BREAKING GROUND

Jon Lake takes a look at the latest development of the European fighter

Even as Squadron Leader Matt Elliott entertains the crowd at Farnborough with his energetic display in the Eurofighter Typhoon, BAE test pilots are this week continuing the work that will see the aircraft gaining a real frontline air-to-ground capability during 2008.

Though the Typhoon has frequently been described as a pure air-to-air fighter, to which an air-to-ground capability was belatedly added, this has never been the case. Typhoon was always intended to be a swing-role fighter-bomber.

But because air to ground capabilities did not form part of the initial priorities of the partner air forces, there was no pressure for an early exploitation of the aircraft's latent ability to deliver air-to-ground weapons.

Germany and Italy were always content to wait for these capabilities until Tranche 2 aircraft were delivered, when a full day/night all-weather precision attack capability will be available.

Austere

Britain and Spain had an interim requirement for a basic LGB capability on the aircraft, however, and the UK decided to bring forward what was called an 'austere air-to-ground capability' in aircraft delivered at the end of Tranche 1, using the Litening 3 laser designator and Paveway II laser guided bombs.

This austere capability is said to represent "80% of the final planned LGB capability", albeit with less flexibility and higher pilot workload. EF GmbH sources insist, however, that "even this will compare well with the Jaguar in workload and capability terms."

By comparison with the full LDP capability planned for Tranche 2 aircraft, the austere air-to-ground capability will allow manual attacks against planned single targets only, in the forward hemisphere, using the head down display. The full LDP integration will allow multi-target attacks in a single pass, and will be more highly automated and integrated with the helmet.

Crucially, the definitive LDP solution will allow an aircraft to engage air-to-air targets even while prosecuting an attack, while the austere capability will allow no air-to-air capability during the actual attack.

While this may seem a relatively modest capability, Eurofighter is confident that it represents a huge improvement over any existing RAF fast jet, day/night, all-weather precision attack capability, and that it will deliver a particularly impressive and new swing-role capability.

The UK austere air-to-ground capability is covered by a change proposal, delivered to the customer on 12 May 2006. There has been some delay in achieving a contract signature, due to what EF GmbH sources called 'cost allocation' issues, but industry has been continuing with development and engineering work 'at risk' and using some advance funding.

Weapons

Typhoon air-to-ground weapons testing began quietly in June 1999, and flying began in 2004. More recently, with the testing of the Phase 5 air-to-ground flight control software, air-to-ground weapons testing entered a new phase, and from February 2006, six aircraft in all four partner nations began working towards a suite of initial air-to-ground weapons clearances.

Test aircraft IPA3 at Manching, Germany was used for under-wing load tests carrying four 1,000lb UK Paveway II LGBs, full air-to-air weapons and three external fuel tanks. The aircraft was then used for supersonic tests, and was scheduled to fly with the LDP in August.

In Spain, where much of the earliest air-to-ground work was undertaken, EADS CASA's IPA4 undertook a number of drops of the 1,000lb GBU-16 laser-guided bomb.

Here in the UK, IPA1 has been used for clearances of the 1,000lb UK Paveway II LGB, flying with a load of six bombs and a single fuel tank. The aircraft has now cleared the whole subsonic envelope with air-to-ground loads, and has even undertaken air-to-air refuelling while carrying six Paveways.

IPA 1 successfully released the first UK Paveway II bomb on 29 June 2006, jettisoning the store over the Aberporth range at 450kt (830km/h) and an altitude of 15,000ft (4,500m) in straight and level flight. The aircraft made three drops in three days, and the latest weapon release is scheduled this week.

Also at Warton, development aircraft DA2, the only test aircraft to be flown with an antispin gantry, is being used for carefree handling tests, and envelope expansion with asymmetric loads, and will fly this week with a single 2,000lb Paveway under one wing. This represents the 'worst case' asymmetry.

Eurofighter helmet with looks that can kill

The Eurofighter Typhoon test team at Warton is now regularly flying the new avionics Mk 1 helmet version of the aircraft's head equipment assembly (HEA), which some believe represents the most advanced helmet mounted display system currently being flown.

By the beginning of July, BAE test pilots Mark Bowman and Will Jonas had each flown with the helmet three times, and were enthusiastic about the capabilities offered.

"It's much more than just a head-up display (HUD) in your line of sight," Jonas says. "My impression is that we are ahead of the game, especially in the way in which we can see tracks from the radar and sensors.

"Even as you taxi out, the real world position of radar tracks can be displayed in the visor, so that you can see exactly where they are, even though they may be far beyond visual range, and all without having to interpret a radar display."

The HEA brings together an array of advanced technologies and systems in a single integrated operational helmet, providing flight reference data and weapon

aiming and steering cues through the pilot's visor, allowing him to maintain situational awareness without having to refer to the head-down displays or HUD.

The HEA also incorporates a highly accurate optical head tracking system (HTS) which tells the aircraft system exactly where the pilot is looking, with better than 1° of accuracy at all viewing angles. This allows the Typhoon pilot to slave weapons and sensors to high off-boresight angles, and to keep a target in his eyeline and designate it (using voice commands) even for an 'over the shoulder' missile shot.

Though technologically advanced, the helmet is light, well balanced and exceptionally comfortable and stable, with air-cooled temperature control. "It feels exactly like a normal helmet," says Jonas, "with no weight issues, and with the centre of gravity in exactly the right place."

The helmet's tough shell, blast visor, and secure fastening provide blast protection at up to 600kt (1,100km/h), while the helmet is fully compatible with modern aircrew NBC (Nuclear Biological Chemical) protection systems and respirators, and the visor provides laser protection.

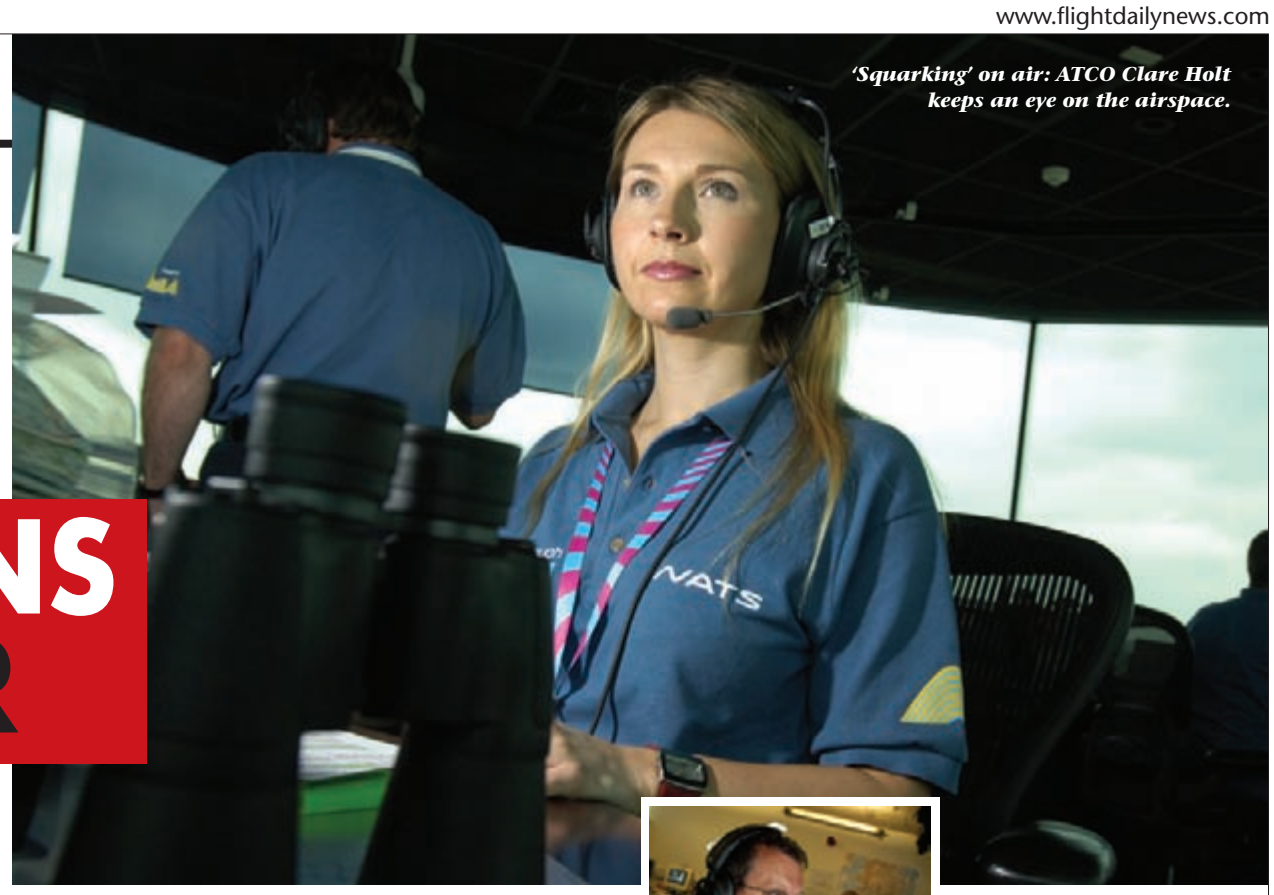
The mask allows positive pressure breathing for high g manoeuvres, while incorporating a direct voice input (DVI) compatible microphone, while the built-in earphones provide a high degree of attenuation of external noise.

The full standard HEA will combine flight and targeting symbology with the picture provided by the fully overlapped wide (40°) field of view cathode ray tube (CRT) displays.

FOCUS ON ATC

For a fortnight every two years, operations at Farnborough airport are transformed as the National Air Traffic Services controllers handle flights for one of the largest aerospace events in the world. *Joe O'Shea* reports

GUARDIANS OF THE AIR



'Squarking' on air: ATCO Clare Holt keeps an eye on the airspace.

In an average week, the executive airfield at Farnborough handles around 400 flights. But for two weeks in July, the control tower has to cope with more than 2,000 flights as civil and military suppliers showcase their latest technology. Welcome to Farnborough's international airshow, this year in its 45th iteration.

With an additional 1,000 helicopter flights at a temporary heliport on the east of the airfield, the challenge for the National Air Traffic Services (NATS) team is to co-ordinate so many movements and provide safe passage for some of the world's most impressive aircraft.

NATS Farnborough general manager Sarah Lee says: "During display fortnight, we can expect to have at least 2,000 movements, so it is a lot more pressure for the team because of the sheer volume of traffic." The arrival and departure of numerous executive, military and display aircraft form just part of schedule managed by the NATS team during show fortnight. Every display routine has to be validated by the Flight Control Committee prior to the opening of the show.

That is no easy feat, especially when the airspace over and around Farnborough is busy with flights to and from Heathrow, Gatwick, Luton and Southampton airports, not to mention smaller airfields nearby such as Blackbushe.

Discussions

Lee says: "We spend a year discussing the airshow with the airfields around us so that they can fly freely without impact on Farnborough.

"We have a special agreement that, during the display week, we have a chunk of airspace above Farnborough up to 7,000ft (3,000m) that we borrow from Heathrow controllers. They have special routes that they use for departures that allow Heathrow to carry on as normal, in such a way that allows Farnborough to operate safely." The air traffic control (ATC) facilities at Farnborough are more than equipped to cope with the larger volume of traffic, following a multi-million pound redevelopment since TAG Aviation took over the airfield.

After a year in construction, the new 36m tower opened in November 2002 and was first used for an airshow in 2004.

With tinted, self-cleaning glass, state-or-the-art technology and a number of internal CCTV cameras for security, the silver-soundproofed tower stands out as a beacon alongside the main strip.

It is a far cry from a bygone era at Farnborough, when the show was principally a military exhibition co-ordinated from a small 10m control tower at the north of the airfield.

Sarah says: "It's a more central location and the height of the tower gives much better visibility. We can see so much more than we used to in a clean and clear environment with all new facilities."

During normal operations, the new ATC facilities are manned by 15-18 controllers and seven assistants on a roster, but they boost the number to 37 during show fortnight.

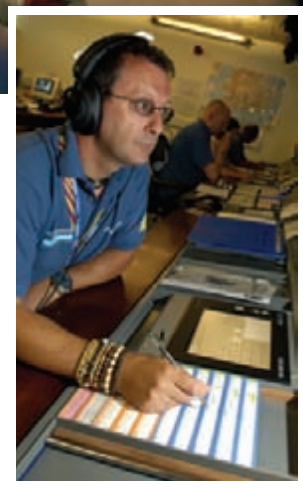
Sarah says nobody is allowed annual leave during an airshow, so all staff are available. "We also borrow from other NATS centres. We have seven additional controllers to operate the heliport during the main display week and seven extra assistants to help in the control tower and air operations centre where the display pilots book their flights."

While in a normal week the tower operates with one ATC and one assistant, during the show there are six people on the tower at all times, spending a maximum of 2h in a position to stay alert.

Permission

The ATC controls departures and arrivals and monitors the display frequency to clear the pilots for take-off. Beside him sits the ground controller who co-ordinates all ground movements and gives permission for all pilots to start their engines.

The VCR co-ordinator makes sure everything runs according to plan and updates everybody on the schedules and display order.



Deputy watch manager Harry Douglas in the approach room.

Also in the tower during the show are three NATS assistants. One monitors flight data strips while the other two carry out Met office observations providing two detailed reports each hour on real time weather conditions including wind speed, temperature and air pressure.

For many NATS staff, airshow fortnight is a calendar highlight.

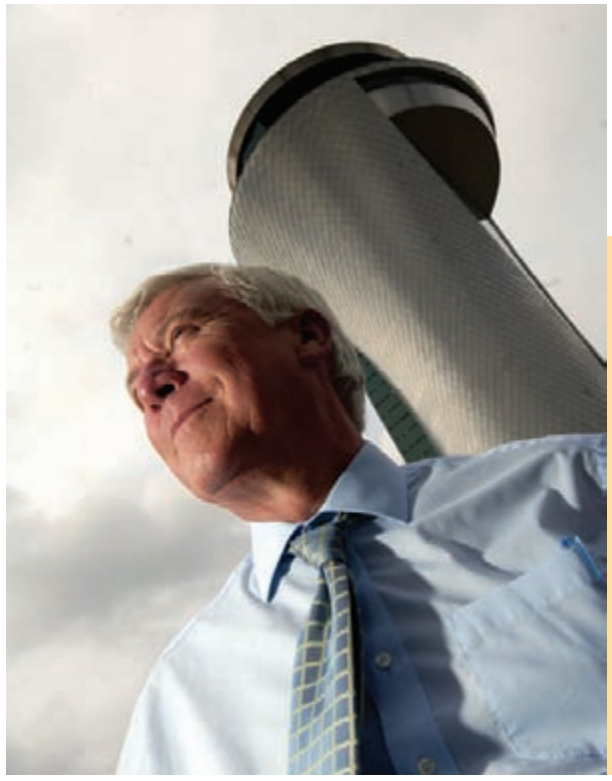
Clare Holt is an ATC officer (ATCO) in C watch, which operates in the tower. She qualified last year and is now enjoying her first show.

"The people who are on their 10th show have seen most of it before, but I've been really excited and couldn't wait for it to start. There's a real camaraderie in the team and they pass on any relevant experience which might help," she says.

"During the show we have to follow the same rules and standard separations we normally follow, but for example with the arrival of the Airbus A380 we have to maintain a 10 mile separation in the final approach."

At the foot of the tower sits the approach room, housing a digital system that gives an overview of the south-east of England, through the primary radar on site at Farnborough, and a secondary feed from Heathrow airport.

The approach room monitors a restricted area 10km around the control tower, which is only responsible for the area 2.5km around the tower. Each aircraft is tracked by its identification or 'squark' code and its route is fed to the tower.



Safety first in the flying battles to impress

If anyone knows how those magnificent men (and women) in their flying machines are feeling this afternoon it's Colin Hague, flight director. He has been in the hot seat himself.

"Initially you're very aware that you're flying the valuable prototype of a whole mega-billion dollar programme that you've been treating like eggshells for the past few months," he says. "There is a lot of pressure."

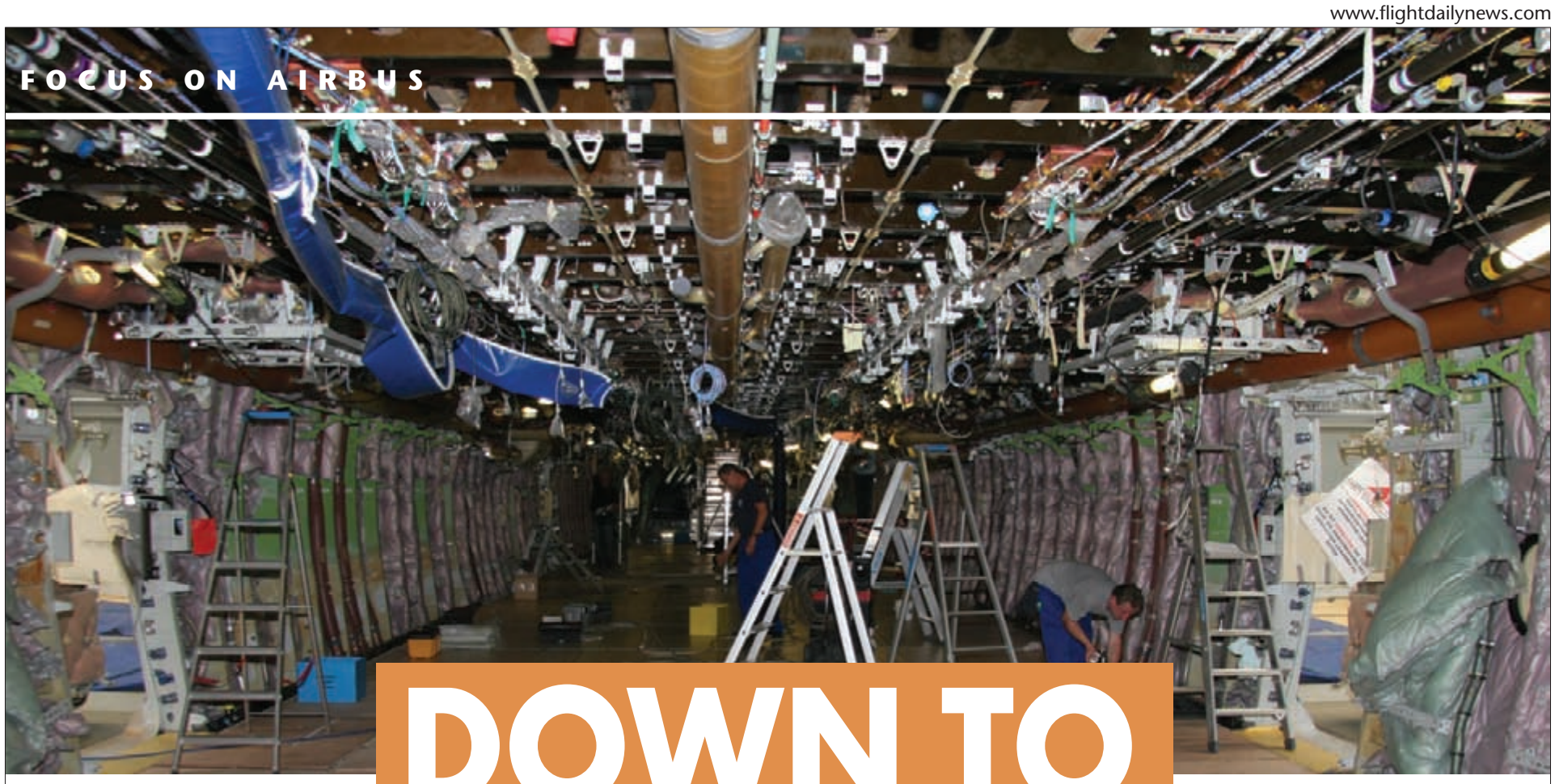
Then there are the local conditions. As one of the world's largest airshows, Farnborough attracts the flying elite. Pilots are checked for display experience and hours on type, as well as fluency in English.

Once they do turn up, they have to meet very stringent requirements from the Flying Control Committee, which consists of 13 expert test pilots. They come from across all aviation sectors and check for minimum heights and adherence to aircraft limitations.

"We've never had to ground anyone," says Hague. "We might ask someone to redo their validation for familiarisation, but we've never had to throw anyone out. Of course if there were to be a major transgression, we'd stop the show and bar that pilot instantly."

There is no way a display pilot can get away with busting airspace – and nor would they want to – most are primarily there to sell aircraft.

As well as the hawk-eyed committee, a controller is scrutinising each pilot on a radar screen, so they cannot change their display halfway through. Safety is paramount, Hague stresses. "We're looking for a safe display from turboprops to jets. The only differences are limitations differences – light jets can come lower."



DOWN TO THE WIRE

Enjoy the awesome sight of the Airbus A380 in the Farnborough flying display – it won't be seen at the world's airports quite as much as planned over the next two years. The bombshell announcement that the production schedule for the superjumbo has been hit by wiring problems has triggered an avalanche of trouble for Airbus. *Max Kingsley-Jones* of *Flight International* has been given unrestricted access to one of the affected aircraft and given a detailed briefing on the issues.

Airbus will provide more details this week on the background to the production problems that have caused serious delays the A380 programme.

In an exclusive briefing in Toulouse last week, Andreas Fehring, who is responsible for the "industrialisation of A380" gave *Flight Daily News* a guided tour of one of the A380s undergoing modification in the final assembly line hangar to explain causes for the delay and outline the task the manufacturer is facing to get the programme back on an even keel.

Fehring, whose official title is vice president A380 programme management, says that the problems have arisen from the fact that there have been "a much greater number of changes than expected resulting from modifications to electrical systems and structure following feedback from bench-testing, flight-testing and customisation needs".

Problem

He adds that the problem has been exacerbated by the A380's scale and complexity, and the ambitious development timetable that had Airbus "undertaking customisation and production ramp-up in parallel".

Although Airbus had built in a contingency plan into the A380's ambitious development schedule, it was caught out by the high volume of changes required: "You can plan for a certain amount of unexpected issues but we have simply eaten up our constituency," Fehring says.

The wiring problems boil down to two simple fundamentals – a harness may need to be extended or replaced as it is too short following a configuration change, or may require modification due to a specification change.

Although some modification work results from late cabin specification changes by customers, Fehring concedes that this is due to early definition freeze enforced by Airbus "to ensure that the manufacturing process was fully running downstream. But because of this early cut-off, some of the cabin features specified had not been fully thought through by the customers."

Another issue that has slowed the production progress has been the need for out-of-sequence work to be completed on the Toulouse assembly line by working parties despatched from the main sub-assembly production plants in France, Germany and the UK. "They are carrying out work that should have been done during the sub-assembly process," says Fehring. This has resulted from the policy last year to ship sub-assemblies to Toulouse incomplete, rather than hold them back and cause a bottleneck.

While the delay is not expected to affect the first delivery to A380 launch operator Singapore Airlines (SIA) at the end of the year, it has resulted in significant hold-ups to deliveries of subsequent aircraft for SIA and other early operators, and will see a major reduction in the number of aircraft completed during the initial years of production.

Fehring a long-serving German Airbus cabin systems engineer, who was appointed to the Toulouse-based role on 1 April, is confident Airbus has got to the bottom of what originally caused the problem. "You slice up the elephant, then you eat the elephant – we know what we have to do now," he says.

Fehring says that in the design phase Airbus tried to forecast harness routeings around rigid components to determine required lengths and configurations as accurately as possible using tools such as the digital mock-up, "but some things cannot be verified until you fly the aircraft".

For example, it may be that during flight testing it is established that a "pure power cable and an electrical signal line are running too close to each other, so they would have to be separated to avoid electrical interference", says Fehring. "A change to a bracket location, which alters a cable routeing, could require a longer harness, or if the cable has to be rerouted around a fixed, rigid item, such as a water waste pipe," he adds.

Fehring says Airbus has developed two basic fixes where harnesses are found to be unsuitable. "For simple definition changes we can modify with a kit – that is a bundle that could contain say, 13 wires. If there are routeing changes and the existing cable is too short we will need to replace the entire harness," he says.

He adds that replacement of the complete harness, rather than simply crimping in an extension, is necessary as "we have to be wary of increasing electrical resistance in the wires, and every time we add a new connection it would affect this".

The complexity of the cables cannot be underestimated, says Fehring as "they are just not running from A to B, they're going from A to B to C to D to E, and so on".

He says a change that needs to be verified in flight testing "will have to be installed on the three flight-test aircraft as well as the other 10 structurally assembled airframes, so even a relatively straightforward revision that requires 100h per aircraft adds up to 1,300h of work".

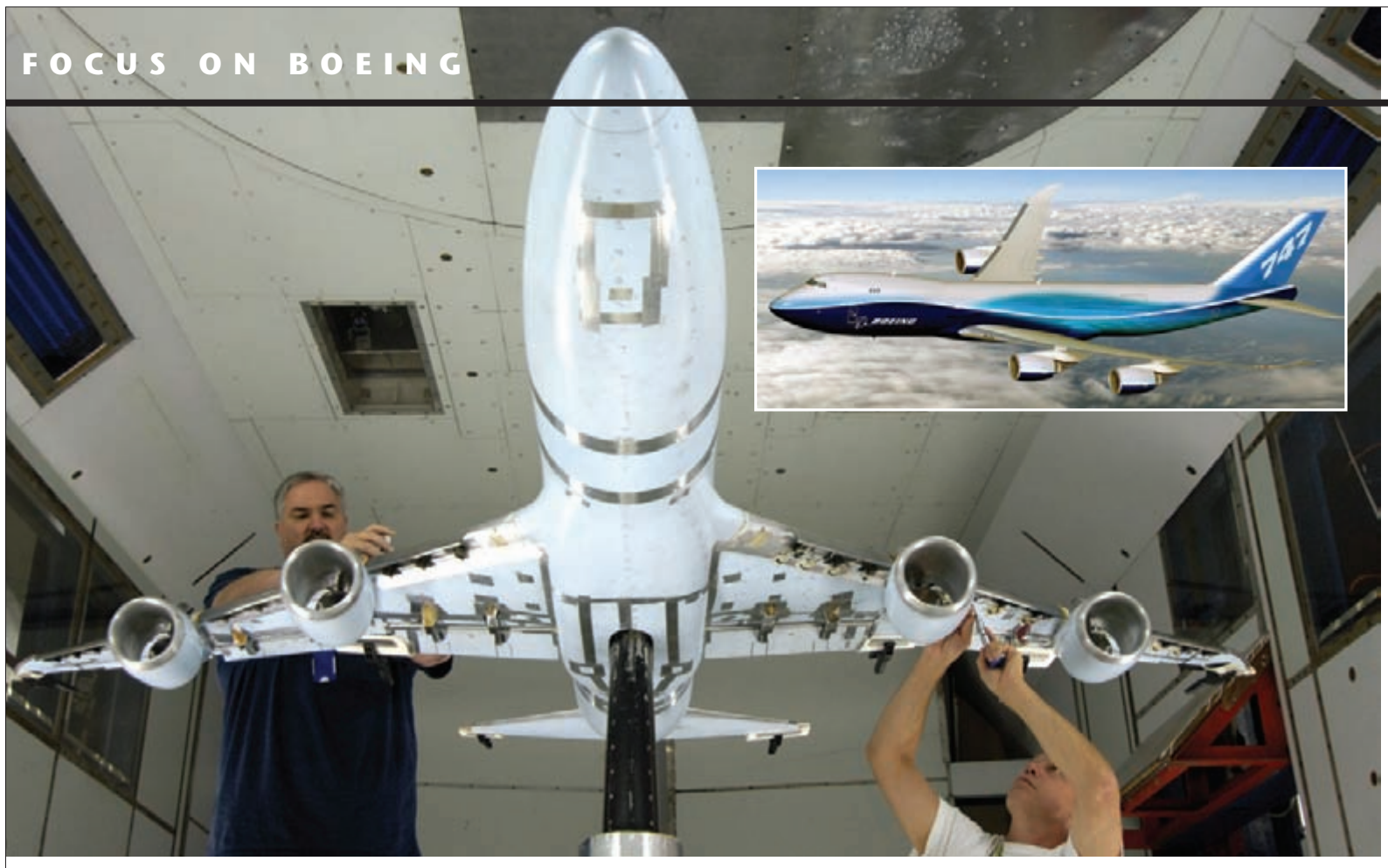
Like any other aircraft, the A380's wiring harnesses run throughout the fuselage, but the ultra-large-aircraft's full double-widebody passenger deck configuration makes the layout much more complex.

Overhead

For example, the main deck ceiling forms the floor of the upper deck, so it carries a mass of cables that serve both overhead needs of the main deck as well as some of the requirements for the upper deck. "We have around 500km (310 miles) of cabling, compared with 300km on an A340," says Fehring.

He says there is now some light at the end of the tunnel for Airbus. The first customer A380 (MSN003) was ferried to Hamburg in May for cabin installation and is to be completed in time for year-end delivery to SIA. Although Fehring is vague about the delivery schedule beyond MSN003, he is confident SIA's second aircraft, MSN005, will soon fly and be ready to depart for Hamburg "in the coming weeks".

Fehring declines to say when the second SIA aircraft will be ready for delivery, but hints it will not be too far behind the first, pointing out that an airline needs "a minimum of two" when introducing a new aircraft model into service.



Latest 747 variant firms up in windtunnel testing

Guy Norris

Boeing's 747-8, the nearest challenger to the Airbus A380, is nearing firm configuration thanks largely to tests now under way at Qinetiq's low-speed windtunnel at Farnborough.

Hidden from view from the chalets by the trees to the north of the main runway, the Qinetiq facility is being used by Boeing to develop the stretched 747's final aerodynamic lines, loads and flight control laws. At the heart of the site is a 5m (16ft) pressurised test section of the windtunnel in which a 5% scale model of the 747-8 is being subjected to airflows up to 0.24 Mach.

The $10 million model, measuring almost 4m in span, is peppered with 1,600 tiny pressure ports that carefully sense the changing pressures around the airframe at various simulated speeds and angles. Various wing configurations are also being tested including the 747-8's new double-slotted inboard and single-slotted outboard flaps. Unlike the original 747's familiar and massive triple-slotted flaps, the -8's simpler units are based on the 777 design, weigh less and will be quieter.

The whole wing is also completely redesigned aerodynamically, and is based on the super-critical shaping used for the 777 and later 787.

Development

"It is remarkable," says Roy Eggink, 747-8 product development chief engineer. "The landing weight is changed by 100,000lb (45,000kg), and we have changed the flaps, and yet you're at the same approach speed as today's aircraft and have much less noise from the airframe."

Noise is a fundamental design driver, with Boeing guaranteeing operators the ability to depart Heathrow at the lower stringent QC2 noise levels. Overall Eggink says the -8, in either freighter or passenger guise, will have a 30% lower noise 'footprint' around the airport area than the 747-400 and a 70% smaller footprint than the 1970s-era 747-200 version.

Another key element of the attack on noise are the engines, which will be derivatives of the General Electric GEnx in development for the 787.

Although not shown on the model in the tunnel at Farnborough, the GEnx-2B67s will be housed in nacelles sporting distinctive noise reducing chevrons on the trailing edge. Resembling a cookie cutter, the chevrons were proved during Quiet Technology Demonstrations (QTD) using 777 testbed aircraft.

A third planned QTD is expected to produce further advances which may help the 747-8 towards overcoming the remaining few decibels lying between it and unrestricted QC1 operations.

Firm configuration for the freighter is expected around September, while the design of the Intercontinental passenger variant is still being finalised, says Eggink. The first 747-8F, which at 76.3m (250ft) long overall is 5.6m longer than the -400F, is due to be delivered to launch customer Cargolux in September 2009. The first passenger versions are expected to be delivered a year later.

Cargolux can honestly say to be have been deeply involved in the development having been used to transport the model to the UK.

Steep option for the 747-8 is revealed

Boeing is studying a 777-style electronic tailstrike protection system for the 747-8, which would enable steeper touchdown and take-off angles and help reduce noise during critical approach and departure phases.

The electronic tailskid trade study forms a key element of Boeing's attempts to close the gap on QC1 noise limits at London.

Tailstrike protection system technology, developed for the 777, is embedded in the flight-control computer.

If the system senses an impending tailstrike, it automatically commands the elevators to avoid it.

Fuselage

The idea would be to approach the runway with a higher fuselage attitude, slowing the approach without the use of maximum flap and requiring a steeper flare angle.

The reduction in flap deployment, already cut to a simpler double/single slotted configuration on the -8 versus a triple-slotted design on the -400, would be one way of further reducing noise.

The higher take-off angle similarly reduces noise by reducing the 'footprint' around the departure path, adds Boeing.

Noise

Roy Eggink, 747-8 product development chief engineer, says: "It could be helpful for both take-off and landing noise performance."

The overall approach would remain unchanged at the standard 3° glideslope angle, but "are you going to do that with flap or by deflecting the entire aircraft?" asks Eggink.

Although the 747-8 will have fly-by-wire controlled spoilers and drooped ailerons, the current plan calls for the elevator to be conventionally controlled.

"However, we can still put in a device that activates a part of the elevator," he says, adding that the windtunnel work will help show if "we are stall-limited or attitude-limited. If we are attitude-limited then the electronic tailskid could pay off."

Stretched jumbo may grow some more

Boeing is considering adopting a longer stretch for the Boeing 747-8 Intercontinental passenger model to increase capacity to around 470 passengers.

When the General Electric GEnx-powered 747-8 programme was launched in November last year, the 747-8I featured a 3.6m (11.8ft) stretch over the 747-400, increasing three-class seating by 34 passengers to 450. However, the lead variant on the programme is the 747-8 Freighter, which has a 5.6m stretch.

Says Randy Baseler, Boeing Commercial Airplanes vice-president marketing: "We originally believed that the 20% size increase [over the 747-400] for the passenger model was what the market wanted, but some airlines have asked us to look into adopting the 5.6m fuselage stretch, and weren't worried about losing a little range," he says.

"Three-class seating would increase to 467 passengers, but range will fall by around 200-300nm [370-560km] to around 8,000nm," he adds.

Roy Eggink, Boeing 747-8 product development chief engineer, confirms "we're working with customers" to define the exact length of the forward fuselage stretch, but adds that the final outcome rests on discussions over range/payload requirements and the potential uses of the "Skyloft" upper crown space. Although Eggink says various plug inserts are being studied, a "5.6m stretch, in terms of body length, is what we'd be looking at."

Baseler plays down Boeing's latest advertising campaign, which describes the 747-8I as having "500-seat capacity". He says that "the aircraft we're offering today is the 450-seater," and that even the capacity of the 5.6m stretch version would be well below 500 seats.

WIN a flight in a MiG-29

- The ultimate prize for the aviation enthusiast – a trip to Russia and a flight in a MiG-29 – is on offer to the lucky person who can come up with names for the four new aerobatic manoeuvres flown by the unique vectored-thrust MiG-29OVT in its Farnborough display.
- Anyone wishing to enter should put their suggested names for the four new manoeuvres on the back of their business card and drop it into the MiG chalet (B23).
- There will be a number of prizes for the best suggestions – but the overall winner will win the mouth-watering trip to Moscow, as MiG's guest, and a flight in a MiG-29.

The thrust-vectored MiG-29 is setting Farnborough skies alight. *Jon Lake* reports.

RED STAR OF THE SHOW

The MiG-29, often a star performer in the Farnborough flying display since making its Western debut here in 1988, returns this year in its newest and most impressive guise, wearing an enormous red star on its spine and centre fuselage.

Beneath its striking red, white and blue livery (modeled on that of the Russian air force's Swifts aerobatic team), the MiG-29M OVT is a company-owned workhorse. It was previously seen at Farnborough as the sixth and final prototype for the MiG-29M 'Super Fulcrum', wearing camouflage and the Bort number 156.

The aircraft is now used as a demonstrator for the new RD-33 OVT engine, which incorporates three-dimensional thrust vectoring nozzles, giving the aircraft an astonishing degree of agility, and enabling it to perform manoeuvres never before seen at a Farnborough airshow.

The aircraft is flown by Pavel Vlasov, the MiG Russian Aircraft Corp (RAC MiG) chief test pilot and by his colleague, Mikhail Belyaev.

Vlasov, who is also director of RAC MiG's Fedorov Flight Test Centre, will be a familiar figure to many Farnborough regulars, having displayed a number of MiG-29 variants in previous years, usually backing up former chief test pilot Roman Taskaev.

The aircraft, previously widely referred to as the MiG-29OVT, has been flying in its current configuration since August 2003. It has now completed more than 110 flights, and development of the integrated system controlling the aerodynamic surfaces and the vectoring nozzles is now said to be complete.

Satisfied

Vlasov however has said: "Though we have been fully satisfied by the results achieved, at the same time the new control capabilities have not been finalised yet, and we will continue our work to further extend the aircraft's manoeuvrability."

Serious work on thrust vectoring in Russia started during the 1980s, with Sukhoi and engine design bureau Saturn/Lyulka leading the way. As a result of this early work, the latest Su-30MKI aircraft delivered to the Indian air force are powered by AL-31FP engines with two dimensional (up/down) nozzles that move 15°.

MiG and Klimov began work a little later, with early improvement of the basic RD-33 engine focusing on improving reliability, service life, time between overhauls and thrust. A digital Fadec control system was designed and incorporated before serious thoughts turned to thrust vectoring.

The OVT programme began during the 1990s and from the start, Klimov and MiG decided to aim for all-aspect thrust vectoring, with nozzles that could move in any direction. Klimov achieved this by using three hydraulic actuators to deflect the nozzles, mounted at 120° intervals around the engine nacelle.

In a further effort to improve on rival Saturn's two dimensional 15° system, Klimov's three dimensional system has 18° movement in all directions. Nor has this been achieved at the expense of reliability, says Vlasov, who comments that: "Though everybody was afraid that the life cycle of the moveable hardware would be very short, during two years of test flights not even one small part both in engines and nozzles has had to be replaced."

Because the thrust vectoring system is integrated with the later digital fly-by-wire control system of the later MiG-29M and its derivatives (and not with the analogue, electro-mechanical system of the baseline MiG-29) there is little scope for retrofitting in-service MiG-29s with thrust vectoring.

The OVT engines were installed in the MiG-29M during 2001, and there were then extensive ground trials. The MiG-29M OVT made its public debut at the Moscow air display (MAKS-2005) in August last year, and then gave a show-stopping, jaw-dropping performance at this year's Berlin airshow. The aircraft comes to Farnborough fresh from displaying at RIAT.

Ability

The MiG-29M OVT's display demonstrates the aircraft's ability to fly at very low speeds without angle of attack limitations, and to remain controllable in zero-speed and negative-speed (tail forward) areas of the envelope for sustained periods, where previous Russian fighters could only venture momentarily – for example during a tailslide or 'kobra' manoeuvre.

The new control system gives the pilot an unparalleled ability to point the aircraft (and thus his missile seekers) 'off axis', away from the direction of flight.

The display includes a number of unique manoeuvres, including the 'double kul'bit' (double somersault) and the 'boomerang', but Vlasov maintains that the aircraft remains easy to fly. Changes to the MiG-29M cockpit are limited, he says: "Only one switch was added: OVT mode on/off."

As a result, it "would take not more than 60 flights for MiG-29 pilots to master the new version with thrust vectoring.

"The use of all-aspect OVT will make the handling of the MiG-29M/M2 more precise and effective.

"This will be not only during 'super manoeuvres' (at very low speed and very low angles of attack) but also in normal piloting, though aircraft controllability will be practically independent of the angle of attack."

The new RD-33OVT engine is ready for production, and is being marketed with the new MiG-29M/M2 now being offered to export customers, including India, where the type will be tendered to meet the Indian air force MMRCA (Medium Multi-Role Combat Aircraft) requirement. It may be marketed under the designation MiG-35.

SMALL SCREENS FOR SAFER SKIES

Are the new integrated flight decks contributing to improved flight safety? *Brendan Gallagher* spoke to the three leading suppliers and found them divided on definitions

Flightdeck improvements (clockwise from top left): Proline 21 on the Cessna Encore +; the Thales TopDeck for regional aircraft and Honeywell's EASy on the Dassault Falcon 900EX.

There can't be many pilots or interested laymen who don't marvel at the transformation in flightdeck ergonomics over the last couple of decades. Where once the crew were confronted by a wall of clockwork and a ceiling of switches, now they face up to half a dozen large, bright, high-resolution screens that can be filled with a wealth of information at the touch of a fingertip.

The screens of today's integrated flightdecks replace dozens of analogue instruments and pounds of paperwork, telling the pilots about the state of the aircraft, where it is and what's going on around it, and even what kind of weather to be expected further down the route.

It's generally agreed that they improve situational awareness, reduce workload and improve the crew's ability to manage the flight from end to end.

Rockwell Collins Business and Regional Systems' David Wu.

On the face of it, these attributes would appear to have contributed to an improvement in flight safety over the last few years. But putting the question to the three top providers reveals a difference of opinion over whether it's the flightdeck itself or the systems integrated into it that deserve the credit.

While Rockwell Collins and Thales Aerospace incline to the former view, Honeywell insists that integration isn't the whole story.

Rockwell Collins's Pro Line 21 entered service at the beginning of the decade and is now established in the corporate aviation market, mainly in North America but also increasingly in Europe. First applications of the system were the Cessna Citation CJ1 and CJ2. Since then it has made its way into types all the way up and down the business-aircraft range, from the Beechcraft King Air to the Bombardier Challenger 605.

Asked if integrated flight decks such as Pro Line 21 are contributing to increased flight safety, David Wu, flightdeck systems marketing manager for Rockwell Collins Business and Regional Systems, says: "Comparing the capabilities of today's integrated flight decks with those of the federated flightdecks of 20 years ago reveals a tremendous growth in flightcrew situational awareness."

Wu also believes that the integrated display of information contributes to more effective crew resource management, which in recent years has emerged as one of the pillars of flight safety. "Instead of spending the time looking for the desired information, the crew can actively plan for what may come next."

Thales offers its TopDeck for military transport, helicopter, and corporate and regional aircraft applications. Though it has found the last sector hard going in the face of competition from Honeywell and Rockwell Collins, its has scored successes on the Sikorsky S-76D, Brazil's P-3 Orion maritime patrol aircraft, and Lockheed Martin C-130 Hercules operated by the air forces of Venezuela and South Africa.

"Improved safety and better situational awareness are probably the main contribution of the integrated cockpit," says Pierre Bonnet, manager of avionics systems at Thales Aerospace. "The newest generation of integrated flightdecks helps to free the pilots' attention, leading to a better focus on aircraft trajectory."

Retrofit

Honeywell's Primus Epic is certificated in over a dozen different types. By the end of last year, more than 500 aircraft had been delivered with the system installed, and the manufacturer expects to see it on more than 1,800 aircraft by the end of 2010.

"We consider ourselves pioneers of integrated systems, and it's clear that the industry has voted for this – aircraft are getting more integrated, not less," says Randy Robertson, vice-president electronic systems engineering and applications at Honeywell Aerospace. "But it's for reasons other than safety – weight, space, reduced wiring, increased redundancy, more efficient upgrades.

"In addressing this question, other people may be thinking about the integration of data for presentation to the pilot – I'm talking about what's below the floor, whether it's a single cabinet containing all the functions, or a lot of separate LRUs."

Robertson insists that the real drivers behind the steady improvement in flight safety over the years are systems such as ground-proximity warning, TCAS and the emerging enhanced and synthetic vision.

"All the things we think contribute to safety and situational awareness have evolved at the same time as architectures have become more physically integrated," he says. "But they weren't necessarily enabled by integration. GPWS is usually a standalone box – as far as I know it's been integrated only into Primus Epic so far – and TCAS is standalone."

The Honeywell vice-president points out also that a clean, information-rich glass cockpit doesn't have to depend on a similarly clean installation below the floor. "The ability to render the kind of information we display today comes from better processing and more data throughput," he says. "I could go to a federated architecture – with perhaps two FMCs, two symbol generators and three flight control computers, all in separate boxes – and achieve the same performance by putting in today's processors and graphics chips."

But Robertson is prepared to give the integrated flightdeck more credit when it comes to considering the current move towards certificating more commercial aircraft for single-pilot operations.

"The aircraft being considered for single-pilot operations are typically smaller, which allows the true space and weight-saving merits of integration to come into play," he concedes. "But it has to be repeated that the functionalities needed to facilitate a Part 23 certification for commuter or air-taxi operations don't in themselves require an integrated architecture."

Steve Nichols takes a look at one of the most exciting technology developments about to hit the market.

HAS SYNTHETIC VISION FINALLY COME OF AGE?

After years of development, synthetic vision systems (SVS) may soon be fitted to production aircraft, and it is likely that the business jet market will be the first to embrace them.

That's the view of Ed Wheeler, vice-president of aerospace engineering for Honeywell (Hall 1, A9), although he feels that the commercial market will keep its wallet firmly closed until convinced of the overall cost and benefits.

SVS gives the pilot a computer-generated, arcade-style display of where his aircraft is, where it is heading and what is around them by fusing the outputs from a number of different sensors with a terrain database. The end result is a realistic depiction of the outside world with a 'highway-in-the-sky' display that the pilot flies along.

Wheeler says: "We are now at a technology-readiness maturity phase. We've demonstrated it, we have had FAA involvement, and have done a lot of work on the human factors.

"There have been many players working on SVS, but I think we are going to see the business aviation market take to the technology first – they often need to get in and out of airports in less-than-perfect conditions and the price will be less of a barrier to them.

"The military are also likely to be an interested party."

Tim Etherington, principal system engineer at Rockwell Collins (Hall 4, F10), who has pioneered the development of the company's SVS systems, says that as a technology, SVS could make flying a lot safer, but the commercial industry either doesn't see the benefits or can't afford to retrofit fit it to its aircraft.

Requirement

"I know that some of the airlines have started to talk about SVS as a possible future requirement, but it is really not clear yet how and when that will happen," says Etherington.

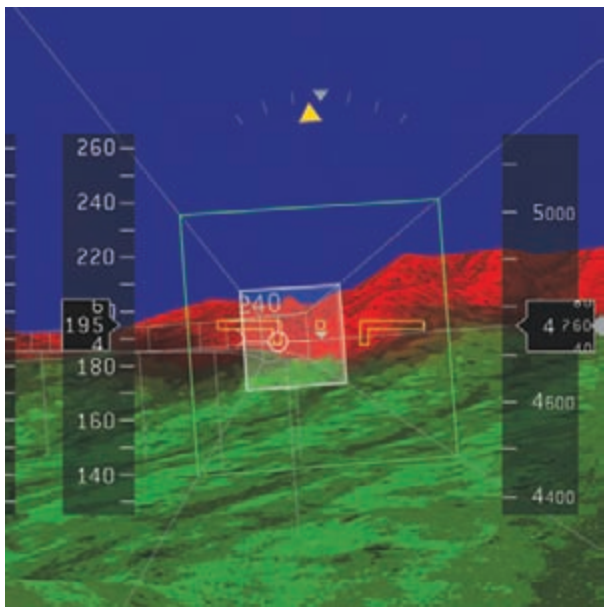
"SVS is a little ahead of its time. When we started working on this, there was an expectation that within a couple of years it was going to be a technology ready for the market and the market was going to embrace it." That was seven years ago.

"What happened was that as a result of the airline economics, especially post 9/11, they are not embracing much new technology. They look at the bottom line and say 'Do we absolutely need to have this'?"

The other problem is that SVS needs the very latest glass cockpit technology to work. Etherington says the upgrade costs would be too expensive as a retrofit on the large numbers of legacy aircraft flying.

"The cost associated with doing that right now is higher than the market wants to pay for the perceived benefit," Etherington says.

Etherington agrees that most of the new SVS developments will be in the business jet area. "But in the military market there is still a reluctance to trust the terrain database," he says. "At the same time they can't afford the sensors from either a cost or weight standpoint."



Rockwell Collins' SVS display.

Rockwell Collins has a number of research contracts for SVS, including one with NASA Langley. Its last test flight was with the FAA last summer with a Boeing 727 at Kirtland AFB in New Mexico.

The tests involved database terrain following, simulated drops and self-contained, curved approaches to the runway.

Successful flight tests with the Air Force Research labs at Wright Patterson AFB used low-level terrain sorties in simulated night instrument meteorological conditions. Evaluation pilots from 412 Flight Test Squadron and the Air Force Test Pilot School conducted blind low-level profiles and approaches using head-up and head-down displays that were equipped with SVS elements.