flight line. *Paul Ridgway*

awarded a contract in October 2006 to supply 28 Hawk AJTs – to be designated in service as the Hawk T2.

UKMFTS

There had meanwhile emerged a new philosophy about UK military flying training. In November 2006 the MoD put out to tender its UK Military Flying Training System (UKMFTS) project. This ambitious outsourcing programme aimed to revolutionise the provision of training through a Public-Private Partnership (PPP) between the MoD and a private company. Key objectives were to reduce the cost of flying training to the taxpayer and modernise training with new aircraft, infrastructure and learning equipment.

Following a competitive process, the MoD in June 2008 awarded Ascent Flight Training a 25-year contract to be its 'Training Systems Partner' in UKMFTS. Ascent, a 50/50 joint venture between Lockheed Martin and Babcock International, was given responsibility for acquiring new training aircraft, designing and managing revised syllabi and providing new infrastructure and ground-based training tools across all areas of military flying training – elementary, basic, fast-jet, multi-engine, rear-crew and rotary-wing. Subsequently, Ascent established a facility near the MoD's Abbey Wood complex in Bristol where it could work directly alongside the RAF and civil servants from Defence Equipment and Support (DE&S). Underlining the partnership, the entire management structure is mirrored at every level, with a combined board comprising a one-star Director Flying Training from the RAF and equivalent senior directors from DE&S and Ascent.

New Infrastructure

The urgent need to modernise fast-jet training was one reason why it was chosen as the first element of flying training to be revolutionised by UKMFTS. With the MoD having purchased the Hawk from BAE under a separate procurement contract (BAE Systems is not part of UKMFTS), the focus of Ascent's work on modernising fast-jet training was the acquisition of the new ground-based training tools and preparation of the supporting infrastructure.

Alongside DE&S and the RAF, Ascent worked on the development of modern Ground Based Training Equipment (GBTE). This consisted of three layers of simulated training – desk top trainers (DTT), flight training devices (FTDs) and full mission simulators (FMS), the DTTs and FTDs being supplied by Lockheed Martin and the FMS by CAE. Ascent worked on the design of the self-contained facility that would form the new home of training at Valley – housing the GBTE, classrooms with videos and interactive smart-boards, the 28 Hawks and engineering support. Ascent also recruited Qualified Instructors (QIs), who in instructing on the GBTE would work directly alongside RAF and RN Qualified Flying Instructors (QFIs). The QIs consisted entirely of ex-military pilots, all with experience working as QFIs at Valley and on the front line.

All this activity underscored the principles of UKMFTS – the private sector not only providing investment in equipment, facilities and people the MoD would find hard to finance itself, but also the concept of civilian contractors working alongside military personnel under the same roof to provide tuition to students, rather than being contractors in a separate building. The new building was handed over to Ascent on November 1, 2010. It was later named the Moran Building, after the late Air Marshal Sir Christopher Moran who had died shortly after inspecting its construction in his capacity as Commander-in-Chief of Air Command.

Paralleling this work, Ascent and the RAF were building the syllabus and courseware for students and instructors while BAE Systems was working with DE&S on developing software that would form an important part of the new Hawk. This work began in June 2008 and evolved over two years into the Operational Capability 2 (OC2) package the Hawk features now. Meanwhile the first Hawks were delivered from the factory, an initial batch of jets arriving at Valley in mid-2009, with the fleet building over subsequent months.

The activity at Valley was centred around the historic No.19(R) Squadron, which was responsible for providing tactical weapons training on the T1 with initial conversion and fast-jet basics being taught by sister unit No.208(R) Squadron. In November 2011, 19(R) was disbanded and renumbered No.IV(R) Squadron, the famous ex-Harrier unit that celebrated its centenary in 2012. The ex-19(R) Hawk T1s moved across to join the 208(R) pool of aircraft, leaving the shiny new Hawk T2s finished with IV(R)'s distinctive red, black and yellow markings. Following the delivery of all 28 Hawk T2s and full GBTE commissioning, the first group of QFIs started training in January 2012. The first course of six students began training on April 2, a second course starting shortly afterwards. They will graduate this spring as the first UKMFTS-trained fast-jet pilots.

So, just what changes are the next-gen Hawk, the new GBTE and ultimately the public-private nature of UKMFTS bringing to UK fast-jet training?

New Aircraft

Pete Thomson, BAE's Engineering New Business Manager, explained to *AIR International* that the T2 was not just designed on a blank sheet of paper. The Hawk has been significantly developed over the past 20 years with the Hawk 100 and 200 series variants and Thomson says the "constant evolution" with the progressive developments of Hawk Mk127s for the Royal Australian Air Force, Hawk Mk120s for the South African Air Force and Hawk Mk129s for the Bahrain Defence Forces was very important in feeding into the T2's design.

There are not many visual differences between the T1 and T2 – a longer nose, wingtip rails and a re-shaped tail. However, make no mistake: this is a completely new jet. "The canopy and the airbrake are the only shared components between the T1 and T2, but even those components have undergone material change," Thomson said. "The fatigue life for T1 has gone up from a 6,000 to a 10,000-hour design life."

This led to some important structural changes including new, strengthened wings and tailplane, fin and rudder, undercarriage and nose wheel steering. The wing was also redesigned to improve aerodynamic performance and to accommodate more weapons hard points. The fuel tank size was increased, bird strike protection around the nose and canopy improved, a brake parachute and in-flight refuelling probe added and the aircraft equipped with new health and usage monitoring systems.

There is a new Rolls-Royce Adour Mk951 engine featuring full authority digital engine

control (FADEC), which at 6,500lb/29kN thrust is more powerful than the T1's 5,200lb/23kN. The Mk951 also boasts an improved time between overhaul (4,500 hours), which Thomson says "is a significant improvement" in enhancing the Hawk's serviceability and, therefore, availability for the RAF.
The new Adour has introduced the only major difference between the T2 and the T1 from a pure flying perspective. BAE test pilot Andy Blythe told *AIR International:* "The engine is very efficient; it never surges, it spools up quicker and it feels sportier… at the end of the runway or when you're doing touch-and-goes in the circuit the engine is far more responsive."

Apart from that, Blythe said the T2's overall aerodynamic performance is so similar to the T1 that differences are "imperceptible". He added: "As far as its handling characteristics are concerned, it hasn't changed much. Fundamentally it's still very easy to fly. It's that classic analogy, 'if it's not broken, don't fix it'. The one step-change aerodynamically is combat flap. On the T1 you can have half flap or full flap; in the T2 combat flap gives you an extra 12 degrees of flap which you can use in an air combat phase – meaning you can have the flaps down at 300-350kts, which gives you a better margin."

The Course

Together the advanced new cockpit in the Hawk and the ground synthetics are significant modernisations of training equipment, so it's hardly surprising the IV(R) Squadron course is, in numerous respects, very different from that taught on the T1.

Take initial ground school. Traditionally students arriving at Valley would spend six weeks having lessons. They still do, but instead of spending time with their heads in textbooks, the DTTs, video and smart-boards mean the tuition provided by Ascent's QIs is now fully interactive. Al Shinner explained: "We might have 20 minutes of pure technical lecture but the DTT means we've got a full working cockpit on their desks, so they can spend the last ten minutes learning it. In the past you'd have three weeks of really dry material and then have to apply it. Now we're trying to do that as we go and build the learning in an integrated environment."

Front cockpit of the Hawk T2.
Paul Ridgway

ADVANCED COCKPIT

The really critical differences between the T1 and T2 are under the skin. The contrast between the cockpits in each aircraft is stark. The T1's dials and gauges are a thing of the past. The T2 has an all-digital glass cockpit featuring three full-colour multi-function displays (MFDs), a head-up display (HUD) and hands-on-throttle-and-stick (HOTAS) controls. MFDs, HUD and HOTAS were first developed for the Hawk in the 1990s on the 100/200 series variants for overseas customers. Pete Thomson says the cockpit developed for the Royal Australian Air Force's Mk127s "was the real genesis" of the design for the RAF's aircraft. This reflects how the Hawk's continual evolution influenced the T2's development.
The MFDs present a full range of information including communications, navigation and a digital moving map, with key information also presented on the HUD. The HOTAS provides intuitive controls on the throttle and stick for pilots to manage their avionics. Other innovations include a ground proximity warning system (GPWS), inertial GPS navigation and, in a first for an advanced jet trainer, a traffic collision and avoidance system (TCAS).
It's all a long way from the T1's map, compass and stopwatch. "In car terms, the T1 is like an old MGB – very basic, great fun but lots of dials and pressures – and the T2 is like a modern sports car," commented former Jaguar pilot Wg Cdr Kevin Marsh, the current Officer Commanding IV(R) Squadron. "It looks quite daunting with three screens and hundreds of pages of data, but actually it's simpler. Rather than having to monitor pressures and temperatures the jet looks after itself and will tell you if something is at fault."
So far, so modern. But the really clever part of the new Hawk is its embedded simulation and emulation technologies which, to quote BAE Systems, are "capable of turning the skies into a hypothetical frontline warzone". The aircraft features a 1553MB data link which generates synthetic, or simulated, threats in the form of hostile radars, aircraft and weapons and allows a pilot to respond to those threats by 'releasing' its own synthetic defensive aids and missiles (the T2 doesn't carry live weapons, though the aircraft is wired to do so). The information about radar, weapons and defensive aids is displayed on the HUD and MFD pages, which the pilot can manage with the HOTAS controls.
Pete Thomson was part of the joint BAE/DE&S design team that developed these simulation and emulation capabilities for the T2. He recalls that the RAF from the outset wanted a very sophisticated system. The specific challenges were "the amount of data we had to process" and "making sure the simulated data actually reflected real sensors and equipment and to make it look as realistic as possible".
So how were these challenges overcome? Thomson explained the process started with a 'requirements capture' that identified exactly what the RAF wanted the cockpit systems to do. He said the responses to those requirements were formulated and prototype systems developed. These were then tested individually and together to make sure they would work in the final product. This preceded the systems being matured over time to create OC2. Underlining the partnership nature of the T2 project, the RAF and DE&S worked fully alongside BAE during every step in this process. "The requirements from the RAF were very specific and we worked very hard and very closely with them which was tremendously beneficial," Thomson recalled. "It was a good team to work for and understand requirements at a detailed level."
The hard work paid off. The Hawk T2 has brought frontline systems into the fast-jet training world where they simply didn't exist before. In replicating a frontline cockpit in layout, feel and operation – it is near-identical to that of the Typhoon – the T2 has therefore bridged the gap that's grown in recent years between the cockpits pilots trained with at Valley on the T1 and what they found on postings to frontline OCUs.

Rear cockpit displays of the Hawk T2.

There is a good reason for this building-block process. "The T2 is a systems aircraft," Shinner said. "Until you understand where the systems are, how all the menus interact, you can't even start the aircraft." The DTTs are therefore critical in helping students get to grips with understanding HUD symbology, using the HOTAS and operating the MFDs. There are at least 20 functions on the throttle and another 20 on the stick alone. During each lesson students are taught how to manage the myriad of pages using the MFD soft keys and HOTAS controls. "They need to start learning how to use their hands to operate the systems," Shinner said. "You don't want to be thinking about that in the air. Everything you can practise on the ground frees your capacity to perform key tasks in the air." The students' laptops have an invaluable function here. Being able to dock them with the DTTs means students can directly feed the lessons into their individual learning, writing their own notes and looking back through video tutorials in their own time to build 'muscle memory' in operating the cockpit.

After ground school, students move through a number of phases, split between IV(R) Squadron's A and B Flights. Arriving first on A Flight they start with a 'convex' (conversion exercise) phase learning the basics of fast-jet flying before progressing through phases on instrument flying, navigation (at high, medium and low level), formation flying and tactical low-level battle formation flying. This is followed by a range phase (involving low/medium-level bombing, dive/loft bombing, dive-strafing, smart weapon delivery and off-range tactical flying) and finally an introductory air combat phase of 1 v 1 basic fighter manoeuvres (BFM). There are solos at the end of each of these phases.

Students then move to B Flight where they progress to learning frontline tactics and procedures. Sqn Ldr Rob Caine, who's in charge of flying standards and staff training on IV(R) Squadron, told *AIR International:* "By the time the students have completed A Flight they will be competent fast-jet pilots with the capability to employ air-to-ground weapons and 1 v 1 BFM. B Fight will stretch them into OCU and frontline-style flying. The emphasis is on Typhoon air defence mixed with Tornado GR4 close air support."

The demanding B Flight syllabus comprises the following phases: basic radar with Typhoon-style 1 v 1 beyond visual range (BVR) engagements involving radar warning receiver operation; advanced medium-range and short-range air-to-air missiles (AMRAAMs and ASRAAMs) and countermeasures, culminating in 1 v 1 BFM; advanced radar encompassing 2 v 1 BVR engagements developing into 2 v 1 air combat; operational training manoeuvres (OTM) at medium and low-level; advanced frontline interdiction; close air support; 2 v 1 evasion/operational manoeuvres; and, lastly, a 2 v 1 self-escort phase.

The structure of the teaching in all these phases has changed significantly from the past because of the new GBTE. Rather than having a discrete block of simulator training in between ground school and flying for real, each phase – and its individual elements – now has a combination of simulated and real flying ('synthetic events' and 'live events', to use the course-speak).

Looking in more detail at some of the phases shows how this works. The convex phase on A Flight, for instance, comprises 12 elements including circuits, handling, maximum performance manoeuvres (formerly aerobatics), stalling, spinning, emergencies, flapless approaches and some initial instrument flying. Each of these elements is now taught initially using the FTDs with tuition from Ascent QIs before a sortie in the FMS and then a 'live event' with a QFI. So, for example, initial circuit flying is taught synthetically on the FTDs and in the FMS before a student and instructor fly circuits for real. The student then goes onto the next element, working on the synthetics first before progressing onto a real flight. Ex-Tornado F3 pilot Flt Lt Stefan Brown, one of the RAF QFIs on A Flight, said: "It's expected that each student will be able to do it synthetically before they fly it for real. By then the idea is that they just do it with the minimum amount of assistance from us." At the time of *AIR International's* visit, the first course was about to start the low-level bombing element of the range phase on A Flight. The students were working with the Ascent QIs and the QFIs on the basics of low-level attack profiles, using the FTDs to practise managing the MFDs, HOTAS and HUD for that purpose. This would be followed by students undertaking a full mission rehearsal in the FMS before going on a live sortie.

Such are the capacities of the synthetics that some elements of the course are actually taught completely on the ground using FTDs and the FMS – a big change from students having to fly virtually everything on the T1. An example is basic radar operation, as Shinner explained: "All the instructional points are based around the MFDs and

1 Hawk T2 ZK026/'Q' lifts off the runway at RAF Valley. **2** Hawk T2 ZK031 seen at low level in the Mach loop in northern Wales. *Paul Ridgway* **3** The new Moran building was purpose-built for the Hawk T2 at RAF Valley. *Paul Ridgway*

the operation of the simulated air-to-air radar. The flying is fairly benign, so most of this phase is taught in the GBTE." Equally, however, Shinner emphasised that "we don't pretend the GBTE is good for everything". Several elements are undertaken in the air with little synthetic involvement because there simply isn't a substitute for doing it for real. As Wg Cdr Marsh observed, "doing it at five or six g, the adrenaline pumping, looking over your shoulder" still matters.

The rationale of blending synthetics and live flying throughout the course goes back to the T2 being a systems aircraft. Wg Cdr Marsh said that with so much involved in operating the MFDs, HOTAS and HUD it simply "makes commonsense" for students to spend time working synthetically at each stage to build confidence and avoid being swamped. Here again, the laptops are invaluable. There is detailed courseware for each element of each phase, whether students are preparing to fly synthetically or for real. For instance, one of the early A Flight convex sorties contains seven pages of material on the trip's aims and objectives. Students can look at video tutorials to see how to operate the MFDs and HUD for that trip. They are able – and expected – to prepare fully for everything.

However, Wg Cdr Marsh pointed out that, despite the differences to the T1 course, students would not spend less time flying than their predecessors. "There is no reduction in flying hours, we've just upped the simulation," he said. No.IV(R) Squadron students will spend approximately 120 hours flying the Hawk T2 – pretty much the same as it's been on the T1 for years.

Realism

And those at Valley say the hours students spend in the air will be far more effective than before. Being able to generate synthetic radars, aircraft and weapons has led to the most important change in the provision of fast-jet training at Valley – the ability to set up realistic combat scenarios. Looking at parts of the syllabus in more detail reveals exactly how revolutionary the simulation and emulation is in the context of fast-jet training.

During the 1 v 1/basic radar and 2 v 1/advanced radar phases early on B Flight, the software allows hostile aircraft, radars and AMRAAMs/ASRAAMs to be generated which lock onto the student. The threats can be set up to behave exactly as they would for real – the synthetic aircraft threats can be designated as a MiG-29 or Su-27, for example. The student's radar shows up 'spots' and 'spikes' on the MFD and HUD when it's being targeted by radars or missiles – just as it would for real. The student must respond with synthetic defensive aids (chaff/flares) and missiles. If they don't respond, or get hit, a message flashes up on the MFD telling them they've been killed. During the operational training manoeuvres phase, synthetic ground radars and surface-to-air missile (SAM) batteries lock onto the student, forcing them to use countermeasures. The interdiction phase allows students to 'drop' simulated Paveway IV laser-guided bombs and practise time sensitive targeting. The 2 v1 evasion/operational phase forces students to self-defend using evasive manoeuvres, electronic warfare techniques and countermeasures. The end of the course is a self-escort composite sortie combining all these skills – fighting BVR on the way to a target against a radar and missile equipped aircraft, undertaking an attack using smart weapons amid radar and SAM threats and fighting out again against more aircraft.

Quite simply, this is a world away from the T1. The new equipment allows IV(R) Squadron to provide what Sqn Ldr Caine describes as "a demanding environment within which students can learn their trade". Indeed, much of the B Flight syllabus – including the basic and advanced radar, the operational training manoeuvres, interdiction and 2 v 1 escort – contains completely new elements to fast-jet training at Valley. Their introduction has been made possible purely because of the new software. On 1 v 1 and 2 v 1 air combat manoeuvres on the T1, students never had radar and missile locks to deal with which flash up on MFDs and HUD in exactly the same way as on the front line. In the close air support phase on the T1, ground radars and SAMs never locked onto them, nor could they practise 'dropping' a Paveway or use their own missiles and countermeasures. All of this is now possible. And if the instructor feels a student is coping well with these demands, they can turn up the heat even more. The independent wiring of the Hawk's front and rear cockpits enables an instructor, by pressing the 'R' button on their MFDs, to separate their cockpit and, in Wg Cdr Marsh's words, "start manipulating things" such as generating threats the student isn't expecting.

This is the value of the new Hawk. Students are receiving realistic combat training – they are threatened and must act to survive. To all intents and purposes they're not flying a Hawk but doing it for real in a Typhoon or Tornado. Valley's students, then, are no longer simply learning the basics of air combat and weaponeering but frontline procedures and tactics too. "The result should be a highly-

HAWK T2 SPECIFICATIONS AND PERFORMANCE

Length: *12.43m (40ft 9in)*

Wingspan: *9.94m (32ft 7in)*

Height: *3.98m (13ft 1in)*

Wing area: *16.70m² (179.64ft²)*

Wheel track: *3.47m (11ft 5in)*

Max Take-Off Weight:
9,100kg (20,062lb)

Empty Weight:
4,570kg (10,075lb)

Max Payload:
3,000kg (6,614lb)

Max Internal Fuel:
355 imp gal (1,613 litres)

Max External Fuel:
Two under-wing tanks 26 imp gal (1,182 litres)

1 centreline tank:
100 imp gal (454 litres)

Powerplant:
One 29kN (6,500lb) Rolls-Royce/ Turbomeca Adour Mk951

***Max Level Speed** (sea level):*
560kts/Mach 0.8

Maximum Mach Speed:
Mach 1.2

Data courtesy BAE Systems

1

2

3

1 Routine maintenance under way inside No.IV(R) Squadron's hangar, which is part of the Moran building at RAF Valley. *Paul Ridgway* 2 Hawk T2 ZK022/'M' sits on jacks during routine maintenance. *Paul Ridgway* 3 Night time ops.

trained single-seat pilot capable of managing fourth and fifth-generation aircraft in multi-role missions with advanced sensors, weapons and countermeasures," said Sqn Ldr Caine.

He added that, crucially, students are also gaining cognitive abilities – the skill sets required to manage the interplay of communications, radar, weapons and countermeasures using MFD pages, HOTAS and HUD in the pressure of combat. That's what pilots flying complex modern fast jets have to do and the Hawk T2 exposes them to this. Wg Cdr Marsh said: "There's no radar in the aircraft, it's just a data link – just noughts and ones – but for the student it's real. Traditionally, training aircraft have been exactly that – pure training. Although we don't carry live weapons, from day-one we're teaching people how to use a weapons platform."

This realism manifests itself in other ways on the course. The terminology used in the courseware mirrors that of the modern frontline types, preparing students for what they'll encounter when they move to the OCUs. Aerobatics are no longer taught to students in the form they were. The justification for aerobatics is that they help build confidence in an aircraft, which is probably still true, but with flying frontline jets like the Typhoon really being about managing systems it's now considered more effective to teach manoeuvres that can be used in a fight. Wg Cdr Marsh explained: "We don't do aerobatics anymore, we do combat manoeuvres. We're still teaching the edge of the envelope but in a manner [students] can use operationally. They still do looping, rolling, spinning, low speed, high speed, but it's about manoeuvring the aircraft in a way so you can kill your opponent or not be killed yourself."

Debriefing

A further innovation is the mission debriefing equipment. Each FTD, FMS and real Hawk sortie is recorded, the latter using the 'data brick' removed from the jet after landing. Missions can be played back in their entirety, with every aspect of a flight available for analysis. The course flown (in 2D or 3D), the moving maps, the MFD screen and HOTAS selections, the HUD symbology, communications (external as well as cockpit voices) and more can all be reviewed – with forward and backward playback at either 1x or 20x speed and freeze-framing possible so a mission can be viewed in second-by-second detail. Trips are time-stamped so instructors and students can select specific events from any point of the sortie.

This level of detail enables instructors to see exactly what the student did at any point – whether they flew over the correct waypoints, the selections they made on the MFDs and HOTAS, their HUD symbology, radar scans they selected, radio calls they made, their selections of combat flap and weapons, trigger presses, the dispensing of defensive aids, the relative speeds during air combat and even aspects (angles of attack, release heights and speeds) of weapons launched. Flt Lt Brown said: "We can assess them going down the range, stopping it at the moment they pressed the pickle-button and check whether the bomb would have been good and whether they recovered properly. We can measure the exact distance of a missile shot so we can see whether that would have been a valid air-to-air kill or not. We can assess things properly. It's fantastic and there is no hiding!"

Drilling down into this level of detail and being able to freeze the trip at any point is revolutionary in several ways. Besides being equipment fast-jet students simply haven't had before, and giving instructors greater insight into their students' progress, the students can see what they did right or wrong and take away practical points to help their learning. There's also a less obvious cultural change. Wg Cdr Marsh said: "As a student you used to go flying and the guy in the back seat or in the other aeroplane told you what you did. There were certain things that were black and white, but a lot of it was subjective as to what the instructor saw." The debriefing equipment removes subjectivity, as Flt Lt Brown explained: "We can get to the bottom of anything if there's a different perception of what happened between an instructor and a student. I might say: 'Well you did this,' and the student might say: 'No, I don't think I did.' Telling the student their perception was wrong, or vice versa, by proving it is the only way."

In this sense there's more interaction between students and instructors than previously. A by-product of this is that students are now, according to those at Valley, much more questioning than they ever were. Noting that students here now have wings (which, in contrast to years past, are awarded on completion of basic fast-jet training on the Tucano at RAF Linton-on-Ouse rather than at the end of their time at Valley), Wg Cdr Marsh said: "The guys who come through here now have a bit of confidence about them." This means they are more inclined to question their instructors. That isn't to suggest the lines between instructors and students are blurring ("we know our places", said Wg Cdr Marsh) but rather to observe that the traditional instructor-student relationship is now subtly different because of the new debriefing technology. Equally, however, Wg Cdr Marsh said the new kit means "the instructors have to be on top of their game; our guys have had to step up".

There's little doubt the year students spend on No.IV(R) Squadron is intense. Indeed, with the amount they must learn to operate the Hawk's systems, the intensity of the course, the realism generated by the emulation and the freeze-frame detail of the debriefing, fast-jet training is arguably tougher than ever. "A lot is expected of them, but there are no excuses when you've got the facilities they have here," Flt Lt Brown said.

This intensity is by design. "Up to now, flying training has been 'fluffy'," said Al Shinner. "The focus has been on learning to fly in a controlled school environment. When they get to the front line, there's a lot less direct supervision and they need to stand up for themselves, much like progressing from school to college and then out into the work environment." Wg Cdr Marsh echoed this point, saying: "What we're trying to do is to teach people to be single-seat pilots in an extremely complicated aircraft whether it's the Typhoon or, in future, the F-35. Those guys have to be able to operate on their own and work at a very high level. It's important that we can start instilling that here so they start learning for themselves rather than being spoon-fed." Just as much as the skill sets and cognitive capacities to operate frontline systems, the new technology allows No.IV(R) Squadron to teach an operational mindset.

Progress

With two courses now running, how is the new world of fast-jet training bedding down? Since Valley is the flagship for UKMFTS there's interest in how the new relationship of military and private contractor working alongside each other in the same building is working out. Wg Cdr Marsh said: "We're in a contracted world but we've built a team. No matter whom you work for – Ascent, RAF, DE&S – you're all part of the squadron. It's very important for the students to see that civilian personnel are wearing the same squadron badges. It's the classic 'who do you work for?'

It doesn't matter, because 'I'm doing the same job as everyone else'. I'm really proud of that."

Speaking separately, Shinner agreed: "As far as I'm concerned, my staff are fully integrated into a military flying squadron and are treated as being a flight on that squadron. The Central Flying School assesses all of my staff and awards them a Competent to Instruct categorisation. In UKMFTS, whether students are in the GBTE, the classroom or they're flying, they have the same standard of instruction, assessment strategy, discipline and regulations. It's a full integration."

Things are still progressing. "This is a brand new concept and we're all learning. We sit with the RAF weekly and discuss what we're doing," Shinner said. "The students' progress on all our courses and the way in which they have responded to the new syllabus and courseware is being constantly reviewed. Changes to the order of events and the precise mix of synthetic and live training will be made if necessary. Finding the optimal balance is key. We will continually adjust our courses over this 25-year programme. Right now only the second course is under way."

How are students coping with the demands of the course? Shinner admitted "there was a concern about whether we'd set the level of learning at the right speed given the amount and intensity of the course". However, he said: "To be honest, the students in the early parts of this course are doing better than the students still running on the T1 [some students are still completing their training on the T1 on No.208(R) Squadron while No.IV(R) Squadron gets fully up to speed]. Even basic things like instrument flying are more difficult in this aircraft because there is more to do, but with the GBTE the students are better prepared. This has greatly reduced the re-fly and failure rates of the airborne sorties in comparison to training previously."

Flt Lt Brown said that with self-study periods in the DTTs and FTDs available, students "spend hours practising and playing with the avionics and learning what everything does". He added that No.IV(R) Squadron expects to lose fewer students than has traditionally been the case on courses at Valley. Students are also taking the synthetics in their stride, possibly because the equipment brings out intuitive skills acquired while growing up playing with computer games. "The Xbox generation thing stands true. These guys are used to using their hands and handling the throttle and stick," Flt Lt Brown observed. "They're prepared for it and they learn very quickly. They know how to manipulate the avionics because it makes sense to them, though part of it is good design."

More broadly, there is a feeling at Valley that the Hawk is doing what it was purchased to do. Wg Cdr Marsh said: "The T2 takes us back to when training and front-line aircraft were aligned [as in the 1970s/1980s when the T1 was aligned to front-line analogue cockpits]. There's no gap between the students finishing and going on to the front line. Indeed, we're actually overlapping. The high-end sorties the guys are doing here are of equivalent difficulty and procedure to what the guys at the end of the Typhoon OCU are doing today."

This leads into another important aspect of the T2 – its potential to save the MoD money. With the T1's limitations meaning students never handled MFDs, HUD and HOTAS let alone operated them in combat scenarios, OCU courses have over the years become lengthier as cockpit complexity has increased. Pilots don't become combat-ready until four to six months into their frontline posting after the OCU. With the capabilities of the new equipment meaning No.IV(R) Squadron can now teach the initial elements of OCUs, students leaving Valley should have more advanced skills in operating frontline cockpits than before. Ascent's and the RAF's expectation is that OCUs will be able to spend less time on the basics and more on teaching advanced tactics and procedures. In turn, it's hoped that pilots will become combat-ready on the OCU prior to a frontline posting. By bringing everything forward the theory is that expensive frontline aircraft will in future spend far less time on training tasks, thereby reducing operating costs (the Hawk T2's hourly operating cost is a tenth of Typhoon's).

Paul Ridgway

Ascent and the RAF admit this ultimate benefit can only be judged when the first T2-trained students arrive on their OCUs this year. But they insist there is real potential for significant cost savings. BAE believes the T2 also offers potential savings in the refresher training role. With the simulation and emulation capacities there is the possibility that pilots returning to the front line could undertake some of their refresher electronic warfare training, for instance, on the Hawk rather than at the OCU. "The jet is extremely capable. It's one of those situations where they [the RAF] have probably got more than they've asked for. The world's their oyster," observed Andy Blythe. Of course, decisions about whether the Hawk will be used in this way are down to the RAF.

Engineering

The Hawk T2 should also bring cost savings in the important area of engineering. The new Hawks are maintained at Valley by Babcock, which was sub-contracted to fulfill this role by BAE Systems – BAE was awarded an in service support (ISS) contract by the MoD to provide maintenance and rectification for the T2s (Ascent is not part of this contract).

A crucial new part of the T2 from an engineering perspective is on-site diagnostic and rectification capabilities. In contrast to the T1, if problems occur they can be investigated at Valley using the new diagnostic equipment. Rectification work, if it's required, can also be undertaken on-base rather than parts being removed and shipped back to the manufacturer. This minimises downtime, which directly impacts not only on aircraft availability but also on the cost of operation. As with the previous Hawk, the T2 airframe is largely metallic which, according to Pete Thomson, makes it "easy to repair and maintain". These support considerations are important factors in training aircraft contracts. "It's all about value and availability… the key is to make the maintenance and through-life costs as low as possible," he added.

But have the new Hawk's more complex systems made it more challenging to maintain than the T1? Thomson says not: "Overall it's easier. We do have more complex systems on the aircraft now. However, they are all designed with maintenance requirements in mind. The avionics maintenance has vastly increased, but it's all been designed to be user-friendly and easy to achieve." He added that BAE would continue to "introduce product enhancements to make maintenance easier".

Future

Even though the T2 is still in its early days of RAF service, attention is already turning to the future. With further capability enhancements for the Typhoon and the arrival of the F-35 scheduled for later this decade set to bring an era of ever-more advanced – and demanding – sensors, radar and smart targeting and weapons, there is real focus on how to exploit further the Hawk's capabilities. "We're looking now to the F-35 and finding out what exactly that means for us," said Wg Cdr Marsh. "I have no doubt there will be certain skills you'll need to be an F-35 pilot that you won't need to be a Typhoon pilot, or vice versa, so we may have to change our syllabus." The

SYNTHETICS

Alongside the new Hawk's cockpit, another important innovation is the synthetic training capabilities of the ground-based desk top trainers (DTT), flight training devices and full mission simulators (FMS). Although T1 students used simulators, this equipment provides more comprehensive synthetic training. It uses the same OC2 software and mission computers as in the Hawk T2's cockpit to ensure a seamless integration between the two.

The ten DTTs are desktop computers that display a fully-functioning T2 cockpit, in a similar way to a very high-end consumer flight simulator. The students dock their personal laptops (which they receive on arrival at Valley and which hold their syllabus and courseware, including video tutorials) with the DTTs and their flying controls. Using the touch screen, students can activate any button in the cockpit, the idea being that they learn to operate the MFDs, HUD and HOTAS by doing so. The six FTDs offer a step up in realism, constituting a fully-representative T2 cockpit for practising checks and procedures and rehearsing missions covering the majority of UK airspace and airfields.

Lastly, two FMSs use 360° domed visual projection in front of, around and above a fully-representative cockpit. "Everything is exactly as in the aircraft, apart from the fact that the HUD is projected onto the screen," explained Al Shinner, Ascent's Station Manager and a former Tornado F3 pilot and Hawk T1 QFI, who heads the Ascent side of the partnership at Valley. Missions can be flown with one or multiple aircraft, at day or night and in all weathers. As in the Hawk's cockpit, synthetic radar, aircraft and weapons can be generated, enabling a student to practise what they're going to do for real. "This is as good a flight simulator for any fast jet anywhere in the world," Shinner said. "When ETPS [Empire Test Pilot School] at Boscombe Down sent a test pilot here he said it was the first sim he'd been in where it felt like he was flying the aircraft. Here you feel the take-off and the landing, you see and feel the weather, accelerations and even the brake chute deploying." Having witnessed a brief 'sortie' in the sim, AIR International can testify to the impressive graphics. Think Google Earth but fully-immersive and in considerably greater resolution – right down to the crests on waves and moving wind-turbine blades.

Cockpit set-up of the Hawk T2 flying training device.

Flying training devices offer a step up in realism, constituting a fully-representative T2 cockpit for practising checks and procedures, and rehearsing missions covering the majority of UK airspace and airfields.

1 The two-ship formation breaks up as one plane peels off in dramatic style. **2** View through the head-up display during a night time sortie.

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contract between the MoD and Ascent allows for changes to be made to the software architecture, courseware and GBTE.

One potential impact of the F-35 on the T2 fleet may be the emergence of common training standards between the RAF and the other F-35 customers, two of which – Canada and Australia – are also Hawk 100-series operators. Wg Cdr Marsh said: "We are starting to work together with the other F-35 nations, especially those who've got the Hawk, to come up with a common [training] requirement. That's going in parallel with those guys designing the F-35 syllabus."

This leads back to that all-important area of the Hawk's software. If the RAF wants to update the aircraft's simulation and emulation capabilities to reflect new technologies arriving with the F-35 – or updates to the Typhoon and Tornado – with it being just a data link, then that's possible. "Because the jet doesn't have real radar, any obsolescence issues have been removed. If some new, clever techniques come out in the future, all we have to do is update the software," explained Andy Blythe. In other words, the T2 is future-proofed – because it's only the software that needs updating, changes can be made without having to resort to costly hardware replacement. Blythe said "there are sketches out there for OC3 and OC4, the next couple of iterations" to the software, though no development contracts have yet been awarded.

This future evolution of the T2 may not just stem from the UK's requirements. With other countries' defence budgets under remorseless pressure, it's hardly beyond plausibility that Hawk operators could look at pooling their future investments in the aircraft to make cost savings. According to Blythe, this is something BAE is trying to encourage its customers to do. The fact that some F-35 customers operate the Hawk would make such partnerships even more natural. Also coming into play is the desire of some countries operating older Hawk 100-series aircraft to update their cockpits. In this regard, it's interesting that the Royal Australian Air Force signed a contract with BAE last summer for the upgrade of their Mk127s to bring them into line with the RAF's T2s.

The ways in which the T2 will evolve in light of any such co-operation, the development of the Typhoon and the arrival of the F-35 are all for the future. Right now, Wg Cdr Marsh said the RAF's view is that the Hawk T2 has already "changed the face of flying training in the UK".

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