



Sustaining Airworthiness in Ageing Aircraft



Key insights from the IET Aerospace Network seminar discussing techniques and technologies to deal with the aircraft ageing issue.

In both the commercial and military aviation sectors there is a growing awareness of the importance of sustaining airworthiness of ageing aircraft. This has come not just from high profile accidents, but also recognition of the benefits that come from a proactive approach.

As Giles Huby, Managing Director of Copernicus Technology points out, it's an issue of particular importance to today's military engineers, who are dealing with continually stretched resources.

"It's a strategic issue with different connotations depending on the aviation sector you work in," he explains. "In the commercial world, airlines need the minimum possible cost of ownership, so they try to operate with the youngest fleets possible to minimise the costs of fuel and scheduled maintenance. This has resulted in a burgeoning 'end of life services' sector, such as component recycling from retired airframes.

"Conversely, military aviation doesn't have the luxury of replacing aircraft types at the same rate as its commercial colleagues. The military frequently extend fleets' service lives by years because of the delayed introduction of replacement types."

Unsurprisingly, the challenges facing ageing aircraft are extensive. Obvious issues revolve around the deterioration of materials and components, sometimes left undiscovered for an extended period if in an area of the aircraft seldom checked. But even when undertaking routine maintenance checks threats can develop insidiously, as when dealing with an aircraft

from day-to-day, small changes can become hard to spot.

Indirect threats

There are also indirect threats, which can arise from a failure to maintain controls put in place to sustain airworthiness.

"An example of this might be that there has been a failure to ensure that there are sufficient trained and experienced personnel to support an aircraft type throughout its whole operational life," notes Jeff Jones, a Safety Consultant at QinetiQ. "Or where repairs have been conducted on the aircraft but over time, configuration control of these repairs has been lost, with the effect that the potential cumulative impact of these on the integrity of the aircraft cannot be gauged."

Professor Steve Reed, a Technical Fellow at dstl, agrees that some of the challenges are less obvious than others, although equality concerning.

"Changes in legislation, such as REACH regulations, are and will have huge effects on the chemical constituents in products used to support aircraft, such as surface finish and sealants," he points out. "Generally, environmentally-acceptable alternatives have reduced performance, which if unmitigated can increase risk further.

"Technology advancements, such as advanced non destructive evaluation (NDE) capability, can offer step improvements in our ability to identify faults, flaws or damage but the investment costs for new technology can also be prohibitive, particularly for aircraft towards the end of their lives. Funding is always a huge challenge," he notes.

Changing maintenance culture

There's much to consider, but experts agree that one of the main challenges around sustaining airworthiness is not technical, but instead revolves around maintenance culture and an issue of 'too many cooks'.

"There are often a number of different organisations involved in supporting a military aircraft at any one time," says Jones. "These different organisations, unsurprisingly, often have their own culture, practises and objectives. "Whether as an auditor or an airworthiness holder, it can therefore be difficult to look across organisations to gain a coherent view of the nature and scope of the threats from ageing. This is particularly so where there are commercial and legal constraints – usually related to intellectual property issues – that prevent the timely distribution of information. For example, often systems or aircraft are on availability contracts and the repair and overhaul information relating to these components is often not seen by airworthiness holders higher up the chain.

Audit fatigue

"Another challenge is that many organisations undergo multiple audits to satisfy different organisations," he continues. "Audit fatigue is something that you do need to be aware of. I think that regulatory bodies and auditors have to strike a balance between doing sufficient audit activity to be confident that ageing threats are being managed and not placing too high a burden on the operating and support organisations."

The challenges are indeed immense, but the positive news is that there are a number of technologies, techniques and processes being developed and employed in response.

Take maintaining the integrity of airframes and engines, which has used the same tried and tested approaches for years. Huby notes that system integrity now has to be given equal consideration, including avionics systems and the electrical wiring and interconnection system (EWIS).

"To date there has not been a concerted 'joined up' approach to apply new technologies and processes to the maintenance of avionics and EWIS. Traditionally it is reactive; and scheduled maintenance of EWIS is predominantly based on visual inspection," he says.

IFD test equipment

"However, the US Department of Defence has successfully introduced intermittent fault detection (IFD) test equipment, which detects and locates the intermittent faults that are the first symptoms of degrading integrity in avionics and EWIS.

IFD testing is in constant use on F-16 and F-18 avionics and has already saved the department over US\$220 million. It has also improved the availability of the Line Replaceable Units concerned by over 300 per cent.

"It's also been successfully applied in targeted projects in Europe, on Tornado, Chinook, C130J, Sentinel and Eurofighter aircraft," he adds.

Zonal hazard analysis

Jones goes on to highlight how QinetiQ employs zonal hazard analysis (ZHA) to conduct in-service, on-aircraft hazard identification.

"ZHA can be useful in helping identifying threats from ageing," he says. "It involves a systematic physical examination of an aircraft, the results of which give a real-world and impartial view of the condition of the aircraft and an opportunity to identify aircraft system integrity issues.

"Furthermore, the hazard analysis part of the task also involves estimating the expected frequency at which certain faults may occur. For this to be representative, QinetiQ has found that it is a good idea to use as broad a range of evidence as possible to inform this activity. Typically, this involves independent evaluation of data, but also discussions with maintenance and operating personnel. This real world information almost invariably provides leads to potential ageing issues that scrutiny of tables of data seldom does.

"Both these aspects present the opportunity for someone to take an independent look at the physical aircraft and challenge the existing airworthiness assumptions and confirm that they are still valid. The results of opportunity-based reviews such as ZHA can therefore be used to inform and focus the scope of a future ageing aircraft audit," he adds.

New challenges ahead

Engineers continue to work hard on new and innovative ways to help sustain older aircraft, but Reed concludes by noting that they should also be looking ahead to what future challenges this field will face.

"As the more recent aircraft designs gradually make up a greater proportion of the ageing fleets we are likely to see different issues emerging and we will need to be alert to these changes," he points out. "What new issues will we see with widespread use of lead-free solder, ageing modular avionic systems, and greater reliance upon software-based systems?"