AIRCRAFT AND SATELLITE INSURANCE
FARNBOROUGH AIR SHOW REPORT
MH17 AND THE MISSILE THREAT

LIFE BEGINS AT 40
OLD HAWK TEACHES NEW TRICKS

September 2014
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* Images show hired chairs that would be an extra cost
Beware a messy divorce

This month Scotland goes to the polls to decide its future inside or outside the UK. The decision, by Scotland’s voters, has profound implications not only for this 300-year partnership but also for the UK’s aerospace, aviation and defence sectors. The SNP’s wish to move the location of the UK’s Trident nuclear deterrent and close the Faslane base could result in an extremely costly and lengthy relocation process — and would blow a hole below the waterline of the UK’s defence budget planning. In addition, the SNP has published its post-independence desires — which include 16-18 Eurofighter Typhoons, four C-130Js, four frigates and six army helicopters which will fragment the UK’s shrinking combat power even further — just at a time when the need for a robust NATO capability has been at its highest since 1989. There are also questions over a small nation supporting and operating 18 Eurofighters — when other countries such as South Africa have difficulty fielding the cheaper Gripen. In addition to the effect of independence on high-level organisations, such as the EU and NATO, there are also other aerospace implications. Complex multilateral agreements with international bodies such as ICAO, ITAR waivers, airworthiness (a Scottish CAA/AAIB?) and airspace (a divided Scottish/UK NATS?) will all need to be examined in detail, unpicked and then reapplied. Independence may affect the location of the UK’s first spacecraft (six of the current eight potential sites are in Scotland). At the national level there are industry bodies like the new ATI, Space UK and ADS to consider too. In short — should Scotland decide to go it alone, untangling these deep aerospace and aviation ties may prove more challenging than at first glance.

Tim Robinson
tim.robinson@aerosociety.com
Tiltwing
Not strictly a tiltrotor, the E7 would use a tiltwing with two 'proprotors' to achieve vertical flight. The whole wing, with four control surfaces, would be able to swivel up to 100 degrees from horizontal. The tiltwing would also act as an airbrake for steep descents.

Joined-wing configuration
The high-lift 'box' or joined-wing configuration is not new but here joined with a tiltwing gives the E7 unique qualities including, a higher operating ceiling and better lift-drag ratio than the current V-22 Osprey. The joined-wing configuration also gives low stall speeds — important in transition to and from forward flight.

GENERAL AVIATION
Diamond-wing VTOL
From California, comes this advanced high-speed VTOL concept from Elytron Aircraft — the 7S which combines two technologies, a tiltwing and a 'box' or diamond-wing configuration, for a next-generation executive or business transport. The seven-seater 7S is the larger of two concepts from the company, with a smaller two-seat 2S technology demonstrator set for flight tests in 2015. As well as an executive transport, Elytron also foresee other missions such as SAR, offshore oil support and EMS.
Engine
A turbocharged engine with FADEC powers the proprotors via two gearboxes. Once in the horizontal forward flight mode, speeds of 300kt are predicted. The proprotors also counter rotate, eliminating yaw issues.

Ease of piloting
Elytron envisage a fully-equipped glass cockpit with ADS-B, TAWS, WAAS and NextGen ready EVS for low-visibility would also be fitted. The aircraft would also be fitted with optional pilot assistance including envelope protection and yaw dampening.

Safety
As well as an enhanced glide ratio compared to helicopters or tiltrotors, the 7S also features other safety enhancements. The position of the proprotors inside the boxwing prevents rotor strikes. Meanwhile, Elytron say that it will also feature a run-dry gearbox and an advanced ballistic parachute — able to be deployed from 0-130kt.

Undercarriage
The Elytron 7S would feature a retractable, wheeled tricycle undercarriage.
MH17 shootdown stokes tensions

On 17 July, a Malaysian Airlines Boeing 777-200ER on a flight from Amsterdam to Kuala Lumpur crashed over eastern Ukraine killing all 283 passengers and 15 crew.

Flight MH17, which was flying at 33,000ft, is strongly believed to have been hit by a SA-11 ‘Buk’ SAM fired by pro-Russian separatists. Eight other commercial passenger flights are reported to have flown over the eastern Ukraine on the same afternoon as MH17. Access to the crash site proved difficult owing to the conflict in the region. The CVR and FDR from MH17 were handed over to investigators by pro-Russian rebels on 22 July who agreed to guarantee safe access for investigators to the crash site. The black boxes were then handed to the UK AAIB on 23 July who will attempt to retrieve data from them as collaboration with the Dutch authorities who are leading the accident investigation.

A total of 282 bodies recovered from the crash site were moved by train to Kharkiv and flown to The Netherlands aboard a RNLAF C-130 and RAAF C-17.

The incident sparked a major international incident with Russia being blamed for supplying the separatists with the SA-11, including tit-for-tat sanctions. France has resisted pressure to halt the delivery of two Mistral helicopter carriers to Russia. Meanwhile, Russia has threatened to ban European airlines from overflying Siberia on flights to the Far East.

Rosetta rendezvous with comet

Europe’s comet probe, Rosetta has successfully rendezvoused with the comet 67P/Churyumov-Gerasimenko after a 10-year chase. ESA is now adjusting its orbit prior to deploying the Philae lander in November.

Bristow’s AW189 enters service

Bristow Helicopters has reported that, on 21 July, it carried out its first commercial offshore flight with its new AgustaWestland AW189 super-medium helicopter. Bristow will have two AW189s based at Norwich Airport, UK, to serve the southern North Sea oil fields.
Texas. The facility will comprise the rocket launch site, a control command centre and a ground-tracking station, all within two miles of each other.

Aero Glass has developed a new ‘augmented reality’ Google Glass-based head-mounted display for GA pilots. Scheduled for release in Q3 of this year, the glasses offer a wearable solution for providing pilots with navigation, ADS-B, instrument, weather, and airspace information in the cockpit.

Now on its final test phase, Airbus’ A350 XWB MSN6 has completed a three-week global route-proving tour of 14 cities in Canada, Asia, South Africa, Australia, South America, Middle-East, Russia and Europe.

Dobrolet, the low-cost arm of Russia’s Aeroflot has been grounded due to EU sanctions in the wake of the MH17 shootdown. However, it is still reported to be planning to buy up to 16 Boeing 737-800s.

Bell Helicopter has delivered the first Bell 429 to the New York Police Department as one of four on order.

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All Nippon Airways (ANA) has become the first airline to begin revenue flights with the Boeing 787-9 Dreamliner on 7 August. Meanwhile, first to take delivery of the -9, Air New Zealand followed suit on 9 August.

Pilatus PC-24 rolls out on Swiss National Day

Swiss national day. The first flight is scheduled by spring 2015 and a total of three aircraft will be produced for the flight test programme.

Pilatus has officially unveiled its new PC-24 ‘Workhorse’ business jet, rolling the first prototype out of the production hangar on 1 August; the flight test programme is set to run through to 2016.

Etihad, Alitalia agree stakeholder deal

Abu Dhabi-based carrier Etihad will now acquire a 49% stake in ailing Italian flag carrier Alitalia for €388m — as the two airlines agreed terms of the partnership. The agreement will see the two airlines invest some €1.76bn in Alitalia to restructure and rebrand it, with the goal of profitability in 2017.

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Buzz off

German aerospace research lab DLR has conducted test flights using its A320-based Advance Technology Research Aircraft (ATRA) to assess how wing contamination by insects can be avoided on laminar-flow wings to redirect insects away from the leading edges during take-off and landing as well as enhance lift.

AEROSPACE

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South Africa’s Paramount Group flew its low-cost AHRLAC (Advanced High-Performance Reconnaissance Light Aircraft) COIN/ISR aircraft for the first time in Wonderboom Airport in Pretoria.

Sierra Nevada Corp (SNC) and Lockheed Martin have unveiled the first Dream Chaser spacecraft composite structure which will be used to conduct the first orbital flight due to launch in November 2016 atop an Atlas V rocket.

Russia’s new twin-engined Technoavia Rysachok aircraft, will now be equipped exclusively with Russian engines. A light utility aircraft, it is aimed as an An-2 replacement.

Boeing is to build the stretched 787-10 Dreamliner exclusively at its South Carolina factory.

On 10 August 38 people were killed in Tehran, when an Iran140 turboprop with 48 people on board crashed on take-off from Mehrabad Airport.

Japan has rolled out the first prototype of its Mitsubishi ATD-X stealth fighter demonstrator. It is set to fly this year with a two-year test programme.

SpaceX’s Falcon 9 rocket launched the AsiaSat 8 commercial telecommunications satellite into orbit on 5 August. The launch took place at Cape Canaveral Air Force Station in Florida at 4 am EDT.

NASA and the US Navy have completed the second recovery tests of the Orion space capsule off the coast of California. The aim of this test, conducted on 2 August, is to determine primary and alternate means of recovering the Orion module in preparation for Orion’s first trip to and from space in Exploration Flight Test-1 in December this year.

For the first time since the mid 1960s, two Avro Lancasters are flying in UK skies. Lancaster ‘V-Vera’ from the Canadian Warplane Heritage Museum made a transatlantic flight on 4 August from Hamilton to RAF Coningsby. As AEROSPACE goes to press, the aircraft has joined the RAF BBMF Lancaster for a six-week tour of air displays.

Operation Protective Edge on 8 July, some 1,881 Palestinians have been killed, while 67 Israelis were killed. Israeli forces struck over 3,834 targets. Meanwhile, Hamas forces have launched over 2,927 rockets at Israel.

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International Airlines Group (IAG) has firm ed up an order for eight Airbus A350-900s for its Spanish flag carrier, Iberia. The buy for Iberia’s long-haul fleet also includes eight A330-300s. They will replace the A340s in service.

Russian manufacturer Antonov announced that the first assembled fuselage of the new An-178 has been rolled out and it expects to complete assembly of the first prototype later this year before beginning flight tests in early 2015.
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**Skymark A380 order axed**

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**ON THE MOVE**

As part of the company’s restructuring, Bombardier Aerospace President & CEO Guy Hachey is to retire. Giorgio Moreti is the new ATR Chief Financial Officer, succeeding Eric Baravian.

GAMA has named Jonathan Archer as Director of Engineering & Airworthiness.

**JMR prototypes downselected**

The US Army has awarded two development contracts for prototypes for its new Joint Multi-Role (JMR) technology programme designed as eventual replacements for the UH-60 Black Hawk and AH-64 Apache. The contracts have gone to Boeing and Sikorsky for their joint SB-1 Defiant coaxial rotorcraft and to Bell Helicopters’ V-280 Valor tiltrotor.

**INFOGRAPHIC: The RFC goes to war, 1914**

**Royal Flying Corps No 2 Squadron**

1914

**Royal Aircraft Factory BE-2**

*BE* stands for “Bleriot Experimental.”

First ever naturally stable aircraft.

Type: Reconnaissance, Day/night, Attack.

Aircrew: 1 or 2 depending on role.

Wingspan: 11m (36ft).

**Engines:** 2x Rolls-Royce Turbojets.

**Length:** 8.3m (27.5ft).

**Weight:** 3,370kg (empty)

**Fuel Load:** 3,370kg

**Armament:** Hand-held pistol, Lewis machine gun or selection of bombs or explosive darts. On many sorts no armament were used.

**Navigation:** Magnetic compass, maps and basic aural navigation.

**Targeting:** None.

**Royal Air Force No 1 (AC) Squadron**

2014

**Panavia Tornado GR4**

*GR* stands for ‘Ground Attack & Reconnaissance’.

Deployments since 1991: Iraq, Afghanistan, Libya, Kosovo & Serbia.

Type: Day/night, all-weather, precision ground attack, reconnaissance.

Aircrew: 2.

**Engines:** 2 x 16,000lb. Thrust.

**Length:** 16.7m (54.6ft)

**Weight:** 31,800kg (empty)

**Fuel Load:** 3,855kg in tanks

**Armament:** Storm Shadow, Brimstone, DMSB, ALARM and ASRAAM missiles, Enhanced Paveway II, Paveway IV laser and GPS guided bombs, Mauser 27mm cannon.


**Targeting:** Laser Range and Marked Target Seeker (LRMST), Lethal II.

**SPACEFLIGHT**

**‘Impossible’ space drive gets validation**

NASA researchers have announced the result of validation tests on the ‘impossible’ EmDrive electric space drive system, which appears to violate laws of physics by not needing any fuel.

First proposed by British inventor Roger Shawyer in 2001, the EmDrive generates thrust without propellant using the properties of electromagnetic waves. Scientists in China have also replicated these results. The thrust generated is tiny but could be used to create long endurance space propulsion systems. One estimate the transit time to Mars using the EmDrive could be as little as 28 days.
The phrase ‘intelligence leads to smart regulation’ would make an excellent motto for the Military Aviation Authority (MAA), an organisation established in April 2010 in the wake of the Nimrod XV230 disaster and that which is now the established regulatory body for UK military air safety governance. Responsible for all aspects of military air safety, including airworthiness and, wherever there may be risk to life or capability, the governance, ownership and accountability of the established rules-based model, the MAA has set exemplary standards that other world militaries would do well to follow.

Smart, focused, evidence-based information is at the heart of the MAA regulatory culture. From its inception the MAA has been built on the need to acquire knowledge of what is going on across the whole military air environment and the ability to independently investigate on a safety, as opposed to blame, basis. Airworthiness is, within the military air power capability component, arguably the single most important element of air safety. Four years on the MAA is already mature and is the responsible governing authority for all aspects of military air safety. Those impacted by what the MAA has already achieved should be content that never again will air safety be determined by blurred regulation and affordability options.

While there can never be an absolute guarantee of aircraft airworthiness — the ultimate decision and final responsibility for this will always remain with the ultimate user — the destruction of Nimrod XV230 over Afghanistan in September 2006 with the loss of 14 military personal was confirmation enough that the then existing regulatory framework, rules and policy standards built up over many years were no longer fit for purpose.

The 2009 Nimrod Report, written by Mr Justice Charles Haddon-Cave QC not only provided a substantive critique of events that led to the crash of XV230 but exposed a complete lack of air safety co-ordination and operation across all three armed forces engaged in the use of military aircraft, helicopter and unmanned aerial vehicle capability. Safety, he concluded, was “a 24/7 business” and ‘by and large’ it should be organised by those who are directly affected by the implications of failure."

Five years on from the Nimrod Report the MAA is the much-needed result of effort to combine the air safety regulatory responsibility requirement for the Royal Air Force, the Royal Navy and the Army. While operating different forms of air power capability there is, today, one set of accepted air safety standards to work to.

From its inception the MAA set out on a combined approach of enhancing delivery of operational capability without getting in the way of operation. Through a process that required continual improvement in military air safety standards to be put in place, the culture of military air safety, regulation, governance and practice has radically changed. It is a culture that everyone engaged has been happy to sign up to. With the establishment of the MAA, Haddon-Cave’s principal recommendation that what had been a fragmented safety structure, culture and approach should be merged into a unified self-regulating body had been achieved. The strategy, to provide the military air power component with coherent policy, well-defined process, communication and governance has, in my view, been very successfully achieved.

As it brought about a huge change in air safety culture, under the guiding hand of its first Director General, Air Marshal ‘Timo’ Anderson, the MAA was quick to earn praise and respect from the end user. Today, under the charge of the second DG, Air Marshal Richard (Dick) Garwood, the MAA has moved on and made great strides
forward in its attempt to achieve the right level of balance between operation responsibility and operational risk.

Employing 260 personnel, of whom 146 are military and 114 civilian, apart from six at MoD Main Building and 19 specialists at Farnborough, the bulk of MAA staff work at DE&S headquarters at Abbey Wood.

The MAA has, of course, not been without some critics, particularly those engaged in Watchkeeper and Airseeker RC-135W ‘Rivet Joint’ programmes, both of which had been delayed awaiting ‘Statement of Type Design Assurance’ (STDA) and full ‘Release to Service’ (RTS) statements. The MAA was also blamed for causing delays to entry into service of the RAF Voyager KC Mk3 refuelling tanker and transport aircraft derivative version of the Airbus A330-200 aircraft. In the case of the delay in issuing a release to service for Airseeker the problem was unusual and caused by there being, due to the age of the airframe, a lack of ‘aircraft type certification’ and, due to unavailability of design, technical and other required specification details, a large evidence gap.

Apart from imbuing a system of regulation and certification, oversight and approvals, safety and policy, analysis and enabling, the MAA also has responsibility for both the Centre of Aviation Safety Training and the Military Air Accident Investigation Branch which, like its civilian counterpart, is also based at Farnborough.

At the heart of what the MAA has subsequently established, is ownership and management of responsibility of risk. It has achieved this through a system of ‘Duty Holder’ process sitting over a chain of military operators all of whom act in support of each other and who bear elements of personal legal responsibility for the safety and airworthiness of platform capability. The ‘duty holder' construct is based on ‘their decision and their accountability’. While there are also around 16 industrial ‘duty holders’, suffice to say that five senior military officers now ‘own’ the ‘duty holder’ process. They are ‘owned’ in terms of senior level ‘duty holder’ by the heads of the three armed forces involved with the Secretary of State for Defence sitting at the top of the ‘duty holder’ process ladder. As was said to me very recently by a senior military officer, once you have been a ‘duty holder’ you ‘get the message very quickly’.

The ‘Duty Holder’ process allows clear responsibility of action, ownership and management of risk. Additionally, although more work is needed, the MAA Assurance Plan encompassing an audit process of Duty Holder-facing organisations including DE&S is now maturing.

While I suspect that, to some, the MAA may appear to be an imposition that has the potential to cause serious delay and frustration, the placing of the ownership of risk with key individuals that carry personal and legal responsibility and that are required by law to be accountable for their actions and decisions, has rightly changed the face of air safety in the UK. Notes Sir Charles Haddon-Cave QC of the safety organisation’s progress: “a remarkable achievement, the MAA is well on the way to building a world-class organisation.”

Since its inception the MAA has been involved in certification of various air systems, such as Voyager KC Mk2 for the RAF, Wildcat AH Mk 2 and HMA Mk 1 for the Army and RN, Puma Mk2 mid-life upgrade for the RAF, along with Watchkeeper RPAS replacement for the Army and Airseeker RC-135W for the RAF/SIGINT. It will have similar activity on programmes such as A400M Atlas, F-35 Lightning II, Tucano and Grob trainer replacements as part of the MFTS programme, Apache upgrade and, following work already achieved on avionics upgrade, for Merlin Mk2 for the RN’s proposed ‘Crowsnest’ AEW modifications for the same helicopters. Earlier this year the MAA produced a report into the mid-air collision between two RAF Tornado aircraft that occurred in 2012 and concluded that it could have been avoided, had planned acquisition of collision avoidance systems agreed many years earlier not been cancelled by the Government in 2010.

The MAA was but a first step in the process of improving defence safety as a whole. The Haddon-Cave report has also led to the creation of the Defence Safety and Environmental Authority (DSEA) which, in order to avoid conflicts of interest, means that those charged with the responsibility of safety should be independent of those responsible for delivering output. Bringing in safety regulation of nuclear, maritime, land, explosives, ordnance, fuels and gasses and, maybe in future, other related activities, the intention is that defence safety will, I suspect, eventually have one voice and single ownership.
Russian rocket engines

Keith Hayward's thoughtful commentary, 'Unintended Consequences' does highlight a serious flaw in US space policy. However, the decision to support development of the Russian RD-180 engine for the Atlas launch vehicle was not in any way a product of policy. It was solely a technical and economic decision by the third-removed ancestor of United Launch Alliance (ULA), General Dynamics Space Systems Division (GDSSD), original developer of the Atlas that launched America's Mercury astronauts. The rationale for this statement is outlined below. The initial decision to then purchase RD-180s from Energomash was also not a US space policy decision, nor was it made by ULA, but by ULA's immediate ancestor Lockheed Martin Astronautics, who employed the RD-180 to develop and then launch, first the Atlas-2AR, then the Atlas-3 and, finally, the Atlas-5. I was then a member of Lockheed Martin's Executive Advisory Board, and participated in the design reviews of all three RD-180-powered vehicles. Subsequent events, including the inability of Amross to set up a US RD-180 production line as requested by the US Air Force, were the result of US policy decisions. The following quotations are extracted from a letter by Jerry Grey, dated 9 April 1992, to Chief Engineer, General Dynamics Space Systems Division (GDSSD — Michael Wynne, CEO):

"As requested, here's my reaction to the 6-7 April meeting with Russian Energomash representatives... They would like very much to receive GDSSD funding to conduct the studies and development needed to adapt their engines to whatever requirement GD specifies. Our 'Atlas Alternate LO2/RP Engine Study' dated 6 April 1992 showed four engine options: a dual-chamber RD-170, a single-chamber RD-170, a 1.5-stage vehicle using three RD-120s and a single-stage vehicle with two RD-120s... The disadvantage of the RD-120 (options) is their low thrust and probable high cost of multiple units, and also marginal performance of the resulting vehicle... The two RD-170 options... provide adequate thrust levels for the single-stage [Atlas] configuration... Of the two, the better choice is the two-chamber configuration..., for the following reasons:

1. The single-chamber version requires more new (and therefore developmental) hardware than the two-chamber version.
2. The single-chamber version requires a chamber-pressure increase... imposing an extra risk burden on the vehicle... In contrast, the two-chamber version could be de-rated by 20% and still deliver more thrust than you need for all Atlas configurations, including the Atlas 2AS..."

3. The extra thrust margin of the de-rated two-chamber configuration would be extremely useful in allowing simplification of other Atlas systems. It also provides for evolutionary payload growth via incremental upgrades to full rated thrust, and might allow manifesting dual payloads... If thrust is too high for certain missions, it might be cost-effective to de-rate chamber pressure even further, offload propellants, or use the RD-170's impressive throttling capabilities.

4. The additional recurring cost of the two-chamber version (relative to the single chamber) is essentially the cost of the second thrust chamber, which is a relatively small fraction of the total propulsion-system cost. Further, that small incremental cost would very likely be offset by (a) the two-chamber version's lower nonrecurring (development) cost, (b) savings that accrue from the bigger margins it allows, and (c) higher revenues due to the higher payload capability it offers.

5. Because the two-chamber RD-170 engine provides more-than-admirable thrust at little or no additional cost, operating it de-rated significantly improves its reliability potential, with attendant economic benefits to Atlas. It also will have better roll-control characteristics than the single-chamber engine.

"The Russian engine could play an important role in Atlas marketability and evolution. The next step would be to select the best configuration (my own recommendation is that it be the two-chamber RD-170, as detailed above****), write up a set of specifications, and solicit a proposal from Energomash to perform and deliver a preliminary design study which meets those specifications. It is likely that Energomash's proposed cost for this effort will not be excessive****... it would provide you with a sound basis on which to decide whether or not to proceed with development funding and subsequent engine procurement from Energomash."

Jerry Grey
FRAeS

Engineering crisis

Some aeronautical engineers are now entering a crisis. While aircraft are flying, maintenance engineers have enough work. While Airbus, Boeing, etc. are manufacturing airliners, production engineers too have no troubles. But, left out from this are stress and design engineers who work on new designs... Our job depends on having new aircraft in the pipeline. This past ten years we have had the 787, 747-8, A380, A350, A400M, KC-390 and CSeries. A lot of new aircraft. But now they are flying, maintenance etc are manufacturing airliners, production engineers have enough work. While Airbus, Boeing, etc are flying, maintenance engineers have enough work. But now they are designing and in production. This year, Airbus and Boeing, and the companies that work for them have contracted lots of people to deal with this ramp up in production — and are even recruiting engineers without any knowledge of aviation.
The engineering job now is so atomised, that it does not matter if the engineer is an aeronautical one or not, simply that the team leader is a good engineer. But, while production rates are rising, there are no new projects. The Airbus A320neo, Boeing 777X, A320neo and Embraer E2 are older designs that only need updating. The design workload is quite low in comparison with the previous situation. So now there are too many engineers chasing work in too few projects. It is rumoured that Airbus may cut thousands of employees in six years and a significant portion of these may be engineers. Meanwhile, other aerospace companies are firing senior engineers. They say that senior, experienced engineers are too expensive, and that three junior engineers can do the same job of one senior worker. Additionally, the salaries are every day lower than previous. In Spain, for example, companies are offering €1,000 net/month to experienced engineers. But not only in Spain. Wages for engineers are decreasing in the UK, France, Brussels, The Netherlands and Germany. It was not strange to receive offers of £38-40 per hour in UK. Now you can find this has dropped down to £18-20 an hour. The advice to today’s generation of young stress and design aeronautical engineers seems to be: “Don’t worry … and look for a job as maintenance engineer.” It was a similar boom in IT some years ago, and then the bubble exploded. The bubble is near to explode in aeronautics! In summary, Airbus and Boeing and the supply chains have employed lots of people but now there are no fresh aerospace projects for young engineers to work on. Some of us perhaps will be able to find work in maintenance or concessions (but it’s going to be difficult). Where will these engineers come from for the next clean-sheet aircraft?

José Manuel Gil Garcia
Stress Engineer

Frank T. Training Captain
Boeing 777/787 at British Airways [on Farnborough Air Show] Will this be the first year a pilot doesn’t ‘talk to the hand’ when trying to coerce a cup of tea and a sit down for half-an-hour for his dear 85-year-old Dad who is visiting Farnborough for what must be the 25th time at least? It has never ceased to amaze me how unwelcome the people who fly the Boeings and Airbuses, etc. all are by the manufacturers and our own airlines at Farnborough. I appreciate it’s all about sales but do we really make the place look that untidy? Should sales and marketing people not sometime to meet the people who actually fly their planes and operate their kit on a daily basis? Not the same in Dubai, for example.

Frank T. Independent Airlines/Aviation Professional [on whether civil aircraft could be fitted with anti-missile defensive aids] Wholly unrealistic and totally unnecessary, this was an extremely rare event and should not be used to add even more complexity to civil aircraft. The investigators will no doubt be looking at the information and/or advice given to airlines concerning areas to avoid, we should await their findings and, in all probability, safety recommendations.

Roger M. CTO and Business Leader Twenty five years ago in a EUROCAE working group on GPS, an airline representative noted how difficult it would be for a satellite navigation system to achieve four nines availability. An air force expert smiled and said: “We in the military accept we may lose an aircraft if mission circumstances dictate it. You airline people get upset if you lose even one passenger!” Military and civil aviation are still worlds apart. A defensive aids suite (DAS) will improve mission success rates where the risk of attack is significant but will have no appreciable impact where threats are very low. They are not 100% effective, a fact accepted by the military world but one which the civil world (and the press) will find difficult. The loss of an aircraft where countermeasures were deployed but the threat not negated will be seen as negligence rather than a property of the system. False alarm rates are notable and, in the low threat environment of civil aviation, could lead to more lives being lost through DAS related accidents than real threats successfully negated. The expression ‘don’t go there’ says it all.

Frank T. Independent Airlines/Aviation Professional [on the legal status of drones, and the press] will find this very difficult. The loss of an aircraft where countermeasures were deployed but the threat not negated will be seen as negligence rather than a property of the system. False alarm rates are notable and, in the low threat environment of civil aviation, could lead to more lives being lost through DAS related accidents than real threats successfully negated. The expression ‘don’t go there’ says it all.

1. Last Word, AEROSPACE, August 2014, p 58.

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In August 1974 the prototype Hawker Siddeley Hawk took to the skies for the first time. A replacement for the Gnat and Hunter in the advanced and lead-in-fighter training role in the RAF, it quickly became an export sales success with, to date, 998 aircraft flown by more than 20 operators from Australia to Finland. The Hawk also entered the history books by being one of the few post-war UK military aircraft to be manufactured by the US (the other two being Harrier and Canberra) when the Hawk was turned into the Boeing T-45 Goshawk carrier-capable advanced trainer for the US Navy/Marines.

Enter the T2

While the Hawk in its export guise has evolved over a number of marks (and even as a single-seat light fighter) its latest training incarnation is the Hawk T2 AJT (Advanced Jet Trainer). Entering service in 2011, 28 Hawk T2s were procured by the UK MoD for the fast-jet tactical weapons training course. Today, the Hawk T2 that the RAF’s IV(R) Squadron flies is much removed from the earlier T1, with only the canopy and the airbrake remaining common. The longer nose and wingtip rails are clues that, despite appearances, this is not your father’s Hawk.

The Hawk T2 features an uprated Rolls-Royce/Turbomeca Adour Mk951 engine giving increased thrust (6,500lb) compared to the T1’s 5,200lb. The engine is also equipped with FADEC. Says Flt Lt Paul Heasman*, CFS Agent/QFI on IV(R) Sqn: “The R-R 951 Adour offers a lot of power compared to the T1 and the FADEC gives us carefree...”

Forty years ago the Hawker Siddeley Hawk took to the skies. Today it stands on the cusp of a 1,000-aircraft sales record — an export success story for a British military aircraft. TIM ROBINSON asks — does life begin at 40?

BAE Systems Hawk T2 from IV(R) Sqn, RAF, banks over RAF Valley.
Handling of the engine and a rapid response/spool-up time. The aircraft also features an APU and OBOGS (on-board oxygen generation system) for reduced dependence on ground support.

Crucially for an aircraft that may be used (and abused) by students training to be fighter pilots, the Hawk also features advances in its maintainability and mission readiness. HUMS (health and usage monitoring systems) sensors keep track of aircraft fatigue allowing better fleet management. Fatigue life has also been boosted to 10,000 flying hours and the time-between-overhauls is now 4,500 hrs. These features, previously 'nice to have', are now critical for air forces that are looking to save every penny and get the most out of their training system. TCAS (traffic collision avoidance system) and GPWS (ground proximity warning system) are also fed into a moving map display.

And three MFDs that are NVG-capable. INS/GPS the T2 is particularly big. In comes HOTAS, a HUD the jump from the RAF's 'steam gauge' Hawk T1 to 100-series Hawks have introduced glass cockpits, cockpit is now software-driven. While other nations' key to the Hawk's mid-life facelift is how its glass cockpit is now software-driven. While other types (most notably the M346 and T-50) have embraced fly-by-wire (FBW) in a bid to close the gap between advanced trainer and fifth generation fighter performance — the Hawk remains resolutely old-school. But does it matter if the aircraft cannot pull extreme angles-of-attack? Flt Lt Paul Heasman thinks not: "Older versions of the Hawk have been successfully producing students to feed the Canadian and Australian Hornet (both Super and legacy versions) OCUs for a number of years — these are real high AoA operators!"

Digital future-proofing

However, the biggest change is on the inside. Key to the Hawk's mid-life facelift is how its glass cockpit is now software-driven. While other nations' 100-series Hawks have introduced glass cockpits, the jump from the RAF's 'steam gauge' Hawk T1 to the T2 is particularly big. In comes HOTAS, a HUD and three MFDs that are NVG-capable. INS/GPS feed into a moving map display.

More significant than MFDs is that aircraft now come with embedded training, datalinks, simulated defensive aids and a 'virtual' radar. This allows Hawk T2s to 'fight' with other (up to 32) datalinked Hawk T2s in realistic training scenarios. No other T2s airborne? Synthetic 'virtual' enemies can be introduced for the student to practice BVR tactics with. Air-to-surface tactics and weaponeering can also be taught with 'no-drop' scoring allowing re-attacks without having to return to base. More significantly, the advent of precision, all-weather guided weapons means that training needs have evolved from the Cold War low-level, laydown attacks practised in the 1980s. Today, for modern fighters what is needed is sensor and information management skills to guarantee mission success. Says Flt Lt Heasman: "The weapons profiles flown on IV(R) Sqn are frontline representative Paveway IV profiles that have a direct read across to those tactics taught on the OCUs."

These changes now mean the Hawk has been 'future-proofed' ready to incorporate, simulate or emulate other systems, weapons, avionics or sensors that may find their way onto front-line fighter aircraft. Much as a user's iPad retains the same operating system, yet allows a variety of different 'apps' to be installed, so the software-driven T2 allows flexibility for operators to customise the glass cockpit for their training. For example, in the future, with a 'virtual radar', it might be possible to teach basic stealth tactics or IO aspect awareness to pilots set to transition to the F-35.

A complete training system

However, the Hawk T2 today is more than the airframe itself. It also comes as part of a bigger training package that includes simulators, instructors and support under the auspices of the Ascent MFTS training contract. This includes FMS (full mission simulators), FTD (flight training devices) and desktop trainers — making the aircraft and facility at RAF Valley one of the world's best-equipped fighter pilot training schools. Says Flt Lt Heasman of the T2 and its training system: "The trainees are truly of the 'Playstation Generation' and they seem to embrace the glass cockpit elements of the aircraft. The trainees also have access to issued laptop computers and high fidelity flight training devices that allow them to self study the aircraft and mission systems."

Add instruction from highly experienced RAF and civilian instructors and staff — and the T2 part of the training system itself could be highly attractive for air forces wishing to send students to this FJ 'finishing school'. Once the syllabus evolves to incorporate the F-35 — this also could position T2/Valley as Europe's F-35 lead-in training school of choice.

The IV Squadron 'product'

After upgrading from the 'steam gauges' era T1, the RAF is now at the forefront of melding simulation, synthetic radar and weaponeering and real flying to produce a pilot ready to step into a fifth-generation
BAE believes so, pointing out that the Hawk is first and foremost a trainer, with additional combat capabilities, rather than the other way around. RAF QFI Flt Lt Heasman agrees: “In my view the M346 and T-50 are superb light fighters. They offer superb performance in that role but are not training aircraft — operators of these types will pay a significant premium in both initial outlay and through-life costs to acquire a lot of unusable capability in the training role.” While the AoA limits, G-rating, FBW and performance of these new trainers more closely match the Typhoon, Gripen, F-35, Rafale, Super Hornet, etc, Heasman believes that these are the wrong priorities for today’s training requirements. “From a training perspective, it’s very easy to get mired in a ‘Top Trumps’ style numbers game when comparing aircraft types. You need to ask a bigger question: what are the skill sets that I need to train my ab initio pilots?“

Rival trainers

Today there are new pretenders to the Hawk’s training crown, in particular the Alenia Aermacchi M346, Lockheed Martin/KAI T-50, Yak-130 and an as yet unnamed Boeing/Saab T-X trainer. Can the Hawk hold its own against these new upstarts?

It’s very easy to get mired in a ‘Top Trumps’ style numbers game when comparing aircraft types. You need to ask a bigger question: what are the skill sets that I need to train my ab initio pilots?

Flt Lt Paul Heasman
CFS Agent/QFI, IV(R) Sqn, RAF

+8 and -4G limits give students exposure to representative combat limits.

Rival trainers

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Future prospects

So what are the export prospects for the Hawk? Phil Hodge, Hawk Business Development Director, BAE Systems, notes that trainer fleets worldwide have suffered undercapitalisation in recent decades, compared to front-line fighter fleets. “As a result”, he says, “there has been underinvestment in training pipelines and training fleets.” While there are significant opportunities for the Hawk (including an additional 20 for India that may be finalised shortly), the biggest prize in the military trainer market is the USAF’s T-X requirement — which could be around 350 aircraft. Here the Hawk faces fierce competition from the T-100 (M346), the LM/KAI T-50 and a Boeing/Saab clean sheet design — as well as potentially a new entrant in the Textron AirLand Scorpion. To that end, BAE is teamed with Northrop Grumman, and recently swapped places to give NG the lead in this bid.

It is also important to note that the development of the Hawk is not finished with the T2. “Our focus is that it stays at the pinnacle, stays relevant and we continually evolve some of the capabilities,”

Digital cockpit — with the first fast jet students graduating from the T2 in 2013.

Says Flt Lt Heasman: “A trainee graduating from Hawk T2 is a rounded pilot capable of flying a wide breadth of flying skill sets while assimilating a lot of data from a complex, frontline representative mission system. The pilot is comfortable and well-versed in the application of modern air-to-air and air-to-surface weapons.”

With the first student ‘products’ of the Hawk T2 now stepping into Typhoon and Tornado GR4 cockpits, the RAF is already seeing results. Group Captain Johnny Stinger, Station Commander at the Typhoon base at RAF Coningsby noted recently at the Farnborough Air Show: “We are already seeing the benefits of exposing people to high-end training on Typhoon on the Hawk T2.” He added: “It is saving money, it is building capacity, it is building capability in the individuals which, in turn, breeds confidence. What the Hawk T2 does very well is prepare people for stepping into a Typhoon cockpit.”

With its new glass-cockpit, synthetic radar and embedded training systems, the Hawk T2 is thus able to ‘download’ some of the Typhoon OCU course to the earlier phase. While swapping expensive flying hours on a front-line jet to an affordable trainer may be one benefit, it also gives front-line commanders more options.

Flt Lt Heasman expands on this: “We are downloading training from the OCU in terms of intercept training for Typhoon. This could allow students to be graduated in fewer hours from the OCU or it could allow the OCU to train to a higher standard within its hours budget — ultimately both routes offer savings for defence and UK PLC.”
— shifting the emphasis from pure flying skills to mission management and tactical skills. This ties in with the final factor to consider — that the increased sophistication and fidelity of flight simulation and synthetic environments means more and more of the syllabus can now be trained effectively on the ground, in a simulator. This not only saves money, but also reduces complaints about noise — a growing issue for many air forces today. Yet the flip side of this suggests perhaps a cause for optimism. Firstly, while the RAF uses the Hawk T2 exclusively in the advanced training role, for many other air forces the Hawk can be armed and also carries out other roles such as light attack. This versatility expands its market reach beyond perhaps what might be considered the pure trainer market. Secondly, the introduction of the F-35 to Western air forces may provide a boost to advanced trainer/LIFT manufacturers — in selling their aircraft as ‘companion jets’ — to deliver cheaper flight currency for Lightning II. Much like the T-38 is used to provide currency for B-2 pilots, if defence budgets continue to be constrained, and operating costs of F-35 prove higher than estimated, there may be a desperate need for LIFT/trainers able to cheaply simulate some of the F-35’s sensors and systems in order that pilots maintain flight currency.

**Possible Future Hawk Upgrades**
- Large single display
- Helmet-mounted display (HMD)
- SAR radar mapping emulation
- Targeting pod simulation

**Summary**
There is plenty of potential life yet in this affordable, but effective jet trainer. ‘Future proofing’ with software means that it can now keep pace with whatever fifth or (even sixth) generation fighter’s cockpits look like in the next 40 years. The introduction of ‘virtual weaponeering’ and synthetic radar means it is now blazing a trail in delivering the kind of fighter pilot at ease with sensor management prevalent in fourth/fifth generation front-line cockpits. It still retains a spritely performance, able to challenge the student up to 8.5+G and even exceed Mach 1 in a dive, without afterburner. The Hawk family also boasts a large customer user base and includes some of the most highly respected air arms in the world — including the US Navy and Marines, the RAAF and the RAF. Says BAE’s Hodge: “The T2 is an evolution that has taken place over the past ten years but which builds on that 40 years of understanding, knowledge and background.”

And, while Western air forces shrink, the introduction of the high-end F-35 may drive a need for the Hawk AJT as ‘companion jets’ — simply for pilots to retain currency, while keeping flying costs down. Now just two aircraft away from achieving a millennium in sales (and beating 824 Harriers produced) at this stage in its career, much like other young-at-heart 40-year-olds, the Hawk AJT is still going strong.

**How big is the market?**
However, weighed against this is that western air forces are becoming smaller — and thus fewer fast jet pilots are needed overall. The rise of UAVs for reconnaissance, surveillance and close air support also reduces the number of tactical fighter aircraft needed — only in 2012 the USAF trained more UAV operators than pilots. Another factor is that four and half/fifth generation fighters are now comparatively ‘easy’ to fly than previous generations of aircraft says Hodge. With the glass cockpit now software-driven, there exists the potential for continued upgrades and tweaks. To this end, this year BAE Systems brought its Hawk avionics and software experts together in one facility at Brough to address future upgrade potential. These range from small (qualifying iPads for use in the cockpit) to larger modifications. For example, a single flat-panel touchscreen display could emulate the F-35’s cockpit design. Hodge reveals: “There is a lot of work ongoing on how we could put a large area display in the aircraft.”

Meanwhile a HMD would introduce the student to this concept earlier in the training process. The introduction of a digital HMD with training specific-symbology perhaps could also allow future T2 students to dogfight virtual bandits within visual range — with no safety restrictions. Indeed, BAE is already working with the SAAF (South African Air Force) studying integration of the Striker HMD on its Hawk 120s.

Meanwhile, the RAAF’s Hawk 127s are set to undergo a mid-life avionics upgrade to bring them up to a similar mission systems standard as the T2. While the jump between earlier glass-cockpit Hawks and the latest T2 software standard is a natural upgrade, for those operators with earlier Hawks, it may turn out to be most cost-effective to buy new, than attempt to upgrade these older trainers. Says BAE’s Hodge: “Could you say upgrade a T1 to T2? You could but it just wouldn’t be cost effective compared to the cost of a new aeroplane.”

**Indian AF Hawk 132 AJT.**
Finalisation of a follow-on order for 20 for Surya Kiran would see Hawk sales pass 1,000.
Incremental airliner revamps and the F-35 no-show dominated headlines at this year’s Farnborough Air Show, held on 14-20 July. TIM ROBINSON and BILL READ report.
attempts to draw their previous guided weapon ideas into a future battlespace C2 network for the year 2035, with air/ground/sea weapons and resources all working seamlessly together. MBDA foresee Stratus assessing threats, then optimising responses and suggesting weapon options or effects to the human operator.

Lessors drive huge deals

The pace of airliner orders reached a fever pitch on the Tuesday — mainly driven by leasing companies — who know airlines’ needs perhaps sometimes better than the carriers themselves. The biggest deal was from Japanese lessor SMBC which ordered 110 Airbus A320neos and five A320ceos, in an agreement worth $11.8bn at list prices. Meanwhile, air lessors Avolon ordered six Boeing 787-9 Dreamliners in a deal worth $1.5bn. Avolon also reconfirmed a previous order for five 737 MAX8s. Singaporean leasing company BOC Aviation also settled for narrowbodies — placing an order for 36 Airbus A320ceos and seven A320neos. Tuesday also saw Air Lease Corporation (ALC), after helping launch the A330neo, switch back to Boeing with an order for six 777-300ERs and 20 737 MAX 8s. Finally another US-based leasing company, Intrepid Aviation, placed an order for six GE90-powered Boeing 777-300ERs plus four options.

‘Stealth’ flying buggy revealed

Looking like something that the ‘Q-Branch’ might issue to James Bond was a ‘flying car’ from Parajet — the SkyRunner — which features a rear-mounted propeller and a paraglider flexible wing. The SkyRunner, say Parajet, who normally specialise in the smaller, one-man powered paragliders, is still at the concept stage but has been attracting attention at the show.

Civil Super Herc gets first order

ASL Aviation Group has become the first customer for the civil version of the Lockheed Martin C-130J Super Hercules — signing a letter of intent to buy up to ten LM-100Js. South Africa’s ASL already operates C-130s/L-100s in the freight role.

Perhaps the biggest news story of the show on everyone’s lips, whether staunch supporter or fierce critic of the stealth fighter programme, was the cliffhanger of whether the Lockheed Martin F-35 Lightning II would make it to the show for its international debut. With the UK as a Tier 1 partner, and strong ties between the US/UK military and industry, there was a natural desire to aim for Farnborough Air Show as the ideal venue to display this aircraft — set to be the dominant western fighter. However, it was not meant to be. After an engine fire that grounded the F-35 fleet, officials and executives remained hopeful that, even after missing RIAT, the four USMC F-35Bs could fly the trip and appear at the tail end of the airshow. Hopes were boosted late on Monday when the US safety chiefs lifted the grounding order — allowing aircraft to return to flight. However, on the Tuesday afternoon of the show, and hints that a public statement would give the good news of an attendance, were dashed later with an announcement from the US Pentagon that it would not allow the aircraft to make the transatlantic flight, as the engines still need to be inspected every three hours following the fire incident. Despite the F-35 team’s pledge to keep fighting for the F-35 to get to Farnborough until the bitter end, by Tuesday night, its air show hopes were over.

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<td>Airbus Helicopters is to design a large-scale compound rotorcraft demonstrator. To be called LifeRCraft (Low Impact Fast &amp; Efficient RotorCraft), the new aircraft will combine fixed wings for energy-efficient lift, open propellers for high-efficiency propulsion and a main rotor for vertical take-off and landing (VTOL) flight capabilities. The LifeRCraft will be developed in the framework of the European Union’s Clean Sky 2 Joint Technology Initiative which was formally launched in early July at Brussels.</td>
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Eastern Air Lines Group signed an MOU for 20 Mitsubishi MRJ90 regional jets plus 20 additional purchase rights. Additionally, Air Mandalay placed an order for six MRJ90 regional jets with purchase rights for an additional four.

Embraer updated the media with progress on its KC-390 jet military tactical transport — now in final assembly. The company highlighted its jet speed (470kt) advantage over the slower C-130 cutting a 6hr mission down to 3.35hrs. The type is set to make its first flight by the end of the year — with delivery to launch operator — the Brazilian AF in 2016.

INAER is to acquire a Bell 429 light twin in helicopter emergency medical service (HEMS) configuration. Meanwhile, a further seven Bell 429s have been sold to the Swedish National Police.
Airbus launches A330neo with 121 orders

In perhaps the worst kept surprise announcement of the show, Airbus used the Monday to launch its anticipated A330neo which fills a gap at the smaller end of the A350 XWB and is aimed directly at customers for whom the ultra-long range A350 is ‘too much aircraft’. Despite being based on an older 767, Airbus is confident that the updated, re-engined A330 (to be available in two variants -800neo and -900neo) can hold its own against Boeing’s composite challenger — the 787. Driving the 14% better ‘game-changer’ per seat fuel efficiency, will be a new Rolls-Royce engine — the Trent 7000. Other neo tweaks include the wingspan extended by 3’7m and XWB-style blended winglets. The A330neo will feature 95% spares commonality with the standard A330 and keep the same type rating as the A330. Interestingly, drawing on their experience with the A320neo, Airbus intend to shave one and a half years off the development schedule to achieve an entry into service of 2017. Said Airbus chief Fabrice Bregier: “I want an Airbus that is faster, more agile.” First sign of the ‘overwhelming customer demand’ for the A330neo came from global lessor, Air Lease Corporation (ALC) which signed a deal for 25 A330neos and 60 A321neos. Meanwhile the first airline customer to take the plunge was Malaysia’s AirAsiaX — placing an order for 50 A330-900s.

Ruffled Russians

While there were two Sukhoi Superjet 100s at Farnborough, the lack of Su-35s and Ka-52s that appeared at Paris last year was a large clue that, after Crimea and Ukraine, relations with Russia were less than cordial. Complaints by Russian delegations of slowness in processing visas by the UK Foreign Office and instructions from Russia’s deputy prime minister for defence delegations to return home, led to a diplomatic snub and official frostiness — though it is unclear how many Russian delegates were denied visas in time or chose to obey Moscow and leave.

More A350 XWBs ordered

Air Mauritius signed a MoU for four Airbus A350-900s. The airline also announced that it is leasing two more A350-900s. The six new aircraft will be operated on European, Asian and Australian routes.

New collaboration platform

3D design software specialists Dassault Systèmes has launched a new European aerospace and defence industry’s collaboration platform. Called AirDesign, the system is a neutral workspace for advanced OEM and partner PLM collaboration in design and manufacturing. Available on a high-security, private cloud or on-premise, AirDesign is a scalable collaboration platform designed to integrate all industry players, from OEMs to SMEs. AirDesign can manage the exchange of PLM data between all partners whatever their systems may be. The system has three key capabilities:

1. An OEM can exchange programs and projects, including the delegation of administrative roles;
2. An integrated, secured and automatic technical data package exchange ensures the management of large technical files between OEMs and suppliers and;
3. Partners can access a wide variety of services, including converters based on standards or approval services.

ATR wins Myanmar Airways order

State-owned Myanmar Airways ordered six ATR 72-600 regional turboprops plus six options. The aircraft are scheduled for delivery between 2015 and 2017.

Head to head rivals?

Key to making the best use of sensor-fused fourth and fifth generation fighters is the new generation of helmet mounted displays (HMD) — and the show saw two companies provide details on their latest combat helmets. Vision Systems (Rockwell Collins/Elbit) helmet mounted display system (HMDS) — it was revealed, is now up to its Gen III standard and has been delivered for software integration with the jet. The Gen III HMDS fixes earlier latency flaws, enhances capability and is set to be integrated with the LRIP 7 F-35s. Says Lockheed Martin’s Chief F-35 Test Pilot Al Norman of the HDMS: ‘I love it. Once I put this helmet on, I become one with the...
aircraft. I have information everywhere I look." For the F-35 which has no HUD, the helmet is critical for its outstanding situational awareness and its 360 degrees DAS (distributed aperture system) — allowing pilots to look ‘through’ the structure of the aircraft to see an IR image of what is around them.

Meanwhile, BAE Systems (which from 2011 to late 2013 was called in to develop a back-up F-35 helmet) launched its Striker II HMD — an upgrade of the Striker I already in use by Typhoon and Gripen pilots. The Striker II builds on the alternate F-35 HMD experience and the earlier Eurofighter/Gripen HMD. The Striker II, an ‘agnostic-type’ helmet for any fixed-wing or helicopter gives HD seamless day/night vision with an integrated digital night vision camera (DNVC) rather than bulky, weighty NVG goggles. Said BAE Systems Chief Test Pilot, Mark Bowman of the Striker II: “NVG goggles on combat helmets are now essentially a thing of the past.” BAE plans to test fly the Striker II with Typhoon later this year.

**Meet the Trent 7000**

With Airbus aggressively targeting 2017 for entry into service for its re-engined A330neo widebody, as sole supplier, the responsibility for meeting engine deadlines rests on the broad shoulders of Rolls-Royce. For the A330neo, Rolls-Royce has merged the best of three existing Trent engine technologies (the Trent 700/1000-TEN/XWB) to create the new Trent 7000 turbofan. The Trent 7000 doubles the bypass ratio of the 700, features another ten aircraft.

On display outside the Textron chalet was the prototype Scorpion low-cost light attack/military tactical surveillance aircraft which flew from Wichita in Kansas to Farnborough in the UK in seven stages. “We’re pretty proud of it,” said Textron Airland President Bill Anderson. “We started back in January 2011 with an empty building, nine people and a white board and this is what you’ve got now. The only thing we needed to get over here was fuel and good weather — and we got both.” The $20m strike/ISR jet is looking to create a new combat aircraft niche between expensive fighters and lower-cost turboprops for a variety of missions and is already in advanced negotiations with potential customers. (See Q&A with the Scorpion King, Insight blog).

**PM visits show, boosts defence**

The UK defence sector received a significant boost on the Monday when UK Prime Minister David Cameron visited the show and announced £1.1bn of defence investment towards ISR, UxVs and Eurofighter radar development. The official announcement is also a stay of execution for UK Sentinel R1 and Shadow crews, who were set to be axed after the withdrawal from Afghanistan. The new timetable sees Sentinel and Shadow ISR platforms continue until at least 2018, with the Sentinel’s radar being enhanced for the maritime domain.

Meanwhile, the show also saw the official launch of the Defence Growth Partnership (DGP) — intended to replicate the success of the UK’s Aerospace Growth Partnership (AGP).

Egypt has ordered eight additional Airbus Defence and Space C295 military transport aircraft. The order follows an earlier deal for 12 C295s, of which six have already been delivered.

Piaggio Aero won a firm order for ten of its updated Avanti EVO business aircraft, with options for a further 40 from Hong Kong-based lessor Bravia Capital. First deliveries will begin in 2015.

The Netherlands Aircraft Company was reported to be negotiating with financiers and suppliers with a view to relaunch the defunct Fokker 100 regional jet as the F120NG.

**Scorpion Jet flies Atlantic to make international debut**

The Scorpion Jet, a low-cost light attack/military tactical surveillance aircraft, has flown from Wichita in Kansas to Farnborough in the UK in seven stages. The aircraft is being developed by Textron Airland, a joint venture between Aeronautics Group, Israel, and Textron Aviation, the United States. The Scorpion is intended to fill a niche between expensive fighters and lower-cost turboprops for a variety of missions, and is already in advanced negotiations with potential customers.
Gripen to stay lethal to 2040+

Lennart Sindahl, Deputy CEO of Saab, outlined his vision of the future for the Gripen fighter up to 2040 and beyond. His first words were to reassure operators of the current Gripen C and Ds that they would not be left behind while development continued on the new Gripen E and F. He said: “We have a policy of continuous upgrades to the C and the D, the latest of which is MS20, that will expand the aircraft's operational capability.” Meanwhile, certification of the Gripen E and F is expected in 2018. One test aircraft, the 39-7, is already flying, this year will see the testing of tactical rigs and three more test aircraft will fly in 2015, 2016 and 2017.

500 up for Bombardier

Farnborough saw Bombardier celebrate a double milestone when three deals pushed its CSeries and Q400 orders over the 500 aircraft mark. The first deal, worth around $375m, from an unnamed African carrier was for five CSeries. Meanwhile, an existing undisclosed CSeries customer placed an additional order for seven CS300s and purchase rights for another six. This now brings the CSeries order book to 513. In Q400s — Thailand’s Nok Air converted two Q400NextGen purchase rights to firm; giving it six on order — and bringing the total number of Q400s sold to 501.

Raytheon’s silicon carbide tech paying off

While Raytheon is mostly known for radars and missiles, it is also now moving into high-end niche technology for civil aerospace. Talking to AEROSPACE, Raytheon UK revealed that its silicon carbide technology, made in Glenrothes in Scotland, had already proved vital in winning places on several projects for the UK’s ATI civil aerospace R&D effort. Potential applications for this technology include high-temperature sensors, engine monitoring and more-electric aircraft.

Final airliner tally

The trade days finished on the Thursday with some $115·5bn worth of deals done. Having its best-ever Farnborough was Airbus, which notched up some 496 aircraft orders worth $75·3bn. Chief Salesman John Leahy pointed out that 121 of these were for the freshly launched A330neo, the last of which, from Russian carrier Transaero, only was announced minutes before the final tally. While lessors made up the bulk of A330neo sales, regular Airbus customer Tony Fernandes, signed for 25 A330neos — becoming the type’s first airline customer. Meanwhile, Boeing scored 201 orders at the show, worth $40·2bn — with highlights including Qatar firming up its 777X order and Monarch defecting to select the 737 MAX.

With the UK likely to restore its Nimrod MPA capability in the 2015 SDSR, manufacturers used the show to display their potential solutions. Airbus Defence and Space had a C295 MPA from Portugal, while Saab brought its 340MSA. Boeing, meanwhile, was taking no chances and, as well as its P-8A Poseidon had also brought its new MSA (Maritime Surveillance Aircraft) — based on a Challenger 604 bizjet on static. Packed with sensors, the MSA uses mission systems based on its bigger brother, the P-8A, but ditches the ASW mission and weapon carriage for an affordable, jet maritime (and overland) patroller. Particularly impressive in this aircraft are the mission displays — in place of bulky consoles there are giant hi-res touchscreen displays that fold away clamshell-like. iPad owners will feel right at home, as the displays also feature ‘pinch and zoom’ touch functions — similar to tablets and smart phones. After sensor testing after the show, Boeing plans to begin customer demonstration flights with the aircraft at the end of 2014 or early 2015.

Boeing sends maritime patrollers, large and small

E-Fan flies at show

Farnborough visitors caught a glimpse of a greener, quieter GA aircraft when Airbus Group’s electric E-Fan demonstrator flew at the show. (See ‘It’s Electrifying’ AEROSPACE, June 2014)

Lessor Nordic Aviation Capital (NAC) signed an order for 25 ATR 42-600 regional turboprops plus 50 options in a deal valued at over $1·55bn.

AERO Vodochody announced the launch of an upgraded version of its popular L-39 training jet. Called the L-39NG, the new aircraft will feature advanced modular ‘glass’ avionics and communication systems, embedded virtual training systems, a new wet wing, weight-saving materials and a more efficient Williams International FJ44-4M engine.

In the UK, the Kent, Surrey & Sussex Air Ambulance Trust (KSSAAT) selected the AgustaWestland AW169 twin-engine light intermediate helicopter for emergency medical service missions. The aircraft will be operated by Specialist Aviation Services (SAS) for the KSSAAT.
Scottish sites dominate UK spaceport choices

sites which could be adapted or improved, if required. The sites are: Stornaway Airport, RAF Lossiemouth, Kinloss Barracks, Cambeltown Airport, Glasgow Prestwick Airport (all in Scotland), Llanedeyrn Airport in Wales and Newquay Cornwall Airport. In addition to meteorological, environmental and economic factors, the eight sites were chosen on the basis of: being a reasonable distance away from densely populated areas, having the ability to operate segregated airspace and having an existing runway of 3,000m — or the capability of extending to that length. The Department of Transport is now awaiting comments from stakeholders of the proposals but the plan is for the site to be operational by 2018.

Turboprop manufacturer ATR won a total of 38 firm orders as well as 56 options. Bombardier, meanwhile, celebrated winning 20 commitments including 12 for its CSeries — which pushed the total number over the 500 mark. Embraer did well with 135 orders in total, the bulk of which were for its new re-engined E2 model. Japan’s Mitsubishi also secured 26 orders for its MRJ — including a MoU for 20 from the relaunched US carrier Eastern Airlines. Finally Russia’s Sukhoi picked up a total of 15 orders for its SuperJet.

Summary

In civil aerospace, while the A330neo caused a stir, the success of these incremental upgrades prompted media questions to both Airbus and Boeing on their next re-engining projects. Would Airbus, for example, take heed of Emirates’ urging to launch an A380neo? Chief Fabrice Bregier thought not, at least not yet — saying that the priority for the Airbus A380 would be cabin enhancements and tweaks. Meanwhile, Boeing, facing stiff competition from the A321 was probed on a possible 757 ‘MAX’ — although the company has quashed such rumours before. Other options might be another stretch of the 737, or smaller 787. However, while these re-engined airliners are a sales hit (and this includes Embraer’s E2) in one respect they are sorely lacking — that of inspiration for the next generation. As one industry veteran remarked when watching the ’787 and A350 display: “These are the only airliners you will see for the next decade — get used to them”.

In defence, the biggest story bar none was the Lockheed Martin F-35 apperance cliffhanger. Having missed the HMS Queen Elizabeth aircraft carrier launch, and the Royal International Air Tattoo, its appearance at Farnborough was always going to have been a close-run thing. In the event, it did not make it. While eminently sensible it was a big public-relations disaster for the programme — turned what should have been the jet’s exciting international debut into fresh ammunition for critics. In the long term, this episode will probably not make much difference to what is a decades-long defence programme (and indeed valuable lessons on deploying overseas were learned) — however, it also meant that the team went home empty-handed without the predicted order announcement from the UK of its first production batch. There was one other theme that emerged during the show — that of a major UK cabinet reshuffle — which saw Philip Hammond moved to the Foreign Office and Michael Fallon made the new Secretary of State for Defence — ahead of the expected SDSR in 2015. This comes on top of other political distractions like the Scottish referendum and the General Election of 2015.

A major step forward for the UK space industry was announced by Robert Goodwill, UK Parliamentary Under Secretary of State for Transport, who explained that the CAA had identified eight potential sites for a new UK spaceport from which to operate sub-orbital space flights. The sites are all on existing airport or military land which could be adapted or improved, if required. The sites are: Stornaway Airport, RAF Lossiemouth, Kinloss Barracks, Cambeltown Airport, Glasgow Prestwick Airport (all in Scotland), Llanbedr Airport in Wales and Newquay Cornwall Airport. In addition to meteorological, environmental and economic factors, the eight sites were chosen on the basis of: being a reasonable distance away from densely populated areas, having the ability to operate segregated airspace and having an existing runway of 3,000m — or the capability of extending to that length. The Department of Transport is now awaiting comments from stakeholders of the proposals but the plan is for the site to be operational by 2018.

British Airways’ parent group IAG, placed a firm order for 20 Airbus A320neos.

Thales launched a maritime version of its I-Master lightweight tactical surveillance radar. The 30kg radar can be used in either ground moving target indication (GMTI) or synthetic aperture radar (SAR) modes.

Taranis flies ‘full’ stealth

BAE Systems revealed that its Taranis UCAV demonstrator had now successfully undertaken the second phase of flight tests at an ‘undisclosed location’ in its ‘full-up’ stealth mode. This saw the antennas replaced by low-observable ones and the air data probe, switched to stealth conformal sensors — to make the Taranis virtually invisible to radar.
In common with other forms of transport, there are mandatory insurance requirements that apply to air carriers. For example, air carriers in the European community are required to be insured to cover liability in case of accidents, in particular in respect of passengers, luggage, cargo, mail and third parties. Aviation insurance can also be taken out by manufacturers of products including airframers or engine manufacturers for liability in respect of their products which may give rise to claims arising from incidents.

Aerospace insurers underpin the whole of the aviation industry which would be unable to operate without them. While aviation insurance comprises a modest proportion of the overall insurance market, the risks borne by aerospace insurers run into billions in respect of a single incident. Cumulative exposures in the event, e.g. of a terrorist attack on a number of aircraft, such as that at Tripoli Airport in July, are enormous.

Specialist aerospace insurers include Global Aerospace Underwriting Managers (GAUM) while large insurers, such as AIG, Allianz, Amlin, Axa and Catlin, write specialty business, including aviation and aerospace risks, as part of their portfolio. The European Commission recognises the aviation/aerospace market as highly competitive, due in part to the structure of slips and policies in a verticalised, subscription market. Claims in this market are handled by a ‘leading underwriter’ who

**Taking cover**

GILES KAVANAGH* explains the vital role played by the aviation insurance market to protect aircraft owners, operators and financiers against liabilities in the event of an accident.
has the power to bind a ‘following market’ comprising a number of Lloyd’s syndicates or companies. The leader’s authority is subject to buy-in also from a limited number of ‘agreement parties’ — other participants on the insurance slip.

**All risks and war risks**

Aircraft insurance will be purchased by airframmers to cover damage caused as a result of pre-delivery incidents, e.g. test flights. Following delivery, operators of aircraft will have various types of insurance in place, depending on the nature of their operations.

The insuring clause in the policy will describe the risk in relation to which cover is being provided. Insurers may express their obligations by way of a general undertaking to cover the insured against all risks of loss, subject to exclusions that will appear elsewhere in the policy. Such policies are described as ‘All Risks’ policies, covering the insured property against all losses provided they are accidentally caused. Alternatively, the policy may specify ‘named perils’ in respect of which cover is provided, such as ‘war risks’.

Policies typically provide agreed values in relation to the aircraft covered so that there is no argument in the event of a total loss or constructive total loss. Such policies are also typically subject to deductibles which may also be insured under a separate ‘hull deductible’ policy.

**Pay first, ask questions later**

The importance of these types of cover, in the context of commercial aircraft, has been illustrated by the loss of MH370 and, more recently, MH17. Policy provisions enabled Malaysian Airlines to be paid quickly in respect of the MH370 aircraft hull, without there having to be a final determination as to whether the aircraft had been lost as a result of an accident or whether there had been sabotage. MH370 demonstrates the flexibility of aviation insurance products and the readiness of the aviation insurance market to provide rapid solutions for airlines and their financiers.

**Litigation complexities**

The lessor of an aircraft will generally insist on being named as an ‘additional insured’ under an operator’s all risks policy, so that the lessor’s interests and exposures are also covered by the operator’s insurers. The implications of these insurance arrangements are that the cover afforded to a lessor in the airline’s policy has been used by some lawyers to draw the airline’s insurers into litigation in a jurisdiction (typically the US) where there is no real connection to the accident. So aviation insurers are increasingly conscious of where lessors are domiciled. Average awards in death cases in the US are over $5m, contrasted with more modest awards in other countries. Plaintiffs lawyers (who in the US will typically be paid 30% or more of any damages recovered by their clients) are therefore incentivised to bring claims in the US, even where the accident has occurred in Africa or Asia and the connections with the US are tenuous.

Regarding the loss of flight MH17 which was shot down while flying over the Ukraine on 17 July, the incident gives rise to exposures on the part of war risks insurers in relation to the aircraft. Claims by passengers’ families are most likely to be made against the airline and its insurers in the first instance, although the airline has a potential defence to claims exceeding $170,000, if it can prove there was no negligence on its part and the carriage by air was governed by the Montreal Convention 1999.

There has been talk of passengers’ families bringing proceedings for the full value of their claims against the Russian Government; the recent award in the Yukos arbitration against the Russian Federation may encourage such thoughts, although enforcement against Russian authorities may not be easy.

**Value for money**

The products provided by the aviation insurance market are real value for money. The financial limits attaching to third party liabilities (e.g. injury to or death of passengers) under aviation policies will often exceed $1bn in the case of commercial carriers and may reach $2bn. Premiums paid by airlines and even manufacturers do not currently reflect these levels of exposure, although those premiums are now, sensibly, rising following the recent spate of crashes, including the TransAsia Airways crash on 23 July and the Air Algerie crash on the following day in Mali where 116 people were tragically killed.

**Policy cover and exclusions**

Are there any circumstances under which an insurer wouldn’t pay out? The insuring clause in an aviation policy will define the scope of cover provided and so for example, losses incurred by airlines due to the closure of European airspace following the eruptions of the Icelandic volcano in 2010, were typically not covered. Aviation policies, like other types of insurance, will...
provide for exclusions. There may be territorial exclusions, restricting the carrier from flying into or over certain countries. But the scope of cover provided under aviation policies is broad and debates about cover are the exception, not the rule. The aviation insurance market is in the business of paying claims and has a long record of doing so.

**Future challenges**

Aerospace insurance is continuing to evolve, to adapt both to changes in levels of existing risks and to new risks. **If you look at trends for commercial air carriers, safety has improved considerably, accident trends are generally downwards and there have been fewer large claims scenarios. However, claims arising in the past decade from airline losses have been substantial and complicated, involving significant cost to aerospace insurers, including legal costs. In addition, there are segments of the aviation sector where accident trends are less benign, for example for rotorwing operations and the GA sector more broadly. Rotorwing accident trends are currently a major concern for the NTSB in the US.**

Aerospace brokers and insurers are innovating, examining not only the ways in which risks are changing but also new forms of cover. The risk of cyber attacks has been much publicised and some aviation brokers and insurers are considering whether policy provisions may be included to provide significant levels of cover for resultant financial losses to airlines ATC etc. Another development is the increased use of unmanned aircraft. The International Union of Aerospace Insurers (IUAI), whose members underwrite approximately 90% of the risks in the aerospace sector, has been looking closely at the insurance implications of the commercial operation of UAVs which involve risks to property, injury and even death to people on the ground. UAV regulation in the UK and the US is in its infancy but this is a huge growth area for aviation.

Yet another interesting development is the advent of space tourist flights. There is a specialist satellite insurance market, but commercial manned spacetravel, for example by Virgin Galactic, is insured in the aerospace insurance market. Issues arising may depend on whether an incident occurs in space or atmosphere, where different legal regimes apply. What is clear is that those who undertake such travel are likely to be high-earning individuals such that any claims arising could be very expensive indeed.

The huge and continuing growth in air travel and man’s technical ingenuity means that the risks for the aerospace sector will grow and diversify. But, the aerospace community can rest easy that there is huge experience and expertise in the aerospace insurance market that will underwrite the risks that innovation presents.

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Stormy skies ahead? The aircraft insurance market is considering the future risks posed by cyber attacks against airlines and air traffic control systems, the advent of space tourism and the third-party liability issues posed by the increased use of UAVs.
Reliability in an era of change

ANTOINE BAVANDI, Space Risks Underwriter at Argo International, looks at the role of space insurance and risk management in the ever-evolving satellite industry.

Reliability is an essential attribute for space systems, with a failed launch having significant and often lasting financial and reputational effects for operators. After take-off, little can be done to correct anomalies on a spacecraft and, consequently, insurance is an important element in allowing companies to mitigate these risks. However, the limited availability of launch failure data, due to the small number of launches, combined with constantly changing technology has made it increasingly challenging for insurance underwriters to precisely assess and predict the ability of space systems to perform as intended. This problem is compounded by the lack of a consistent measure of the reliability of space systems. To address this, space insurers have proposed a method by which the reliability of both current and future systems can be more thoroughly assessed to the benefit of the space industry as a whole.

Technological advancements have dramatically altered the aerospace landscape. There are large-scale innovations, with new launch vehicles such as SpaceX’s Falcon 9 and ESA’s Vega rockets. These new vehicles, which are...
already in use and commercially operational, are challenging the dominance of established models such as Ariane 5 and Proton, compelling their manufacturers to assess every component to maintain profitability. This increased competition has, in turn, driven change and innovation across the entire procurement chain. An example of this is the significantly increased use of COTS (commercial-off-the-shelf technology) in launch vehicles over the more expensive space-qualified components.

Size does matter

Satellites are also changing dramatically. They now tend to be either bigger and more powerful — allowing economies of scale for a lower cost per amplifier in orbit, a key metric for the profitability of a commercial telecom project — or smaller and smarter, with adaptive antennas, on-board signal processing, improved spectral efficiency, and optimised use of higher frequencies (from C and Ku to Ka band). However, arguably the biggest change for satellites comes from the development of all-electric platforms, with the first Boeing 702-SP slated for launch in 2015. Benefitting from one of the lightest electric-propulsion technologies on the market, those satellites maximise the weight savings (and launch costs) but at a price of lower thrust, requiring between six and eight months to travel from initial launch vehicle injection to final geostationary orbit.

While the launch supply is diversifying, and the small satellites market is expanding, project financing has also become more accessible with the rise of low-interest export-credit agency (ECA) satellite funding. This has allowed more countries to enter the satellite industry and, today, the fastest emerging space countries are Brazil, Argentina, Taiwan and South Korea. There are new organisations, new operators, and new space nations, which reflect the ongoing democratisation of satellite communications in what seems to be a transition to mass market, driven, in no small part, by the appetite for direct-to-home (DTH) services and broadband applications (Internet by satellite). These new business forces often demand tight manufacturing schedules and, if unchecked, may jeopardise the overall quality standards.

Space insurance

While none of these changes are truly unique, the history of space communications has always been shaped by innovations and the combination is unprecedented, making it a nerve-racking and exciting time for operators, manufacturers, space enthusiasts and insurance underwriters. These developments have already had a profound impact
on the space insurance market, which, in recent years, has experienced a great deal of volatility, unexpected failures and unforeseen success stories. Statistics alone emphasise the unique nature of the space insurance market: a single rocket launch can generate 10% of the industry's annual premium, while one launch failure can wipe out the market's annual income. And this unpredictability has somehow been amplified lately, as the space communications industry as a whole experiences a sea-change.

Space insurance is a key element of any commercial space project, providing the certainty of loss-free operations in exchange for a premium proportional to the risks involved. The complexities of the space industry, enhanced further by the recent developments, mean that, regardless of whether the duration of the insurance protection required is for as little as athree-hour launch sequence or as long as a full year of in-orbit life, it requires a thorough understanding of the operator's asset, finance and business plan as well as the models it employs. It also demands an in-depth knowledge of their history, experience and long-term vision. With the life-cycle of a single satellite project typically being around 20 years (from early design to end of life), it is a long-term investment, a close partnership that requires transparency, stability and confidence. To maintain this over the years in a financially stable and sustainable way, it is necessary to refine the insurance market's risk approach and improve the correlation between current pricing and new risks, while accounting for a significant amount of uncertainty. This can ensure that confidence in the insurance community is maintained and the strong co-operation between client, finance and insurance is reinforced today and for the future.

**Understanding risk**

Collaboration between operators and insurers will significantly benefit both parties. From improved risk understanding, to reduced volatility of premium rates and valuable risk prevention and mitigation planning. Given the financial requirements for any launch, the cost of risk prevention will always be less than the impact of a loss. The payment from an insurance claim payment will never fully compensate for all other losses an operator or manufacturer might suffer such as anomaly investigation costs, the impact on reputation, or on future sales. Unique opportunities can also be missed with, in the case of a total loss, the operator often needing two-to-three years for another satellite to be financed, designed, procured and built, during which time the market will have changed and the opportunity may no longer exist, in particular for new ventures.

As a consequence, insurers, in collaboration with operators and manufacturers, propose to redefine our way of assessing reliability for satellites, through the implementation of a common terminology and a transparent computation method. This will enable more diligent underwriting and allow in turn for more technical pricing and improved rate differentiation. The risk quantification exercise should be supported by actual flight data. Soft factors such as quality, design robustness and redundancies, system sensitivity to any given failure (to improve our understanding of the satellite's ability to absorb critical anomalies), corporate culture and vision should also be assessed as part of a separate but complementary qualitative approach.

Satellite manufacturers are implementing more stringent quality control standards in the design and manufacturing processes, which have been under the spotlight in the recent past, following a series of quality-related anomalies. This increased emphasis on quality control is a promising indication that the outlook for the future of geostationary commercial communications satellites will be one of higher reliability. Significant changes are ahead of us, which come with a great deal of uncertainty. The past will not reflect the future. It is insurance community its underwriting tools of assessing reliability, of an improved risk process which would language and track records in an agreed format. We believe this is a necessary step towards more diligent underwriting, and a great step towards reaffirming the insurance market's stability and its long-term partnership with the space industry.

**Boeing's 702-SP all-electric satellite is scheduled for launch in 2015.**
The SAM threat & civil aviation

The tragic loss of Malaysia Airlines MH17 has highlighted the dangers of surface-to-air missiles to commercial air transport. Can anything be done to protect them? TIM ROBINSON offers analysis.

This July has been a black month for civil aviation – with the loss of so many lives. Perhaps most shocking was the loss of almost 300 people on 17 July on flight MH17. Compounding the horror of the 298 people who died on the Malaysia Airlines Boeing 777 over eastern Ukraine was the cause of their death, not mechanical failure, bad weather, or pilot error — but likely destruction by a surface-to-air (SAM) missile fired from the ground.

The aircraft was on a recognised, international flightpath and flying at cruising height (33,000ft). Attention has turned to what can be done to prevent this type of incident in the future. Certainly, there have been similar disastrous shootdowns of civil airliners in the past. The late 1970s, for example saw two airliners shot down in Zimbabwe by rebels using MANPADS. Meanwhile, in 1983, there was international outcry when a Soviet interceptor shot down Korean Air Lines Flight 007 with an air-to-air missile. In 1988, a US Navy missile cruiser, USS Vincennes, mistook an Iran Air A300 airliner for an Iranian F-14 — blowing it out of the sky. More recently, in 2001, a Russian Siberia Airlines Tu-154 was downed over the Black Sea, most likely by an Ukrainian S-200 SAM in an air defence exercise gone terribly wrong.

Today though, the overall safety of air transport makes this latest isolated event even more shocking and unfathomable. In the wake of MH17 there have been fresh calls to look at missile defences for airliners — with one US senator saying he will petition the FAA to install active missile defences on airliners. Is he being realistic?

The MANPADS threat

The most common type of missile threat an airliner might face is from small, portable shoulder-launched missiles — or MANPADS. However, despite dire warnings over MANPADS proliferation since the 1990s, the spectre of civil airliners being shot from the skies every week never came to pass — why? Firstly, despite the vulnerability of civil airliners, they are usually much larger than the targets MANPADS are intended for — helicopters and low-flying fighters or attack aircraft. The attempted shootdown of a DHL A300F cargo aircraft with MANPADs over Baghdad in 2003 shows the surprising resilience of modern airliners to IR missiles with small warheads. This failure may have played a part in discouraging other terror or insurgent groups that despite the opportunity presented by these tempting targets, the risk is simply not worthwhile for a low-chance of success.

Second, is despite that airliners are low and slow on approach and take-off, the effective range (approx 3km) of MANPADS coupled with the limited maximum altitude (approx 11-15,000ft) of missiles like the SA-7, SA-16 or SA-24, means any
insurgent will need to be fairly close to the end of the runway in order to get a shot with a high probability of success. There are thus limited places for a successful kill which airports and security agencies are aware of and keep at many airports a special watch on for any unusual activity. The third challenge for insurgent groups is that, without the extensive support and spares system that an established military has, it may be difficult keeping MANPADS in working order as they (like consumer goods) have ‘best-before’ dates. In particular, batteries can run down, leaving the missiles useless.

Fourth, is that counter-proliferation efforts have so far proved remarkably successful in restricting the flow of these weapons — especially in rounding up and buying back US-made Stingers, which changed the course of the Soviet Union’s conflict in Afghanistan.

Finally, while many terrorist groups aspire to violence and indiscriminate killing, shooting down an airliner, while guaranteed to grab headlines, also puts the insurgents on a number one enemy list. An international passenger list means that not just one country but several countries intelligence and security agencies will be hunting your group and crucially sharing information. It may be that, while ownership of MANPADS will be a status symbol to many groups, actual use has not matched fears. Indeed, since the Mombasa 2002 attempt and the DHL/Baghdad incident in 2003 there have been no confirmed cases. This, of course, is not to understate the threat. The political and social convulsions in the Middle East from Libya to Syria are especially worrying in that fears that ‘Arab Spring’ and uprisings have put large stocks of MANPADS into the wrong hands.

‘Buk’ and high-end SAMs

However, the missile system fingered for the destruction of MH17 is of a more sophisticated nature. The ‘Buk M1’ (Sa-11 NATO codename) is a tracked vehicle with four missiles ready to launch. Crucially, in normal doctrine it is deployed as part of a battery, with a radar vehicle (Snow Drift) and a command vehicle allowing simultaneous launches and situational awareness of the wider air picture (including IFF). However, should the Sa-11 individual missile vehicles (TELAR) become separated, or the radar destroyed — they can act in an autonomous, stand-alone mode, with their own radar. It was, very most likely that this stand-alone mode — with no IFF and limited situational awareness of the wider air picture, was a key factor in dooming MH17.

Yet the ‘Buk’, despite its large warhead and engagement altitude (72,200ft), is only a medium-range (42km) system compared to the S-300V (SA-12) series — which can not only reach 82,000ft, but also has a range of 200-250km — giving it

Shoulder-launched terror?
Igla-S MANPADS at a defence show. Light, portable and lethal they allow infantrymen to counter enemy air attacks

DESPITE DIRE WARNINGS OVER MANPADS PROLIFERATION SINCE THE 1990S, THE SPECTRE OF CIVIL AIRLINERS BEING SHOT FROM THE SKIES EVERY WEEK NEVER CAME TO PASS

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Air transport
MH17 shootdown implications

The ability to deny large swathes of airspace to aircraft. The ‘Buk’, with its smaller engagement zone, would have relied on the separatists putting it in a favourable position where Ukrainian transport or ground attack aircraft were known to fly. It thus seems it was sheer bad luck that the Malaysian flightpath intersected the threat zone of this vehicle, especially when other civil flights had also been in the vicinity at the same time.

The more advanced S-300/400 family is a complex, lethal SAM system only used by nations — as part of a battery and tied into a national integrated air defence (IADS) system. It would thus seem unlikely that this level of equipment could be operated successfully by insurgents or rebels. Key factors in the MH17 shootdown are that the ‘Buk’ can operate as a single vehicle, outside the usual battery. This, coupled with Ukrainian rebels with army experience who probably had either switched sides and/or received additional training from Russia in handling this weapon, perhaps explains how a medium-altitude, mobile, tracked SAM system could be operated and fired by irregular forces. The downing of Ukrainian AF An-26 on 14 July while flying at 21,300ft, (above the usual MANPADS maximum engagement zone) showed that the ‘Buk’ most probably had been used in this previous incident.

Defensive measures

Given these lethal threats — can anything be done for civil airliners? Modern military aircraft carry a wide range of defensive aids, from electronic jamming pods, to chaff and flare dispensers to spoof incoming missiles. Larger aircraft, such as tankers, transports and VIP assets, also can be equipped with DIRCM (directed infra-red countermeasures) a laser in a turret able to burn an IR missile seeker out. However, against radar-guided missiles, HVA (high value assets) such as transport aircraft would, in the first instance, be kept well away from these threats.

Some of these technologies have already made their way into the civil arena. Certain VIP aircraft or government bizjets are already equipped with defensive aids, such as DIRCM turrets. In 2002, an attempted attack by Al-Qaeda militants using MANPADs on an Israeli charter airline in Kenya saw Israel take the unprecedented step of deciding to equip all its airliners with anti-MANPADS defensive aids under a project called SkyShield.

Following these near-misses in the 2000s, anti-MANPADS systems for civil airliners are now being offered on the wider market. Israel’s Elbit Systems, for example, produces the C-MUSIC a low-profile DIRCM now under testing for SkyShield. Meanwhile Sweden’s Saab offers CAMPS (Civil Aircraft Missile Protection System) which uses decoy flares that can only be released in flight (a major worry for airlines in regular airport operations).

Finally, another approach is to protect the airspace around airports with a ground-based system to destroy or spoof any MANPADS missile away from its intended target. Raytheon, for example, proposed a ground-based system called ‘Vigilant Eagle’ for the US Department of Homeland Security — which would use high-power microwave directed energy to fry the missile’s electronics in flight.

However — an important fact lost in the calls for airliners to be equipped with military-specification missile defences is that chaff and flare release is usually combined with a radical manoeuvre to assist in breaking lock and make the missile go wide. Timed correctly, a fighter pilot can use the massive speed of an incoming radar-guided or IR missile to force it to overshoot.

Elbit Systems is now marketing the C-MUSIC defensive system for airliners.
There is, of course, no way a civil airliner can perform these manoeuvres — even if the pilots were aware a missile was coming their way.

It is also notable that all of these current anti-missile systems for airliners are designed to counter IR MANPADS at low altitude. Incorporating jamming pods, electronic warfare capabilities or chaff to foil radar-guided missiles would be hideously costly, impractical and, because of the above point about manoeuvring, it still would not guarantee the safety of the crew and passengers. Adding the additional complexity of defensive aids systems also raises issues of airworthiness and training.

The evolving SAM threat

One other related point that the loss of MH17 and military aircraft to SAMs over Ukraine highlights — is the need for stealth aircraft, EW and SEAD to effectively counter these ground-based threats in modern conflicts. In a matter of days since 16 July Ukraine lost four of its ground-attack Su-25s — a sizeable chunk of its combat effective force — and an unsustainable loss rate for any air force. Compare this to coalition fixed-wing losses in Afghanistan — which, despite operations lasting over a decade, saw accidents, not enemy shoot downs as the biggest cause of destroyed aircraft. Part of this can be attributed to differences in the threat level (MANPADS and AAA being the chief threat in Afghanistan — the insurgents having no systems comparable to the ‘Buk’). Another part of this is in the technology. Targeting pods, precision guided weapons and armed UAVs have evolved close air support for western forces — allowing them to ‘stand-off’ above low-level SAM and AAA threats — yet retain accuracy. Recent shoot-downs of Ukrainian aircraft (and Russian combat aircraft in the 2008 Georgian conflict, along with Syrian AF losses in its civil war) demonstrates how high the level of losses would be without these key technology and tactics.

However — the appearance of a Sa-11 ‘Buk’ in Ukrainian rebel hands underscores that, in future conflicts — even perhaps against insurgent forces, higher altitudes will be no guarantee of safety. Air forces, will need to consider this in procuring equipment and in evolving tactics. No wonder that, despite the price tag (and the recent no-show at Farnborough), many nations are keen to acquire the low-observable F-35 — as this offers a way to complete missions, even in airspace defended by the latest long-range ‘triple digit’ SAMs.

Conclusion

While technology certainly exists to defend against airliners against IR-guided SAMs, fitting it to the world’s civil airliner fleet would be prohibitively expensive. If mandated, it would throw up all sorts of additional questions. Would all airliners, whatever size, need them — from Twin Otters to A380s? Or would it be required only for airliners that flew into danger zones? What about airliners that only fly domestically? Would they need them too, or would that just open a new security loophole, with terrorists then focused on smuggling missiles to target internal flights?

Defending airliners against high-end radar guided SAMs such as the ‘Buk’ or even the more lethal S-300/400 series is even more unrealistic. Even 9G-capable agile military fighters equipped with EW jammers, towed decoys, flares and chaff face stiff challenges in penetrating the threat rings of the latest SAMs — hence the move to stealth, electronic attack and stand-off weapons. Large, ponderous targets would have no chance.

In summary — the safest course of action for the civil airline industry when faced with unstable regions where there may be an elevated threat from high-level SAMs (beyond low-altitude MANPADS), is to avoid the area completely. Instead, quicker and more co-ordinated global intelligence sharing of airspace threats is a key lesson from this tragic incident.

This could perhaps include tweaks to the existing NOTAMS to ensure that critical information like ‘An-26 shot down by suspected SA-11 Buk at 23,000ft’ is better highlighted among the hundreds of other warnings, safety notifications and directives that pilots, dispatchers and airline bosses must digest in risk decisions about flight planning, routes, and diversions.
TECHNOLOGY Horizons

From human-machine interfaces of the future, to 3D printing and ultra-fast wireless communications, NAN MATTAI outlines Rockwell Collins’ R&D path to innovation.

From the early days of flight to the connected sky of tomorrow, Rockwell Collins has a heritage of pioneering technologies in aerospace and defence. Our company is dedicated to serving our core markets through exceptional execution of current commitments while leveraging that performance to gain new business opportunities. Looking forward, accelerating growth is a top priority and we plan to do this by enhancing and expanding our addressed markets, growing our international business and maintaining our strong commitment to innovation.

Biggest challenges

Currently, there are two sets of challenges that stand out. The first is the tough economic environment and continuing budgetary pressures, primarily in the advanced economies. This has resulted in changing priorities and the pressing need to reduce total cost of ownership. The second challenge is maintaining an innovative edge in an increasingly competitive environment to provide our customers with the best capabilities to meet their mission and operational needs at an affordable cost.

Innovation is at the heart of how we best serve our customers and, given fewer funds for next generation technologies, the intense global competition and the increased pace of technology change, it is a challenge for companies to raise the stakes and invest in the right areas to have the right solutions ready at the right time. We cannot afford to stand still, as there is always the risk of disruptive innovation and new players entering the market, displacing the incumbents. To stay ahead and differentiate in this challenging environment, Rockwell Collins invests between 18-20% of its annual revenue in research and development. These investments are targeted to high priority technologies that align with customers’ needs and corporate strategic direction.

Future technologies

These are some of the future technologies we are most excited about:

Photonic communications — Radio frequency (RF) systems on the modern battlefield must cover many RF and microwave bands and deliver accurately processed information. Software-defined radios provide the capability for a single radio to generate multiple wave forms, allowing them to serve the functions of many different conventional radios. Photonic technology transmits information using light and has the potential to digitise signals at

Z-Fab brings 3D printing to the computer chip scale.
higher frequencies and with more resolution than ever before. This technology can further enhance the capabilities of today’s software-defined radios with direct conversion receiver capability. Silicon based photonics-integrated circuits enable high-speed, high-resolution analogue-to-digital converters, significantly reducing size, weight and power requirements while boosting performance of today’s RF systems.

Information analytics and human machine interfaces — Rockwell Collins has pioneered information delivery and security for over 80 years. Today we are building on that experience to develop systems for the 21st century: information-rich flight decks, smart targeting systems, real-time battle-space networks, and aviation information management solutions. The future lies in connecting everything, getting hardware functions into software applications that run on open architectures, proliferating sensors through aircraft and systems, and controlling where data goes, how it is distributed and analysed. We expect that the number of aircraft that are information-enabled — those featuring advanced avionics, connectivity and information services and applications — will increase significantly by 2030. The volume of data available to these systems will be much greater and more complex, requiring new technologies and tools to integrate and translate into meaningful, actionable information.

Given this more interconnected world, improving information analytics and human machine interface to provide the most efficient, secure and reliable real-time interconnectivity possible is foundational. A good example is air traffic management in the NextGen airspace. The backbone of this system is the new surveillance system, Automatic Dependent Surveillance — Broadcast or ADS-B. With the ADS-B Out mandate to go into effect in 2020, aircraft will broadcast precise location and other information about the aircraft to ground stations and other aircraft equipped with ADS-B receive capability. Processing and presentation of this information will give air traffic controllers and pilots a better understanding of their environment.

Additive manufacturing /3D printing — The potential for this technology to be a game changer in aerospace manufacturing is out there with dramatic progress being made. Additive manufacturing builds objects by adding parts together in layers, rather than taking raw material and ‘subtracting’ excess material away from fitted moulds, as in traditional ‘subtractive’ manufacturing. Additive manufacturing isn’t new but was typically used for small plastic prototypes of objects, aiding design tweaks. Mass production of metallic objects for commercial and industrial use, built up layer-by-layer and modelled through software, has sparked excitement in manufacturing. Rockwell Collins has developed a game-changing additive manufacturing technology at the microelectronic device scale called Z-Fab. Z-Fab is used to create 3D radio frequency (RF) components that reduce size and cost of radio systems while improving performance and increasing functionality. The Z-Fab design process utilises the latest in 3D parametric design tightly coupled with high fidelity co-simulation methods (electrical, thermal, and mechanical). This technology is quickly growing to include active integrated circuits, greater functionality, higher power and frequency, and further reductions in size and cost.

R&D investment

Meanwhile we are investing in R&D to create the technologies of tomorrow:

Adaptation of commercial-off-the-shelf (COTS) technologies — With defence budgets tightening, the days of defence programmes spending billions of dollars developing new technologies are gone. Actually, defence programmes are placing greater emphasis on open architectures and affordable mature technologies (high technology readiness levels) that are ready to be introduced onto programmes to reduce program uncertainty and technical risk.

Given the investments being made in the consumer industry in technologies such as connectivity, computing, high-speed networking, graphics, displays, augmented reality and 3D printing we are working to rapidly adopt and adapt these COTS technologies for the unique commercial and military applications.
Cockpit of the Future (2020 and beyond) — The cockpit of the future (2020 and beyond) must be ready to meet the requirements of global air traffic modernisation initiatives such as NextGen and Single European Sky. The future flight deck will be an intelligent cockpit that forms an integral and interactive part of the airspace eco-system, aware of the aircraft and the environment around it with an unprecedented amount of information available from advanced sensors, databases and connectivity channels.

Rockwell Collins is focusing its research and development efforts to provide greater safety, security and efficiency through enhanced situational awareness, improving human-automation interaction and efficiency in operations. Sensing and other technologies are creating the ability to see weather and terrain outside the specified flight path, as well as other aircraft, allowing the pilot to make real-time decisions to benefit the passenger or mission, while improving operational efficiency. We are developing next generation large format display, sensor and data fusion and intuitive human machine technologies to provide pilots a heads-up, eyes forward capability for operations in challenging low-visibility conditions.

Adaptive Networked Communications — Rockwell Collins has been pioneering airborne and surface communication capabilities for military customers for more than 80 years. We provide solutions that offer high throughout, spectrum-efficient, ad-hoc networking capabilities that address tactical operations requirements. The future battlespace is becoming even more complex, contested and highly congested. Assured secure communications regardless of the electromagnetic environment is critical to mission effectiveness. Therefore, the need for jam-resistant communications and difficult-to-detect communications technology to keep battlefield networks functioning amid a variety of spectrum-warfare threats is a top priority and aligns well with our capabilities and strengths.

Terahertz communications — Today’s radio bands are heavily allocated, data rate limited and near saturation. One of the avenues of research that is being explored to address this problem is terahertz communication. The challenges of working in the THz regime are balanced by the massive potential to unlock very high data rates for end-users in a large new carrier frequency space for wireless communications. The terahertz frequency range from 100 GHz to 10 THz, lies in the frequency gap between infrared and microwave wavelengths.

The properties and propagation characteristics of THz waves are shorter wavelengths, wide bandwidth and high directivity. Several research groups around the world have reported impressive results in THz communications but the key issue that remains in achieving robust THz links is obtaining long-term error-free performance which is required for real-time applications like video streaming. The realisation of THz communications
relies on stable, robust THz emission chips, including power amplifiers at emission and low noise amplifiers at reception. THz communications with achievable data rates of 50 gigabits per second and more could be a game changer for many applications, such as machine-to-machine interfaces or transferring massive amounts of data. One application would be to eliminate many of the thousands of feet of electrical cable in an aircraft, thus saving hundreds of pounds of weight and freeing up space for other applications.

Formal methods for cyber-physical systems — model-based engineering — The development of modern embedded systems is becoming increasingly difficult and challenging because of their overall system complexity, tighter and cross-functional integration, the increasing requirements concerning safety and real-time behavior, and the need to reduce development and operational costs. Formal methods are mathematical techniques for the specification, development and verification of software aspects of digital systems.

The mathematical basis of formal methods consists of formal logic, discrete mathematics and computer-readable languages. The use of formal methods is motivated by the expectation that, as in other engineering disciplines, performing appropriate mathematical analyses can contribute to establishing the correctness and robustness of a design. Implementing a formal methods-based approach to the development of large complex systems can provide the highest levels of dependability and resiliency. Formal methods also have the potential of reducing DO-178c certification costs and improving test coverage.

Formal analysis can be applied to architectural models before the system is built, allowing ‘virtual integration’ and allows finding problems before going to the integration rig. Formal methods tools are also being developed on the Defense Advanced Research Projects Agency (DARPA) High Assurance Security Program (HACMS). This project involves developing formal methods tools to analyze UAVs for cybersecurity vulnerabilities.

Which technology to pursue?

There are often more ideas than investment dollars which requires us to make consumption choices and place technology bets. This is not a process to be taken lightly, making the down-selection process a complex, rigorous task that involves a wide range of parameters and stakeholders. The key to innovation success is solving problems customers care about, alignment with business growth strategies and market timing. To ensure that we are solving the right problems, we engage with our customers early and often, seeking their feedback during the development of new technologies.

Through the engagement with advanced research labs, such as DARPA, the DoD Service Labs, NASA, FAA, regulatory agencies and original equipment manufacturers (OEMs), we gain awareness of emerging customer needs. At the same time, we stay aware of emerging technologies through universities, academic studies, trade shows and media reports. By bringing together the base of technology know-how with emerging customer needs, we are able to identify where the big opportunities might exist in our markets and the technology and product strategy needed to make it happen. In partnership with business leaders within our company, an assessment of the market and strategic fit is made resulting in a prioritisation of the technology thrusts and initiatives.

To mitigate the risk and exposure, we engage with our customers through technology demonstrations and in-house customer immersion labs so that they can see the prototype and experience what value it brings. Having done all that, we have to remain flexible and be prepared to terminate a project if the market need or customer strategies change. At the end of the day, having a differentiating competitive solution that delivers a powerful convincing value proposition to the customer is what it takes to win.
Aviation history
ORA then and now

Bolt into the BLUE

With tensions between Russia and the West at a new high — IAN BLACK describes a Cold War-era scramble — in the ultimate interceptor — the English Electric Lightning

It is August 2014 and I’m writing this article amid a plethora of ‘hot news articles’ involving air defence intercepts. A Royal Air Force Typhoon FGR4 intercepts Qatar Airways flight QR23 and escorts it into Manchester Airport with a credible bomb threat over UK airspace. Meanwhile, USAF F-15s of Alaskan-based squadrons are intercepting Russian Tupolev Bear bombers close to US waters after the tragic shooting down of Malaysian Airlines Flight MH17 over Ukraine. Tensions are high and the world is a more volatile place than it ever was.

But turn the clock back a quarter of a century and I’m sat on a windswept base in North Lincolnshire — the air reeks of aviation fuel. I’m feet away from a live armed English Electric Lightning fighter built in the early 1960s but still then fulfilling a vital peacetime role ORA (Quick Reaction Alert). Then, as now, the Royal Air Force maintained a round-the-clock alert state. Two aircraft were live armed ready to scramble at a moment’s notice to intercept the unknown. The two pilots and two aircraft (no different today at RAF Coningsby with the Typhoon) are part of a big picture — air defence fighter, pilot, ground crew, engineers, air traffic controllers, refuellers, suppliers, ground control intercept (GCI) officers, civilian radar and, of course, tanker support all keep Britain’s skies safe.

**English Electric Lightning F.6**

**54,000ft**

**SERVICE CEILING**

**1,300mph**

**MAX SPEED**

(36,000FT)
The Lightning was well suited to the job of a rapid response fighter capable of launching in all weathers in well under five minutes from idle to airborne. Pilots sat waiting in full exposure suits on 24-hour calls of duty day and night. The monotone click, click of the telebrief was a stark reminder of the open line to GCI (ground control). This would either be pre-warned with a phone call of expected 'activity' as 'Zombies' (unknown contacts) headed round the Iceland-Faeroes gap or in true Battle of Britain style, the call of "Scramble Scramble Scramble" followed by your own personal callsign and a vector and height for initial contact with GCI.

It is hard to describe in words, the feeling of sitting in a dormant state fully kitted-out to getting the message to launch. With just a frequency, heading and height you run to your aircraft, grab your 'bone dome' and climb the ladder into your cockpit — outside it could be a beautiful summer's day or it could be the dark of night mid-winter snow blowing round the hangar — it matters not. The clock is now ticking. It is vital you are airborne in under five minutes and the only joker you can play for not achieving this task is a technical fault — but it needs to be good.

**Strapping in**

Strapping in takes the longest part, ensuring your harness is locked, safety pins are removed and oxygen is connected. As soon as the ground crew remove your ejector seat safety pins and your seat is live, he dismounts, removing the cockpit ladder, the rapid start gang bar is pulled up, power is on and with a single finger raised you give a circling motion of the hand and press the number 1 starter. An almighty wheezing noise is followed by a 'whoosh' as a gallon of volatile Avpin A Mono combustible fuel similar to the German T-Stoff/V-Stoff rocket fuel is injected into the starter and the massive Rolls-Royce Avon springs to life. As soon as the RPM rises, a check of the jet pipe temperature (as a hot start will melt the back end and do serious unseen damage) and the number two engine is given the same treatment. With both engines at idle, the electrics and hydraulics come to life.

Now the radio crackles and as calmly as possible, you ask air traffic for taxi clearance. The hangar doors are now open, the ground crew have removed the external power and, as you release the parking brake, the Lightning lurches forward like a pit bull on a lead eager to be released. As a QRA scramble you have absolute priority and the 20 metres you have before entering the active runway is enough to complete the vital pre take-off checks: Canopy is down and locked — seat pins are out — flaps are down and no warning captions are illuminated. The ground crew have worked their magic and your aircraft is serviceable — as you line up both throttles are moved smoothly forward. A low rumble becomes a roar and you push the throttles into reheat (burner) a noticeable kick in the back lets you know they are lit without the need to look inside. The speed increases rapidly and you are now committed to take off. At 165 knots you ease the stick back and the heavy Lightning reluctantly breaks terra firma. Swiftly the gear is selected up to reduce drag and the flaps come from down to up. Head inside and a glance around the cockpit to check nothing is amiss. The radar is selected to 'on' and you hope that this 1950's valve-driven device will function — it's a no-go item and your only means of finding the tanker and target in the dark night sky.

**Identify and shadow**

While the late 1980s might have been the height of the Cold War, the mission today is no different — defending UK airspace. Each pilot has spent the past year on his particular type, training for this moment — the ability to intercept, identify and engage a target day or night. In peacetime the normal routine will be to intercept, identify and shadow or shepherd the target but, in an escalation to war, that may change.

Today, pilots have the added responsibility (as seen recently) of intercepting a civilian airliner and either shadowing it or, in the worst scenario, destroying it. Obviously, this would require Prime Ministerial approval and the threat that an airliner was going to impact a major city causing untold loss of life would not be taken lightly. However,
the fact that the UK possesses the capability to engage any target from a slow-speed Cessna to a high-speed airliner should send a clear message to anyone intent on using an aircraft as a method of destruction that the RAF are prepared for this tactic.

**Then and now**

Having been built in the 1960s, the English Electric Lightning was well suited to getting airborne in rapid time and intercepting an unknown target in day and night in clear air. However, its successor, the Tornado F3 and, more recently, the Typhoon FGR4 have some distinct advantages. The Lightning’s endurance is poor (abysmal might be a better term) and tanker support was a 100% requirement on every QRA launch. Its navigational aids were minimal and it also relied on the tanker for information once outside radar and radio aids navigation. The ability to record the unknown aircraft in a Lightning is down to a trusty Pentax 35mm camera armed with high ASA film. Today video recording is in vogue and pilots have a range of other devices to complete the task — infrared search and track (IRST) as well as night vision goggles (NVGs) which make night flying a walk in the park. The Lightning only had a small light fitted to the refuelling probe to illuminate targets — despite trials in the early 1960s of fitting high-intensity searchlights into one of the two air-to-air missiles, the idea was dropped. Occasionally pilots were known to use hand-held torches to get identification details of Russian bombers but this meant getting dangerously close.

**Summary**

Today the threat may have expanded, but the role remains the same. Quick Reaction Alert is perhaps the most important task the Royal Air Force undertakes in peace time from home soil and future governments would be well advised to diminish this responsibility at their peril. While the Lightning might have been capable of the task in the 1960s, the Typhoon of today’s generation is more than suited to the increased diversity of threats to UK airspace.
**Message from RAeS**

*President*

"Looking to the future, my President’s Conference ‘Space: The Strategic Choices’ will take place in Hamilton Place on 8 and 9 October. We have put together an exciting programme with distinguished speakers from Europe, the US, Asia and Africa. It promises to be a landmark event and I would urge you to attend."

*Chief Executive*

"Almost a distant memory now, both the Royal International Air Tattoo at Fairford and the Farnborough International Air Show were great successes for the Society. The Build-a-Plane teams excelled at both events, with the highlight being a brief display by two of the aircraft at Farnborough. With the ongoing support of the Boeing Company this continues to be an excellent project from which many school children have benefited during recent years."

**Book Reviews**

44 Book Reviews


**Library Additions**

47 Books submitted to the National Aerospace Library.

**The Society at Farnborough**

48 A roundup of the Society’s achievements during the Farnborough Air Show.

**Farnboroughs Past and Present**

50 A small selection of photos from Farnboroughs past and present.

**Diary**

9 September

Farnborough Branch Cody Lecture

The life and times of the Harrier

Sir Donald Spiers

**Corporate Partners**

54 Three new members join the Society’s Corporate Partner Scheme.

**Inaugural Eric Brown Lecture**

55 July saw the inaugural Eric Brown Lecture delivered to the FAA Yeovilton Branch by Capt ‘Winkle’ Brown himself.

**Elections**

56 New Society members elected in the past month.
July was a busy month for many people in the Society, not least because of our involvement in the Royal International Air Tattoo and Farnborough International. There were many memorable moments, but two events stand out for me. The first was watching G-YTLY and G-SBAP, the first two Schools Build-a-Plane aircraft, take to the air and fly an impressive display on the Friday of the Farnborough Air Show. I believe that this is the first time that student-built aircraft have taken part in the Farnborough flying display and it was a fitting recognition of the success of the scheme and the efforts of everyone involved. The aircraft were flown by John Michie and Ray Lewis who, along with many of their colleagues from the Light Aircraft Association and other volunteers, have been stalwart supporters of the scheme.

I was fortunate to be able to meet many of our Corporate Partners during the show and view some of their latest products. I also attended the launch of the UK's Defence Growth Partnership. Judging by the number of ‘movers and shakers’ present from Government and industry, the partnership is starting from a very good position. The Society played a full part in Farnborough's Futures Day on the Friday, with staff and members passing on their advice and experience to hundreds of eager school children. It was encouraging to see the commitment of industry and Government to the aim of encouraging young people to follow a career in science and engineering and, ideally, aerospace. I was privileged to meet several young people who had been involved in the Schools Build-a-Plane Programme and a number of recipients of the Aerospace MSc Bursaries that the Society has been helping to administer. They all made a very good impression. In particular, the bursary holders were clearly excited by the opportunities in aerospace and were looking forward to finding fulfilling careers.

If the young people I met represent the future, then I feel very optimistic.

The second very special event is described in detail on p 55. It was a great privilege for me to be at RNAS Yeovilton on 29 July, to introduce Capt Eric ‘Winkle’ Brown and invite him to deliver the first Society Named Lecture in his name. Winkle, as I said at the time, is quite simply one of the most accomplished and distinguished aviators that the world has seen. I was there as a guest of the Fleet Air Arm Branch of the Society and earlier in the evening I had handed over a striking portrait of Captain Brown to Cdre Jock Alexander, the Commanding Officer of RNAS Yeovilton. The portrait, by the artist Lucasta Partridge-Brown, is part of the Society's collection and it will now hang, on permanent loan, in the Wardroom at Yeovilton.

Looking to the future, my President’s Conference ‘Space: The Strategic Choices’ will take place in Hamilton Place on 8 and 9 October. We have put together an exciting programme with distinguished speakers from Europe, the USA, Asia and Africa. It promises to be a landmark event and I would urge you to attend. Details are on p 59 of this issue and on the website.

The membership survey was run for the first time in 2010 and the results of this were extremely valuable, providing insight into the views and opinions of our members which were used to inform the Society’s future strategy. We are hoping to get the same excellent level of response this year and need as many members as possible to complete the questionnaire to gather the most representative view of the membership as a whole.

RAeS members are encouraged to participate and have your say about how the Society moves forward. In association with Dr Helen Watts (Lead Consultant in Applied Research, Worcester Business School), the questionnaire gives you the opportunity to rate your membership benefits and may take up to ten minutes to complete. The survey is available for RAeS members: https://www.surveymonkey.com/s/RAES2014

The Royal Aeronautical Society Membership Survey 2014 is live throughout September.

Thank you for taking the time to complete the 2014 Membership Survey.

Paper versions of the survey can be provided upon request to Scott Phillips:
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ENGINEERING COUNCIL COMPETENCE REQUIREMENTS

Changes to the competence requirements for Chartered and Incorporated Engineers and Engineering Technicians were published by the Engineering Council in January 2014 in its document UK-SPEC (3rd edition). The revised version can be reviewed on the Engineering Council website: http://www.engc.org.uk/ukspec.aspx

Unnecessary changes have been avoided and the revisions are mostly for the purposes of clarification or updating in areas which have come to the fore since the previous review such as ethics, safety and risk management. Attention has also been paid to enhancing the distinctiveness between IEng and CEng. There is an enhanced focus on the ‘commitment’ element of the requirement for registration and the addition of one new standard of competence for all titles: ‘Exercise responsibilities in an ethical manner’ (E5).

The Society will be implementing those changes as follows:

- Revised application form available on the RAeS website from 1 August 2014 for immediate use.
- Applications based on UK-SPEC 2nd edition will be accepted (together with UK-SPEC 3rd edition applications) up to the August 2015 closing date for applications.

All professional reviews will be conducted in line with UK-SPEC 3rd edition from 1 November 2015.
Percival and Hunting Aircraft
By D W Gearing

Air-Britain (Historians), 41 Penshurst Road, Leigh, Tonbridge, Kent TN1 1 BHL, UK (E mike@absales.demon.co.uk). 2012. 384pp. Illustrated. £32.50 (Air-Britain members), £42.95 (non-members). ISBN 978-0-85130-448-9.

Edgar Percival learned to fly with the RFC during the Great War and, after a period running his own commercial flying operation in his native Australia, came to England in 1928. A firm believer in the superiority of the monoplane over the biplane, he initially formed a relationship with The Hendy Aircraft Company, test flying their Type 281 and Type 302 aircraft, both of which were fitted with Basil Henderson's patented wing spar design. In 1931, considering that there was a market for a three-seat touring and sporting monoplane, Percival conceived the Gull which flew the following year though controversy as to how much the design owed to the Type 302 was to reverberate for years. There can be little doubt that in the Gull, the Mew Gull and his other pre-war designs, Edgar Percival created a breed of effective touring, racing and record breaking aircraft.

The first half of this copiously illustrated book sets out to record the development of these aircraft, balanced with brief details of the more meritorious flights made in Percival aircraft and the impact of the burgeoning Percival Aircraft Company on first Gravesend and then Luton. With separate chapters on each aircraft type supported by others chronicling the company history, the reader can almost choose his own way through the book, whether it be to focus on the changing aircraft designs or to follow the fortunes of the company through WW2 when it produced Airspeed Oxfords and DH98 Mosquitos alongside its own Proctor aircraft. The post-war acquisition of Percival by Hunting & Son Ltd and the eventual merger into BAC are ably covered, as are the development of the Prentice, Prince, Pembroke and both types of Provost.

The second half of the book briefly records the production, in service life and eventual fate, of every aircraft produced by the Percival Aircraft Company and its successors. While this may be of less interest to the average student of British aviation history, it does serve to reinforce the aim of this book as the reference book of choice for anyone seeking information on Edgar Percival and his company’s aircraft. If any criticism is merited, it would be that the technical description of each of the aircraft is more limited than a student of aircraft design might desire but this should not diminish its appeal to the more historically minded.

David Gearing unfortunately did not live to see the results of his comprehensive research in print and Rod Simpson together with the other members of the Air-Britain Percival Project Team are to be applauded for their decision to see his work through to its ultimate conclusion. With its balanced view of both the company and its aircraft this impressive volume will remain a comprehensively used resource for many years to come.

Dr Alex Ellin
CEng MRAeS
Flying the First Wings into Space
By M. Evans


This is an unusual and interesting history, researched and written in the 35 years after the X-15’s 1959–1968 flight programme. The author’s credentials are unique. She was only five when her father, an instrumentation engineer with Sangamo Electric, took her on one of his day trips to Edwards Air Force Base. She was shown close-up the NASA fleet of research aircraft and the X-15 ‘Iron Bird’ controls simulator. This was being used that day by Neil Armstrong, who chatted to this young visitor to such effect that she became a lifelong enthusiast for the X-15 and, in effect, its unofficial historian.

Until now, I have been well-served by the X-15 chapter of Jay Miller’s book The X-Planes: X-1 to X-45 (Midland Publishing. 2001) but this new book fleshes out the X-15 story into a factual, but much more comprehensive, account; it includes material gleaned by the author from dozens of interviews with surviving participants — pilots, engineers, mechanics, family members and acquaintances — and through painstaking and skilled documentary research.

Far more is told than in conventional histories; readers will learn from the various personal accounts how communities, families and individuals reacted to situations such as the desert environment, the Vietnam War, the assassination of President Kennedy and, of course, the vagaries of the X-15 programme itself, which made significant contributions to the Mercury, Gemini and Apollo adventures. Those were some of the big issues.

Inevitably, many small surprises emerge — for example, I was not aware of the Chuck Yeager versus Scott Crossfield rivalry and I did not know that RAF pilots on USAF/RAF exchange schemes flew on many occasions in the right hand seat of the B-52 launch aircraft. At the trivial level, a camper van lost its roof when the impatient driver tried to pass a sharp-edged X-15 being trucked south along inadequate desert roads. The X-15 was heading back for repairs at North American and did not suffer — the camper driver got no compensation.

As I was finishing this review, AEROSPACE broke the news that Lockheed Martin is now working on the SR-72, a Mach 6 cruise speed successor to the Mach 3 SR-71 Blackbird. If such a machine enters service, the X-15 would have contributed enormously, even though its flying career ended as long ago as 1968. Of its 199 flights, 45 exceeded Mach 4, 105 exceeded Mach 5 and five exceeded Mach 6: how’s that for a solid foundation for flight at Mach 6?

The social element in this splendid book adds much to the overall history of this remarkably successful research aircraft. My only complaint about the book — that there is no map to help one understand the extraordinary desert terrain covered by the X-15 — will not prevent the reader being very well rewarded.

Mick Jeffries
CEng MRAeS
The stated purpose of this book is to provide a discussion on the current law of air navigation, the steps being taken in its modernisation and the rights and liabilities of the key players.

Air navigation law is derived from those activities of the International Civil Aviation Organization (ICAO) carried on by its Air Navigation Commission. These activities consist of 12 fields which include those dealt with in this book.

The book also deals with environmental procedures for noise and emissions certification of engines which are part of the activities undertaken by the ICAO Air Transport Committee. Under Article 37 of the Chicago Convention 1944, ICAO draws up and publishes Annexes setting out the international standards and recommended practices for all operational activities including those in the air navigation field. The standard procedures in these Annexes should form legal duties or at least standards of care in the ICAO member states. If a state finds it impractical to comply with these standards it is obliged to notify ICAO.

The summaries provided by the book of the relevant Annexes and how they were developed are helpful, as also are the references to domestic litigation arising out of their application. Annex 6 dealing with operation of aircraft is dealt with briefly: one and a quarter pages at the end of Chapter 4 dealing with Search and Rescue and also pp 125-134 on Air Crew Fatigue Management. A reference to the important Canadian case of Swanson and others v R (The Queen) (Federal Court of Canada) 31.10.89 and Federal Court of Appeal of Canada 1991 would have been helpful.

The book touches on the question of whether the standards in the Annexes are formally binding on member states automatically except where a state opts out from certain procedures under Article 38 of the Chicago Convention. Reference to the conflicting civil law cases Ministere Publique v Schreiber 11RFDA355 (1957) and Etat Belge v Marquise de Croix de Maille de la Tour Landry (1958) Pasicrisie Belge 1,88 might help.

The book also deals with the origin of the sovereignty of airspace, the future development on an agreement on liability arising out of defective GPS signals, the planning and management of modern airports and also describes privatisation of state entities and monopolies law in the United Kingdom. While these subjects are important, they take up space which could, at least in part, have been used for further consideration of the current legal position. The book considers the resolution of disputes between sovereign states.

The text in Chapter 2 on Outer Space Treaties is substantially repeated in Chapter 12. There are a number of references to ‘tortuous liability’ which should have been to ‘tortious liability’.

The information contained in the book is useful. However, the question arises whether the dividing line in content between current air law on the one hand and topics of origins of air law, its modernisation and related subjects on the other is adequately drawn so as to meet the expectations of the reader, whether student or practitioner.

Tim Unmack
FRAeS
**BOOKS**

**AIR LAW**


**AIR TRANSPORT**


The author recalls in this informal memoirs his long career in aviation; originally joining BOAC in October 1940, he was to continue working for the airline through to its evolution into British Airways. Much of his over 40 years of service centred on air safety issues and air accident investigation.


A compilation of 23 papers previously published in various academic journals between 1992–2012 which collectively review the impact of deregulation and liberalisation on the airline industry, how the low-cost airline business model has evolved and the impact that LCCs have had on airports, fares and airline network development.

**AVIATION MEDICINE**


The analysis of human-automation interaction and how the interface can be designed to reduce human error and fatigue — such as can potentially occur on an aircraft flight deck — is discussed over the 21 papers included in this volume contributed by psychologists and medical researchers from the aerospace world.

**HISTORICAL**


The evolution of the V/STOL Harrier and its vectored thrust Pegasus propulsion system from the P1127 and Kestrel through to the operations of the GR5/ GR7 and VAAC (Vectored thrust Aircraft Advanced Flight Control) variants is reviewed over the 15 contributed papers.


A review of the history of the famous fighter from its evolution through to the major impact it was to have in WW2, on its pilots and on the men and women who worked around the aircraft.


A striking compilation of 100s of black-and-white/colour photographs are reproduced in this visual history of the development of aviation during the 20th century.

**HUMAN FACTORS**


A welcome new edition of the first biography originally published by Herbert Jenkins Limited in 1918 of the leading British fighter ace of WW1 who was posthumously awarded the Victoria Cross following his death in action on 7 May. It is preceded with a Foreword by David Lloyd George and Appreciations by Field-Marshal Sir Douglas Haig, Major-General Sir Hugh Trenchard and Brig-Gen F A Higgins.


A detailed revisionist biography of the famous WWO RAF pilot, focusing on his leadership of the attack on the Ruhr dams in 1943 celebrated in his best-selling book Enemy Coast Ahead (London: Michael Joseph Ltd. 1946).

RAeS debates diversity at Farnborough Air Show

The Thursday of this year’s Farnborough Air Show was significant in that a Royal Aeronautical Society Named Lecture, in the form of the Amy Johnson Debate, took place at the exhibition. Organised by the RAeS Women in Aerospace and Aviation Committee, the theme of the debate was ‘Diversity in the aviation industry — what would Amy think?’

On the panel were RAeS Past-President Jenny Body; Marion Broughton, VP, Thales Air and Land; Louise Donaghey, Rolls-Royce; Thierry Baril, Chief HR Officer, Airbus Group and Maria Miller MP.

Speaking about her company, Marion Broughton noted that, while 20% of graduate entrants were female at Thales, this dropped to just 4-5% at the top of the organisation. Meanwhile, Rolls-Royce’s Louise Donaghey, a senior sales director for engine support services, thought that Amy would be disappointed by the lack of progress in the sector and would say: “It’s 80 years on and you are STILL talking about getting started?” Thierry Baril from Airbus Group pointed to South Africa and Spain as two examples of countries leading the way in opening up male-dominated sectors, such as aerospace, engineering and defence, to females. Finally Maria Miller MP noted that aerospace and aviation was not the only sector facing a challenge — women in parliament were also severely under-represented.

The question and answer session also provoked a lively debate with questions about the need for suitable female STEM role-models, the issue that only 4% of those on flightdecks are female, and the question of whether the ‘oil streaked hands, dirty garages’ image of engineering as a whole, still persisted and was putting girls (and even boys) off from entering the aerospace industry.

However, despite the challenges — there were encouraging signs from the panel and the organisations that they represent, that people were now aware of the issue and things were changing for the better — albeit slowly. Said Jenny Body of the RAeS: “Previously, it was ‘male, pale and stale’ — but it is now changing — we are getting there to a certain extent.” However, for the global aerospace and aviation sector, with orders for 931 airliners placed during Farnborough week — the issue at large is not just one of fluffy political correctness, but the looming STEM skills gap that could derail the future growth of air transport, unless extra talent, of whatever sex or race, is found, encouraged and nurtured.

RAeS stand in Innovation Zone

The RAeS stand in the Innovation Zone in Hall 4. From left: Stephanie Jones, Membership and Communications Officer; Emma Bossom, Business Development Director and Pat Norris, Learned Society Board. Far right: The stand was also used by RAeS Corporate Partners. Here Christy Group CEO, Monty Christy FRAeS, discusses the company’s state of the art training technology with the Kuwaiti Air Force delegation.

Previously, it was ‘male, pale and stale’ — but it is now changing — we are getting there to a certain extent

Jenny Body
RAeS Past-President
RAeS Farnborough Summer Reception

The Royal Aeronautical Society Farnborough Summer Reception took place on Tuesday 15 July at the elegant setting of No.4 Hamilton Place.

For many at the Farnborough International Air Show, this is the social highlight of the week. Guests from the international aerospace community gathered on the terrace overlooking Park Lane and Hyde Park to celebrate the air show and make the most of the extensive networking opportunities.

The Society would particularly like to thank Raytheon for their sponsorship of this year’s event. We are also grateful to our resident catering company, food by dish, for providing a delicious spread of food and drinks.

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SBAP makes history

The Friday of the show saw the RAeS/Boeing Schools Build-a-Plane (SBAP) Challenge make aviation history when two Rans S6 ultralights, built by young people took part in the flying display. G-SBAP and G-YTLY took to the skies at this international exhibition not only in front of the young people that had worked hard to build them, but also displayed to 10,000 young people who had been invited to the air show as part of the careers and education Futures Day. This is believed to be the first ever time aircraft built by school children have taken part in a Farnborough flying display.
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An Overview of Hybrid Aircraft and the Airlander — Combining the Best of Aerodynamic and Aerostatic Lift
Chris Daniels, Head of Partnerships and Communications, Hybrid Air Vehicles
Greener by Design Lecture

15 September
Flight Cutaways
Tim Hall
Historical Group Lecture

23-25 September

23 September
Capt Ray Jones Lecture
Capt Simon Wood, Senior Standards Captain, Pilot Development, Virgin Atlantic Airways
Flight Simulation Group Lecture

30 September
Detect and Avoid — Enabling Safe UAS Operations Beyond Visual Line of Sight
Unmanned Air Systems Group Workshop

7-9 October
4th Aircraft Structural Design Conference
Structures and Materials Group Conference
Queen’s University, Belfast

8-9 October
The Strategic Choices for Space
President’s Conference

13 October
Aerospace Medicine Group Lecture

21 October
Alternative Fuels and Propulsion Systems — Reducing Aviation’s Impact on the Environment
Greener by Design Conference, held jointly with the RAeS Propulsion Group

24 October
Civil Aircraft Technology Services — A First Step Towards Achieving Maintenance Credits
Air Transport Group Workshop Group

29 October
Yesterday’s Weapons for Tomorrow’s Operations
Weapon Systems & Technology Group Conference
QinetiQ, Farnborough

All lectures start at 18:00hrs unless otherwise stated. Conference proceedings are available at www.aerosociety.com/news/proceedings

Nord 1500 Griffin, an experimental aircraft to test a combination turboprop-ramjet. The aircraft reached M2-19 at 50,000ft on 13 October 1959. Tony Butler will discuss European experimental aircraft at Brough on 10 September. RAeS (NALL)

BEDFORD
ARA, Social Club, Manton Lane, Bedford. 6.30 pm. Marylyn Wood, T +44 (0)1933 393517.
10 September — Graphene — unexpected science in a pencil trace. Dr Arvind Vijayaraghavan, Lecturer in Nanomaterials, School of Materials, The University of Manchester.

BIRMINGHAM, WOLVERHAMPTON AND COFORD
RAF Museum Cosford. 7 pm. Chris Hughes, T +44 (0)1902 844293.
16 October — A year with the Red Arrows. Wg. Cdr Ross Friday, previously Senior Engineering Officer, Red Arrows.

BOGCOMBE DOWN
Lecture Theatre, Boscombe Down. Refreshments from 5 pm. Lecture 5.15 pm. Visitors please register at least four days in advance (name and car registration required). E secretary@ BoscombeDownRAeS.org
16 September — 40 years of the Hawker Siddeley Hawk. Gordon McClymont.
14 October — Sir Henry Tizard Evertt, F-35 flight testing. Snr Ldr Jim Schofield, F-35 Requirements Manager. Ticket only.
28 October — Antarctic helicopter operations. Lee Evans. 12.15 pm.

BROUGH
10 September — The X-Planes of Europe. Tony Butler, Historian.
12 November — Rotorcraft handling qualities engineering: managing the tension between safety and performance? Prof. Gareth Padfield, Emeritus Professor of Engineering, University of Liverpool.

CAMBRIDGE
Lecture Theatre ‘O’ of the Cambridge Military University Engineering Department, Trumpington Street, Cambridge. 7.30 pm. Jin-Hyun Yu, T +44 (0)1223 373129.
11 September — The Hybrid Air Vehicles Airlander project. David Stewart, Head of Flight Sciences, HAV. Joint lecture with IMechE.


18 November — The Zeppelins. Dr Hugh Hunt, University of Cambridge. Lecture at 6 pm, followed by buffet supper.

14 October — Understanding GPS without the mathematics. Prof David Allerton.
16 October — Understanding the bomb — operational with the V-Bomber force. Alan Macdonald, Jet Age Museum, Meteor Park, Chelsea Road

20 October — Remotely operated aircraft — the future of aerial combat and parcels delivery? Prof Keith Hayward, RAeS Head of Research. Joint lecture with IMechE.
3 November — Attack of the Zeppelins. Dr Hugh Hunt, University of Cambridge.

25 November — Overview of current fast jet flight test activities. Flt Lt Young. 12.15 pm.

CANBERRA
19 September — The future of Airservices Australia. AVM Margaret Staib, CEO, Airservices.

FARNBOROUGH
BAE Systems Park Centre, Farnborough Aerospace Centre. T +44 (0)1252 616181.
9 September — Cody Lecture. The life and times of the Harrier. Sir Donald Spiers.
14 October — TAG Engineering and TAG Aviation. Greg Hoggett, MD TAG Engineering, Farnborough College of Technology.

GLOUCESTER AND CHELTENHAM
Messier-Bugatti-Dowty, Restaurant Conference Room, off Down Hatherley Lane. 7.30 pm. Peter Smith, T +44 (0)1452 857205.
16 September — Tea and medals. Terry Watkinson, MoD Medals Office, Partners Evening & Buffet. 6.30 pm for Buffet. 7.30 pm for lecture.
21 October — Living with the bomb — operational with the V-Bomber force. Alan Macdonald, Jet Age Museum, Meteor Park, Cheltenham Road
18 November — 55 Years of flying fun. Clive Rustin.

HAMBURG
Hochschule für Angewandte Wissenschaften Hamburg, Berliner Tor 5 (Neubau), Hörssaal 01, 2. 6 pm. Richard sanderson, T +49 (0)167 92012. 

18 October — Aircraft fire and evacuation simulation, Prof Edwin Galea, Director, Fire Safety Engineering Group, University of Greenwich, 25 November — Annual Christmas Dinner and Lecture. Anglo-German Club, Harvestehuder Weg 44, 20149 Hamburg.

HEATHROW
Community Learning Centre, Waterside, Harmondsworth. 6.15 pm. For security purposes please contact David Beaumont, T +44 (0)7936 392012. 

11 September — NATS Swanwick Centre. Andy Rankine, NATS. 

9 October — A history of Farnborough’s Royal Aircraft Establishment. Dr Graham Rood, FAST. 

13 November — Developments in aviation medicine over the last 25 Years. Prof Mike Bagshaw, Professor of Aviation Medicine.

LOUGHBOROUGH
Room U020, Brockington Building, Loughborough University. 7.30 pm. Colin Moss, T +44 (0)1509 299962. 


MANNHEIM
Deutsches Museum, 7.30 pm. Bryan Cowin, MANNHEIM HAMBURG, T +44 (0)161 799 8979. 

17 September — Preserving our aviation heritage — the Dornier 17, Darren Frady, RCAF Museum Cosford. 

15 October — Apache helicopter operations. Staff Sgt Chris Phipps, RAF Shawbury. 

18 November — 3D printing in aerospace. Phil Beard, BAE Systems. Joint lecture with I MechE. Venue TBA. 

MUNICH
Ehrensaal, Deutsche Museum, Museumsinsel 1, 80538 München, 7 pm. 

29 October — Willy Messerschmitt Lecture. Flugsimulation — eine Säule der Sicherheit. Dr Ing Holger Duda, Leiter Flight Dynamics and Simulation beim DLR in Braunschweig. 

6 November — Facing the unexpected in flight — what must we do? Jean Pinet, Engineer and Experimental Test Pilot, Doctor of Psychology and Ergonomics, former Head of Aerosimulation/Airbus. Training. Technical University Munich, Garching — Ernst Schmidt-Horas. 

OXFORD
The Magdalen Centre, Oxford Science Park, Oxford. 7 pm. Nigel Randell, E oaktree.cottage@btinternet.com 

16 September — A new light aircraft design and development project. Andrew Barber. 

18 November — Jet engine research at Oxford University. Prof Peter Ireland, Donald Schultz Professor of Turbomachinery and Fellow of St Catherine’s College. 

PRESTWICK
The Aviator Suite, 1st Floor, Terminal Building, Prestwick Airport. 7.30 pm. John Wragg, T +44 (0)1655 750270. 


13 October — Strathaven Airfield. Colin McKinnon, Chairman, Scottish Flying Club LP. 

10 November — Joint lecture with I MechE. 

QUEENSLAND
Engineering House, 447 Upper Edward Street, Brisbane. 5.30 pm. E stratos@queenslandaerospace.org 

1 September — Queensland’s Advanced Biofuels Research Program. Prof Robert Henry, Professor of Innovation in Agriculture, Director of the Queensland Alliance for Agriculture and Food Innovation (QAAFI), University of Queensland. 

SHEFFIELD
Knowledge Transfer Centre, Advanced Manufacturing Park, Bruneval Way, Catcliffe, Sheffield, 7 pm. 

28 October — Airfix — Scaling down reality. Simon Owen, Airfix. 

The NATS Swanwick Centre. Andy Rankine will describe the operations at the Centre at Heathrow on 11 September. NATS.
The Royal Aeronautical Society would like to welcome the following as Corporate Partners.

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**Tuesday 23 September 2014 / London**
The Military Aviation Authority — Military Air Safety and Regulation in the Post-Nimrod World
Corporate Partner Briefing by AM Richard Garwood, Director-General, Military Aviation Authority
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**Monday 20 October 2014 / London**
Industry and SDSR 2015
Corporate Partner Briefing by Sir Peter Luff MP
Sponsored by UTC Aerospace Systems

**Wednesday 26 November 2014 / London**
The Outlook for the British Economy
Corporate Partner Briefing by Dame DeAnne Julius, Non-Executive Director, Deloitte UK, Roche and Jones Lang LaSalle

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For further information, please contact Gail Ward
E gail.ward@aerosociety.com or T +44 (0)1491 629912
The Fleet Air Arm’s most decorated pilot delivered a lecture to the RAeS Fleet Air Arm Branch on ‘Highlights of a life in Aviation’ at the Fleet Air Arm (FAA) Museum at Royal Naval Air Station (RNAS) Yeovilton.

Captain Eric Melrose ‘Winkle’ Brown CBE DSC AFC KCVSA PhD HonFRaeS RN at the age of 94 is a former test pilot who has flown in 487 different types of aircraft, more than anyone else in history and a record unlikely ever to be broken. Winkle Brown’s second world record is for the most aircraft carrier landings performed, 2,407 in total!

On the night of 29 July over 400 people gathered beneath the Wings of Concorde in the Museum to listen to whom can only be described as a living legend in the world of aviation. Silence fell as Winkle Brown took to the podium next to a commissioned portrait of himself on loan to be displayed at RNAS Yeovilton.

“Winkle’ Brown said: “It is my pleasure to be here, thank you for inviting me. It's a wonderful setting.”

Commander Mark Langrill Head of Air Engineering on the Air Station and Chairman of the RAeS FAA Branch said: “RNAS Yeovilton is home to the Fleet Air Arm Branch of the Royal Aeronautical Society. As well as being an icon of Naval aviation, Captain Eric ‘Winkle’ Brown has long been a staunch supporter of the Royal Aeronautical Society, and we are privileged that he has allowed us to name our new flagship annual lecture in his honour.”

The Lucasta Partidge-Brown portrait of Captain Brown on display throughout the evening, was accepted into the RAeS permanent collection in 2013. It is now deemed most appropriate that the portrait resides on long-term loan with the FAA in RNAS Yeovilton.

President of the RAeS, Air Commodore Bill Tyack, said: “It is the epitome of fame to be known by a single name, tonight we are here to celebrate the life and achievements of someone who is known around the world by a single name ‘Winkle’.” Air Cdre Tyack added: “Winkle’ is quite simply one of the most distinguished aviators the world has seen. I am proud and humble to be standing here as President of the RAeS as we honour the man who was my predecessor as President 32 years ago. I thank and congratulate the Yeovilton Branch — particularly the Chairman Cdr Mark Langrill and the Secretary Lt Mark Davis for conceiving of the named lecture.”
ELECTIONS

WITH REGRET

The RAeS announces with regret the deaths of the following members:

John Michael Bloodworth  MRAeS 88
David Alan Drane  CEng MRAeS 86
Vernon Lyle Gittins  IEng AMRAeS 87
Alexander John Hay  ARAeS 82
Vernon Leslie Murphy  Affiliate 69
Walter John Paul  CEng MRAeS 85
Andrew Brian Scott  CEng MRAeS 77

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In June, the European Commission published a road map promoting a ‘New Deal for European Defence’. This was a follow up to a Communication published last year that launched a three-year programme of work promoting a more competitive and efficient defence and security sector. This was backed by a clear and depressing analysis of the deficiencies of the EU defence market.

The Roadmap provides the basis for the Commission’s continuing work programme developing measures designed to strengthen the Single Market for defence, to promote a more competitive defence industry and to foster synergies between civil and military research. In particular, it underlines the importance of maximising returns from all EU research activities as defence-specific R&D has fallen, and continues to fall. There are several practical steps outlined to encourage implementation over the next couple of years and progress will be reviewed by the EU Council next year.

**Seen it all before, many times**

However, the signs are that this programme is too little and too late to arrest the long-term decline of the European defence industrial base. Indeed, the diagnostic path has been so well travelled, I could recite it, and the prescription, in my sleep. The fundamental truth is that Europe rarely gets its act together early enough to build a momentum in the market place.

This failing is all too evident in the continuing struggle to build an effective remotely piloted air systems (RPAS) programme. The latest venture is an industrial memorandum of understanding between Airbus, France’s Dassault and the Italian Finmeccanica, to develop a medium altitude long endurance (MALE) RPAS. They are now urging the three governments to back the proposal with a firm commitment to develop and produce a contender for both military and, more important, the emerging civil market. However, this could cut across existing Anglo-French and a French-led European consortium effort to develop an advanced armed RPAS, which was underlined by the memorandum signed at Farnborough in July.

**The US market is still the place to be**

So, while the US market has shrunk and the future direction of its defence budget remains uncertain, it is still the best place to be if you are a defence contractor and a government looking to leverage its R&D investments. The importance of the US link with the UK was underlined by the agreement earlier this year to collaborate on defence R&D in areas such as space, cybersecurity and chemical and biological warfare protection. This builds on decades of joint work in several sensitive defence technologies, including a lead UK position on the F-35. However, while a programme like the F-35 will undoubtedly be good for some companies, it does not ensure that the UK will maintain an overall capacity or have ready access to the really clever bits of defence production.

Happily Farnborough also saw some positive returns from the Defence Growth Partnership (DGP) promising government-industry investment in centres of excellence that will benefit the UK defence aerospace sector. If the DGP eventually produces the kind of results seen in the equivalent Aerospace Growth Partnership, the UK may be better placed to maintain capabilities than Europe at large.

Yet, without an adequate collective approach, progress on this side of the Channel will suffer in the long term. There is always the prospect of more work with the US but this inevitably contains the risk of all junior partners — doing the less clever and lower value work. European collaboration has its trials and tribulations but, if well managed, it does offer the better set of options for UK-based industry.
Future aircraft will be complex, requiring multi-disciplinary design approaches and solutions in a distributed design environment. The Royal Aeronautical Society’s 4th Aircraft Structural Design Conference will address the challenges facing the designers of the next generation of aircraft.

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