Age is a numbers game

Analysis by ***Keith Mwanalushi***

Commercial aircraft fleets are getting older and can provide economic service longer than ever before, as such, it's even more crucial to enhance early identification of significant structural defects. ***AviTrader MRO*** analyses the ageing aircraft market.

Many aircraft accidents around the world have been linked to ageing aircraft. Service experience has shown that there is need to have continuing updated knowledge of the structural integrity of aircraft, especially as they become older. The key issue is how this identification can be effectively and consistently achieved.

Key to applicable, effective and economical maintenance of ageing aircraft structures is a profound engineering expertise based on in-service experience, especially with aircraft types certified under different philosophies for design against structural fatigue, such as fail-safe versus damage tolerant.

"Aircraft manufacturers have a tendency, at least for metallic structures, to apply design principles which have been used in the past also for new aircraft design, even though regulations since the late 1970s require that all new aircraft types be certified 'damage tolerant'," comments Michael Lariviere, director of aircraft system engineering and modification at Lufthansa Technik.

Essential in this assessment is cooperation with the manufacturer - Lariviere attributes this mainly by means of participating in the relevant working groups, such as the aircraft model specific structure task groups and structure (maintenance) working groups. "This provides to the industry the best chances to develop efficient structural maintenance programmes, which allow timely detection, and rectification, of structural fatigue and corrosion damage before it can contribute to catastrophic failure.

Mr Lariviere - Lufthansa Technik is actively involved in the rulemaking processes for both FAA and EASA rules

An ageing A340 undergoes maintenance works. *Photo: Lufthansa Technik Philippines*

"It also helps to better predict the average downtime an aircraft requires for maintenance purposes; obviously a commercial aircraft aged six years will have significantly less inspection and repair requirements compared to a 20 year old airframe. This expertise is essential for operators to avoid operational disruptions due to unscheduled and unexpected downtimes," Lariviere continues.

Clearly, foresight and preventive maintenance is vital during an ageing aircraft's heavy maintenance event. Rainer Janke, VP for marketing and sales at Lufthansa Technik Philippines chips in and says it's important to continuously collect and archive all significant structural defects experienced by the airline operator.

"More often than not, there are significant structural defects that are recurrent in specific aircraft types and series. Based on collected data and experience, Lufthansa Technik Philippines' record of its customer's aircraft enables us to anticipate what structural defects to expect during the next layover planning so that both LTP and its airline customer are prepared. As a result, we have the ability to foresee and identify areas of structural defects as early as during the work package review and planning, thus reducing an aircraft's downtime,"Janke explains.

Mr Lariviere says most of the metallic fatigue cracking damage types can be safely detected by standard inspection means, which are visual inspections and non-destructive testing methods, mainly ultrasonic and eddy currents. Ageing of composites is dissimilar of metallic fatigue and requires different inspections; due to their material characteristics, additional inspection techniques are required, primarily thermography.

"All of these NDT methods are not particularly new," says Lariviere adding that the challenge for ageing aircraft structure inspections is the size of the inspection area – whilst for a "young" aircraft typically only those areas at isolated locations are inspected where peak stresses occur and fatigue resistance is rather low. An airframe having accumulated a significant number of flights, and therefore having experienced material deterioration by fatigue and/or environmental (corrosion) and/or accidental (e.g. hail strike, turbulence, hard landing) damage may require NDT inspection of large portions of the structure, such as entire skin panels or stabilisers.

Lariviere: "To efficiently accomplish these inspections, new methods are required with a high inspection speed, density and fidelity. Examples are phased array ultrasonic inspections, pulse thermography or automated inspection devices (robotics). Lufthansa Technik's engineering inno-

The challenge for ageing aircraft structure inspections is the size of the inspection area. *Photo: Magentic MRO*

vation teams are involved especially in the two latter methods."

Another phenomenon Lariviere describes is called "widespread fatigue damage", in which cracking does not occur as an isolated, relatively easily detectable crack, but difficult-to-detect small cracking of adjacent structural features, such as each hole along a fastener row, which after cumulating sufficient density can converge to rapidly form a large crack which may cause severe structural failure.

"Therefore, recent airworthiness regulation mandates that aircraft manufacturers determine for all large transport category aircraft types a Limit of Validity (LoV), representing the limit, in terms of flight cycles and flight hours, until sufficient engineering data is available to conclude that the structure is reasonably free from undetected widespread fatigue. Naturally, extending an aircraft's service life beyond that point requires significant amount of testing, analysis, aircraft inspection and even modification, and is hence rather unlikely to occur," Lariviere observes.

So in terms of overall costs is there a real need for airlines to invest in extending the life of older aircraft? Larry Montreuil VP for asset management and business development at Werner Aero Services reminds that the large capital investment an airline makes for it to purchase a new fleet is staggering.

"The lease and finance costs siphons cash from other opportunities and the new fleets carry with them a great deal of financial drag across the organisation in order to support new aircraft," tells Montreuil. "Almost every aspect of an airline is likely to be impacted by the introduction of new aircraft types," he adds.

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Alternatively, Montreuil stresses that proper maintenance of existing, older aircraft can result in a lower total cost of ownership. "It could also be argued that the high degree of familiarity with an existing platform has inherent safety and efficiency advantages. The robust MRO aftermarket for maintaining older aircraft also helps to make older aircraft a viable choice."

The ample supply of relatively low cost spare parts available through the surplus market should provide an additional cost advantage to expensive OEM parts encumbered by high R&D costs. Conversely, Montreuil states that older surplus parts have had the benefit of years of operational experience that typically results in improvements and modifications found in a mature product life cycle.

It's worth noting some aircraft have a mission profile that is uniquely suited to the task at hand and a newer replacement is either unavailable or far too costly to be supported by the operation. "Aircraft life extension may be even more attractive now that fuel prices have dropped some," notes Bryan Anderson, president of RepairMaps, Inc. - a web-based application for managing aircraft repairs and ongoing damage maintenance.

"One area where our system can help maximise the effectiveness of a structural programme is with the ability to track the reliability of the heavy maintenance effort from a findings perspective. Most reliability programmes are geared towards operational issues. I recommend a similar effort with regard to the task cards in the heavy maintenance programme," says Anderson.

He continues: "Tracking the results of performing each card over time allows one to adjust the programme most effectively. For this tracking I tend to focus on tracking the man hours expended as a result of performing a certain inspection task rather than counting individual findings. This gives a better indicator of the structures true condition and effort required for repair and remediation."

The EASA in Europe now has new rules on how to maintain ageing aircraft, interestingly these approaches differ somewhat to FAA rules in the U.S. Lufthansa is actively involved in the rulemaking processes for both FAA and EASA rules, and participates in the working groups to harmonise the regulation. "Harmonisation has been a lengthy process," Lariviere states, saying mainly due to the differences in the underlying basic legislation (U.S. federal laws versus European Commission regulation).

"It took EASA significantly more time to develop a rulemaking – while for US registered aircraft having exceeded their design service goal the grace period for the Ageing Aircraft Safety Rule (AASR)

survey will end in December 2016 under FAA rule, EASA will likely publish its regulation by late 2015, whereby a shift in compliance limits of up to six years may occur," Lariviere stipulates.

It helps to better predict the average downtime an aircraft requires for maintenance purposes. *Photo: IAI Bedek*

According to Lariviere, the main difference from a legislative point of view is that the ageing aircraft regulation is an operator's requirement under FAA (FAR Parts 121 or 129, as applicable). To help operators to show compliance with this requirement, the Type Certificate or Supplemental Type Certificate holders are mandated to develop the necessary engineering data; FAR Part 26 has been created for this purpose. However, he adds that EASA "did not chose" to revise Part-M to add ageing aircraft requirements for operators in a similar way FAA did. Instead, the already existing EASA Part 26 was extended to add both operator and Type Certificate or Supplemental Type Certificate holder requirements. Thus, while the maintenance actions to be accomplished are very similar, FAR Part 26 and EASA Part 26 are different and should not be confused.

"From a more practical point of view, due to EASA's late issuance of the regulation, transfer of aircraft between US and European registrations becomes more difficult, as the same aircraft must already comply under US registration, while it must not yet under EASA Part-M operations. Even more challenging is the transfer of removable structural components which are [or contain] fatigue critical structures, such as passenger doors, as with current standard practices it is very difficult to determine, and to track, if a used component is compliant with the ageing aircraft requirements," Lariviere continues.

In terms of ageing aircraft, seemingly, there are some trends as to the types which have greater demand for MRO services. At Lufthansa Technik Philippines, considering the age of the Airbus fleet of the A340-300/600 and classic A320s they have greater demand for MRO services.

Lufthansa Technik Philippines works with airframe manufacturers like Airbus in identifying structural defects.

Brian Neff CEO at CTS Engines in Fort Lauderdale, Florida believes the 767 has a great life ahead of it in the mature aircraft market, both as a cargo aircraft and for smaller passenger carriers. "Parts are plentiful and inexpensive, and the reduced ownership cost of older 767s more than compensates for the relative efficiency shortfall when compared with a newer A330, for example," Neff observes.

One important design philosophy introduced in the late 1980s was to use more sophisticated calculation methods (such as Finite Element Analysis) and improved manufacturing techniques (such as integrally machined parts) to reduce structural weight. The combined effect was the ability to rely on the damage tolerance characteristics of a single, but stronger part, instead of several parts acting as multiple, fail-safe load paths.

Mr Lariviere comments that while this is beneficial for gross weight, and therefore for fuel efficiency, it imposes some disadvantages for ageing structures: "Once these typically large, complex, integrally machined develop fatigue cracks, they are very difficult, if not impossible, to repair due to their very limited suitability to accomplish relatively simple 'cut and splice' repairs. Therefore, even in cases where the manufacturer can demonstrate the crack present does not constitute an immediate airworthiness concern, replacement of such large part is necessary, which is a very expensive and time consuming undertaking."