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MRO 360°

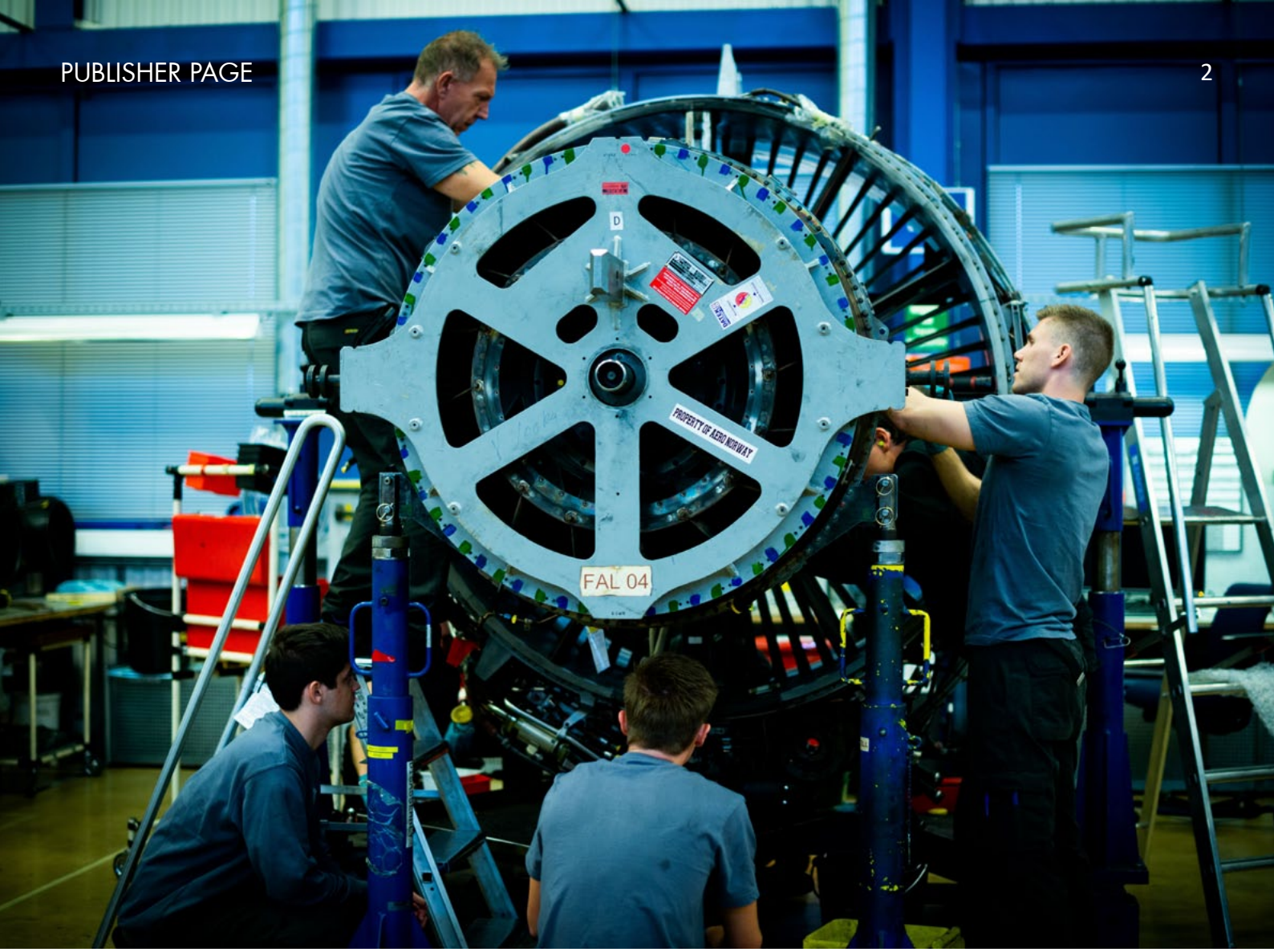
ALIVE AND KICKING

Managing the cost of ageing aircraft

DIGITISATION
When data becomes a safety issue

FINAL DESTINATION
Learning from aircraft teardowns

SUSTAINABILITY
Best practices in MRO



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Dear Industry Colleagues,

First of all, we would all like to wish you all a very happy and prosperous New Year.

This month our feature article, Ageing Aircraft Cost Management, focuses on the continual challenge of maintaining aircraft, and especially ageing ones. We see clear signs that the delays in the delivery of new aircraft are leading to extending the life of older-generation planes, and that has brought with it its own set of problems.

In our article Data Quality, Cybersecurity, and Regulatory Acceptance, we thought it might be interesting to explore the challenges that 'going digital' have created for an essential element of the MRO sector, and that is the word trust. In addition, we hope you will find our article on aircraft teardowns useful. We wanted to show how the benefit to the industry is not simply the provision of additional USM stock to a challenged parts supply chain, but that much can be learned about the wear and tear of an aircraft over time, and especially in hard-to-reach areas.

Finally, my thanks go to Pascal Parant at the Vallair Group who provided a wealth of information on MRO and sustainability in our one-on-one interview with him.

As always, I hope you enjoy the issue.

Peter Jorssen
Publisher

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Managing the cost of ageing aircraft

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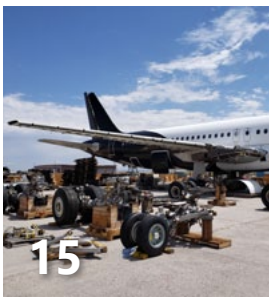

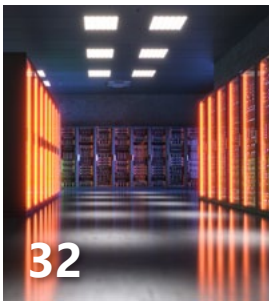

WLFC and Blackstone launch engine leasing alliance

Willis Lease Finance Corporation (WLFC), has entered a strategic aircraft engine leasing partnership with Blackstone Credit & Insurance (BXCI). The collaboration plans to deploy more than US$1 billion over the next two years, targeting both current- and next-generation aircraft engines, as well as a select number of aircraft. The partnership combines Willis Lease's specialist expertise in aircraft engine leasing with Blackstone's scaled private credit platform, creating a focused investment vehicle dedicated to the engine asset class. By bringing together deep technical knowledge and long-term institutional capital, the alliance is designed to capture opportunities arising from sustained demand for efficient, reliable propulsion assets across the global airline industry. The new platform will build on Willis Lease's long-established role as a pioneer in aircraft engine leasing and its expanding asset management capabilities. The company has already identified an initial seed portfolio and a near-term pipeline of high-quality engine assets expected to transfer into the partnership. This approach is intended to provide immediate scale, while also ensuring diversification across engine types, aircraft programmes and airline customers worldwide. Blackstone Credit & Insurance brings substantial financial strength and investment capability to the venture. Its Infrastructure and Asset-Based Credit group manages more than US$100 billion and is supported by over 80 investment professionals as of September 30, 2025. The platform focuses on investment-grade and non-investment-grade credit, as well as structured investments across the real economy, including infrastructure, commercial and consumer finance, fund finance and residential real estate lending. Together, the two partners aim to establish a scaled, resilient engine leasing platform positioned to benefit from long-term growth in global air travel and fleet modernisation. Furthermore, WLFC announced the establishment of Willis Aviation Capital (WAC), a new division

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that will focus on the management of third-party assets and capital through discretionary funds. WLFC will manage engine and aviation asset portfolios primarily funded by third-party capital. The platform is expected to generate recurring management fees, carried interest, and servicing revenues, while expanding WLFC's asset management presence and supporting balance sheet deleveraging. WLFC has partnered with leading institutional investors to help launch the platform, including its leasing partnership with Blackstone Credit & Insurance and credit strategy with Liberty Mutual Investments (up to US$600 million), both of which will be managed in collaboration with WAC. In addition, WAC will oversee WLFC's existing joint ventures with Mitsui & Co. and China Aviation Supplies Company, as well as select third-party aviation assets in which WLFC does not hold an equity interest.

SkyWest chooses Salina for major maintenance expansion

SkyWest Airlines has confirmed plans to establish a new aircraft maintenance facility at Salina Regional Airport (SLN) in Kansas, marking an important investment in both the local economy and the state's aviation sector. The new base will support maintenance operations for part of SkyWest's fleet of more than 500 regional jets, including aircraft currently operating United Express services to and from Salina. The facility is expected to become operational by early spring 2026 and will initially create several new, well-paid technical roles at the airport. These positions will complement SkyWest's existing customer service staff already based in Salina. Recruitment for aircraft maintenance technicians is under way, signalling an early commitment to workforce development and long-term operational presence in the region. By locating maintenance capability in Salina, SkyWest aims to strengthen the reliability and safety of its passenger services for both business and leisure travellers. The airline currently operates multiple daily United Express flights from Salina to major hubs including Denver, Chicago and Houston. These routes are critical for regional connectivity, enabling passengers from central Kansas to access United Airlines' extensive domestic and international network with minimal disruption. The decision to open the maintenance base aligns closely with Kansas Governor Laura Kelly's broader strategy to expand aviation MRO activities across the state. Kansas has increasingly positioned itself as a competitive location for aviation-related investment, benefiting from a skilled workforce, supportive public institutions and a strong aviation heritage. SkyWest's move was made possible through coordinated support from a range of local and state stakeholders, including the Kansas Department of Commerce, the City of Salina, Saline County, the Salina Airport Authority and the Salina Community Economic Development Organisation. This collaboration highlights the importance of public–private partnerships in attracting high-value aviation projects and sustaining regional economic growth. Overall, the new maintenance facility represents a strategic win for SkyWest, Salina and the state of Kansas. It reinforces Salina's role as an important regional aviation hub, delivers high-quality technical employment, and underpins the continued provision of dependable air services that connect Kansas communities to the wider national and global economy.

AJW secures A320 support deal with Air Astana

AJW has secured a long-term PBH contract with Air Astana and FlyArystan © *AirTeamImages*

AJW Group has been awarded a new long-term Power-by-the-Hour (PBH) component support contract with Air Astana and its low-cost subsidiary FlyArystan, covering the airlines' expanding Airbus A320-family fleet. The agreement became effective on January 1 and supports an initial fleet of 56 Airbus aircraft. The covered fleet comprises a growing mix of A320 and A321ceo aircraft, alongside A320 and A321neo, NX and NXLR variants powered by geared turbofan engines. The contract reflects the ongoing evolution of Air Astana's narrow-body fleet strategy and underpins its significant growth plans, including a substantial expansion of neo aircraft over the coming years. AJW Group has a long-standing relationship with Air Astana, having supported the airline since 2006. That partnership began with component support for the carrier's Boeing 757 fleet, which has since been retired. AJW later provided support for Air Astana's Airbus A320ceo fleet from 2011 until March 2019 and currently delivers PBH component support for the airline's Boeing 767 fleet under a contract that was recently extended by a further two years. The new agreement marks AJW's return to supporting Air Astana's Airbus narrow-body operations at a time when the airline is accelerating the expansion of its A320neo family fleet. It also reinforces AJW's position as a trusted long-term partner capable of supporting Air Astana across multiple fleet types and growth phases. The contract will be underpinned by AJW Technique, the group's in-house MRO component repair facility based in Montreal, together with AJW's new European warehouse in Amsterdam. These capabilities will enhance material availability and reduce turnaround times, providing additional operational resilience and support for Air Astana's European operations.

AkzoNobel boosts US aerospace coatings hub

AkzoNobel is investing €50 million (US$58 million) to upgrade its Waukegan, Illinois, facility in the US – the company's largest aerospace coatings production site. The two-phase project will increase capacity through new machinery and higher levels of automation, while also creating a new warehouse across the state border in Wisconsin. "This investment will strengthen our North American supply capability and reinforce our position as a frontrunner in the aerospace coatings industry," said Patrick Bourguignon, Director of AkzoNobel's Automotive and Specialty Coatings business. "With air travel demand set to rise significantly in the coming years, we want to ensure our customers can meet that growth with aircraft of the highest quality." The 11-acre Waukegan site employs around 200 people and produces a broad range of aerospace coatings, including primers, basecoats, clearcoats and pre-treatment products. It also houses an on-site colour centre. Planned upgrades include a new liquid pre-batch area, the installation of high-speed dissolvers and the creation of a rapid service unit to deliver faster turnaround times for the maintenance, repair and operations (MRO) market. Relocating warehousing to Pleasant Prairie, Wisconsin, will free up space at Waukegan, allowing AkzoNobel to expand production of customised coatings and respond more quickly to customer requirements. "Our customers demand – and deserve – best-in-class coatings," adds Martijn Arkesteijn, Global Operations Director, AkzoNobel Aerospace Coatings. "This investment will give us greater flexibility through larger batch sizes, improved responsiveness to market needs and shorter lead times for colour development." The project forms part of AkzoNobel's Industrial Excellence programme, which aims to streamline operations and reduce complexity. By concentrating on anchor sites that offer greater scale and efficiency, the company is seeking to lower operating costs, optimise its industrial network and drive sustainable, competitive growth.

Painting of an aircraft © *Shutterstock*

Thai Airways advances digital MRO transformation

Trax and Aerostrat, both part of the AAR group, have been selected by Thai Airways to support a comprehensive digital transformation of the airline's maintenance, repair and overhaul (MRO) operations. The initiative represents a significant step in modernising maintenance processes and strengthening operational efficiency across Thai Airways' global network. At the core of the programme is Trax's eMRO enterprise resource planning platform, supported by a suite of eMobility applications and a secure cloud hosting solution. Together, these technologies will enable Thai Airways to modernise its MRO activities by providing real-time access to critical maintenance data from any location. This enhanced visibility is expected to streamline workflows, improve coordination across teams and support more informed, timely decision-making throughout the organisation. Complementing the Trax solution, Thai Airways will also implement Aerostrat's advanced maintenance planning software, Aerros. The system delivers industry-leading capabilities in long-range maintenance forecasting and optimisation, allowing the airline to plan more effectively for heavy maintenance events while balancing operational demand. By improving forward planning accuracy, Aerros will help maximise fleet availability and drive greater cost efficiency across the maintenance programme. In addition, Thai Airways will deploy proprietary artificial intelligence-powered solutions developed by Trax and Aerostrat. These tools are designed to enhance advanced planning, automate workflows and provide intelligent assistance with defect resolution. The integration of AI capabilities is expected to reduce manual intervention, accelerate maintenance decision-making and improve overall reliability. The combined implementation of digital solutions from Trax and Aerostrat will add scalability, security and flexibility to Thai Airways' maintenance operations, ensuring the systems can evolve alongside future fleet and network changes. By digitising processes and significantly reducing reliance on paper-based workflows, the airline also expects to improve aircraft turnaround times and maintenance productivity. Beyond operational benefits, the move supports Thai Airways' broader sustainability objectives. Reduced paper usage and more efficient maintenance planning will contribute to a lower environmental footprint, aligning digital transformation with responsible operational practices.

Rolls-Royce and Turkish Technic break ground on new MRO hub

Rolls-Royce and Turkish Technic have broken ground on Turkish Technic's state-of-the-art maintenance centre at Istanbul Airport. Announced in May 2025 as the latest addition to the Rolls-Royce MRO network, the facility will strengthen Turkish Technic's position at the forefront of the maintenance industry. It will also complement Rolls-Royce's existing MRO footprint and support growing long-term demand for new large civil engines. Scheduled to become operational by the end of 2027, the new site will enable Turkish Technic to provide comprehensive maintenance services for Trent XWB-97, Trent XWB-84 and Trent 7000 engines, which power the Airbus A350 and Airbus A330neo respectively. Rob Watson, President – Civil Aerospace, Rolls-Royce, said: "Breaking ground on Turkish Technic's new state-of-the-art facility is a significant milestone for our global MRO network, which supports our TotalCare customers around the world. "We're significantly increasing our global MRO capacity by 2030, and today's announcement marks another step on that journey. It reinforces our strong partnership with Turkish Airlines – whose fleet of Airbus A350s will be supported by this facility – and underlines Turkish Technic's commitment to become a leading provider of civil large aero engine MRO." With a planned capacity of up to 200 shop visits a year, the facility is expected to be one of the largest of its kind in the region. It will serve Rolls-Royce TotalCare customers as well as the Turkish Airlines fleet. In late 2023, Turkish Airlines placed a landmark order for Airbus A350 aircraft, becoming the world's largest operator of the Trent XWB engine. The deal included 120 Trent XWB-84 engines and 40 Trent XWB-97 engines, excluding options and spares.

Official ground-breaking ceremony of Turkish Technic's new MRO facility in Istanbul, Türkiye © *Rolls-Royce*

Powerhouse selects Ramco for digital MRO overhaul

© Ramco

Enterprise aviation software specialist Ramco Systems Corporation USA, a subsidiary of Ramco Systems Limited, has secured a deal to implement its next-generation aviation software at Powerhouse Engines, a South Florida-based aviation services provider focused on jet engine leasing, trading and maintenance, repair and overhaul (MRO) for the CFM56 engine family. The deployment will see Ramco's aviation software platform support Powerhouse's engine MRO activities across the full lifecycle, providing an integrated digital backbone for operations. The company indicated that the system is designed to improve resource utilisation and deliver actionable insights, enabling more informed and timely decision-making as the business scales. Powerhouse is positioning the implementation as a key enabler of accelerated growth while preserving high standards of operational control. By adopting an integrated suite of modules covering engineering and continuing airworthiness management, engine and shop maintenance, MRO contracting, finance and quality, the company expects to gain end-to-end visibility across core functions. Capabilities will include configuration management, airworthiness directive and service bulletin control, task card management and maintenance planning, all within a single platform. The move is also intended to strengthen inventory management, purchasing and cost tracking, while simplifying subcontracting and third-party repair management. Powerhouse signalled that tighter integration across these areas should reduce complexity and enhance overall efficiency within its MRO operations, particularly as volumes increase. In parallel, the company plans to deploy Ramco's digital tools, including Anywhere mobile applications, Hubs and BInGO dashboards, to support a shift towards paperless processes. These solutions will enable real-time tracking of parts, inventory, repair orders, purchase orders and repair tags, improve transparency and reduce turnaround times during engine overhaul and maintenance activities. By investing in a modern, data-driven software environment, Powerhouse is seeking to embed technology at the heart of its operations. The initiative reflects a broader strategy to adopt advanced digital practices that support agility, precision and scalability, while setting a higher benchmark for operational performance within the aviation services and MRO sector.

Air Lease shareholders back take-over deal

Air Lease has secured shareholder approval for its proposed acquisition, clearing a major hurdle towards the company's sale to a new Dublin-based holding company. At a special meeting, holders of Air Lease Class A common stock voted to approve the previously announced merger agreement under which the aircraft lessor will be acquired by Sumisho Air Lease Corporation DAC. The new holding company will be owned by Sumitomo Corporation, SMBC Aviation Capital and investment vehicles affiliated with funds managed by Apollo and Brookfield. Under the terms of the transaction, Air Lease Class A shareholders will receive US$65.00 in cash for each share held immediately prior to completion of the merger. On closing, Air Lease will be renamed Sumisho Air Lease Corporation, reflecting its new ownership structure and positioning. Holders of approximately 80.7% of the shares of Class A common stock outstanding as of the close of business on November 3, 2025, the record date for the special meeting, voted in favour of the approval and adoption of the merger agreement. The transaction is expected to close in the first half of 2026, subject to the satisfaction of customary closing conditions set out in the merger agreement. These conditions are detailed in the definitive proxy statement filed with the US securities regulator in early November 2025 and subsequently supplemented later that month. Once completed, the deal will mark the end of Air Lease's tenure as a publicly listed company on the New York Stock Exchange and usher in a new phase under private ownership, backed by a consortium combining strategic aviation lessors and global investment firms.

KAEMS targets higher-value MRO work through Tadpole tie-up

Korea Aviation Engineering & Maintenance Service (KAEMS) has entered into a strategic collaboration with aviation advisory and ecosystem development firm Tadpole & Co., as the Korean MRO provider looks to accelerate growth and expand its international reach. KAEMS, which has benefitted from strong backing from the Korean Government, has been pursuing a clear growth strategy focused on broadening its maintenance capabilities, expanding its activity base and building a more diverse global customer portfolio. The new collaboration is intended to support these ambitions by strengthening the company's market position and increasing its attractiveness to international airlines and aviation customers. The initial phase of the partnership will concentrate on line maintenance, building on KAEMS' existing operational footprint and core technical strengths. As the relationship develops, the scope is expected to extend into selected heavy maintenance activities. Particular emphasis will be placed on higher-value and higher-margin work packages, including cabin modifications and interior upgrades. These work scopes are seen as complementary to Tadpole's adjacent portfolio, which centres on developing holistic passenger experience solutions for airlines. By aligning technical MRO execution with commercial and customer experience objectives, the two companies aim to offer a more integrated and differentiated proposition to the market. Under the agreement, Tadpole will

KAEMS brings Tadpole on board to support its next growth phase *© KAEMS*

support KAEMS in both business development and capability enhancement. This will draw on Tadpole's industry experience, specialist domain knowledge and established global network spanning airlines, lessors, original equipment manufacturers and other aviation partners. Both parties characterised the collaboration as a mutually beneficial arrangement, combining KAEMS' proven infrastructure and technical expertise with Tadpole's strategic and commercial capabilities. Together, they aim to unlock sustainable growth opportunities while delivering increased value to customers and broader stakeholders across the aviation ecosystem.

GATES expands engine MRO footprint in Asia

CFM56 engine *© CFM International*

GA Telesis Engine Services (GATES), the engine maintenance, repair and overhaul (MRO) subsidiary of GA Telesis LLC, has announced two strategic milestones that expand its global footprint and strengthen its position as an successful, independent engine maintenance provider. GATES has secured Approved Maintenance Organisation (AMO) certification from South Korea's Ministry of Land, Infrastructure and Transport covering the CFM56-5B, CFM56-7B and CF6-80C2 engine types. The approval authorises GATES to carry out full engine overhaul services for South Korean operators, a market with a large and growing installed base of these engines. It also provides airlines in the region with a credible independent MRO alternative in a segment traditionally dominated by OEM-affiliated facilities. The certification increases competitive choice, offers tangible cost benefits for operators and supports improved fleet reliability, while confirming GATES' compliance with stringent international regulatory and quality standards. In parallel, GATES has secured an engine maintenance agreement with MIAT Mongolian Airlines to overhaul the carrier's CFM56-7B engines. The contract further accelerates the company's expansion across the Asia-Pacific region and reflects growing customer confidence in GATES' technical capability and operational performance.

Porter drives digital maintenance overhaul with AMOS

Porter Airlines modernises maintenance operations with AMOS © *SWISS-AS*

Porter Airlines is among the fastest-growing carriers in North America and operates a mixed fleet of more than 70 De Havilland Dash 8-400 turboprops and Embraer E195-E2 jets. With growth accelerating and a strong passenger-first service proposition, high levels of operational reliability are business-critical. To support its long-term strategy, Porter embarked on a comprehensive modernisation of its maintenance and engineering operations, centred on a fully integrated digital solution. At the heart of this transformation is AMOS, the maintenance and engineering platform developed by Swiss-AS, complemented by mobile applications and selected components from the AMOS Digital Tech Ops Ecosystem. Together, these tools provide a single, connected environment to manage end-to-end technical operations. Porter selected AMOS in 2021 as the core system for its technical organisation, with a clear objective: to replace fragmented tools and paper-based processes with a consistent, integrated platform covering planning, execution, compliance and continuous improvement. Today, AMOSdesktop underpins maintenance control, engineering, planning, stores and purchasing activities across the airline. To extend these capabilities to the operational frontline, Porter deployed AMOSmobile/EXEC with electronic signatures, giving engineers and mechanics real-time access to work packages, task cards and electronic work instructions directly at the aircraft. The consistent user interface across desktop and mobile applications has reduced training requirements and enabled rapid user adoption across teams. Building on this foundation, Porter continues to expand its digital maintenance environment to further enhance efficiency, transparency and regulatory compliance. The introduction of AMOSeTL, the electronic technical logbook fully integrated with AMOS, has replaced paper-based defect recording and aircraft release processes. Data flows directly into the system, reducing handovers, minimising errors and providing a complete, auditable record. In parallel, AMOS Line Maintenance Manager (LMM) delivers advanced planning and optimisation, with automated task assignment and real-time workload visibility supporting faster turnarounds and improved decision-making during disruptions. Component shop modules add structured oversight of internal and external components, strengthening planning reliability and compliance. Looking ahead, the planned integration of flydocs' Lifecycle Asset Management will further enhance document control, audit readiness and asset visibility, supporting effective fleet management and lease return requirements.

RESIDCO secures US$100m to accelerate engine acquisitions

RESIDCO has announced the closing of a US$100 million commercial aircraft engine acquisition facility provided by Huntington National Bank, a US$223 billion-asset regional bank headquartered in Columbus, Ohio. The newly established debt facility is designed to support RESIDCO's strategic expansion in the global aviation secondary market, with a specific focus on the acquisition of high-demand commercial aircraft engines. "As the aviation industry continues its strong recovery, demand for engine leasing solutions and liquidity has never been greater," said Scott Daniels, Managing Director Aviation at RESIDCO. "We are delighted by the confidence Huntington has placed in RESIDCO's aircraft engine leasing platform. This facility provides the capital required to execute our growth strategy and to continue delivering value to our global airline and trading partners." Michael Yovkovich, President of RESIDCO, added: "This significant financing reflects the exceptional commitment and expertise of our team, whose relentless efforts have underpinned our success and growth. It marks a pivotal moment for the company. We are excited to begin building a major, long-term relationship with Huntington and greatly appreciate the confidence they have shown in our business model and our people." The facility will enable RESIDCO to further leverage its deep technical expertise and asset management capabilities. With this US$100 million commitment in place, RESIDCO is well positioned to capitalise on near-term market opportunities and to enhance its already substantial portfolio of mid-to-late-life commercial aircraft engines.

Howmet Aerospace takes ownership of CAM

Howmet Aerospace has entered into an agreement to acquire Consolidated Aerospace Manufacturing (CAM), a global designer and manufacturer of precision fasteners, fluid fittings and other complex, highly engineered products for demanding aerospace and defence applications. The company will be acquired from Stanley Black & Decker for an all-cash consideration of approximately US$1.8 billion. The transaction is expected to receive favourable federal tax treatment, resulting in a significant tax benefit for Howmet. Howmet expects CAM to generate revenue of approximately US$485–495 million in FY 2026, with an adjusted EBITDA margin exceeding 20% prior to the realisation of synergies. The combined impact of synergies and the aforementioned tax benefit is expected to result in an FY 2026 adjusted EBITDA transaction multiple of approximately 13x. The transaction is expected to complete in the first half of 2026, subject to customary closing conditions and regulatory approvals.

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Learning From Aircraft Teardowns

An end-of-life aircraft shouldn't be seen solely as a source of USM. It is an entity with a past history that can reveal so much about wear and tear over its lifetime.

By David Dundas

In many ways, the end of the life of an aircraft is not that dissimilar to the end of the life of a human being. Admittedly the end of an aircraft's life can be more easily planned, and fortunately very few aircraft end their life in an accident. However, where there is a tremendous similarity is what can happen afterwards.

If you think about it, the understanding of the human anatomy, our physiology and how the body functions was only discovered through post-mortem dissection. Even today, most medical students have their own cadaver through which they learn so much about anatomy, surgery, and how the body ages over time, and it is that last factor that an aircraft teardown can reveal. How the aircraft has weathered the passage of time.

An aircraft teardown is the best opportunity to discover what has been going on in those hard-to-reach areas, as well as discovering how repairs and maintenance procedures have coped with the passage of time. Thus, an aircraft shouldn't just be seen solely as a supply of USM, but a means of inspiration and driving factors for technical improvement. For maintenance organizations, teardown inspections offer lessons that are difficult, if not impossible, to obtain or recreate through routine in-service inspections alone. They challenge assumptions, validate or contradict maintenance programmes, and often reveal failure mechanisms that only come to light after tens of thousands of flight hours.

The Difference Between Theory and Reality

Maintenance programmes are built on a combination of engineering analysis, service experience, and regulatory guidance. While these programmes may be extremely effective, one of the biggest problems with them is that they are based on assumptions about usage, environment, and human behaviour. The wonderful thing about teardown inspections is that they provide a rare opportunity to test those assumptions against reality.

And the result? A gap between predicted and actual wear often emerges. Components expected to show uniform degradation may display highly localised damage. Structural areas assumed to be benign can exhibit corrosion or fatigue that had not been anticipated, while other areas may well have performed better than expected. These findings are not failures of engineering—they are reminders that aircraft operate in complex, variable environments that no model can fully capture as no two aircraft have identical

lives. Thus, as we have discovered through teardowns, operational factors such as short-haul cycles, high humidity, de-icing exposure, and maintenance access constraints play a far greater role in long-term degradation than many maintenance planners may well have initially assumed.

Hidden Damage in Hidden Places

One of the most valuable aspects of teardown inspections is the provision of access to previously unexplored areas. Because panels are removed permanently and insulation is stripped away, and structures that are rarely—if ever—fully exposed during routine maintenance become visible.

Unsurprisingly, corrosion is a frequent and instructive finding. Teardowns often reveal moisture trapped behind insulation blankets, under floor panels, or in lap joints where drainage is limited. In many cases, the corrosion has progressed slowly and predictably, yet it has remained undetected because it developed in areas that are difficult to inspect. Such discoveries have led to changes in inspection intervals, access requirements, and more thorough and comprehensive corrosion prevention programmes across multiple aircraft types. Fatigue cracking provides similar lessons. Small cracks may be found in areas that technically comply with inspection requirements but are challenging to inspect effectively in practice.

Components Tell Their Own Story

Beyond structure, teardown inspections provide invaluable insight into what happens to components over time. On teardown, it will soon be discovered that items such as actuators, valves, pumps, wiring bundles, and brackets clearly show wear patterns that differ significantly from what was anticipated during the design phase or during early service life. Such discoveries include fretting damage caused by micro-movement, chafing due to subtle installation tolerances, and thermal degradation in areas exposed to unexpected heat sources. In some cases, components removed “on condition” during service life are found to have substantial remaining margin, while others fail in ways that were not predicted by existing reliability data.

These observations are more important than you might at first imagine, as each small observation creates a larger mosaic which can help to shape reliability programmes, task card design, and parts replacement strategies. These observations also underscore the value of teardown data as a complement to operational reliability reporting, which may not capture slow-developing or non-dispatch-critical degradation.

Maintenance Practices Leave Long-Term Signatures

As we touched on earlier, teardowns also provide a true-life as opposed to theoretical assessment of maintenance practices over an aircraft’s life. Fastener condition, sealant application, repairs, and modifications all leave long-term signatures that become clearly visible once the aircraft is fully stripped out. In some cases, well-executed repairs age exactly as anticipated, blending almost seamlessly into the surrounding structure. However, in other instances, minor deviations from best practice—improper surface preparation, marginal sealing, or non-


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optimal fastener selection—become focal points for corrosion or cracking which doesn't occur until decades have passed.

Findings from teardowns reinforce the long-term importance of quality workmanship. Decisions made under schedule pressure during a routine check can influence the overall structural health for the remainder of the aircraft's life. Teardown inspections help to double underline the magnitude of such a cause-and-effect relationship.

Feeding Lessons Back Into the System

Of course it is one thing to make various impressive discoveries during teardown. However, it is what is done with that information that dictates just how important any discoveries are. When teardown data remains isolated within asset management or part-out organisations, the potential improvements to safety and reliability remain unachievable, and that is a total waste of critical information.

The most effective programmes ensure that teardown findings are shared with OEMs, regulators, operators, and MROs. The result can mean that structural inspection programmes are refined, corrosion prevention measures are updated, and maintenance task cards are adjusted to reflect real-world aging behaviour. It can frequently be shown that in certain cases, teardown data has directly influenced airworthiness directives, service bulletins, and supplemental inspection programs. One shouldn't forget that teardown inspections also play an increasingly important role in the management of ageing fleets. As the average aircraft age continues to rise across many sectors, historical teardown data is now providing an invaluable roadmap for anticipating future issues, enabling MROs to be proactive as opposed to reactive.

More Than an End-of-Life Activity

There is a temptation to view teardown inspections as a purely end-of-life exercise, driven by asset recovery rather than safety. However, this would be a massive mistake as, in reality, teardowns represent one of the most information-rich feedback mechanisms available to the MRO community. When you think about it, every aircraft that is dismantled carries the accumulated history of its operation, maintenance, and working environment. Teardown inspections translate that history into tangible data lessons—lessons that can improve inspection effectiveness, refine maintenance programmes, and ultimately enhance current and future safety requirements of aircraft.

So, next time you come across an aircraft teardown, don't look upon it as a lifeless entity that no longer serves any worthwhile function apart from becoming a donor of spare parts. Instead, look upon it as a still active aircraft that has more than a few revealing stories to tell about its past that it is only now able to tell you.

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Ageing Aircraft Cost Management

How the ageing of an aircraft can see considerable changes in the way maintenance is planned and carried out

By David Dundas

The strategy or maintaining a new aircraft is a relatively straightforward challenge. However, over time, various different options begin to present themselves, and the older an aircraft gets, the more complex those options become. Questions arise regarding the merits of proactive as opposed to reactive maintenance, the use of used serviceable materials (USM) as opposed to brand-new OEM parts, whether repair or replacement of parts is a better option, and at what point should maintenance be aligned with any plans to phase out an aircraft. With the current supply chain problems seeing aircraft being cannibalised for parts far younger than was the norm, that introduces another variable factor into the mix.

So, when it comes to aircraft and engine maintenance cost management, what are seen as the best strategies to adopt and why? The following is a conglomeration of thoughts and ideas from eight experienced and reputable MRO-connected operators involved in the commercial airline sector of the aerospace industry.

The point where maintenance cost management becomes a strategic, rather than purely technical, concern for operators

Maintenance schedules for new and nearly new aircraft are easily planned. However, as aircraft age, so they develop a past history, and it is often that past history that can dictate ongoing maintenance schedules. The question is, at what point in an aircraft's life does the maintenance schedule begin to change and cost

Dag Johnsen, Chief Operating Officer, Aero Norway

> **"The strategic cost management decision related to engine overhaul becomes most relevant with fleet exits and lease returns. During normal operation, i.e. not considering any fleet exits or lease returns, operators will typically build in durability, and predictability to the fleet."**
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management become a more strategic as opposed to technical concern?

Anca Mihalache, CEO of AERO CARE shares her thoughts: "In my opinion, we are already at that point. When the market is overinflated, operators naturally start looking more closely at costs. On the other hand, when engine availability is as low as it is today, there is very little that airlines can realistically do in terms of cost reduction. At present, we are in a situation where maintenance management is driven primarily by technical necessity rather than strategy, as operators need to keep aircraft flying and the additional costs cannot easily be avoided." For Dag Johnsen, Chief Operating Officer at Aero Norway, durability and predictability are key drivers: "The strategic cost management decision related to engine overhaul becomes most relevant with fleet exits and lease returns. During normal operation, i.e., not considering any fleet exits or lease returns, operators will typically build in durability and predictability to the fleet. However, as aircraft are planned to retire from service and/or returned to a leasing company, the question will be how much engine life needs to be considered to meet exit targets. Many lease agreements have return clauses such as remaining LLP life, residual performance etc. In some cases where the operator owns the airplanes, they are freer to utilise the residual "green time" engines to support their own operating fleet until retirement or selling these assets on the open market."

At PEM-Air, the company's Chief Executive Officer, Virgil D Pizer, sees a wide array of factors which can affect any maintenance strategy. As he explains: "Maintenance cost management stops being a purely technical issue and becomes a strategic one the moment engine behaviour starts influencing decisions outside the maintenance department. With ageing engines like the CFM56, V2500, CF6, PW4000, PW2000, CF34, or Trent 700/800, this shift usually happens when shop-visit costs become unpredictable and the financial exposure of a single event can swing several million dollars. At that point, planning isn't just about workscopes anymore — it's about protecting cash flow, managing risk, and stabilising the operation. For many smaller and midsized operators, this transition happens even earlier. With limited spare engines and tighter schedules, one unplanned removal can disrupt the entire network,

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force expensive short-term leases, or trigger cascading delays. When reliability starts shaping the flying programme, maintenance becomes a strategic concern by definition. The same is true when material scarcity and long lead times begin dictating the economics more than the technical findings themselves. Ageing platforms rely heavily on USM, PMA, DER repairs, and module exchanges, and when those markets tighten, operators have to think in terms of procurement strategy and long-term planning, not just shop-visit execution. Ultimately, maintenance cost management becomes strategic when engine economics start influencing fleet decisions — whether to extend life, convert, retire, or lease additional assets. At that point, the conversation moves from engineering to finance, operations, and executive leadership. From Pem-Air's perspective, we see this shift most clearly in smaller to mid-size operators. Their exposure to cost volatility is higher, their buffer capacity is smaller, and their ability to absorb long TATs or unexpected findings is limited. For them, maintenance cost management isn't just about keeping engines running — it's a core part of ensuring operational resilience and long-term fleet viability." On the other hand, Bruce Ansell, Technical Manager – Engine Division at APOC Aviation provides us with a very concise yet sound strategy from the onset: "Cost management starts prior to acquiring the engine, it should be part of the financial modelling prior to acceptance. The technical condition and future operational requirements will dictate the costs."

Abhijeet Dey, the VP – Asset Management at Setna iO identifies maintenance problems with the same engines as those identified by Virgil D Pizer as he tells us that: "Operators are met with a unique blend of challenges and opportunities, particularly concerning ageing aircraft engines such as the CFM56-7B, CFM56-5B, V2500-A5, CF6-80C2, and CF6-80E1. These engines, once deemed the workhorses of commercial aviation, now signal an urgent need to re-evaluate maintenance strategies. Operators need to recognize that the costs of shop visits often exceed the residual values of ageing engines. This shift empowers them to navigate maintenance decisions more strategically, thereby ensuring operational efficiency while aligning maintenance practices with broader business goals. Since the CFM LEAP and PW GTF programmes are yet to achieve their individual targeted performance, retirement of older Boeing 737 NGs and A320 CEOs are getting pushed back by another 5-10 years. For operators maintaining the CFM56-7B and CFM56-5B, the industry's two most widely used engines, the stakes are higher than ever. Maintaining these engines requires meticulous planning, particularly regarding lease returns. The emphasis must be on maximising green-time usage

Abhijeet Dey, VP Asset Management, Setna iO

> **"The transition from predictable labour expenses to increasingly volatile material costs is starkly evident. Taking the CFM56 & V2500 engines as an example, operators are witnessing Life-Limited Parts (LLPs) prices increase by an alarming 5-7% annually due to elevated manufacturing demand and constrained availability."**
>
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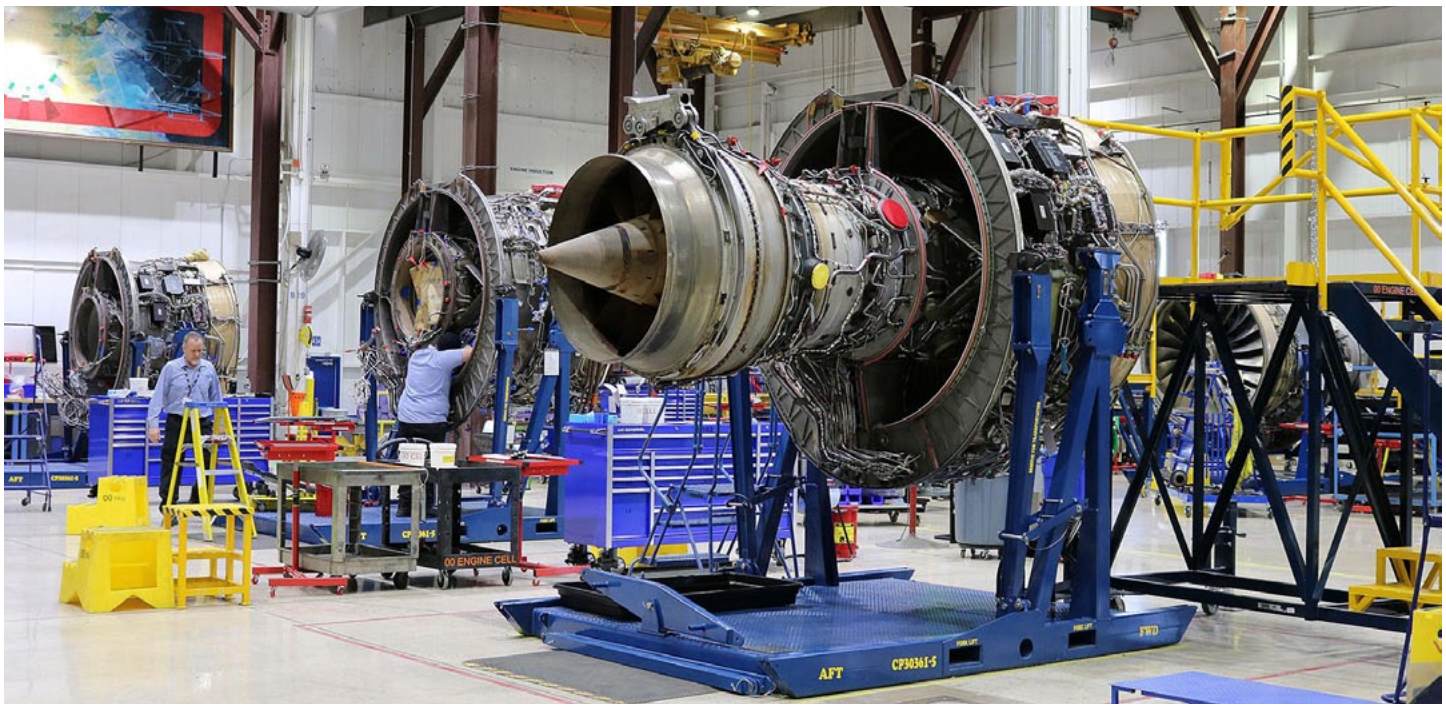
while simultaneously complying with the stringent requirements for back-to-birth documentation and necessary overhauls. This balancing act is critical for preventing costly, unexpected operational downtimes."

For David Williams, Director of Global RB211 Sales at StandardAero, forward planning is key. "We always encourage operators to consider maintenance cost management on a strategic basis, especially during times of extended shop visit turnaround times (and tight slot availability). By working with an MRO provider to plan their maintenance requirements well ahead operators will be able to avoid AOG issues, booking shop visit slots well in advance and securing the parts they need ahead of time," he explains, while for Cliff Topham, Senior Vice President, Werner Aero LLC, "Maintenance cost management is a major strategic driver when engines get towards the first SV."

The maintenance cost drivers which typically escalate most sharply as engines age (e.g., LLPs, unscheduled removals, shop visit frequency).

As engines move deeper into their lifecycle, a few cost drivers start to rise much faster than others, and they tend to do so in ways that operators feel immediately in both budget and operational stability. The most visible pressure usually comes from shop visit costs, because ageing engines accumulate more distress in the hot section, scrap rates increase, and the availability of affordable USM tightens. What used to be a predictable work scope becomes far more variable, and that variability alone drives costs sharply upward. Virgil D Pizer further explains: "At the same time, LLP exposure becomes a major factor. Even if an operator tries to defer full stack replacements, ageing fleets eventually hit staggered LLP expirations that create unavoidable cost spikes. For platforms like the CFM56, V2500, CF6, PW4000, PW2000, CF34, or Trent 700/800, the LLP market has also become more expensive and less liquid, which amplifies the financial impact. Another driver that escalates quickly is unscheduled removals. As EGT margin narrows and components accumulate cycles, engines become more sensitive to operating environment, borescope findings, and minor performance shifts. Each unplanned removal not only adds cost but also disrupts the flying program — especially for smaller operators with limited spare coverage. Finally, shop visit frequency itself increases. Engines that once reliably delivered long intervals between visits begin returning to the shop sooner, often with less warning. This compresses maintenance planning windows and forces operators to absorb more events over a shorter period, which compounds both cost and operational strain. From Pem Air's perspective, these escalating drivers hit smaller and midsized operators hardest. With fewer engines to spread risk across, limited access to green time assets, and tighter cash cycles, the combination of rising shop visit costs, LLP exposure, and unplanned removals can quickly shift from a technical challenge to a strategic one."

LLPs in particular are targeted by Abhijeet Dey, Dag Johnsen and Cliff Topham in terms of escalating costs. "The transition from predictable labour expenses to increasingly volatile material costs is starkly evident. Taking the CFM56 & V2500 engines as an example, operators are witnessing Life-Limited Parts (LLPs) prices increase by an alarming 5-7% annually due to elevated manufacturing demand and constrained availability. In such circumstances, replacing an entire LLP stack can account for an astonishing 40-50% of an engine's total mid-life value. When examining legacy engines, the need for increased scrutiny of shop visit frequently becomes apparent. As these engines age, their performance metrics, including EGT margins, tend to decline more markedly, resulting in shorter on-wing time. This decline not only increases the frequency of shop visits but also raises the overall costs needed to keep these aircraft operational. Coupled with impending fatigue thresholds, the risk of unscheduled engine removals escalates. Even minor component failures can trigger significant internal damage, ultimately leading to costly repairs and extended grounded periods," Dey advises. Beyond this, Johnsen tells us that: "The single largest expense during engine overhaul is the replacement of LLPs followed by the HPT blade set. A new CFM56 engine LLP core stack can cost up to US$5-6m per shop visit, and a new HPT blade set cost is more than US$2m. Unscheduled, or better described as unplanned removals, are always an element in engine operation, but most operators have some level of predictability based on historical data which account for these removals. The nature or failure mode of the unplanned removal will obviously have a large impact on the cost and can vary from a minor oil leak that can easily be resolved with minimum maintenance, to significant failure that can render the engine beyond economical repair. When Aero Norway works with a customer over a long period, we get to know their fleet, their goals and understand how we can really add value at a strategic level. With this knowledge, we can solve targeted problems and assist with unscheduled removals in a trusted, cost-effective way that is transparent with both pricing and process. The shop visit frequency is often predicted by the engine manufacturers



RB211-535 © *StandardAero*

based on the operating environment, and a first-run engine will typically have a longer service life compared to a first, second, third, etc., shop visit engine. Much of these predicted service lives are also dependent on the shop visit workscope level, and a full performance restoration workscope will yield longer service life compared to a limited workscope engine," while Cliff Topham suggests that: "LLPs cost becomes important as they can represent up to 50% of an SV when a combined PSR & LLP visit are combined."

Though Bruce Ansell succinctly advises that: "Mature engines have a reduced MTBOH (Mean Time Between Overhaul), at the same time the cost of replacement parts is rising each year, resulting in ever-increasing shop visit costs," interestingly, David Williams and Anca Mihalache both look beyond the previously identified problem of LLPs. Williams explains: "Parts supply is typically the main cost driver for aging engines such as the Rolls-Royce RB211-535, which we support from our San Antonio facility in Texas. While LLP is certainly a key concern here, it's not unheard of for a single non-LLP (e.g., structural) part to become a critical item, especially where demand for that items is extremely low, with the OEM (or the OEM's supply chain) often having ceased production of that component years ago. In such situations used serviceable material (USM) can become critical." "LLPs are an obvious driver due to the annual price escalation applied by the OEM. However, just as important are non-LLP parts, or parts with only a soft life limitation, such as HPC and HPT blades, nozzles, cases and similar components. Scheduled removals give lessors and operators the opportunity to plan shop visits and secure parts in advance. Unscheduled removals, depending on the nature of the repair required, can very quickly turn into a significant cost driver," says Mihalache.

How should operators rethink maintenance planning once engines move beyond their original economic design life?

It is abundantly clear that there is no 'one-size-fits-all' solution to this situation, a sentiment backed up by the wide-ranging list of strategies and options discussed by all the contributors. To begin with, Abhijeet Dey takes an interesting approach, in particular in relation to the end goal. He explains: "Engines like the CFM56 variants and CF6s eventually reach a sunset phase. Here, operators must pivot from a conventional 'Restore to New' mindset to a more strategic 'Build to Goal' approach. This new paradigm necessitates a focus on tailored workscopes that prioritise modular or hospital shop visits, designed to provide just enough cycles to efficiently meet an aircraft's retirement timeline. Instead of pursuing complete performance restorations, which can be prohibitively expensive, operators ought to prioritise longevity and operational efficiency. Incorporating effective green-time strategies is one method to extend the useful life of these engines across a fleet. For example, by judiciously swapping CFM56-7B or 5B engine modules within a fleet, lessors and operators can optimise the remaining life of both engines and their components across multiple aircraft. This approach ultimately minimises the need for new parts while promoting sustainability and resource efficiency." For Virgil D Pizer, he sees a shift in approach as necessary, in particular moving away from the more traditional OEM-style planning. "Once an engine moves beyond its original economic design life, operators really have to shift their mindset from 'maintaining the engine as designed' to 'managing the asset for the remainder of its useful value.' At this stage, the goal is no longer to chase like-new performance — it's to control cost volatility, extend reliability where it still makes sense, and avoid investing more than the asset can realistically return. For most fleets, this means moving away from rigid, OEM-style planning assumptions and toward a far more pragmatic, condition-based approach. Instead of defaulting to full restorations, operators start asking whether a performance restoration, a module level repair, or a DER/PMA-supported solution will deliver enough on-wing time to bridge to the next fleet milestone. The planning horizon becomes shorter and more tactical, with a stronger focus on aligning shop visits to remaining aircraft life, lease return conditions, or conversion timelines. It also means accepting that shop visit intervals will compress and that findings will become less predictable. Planning teams need to

build more buffer into schedules, secure material earlier, and rely more heavily on USM and module exchanges to keep costs under control. For smaller and midsized operators, this is especially important because they often don't have the spare engine depth to absorb long TATs or unexpected removals. Another key shift is integrating maintenance planning more tightly with finance and fleet strategy. Once engines are past their economic design life, every major investment needs to be weighed against the aircraft's remaining value and the operator's long-term plans. In some cases, the right answer is to extend life with minimal investment; in others, it's to retire or part out the asset rather than fund another heavy shop visit," he informs us.

David Williams sees multiple options available, depending on the circumstances, suggesting that: "The key strategy for operators of ageing engines is to think smart when it comes to maintenance, and to utilise all of the solutions available to them. This includes not just new parts supply and MRO shop visits, but also USM, component repairs, green time engines, exchange pools, module swaps, PMA parts and DER repairs. Another solution sometimes open to operators is a so-called 'Frankenstein' build, i.e., utilising multiple donor engines to create a single airworthy powerplant. This approach may or may not be economical, depending on the condition of the donor engines and the cost of disassembly and rebuild." Bruce Ansell and Cliff Topham both provide brief but salient remarks on the matter. "The primary concern should be availability of spare parts, to the extent that hard to find parts should be sourced well in advance of the required date, allowing for any component repair or overhaul to be completed prior to the shop visit," says Ansell, while Topham adds that: "Many start to think of minimum scope visits to extend life at minimal incremental cost."

Of course, it would be difficult to avoid supply-chain issues when discussing any aspect of aircraft maintenance, and Anca Mihalache explains where it creates a problem. "This is relatively new territory for everyone. Historically, engines would typically go through two shop visits and then be retired which supported a healthy supply of used material for future shop visits. Today, I see two main issues. First, repair shops are increasingly focused on newer-generation engines, such as the LEAP, which means reduced capacity and fewer shop slots for legacy engines. Second, parts availability is very low. Engine parts repair shops are facing delays across the supply chain, including delays from OEMs for even basic hardware such as nuts and bolts," she tells us. Then, to conclude this section, Dag Johnsen takes a very interesting view of the situation in relation to piston-powered aircraft. He explains that: "The engine's economical design life is primarily driven by parts availability and finding MRO shops still maintaining these engine models. There are still piston-powered airplanes in commercial operation where a very few, but specialised MROs continue to overhaul these engines. Of the several thousand B727s, B737-200s and DC9s produced with the Pratt & Whitney JT8D engines, there are only a fraction of these airplanes still in service, and a very few MROs offer repair of these engines. Of the nearly 2,000 B737 "classic" airplanes produced with the CFM56-3 engines, there are a few hundred airplanes still in service. While the CFM56-3 engine production ceased in 1999, CFMI provides strong aftermarket support through new parts production and repair services, and several MROs still continue to provide repair services for these engines."

How operators should evaluate "repair versus replace" decisions as parts scarcity increases

As parts scarcity becomes a defining feature of aging engine programs, the "repair versus replace" question stops being a simple cost comparison and becomes a broader assessment of risk, timing, and remaining asset value. Operators have to look beyond the immediate shop visit quote and think about what each option means for on-wing time, reliability, and exposure to future material shortages. In practice, the first step is understanding whether a repair can realistically deliver the on-wing time needed to reach the next fleet milestone — whether that's a lease return, a conversion, or planned retirement. If a repair only buys a short interval and pushes the engine back into the shop sooner, the lower upfront cost may not actually save money. On the other hand, if a DER- or PMA-supported repair can reliably bridge the gap without compromising performance or compliance, it often becomes the more economical choice, especially when replacement parts are scarce or priced at a premium. PEM-Air's CEO, Virgil D Pizer, further advises us: "Operators also need to factor in the volatility of the USM market. For many aging platforms — such as the CFM56, V2500, CF6, PW4000, PW2000, CF34, or Trent 700/800 — replacement parts may be available one month and unobtainable the next. In that environment, a viable repair path can be more valuable than waiting for a part that may not arrive in time to support the schedule. This is particularly true for smaller and midsized operators, who typically don't have the spare engine depth to absorb long delays. Another key consideration is the long-term value of the asset. If the aircraft or engine is nearing the end of its economic life, investing heavily in new parts rarely makes sense. In those cases, operators often prioritise repairs that keep the engine compliant and reliable without overcapitalising an asset that won't return the investment." He concludes that from Pem Air's perspective, "the best decisions come from evaluating repair and

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> *Cliff Topham, Senior Vice President, Werner Aero LLC*

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replacement options in the context of the operator's actual operating horizon, not the theoretical design intent of the engine. As scarcity increases, flexibility, creativity, and a willingness to tailor the workscope become essential. A repair that fits the business case is often more valuable than a perfect technical solution that doesn't fit the timeline or the budget."

Shane Hennessy, Director of Origination & Trading EMEA at EirTrade Aviation is particularly focused on the shortage of greentime engines and how this is affecting the decision-making process for many. As he points out: "Where airlines have a clear operational requirement for an engine, decision-making in the current market is increasingly tilting toward repair rather than replacement. The primary driver is the acute shortage of greentime engines, which is consistent across key narrow-body platforms such as the CFM56-5B/7B and V2500-A5, as well as wide-body types including the CF6-80E1 and Trent 700. Limited supply has materially constrained replacement options. While asset owners can command strong values for run-out engines from the market, the acquisition cost of greentime engines for the aforementioned engine types has reached peak levels. EirTrade has visibility of market values for CFM56-7B26E engines with approximately 5,000 FC remaining approaching US$10 million, fundamentally altering the replacement economics. Conversely, repair decisions are not without challenge. Operators must carefully factor in extended turnaround times, managing shop-visit scope creep, and rising material costs driven by OEM cost-loading and price escalation. As a result, repair versus replace decisions increasingly require a balanced assessment of parts availability, replacement options and long-term asset value." At AERO CARE, company CEO Anca Mihalache is also firmly in the repair as opposed to replace corner. "Presently, I believe decisions are predominantly made in favour of repair. Newer engines continue to experience technical challenges, while older engines are required to operate longer than originally anticipated. Combined with increased flight demand, this has pushed the market towards repairing engines rather than parting them out," she says. Aero Norway's COO Dag Johnsen is of a like mind to Mihalache as he advises that: "Most operators would prefer repairs during shop visits as opposed to replace with new parts due to cost considerations, as long as the repaired parts meet the service goals. When evaluating whether a repair is the appropriate course of action, it depends on the customer's requirements – mostly cost versus time. Once this has been determined, Aero Norway works closely with our component repair providers to ensure our solutions are as good as buying new, while also saving our customers money." He then adds that: "We also look for opportunities to help with the development of new solutions when we come across parts that are to be scrapped and non-repairable. This ensures that we keep developing new solutions that at the end of the day deliver an expert, cost-efficient service."

Shane Hennessy, Director of Origination & Trading EMEA, EirTrade Aviation

Bruce Ansell at APOC Aviation makes it clear that he feels that they type or 'repair versus replace' analysis is critical. "Repair analysis should involve time & cost, also the potential for BER or scrap rates which can effectively leave you without the required parts. APOC believes it is essential to take advice on repairs and current success rates from the repair shops," he tells us. On a slightly different tack, however, Abhijeet Dey at Setna iO is more focused on cost and availability as a guiding influence, pointing out that: "Operators are leaning toward innovative salvage repairs for older engines. The aviation industry has opened up more towards using parts with Designated Engineering Representative (DER) repairs, which allows them to extend the life of components that were often previously considered non-repairable. While most operators now have PBH contracts to counter parts scarcity during line operation, they do have to rely on repair shop Turn Around Time (TAT) when the engines are going through shop visits. Faced with approximately 3–6-month lead times for a part to be repaired, many operators opt for immediate DER repair solutions or even the acquisition of PMA parts. The financial burden of an aircraft being AOG (Aircraft on Ground) or engines off wing, often makes immediate repairs or the acquisition of Used Serviceable Material (USM) more favourable, even if these options come at a higher price."

David Williams makes it very clear that StandardAero has a long-held 'repair rather than replace' philosophy, wherever practical, based on the company's extensive in-house component repair and overhaul capabilities. "Component repairs are certainly an important option for operators facing parts shortages in the market, as they have the potential to deliver both TAT and cost benefits," he says, adding that: "Key criteria for operators to evaluate will be the TAT and cost differential of new parts versus repairs, as well as locating a reliable source of OEM-approved component repairs." And to conclude, once again, with a concise response from Cliff Topham at Werner Aero, he tells us that it "Depends on the planned life of the engine or aircraft and the return conditions if leased."

How important is the use of USM for the cost management of ageing engines

In general terms, USM offers operators greater cost control, generating savings of 30-50% compared to procuring new parts.

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>
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RB211-535 on test at StandardAero © *StandardAero*

This flexibility plays a crucial role in guiding decisions about whether to retire an engine or extend its service life. Abhijeet Dey goes further by explaining that: "An Overhauled (OH) part is more cost effective than using a new part if the engine is already going through its 2nd or 3rd major shop visit. The on-wing time needs to be justified against the shop visit cost and using USM against new parts helps achieve the targeted economic performance. For example, a half-life OH CFM56 Core LLP set will cost 50% less than a new set of core LLPs. However, for a second-run or third-run engine, using new LLPs doesn't make any sense as the on-wing time will never exceed half-life during performance deterioration." David Williams is of a like mind to Dey with regard to the use of USM, providing traceability is intact. "USM can be a valid option for operators of aging engines, especially when facing long lead-times for new parts, and StandardAero relies heavily on its in-house Asset Management team to provide customers with USM options. USM may also offer operators the benefit of being able to select material to specifically meet their operational requirements, i.e., in terms of cycles remaining. Where USM is utilised, it is of course essential that operators have full 'back to birth' traceability for any LLP being utilised, in order to ensure the integrity of the components in question," he warns us. Of course, the financial benefit of USM depends on one obvious factor, as pointed out by Cliff Topham: "It is very important in controlling cost if you can find suitable material."

Shawn Hennessy sees that as carriers look to extend the life of existing aircraft, so the demand for USM has increased and its importance grown. He tells us that: "In the last 24-36 months, an increased number of airlines have pushed their fleet transition to newer-technology aircraft to the right and are operating their fleet for longer than 24 years, where previously airframes were sent for part out at this point. This is due to several factors, including the well known ones with the PW1100 engine, supply chain issues and entry into service issues from the OEMs. Coinciding with this increase, EirTrade Aviation has seen an increase in demand for USM. For operators, a significant proportion of the cost of engine shop visits & overhauls is made up of the value of the parts, thus reducing these costs with USM makes financial sense without compromising quality. USM can offer significant cost reductions when compared to purchasing parts directly from the OEM when accounting for increases in OEM CLP. Furthermore, Prolonged OEM lead times and supply chain constraints is driving strong demand for readily available USM. EirTrade Aviation is able to provide quick access to stocked engine & airframe USM, helping airlines mitigate downtime risk and avoid the operational and financial impact of extended OEM delivery timelines."

However, there is the challenge not simply of finding USM, but sourcing USM with matching cycles and this can be a whole different ball game. As Dag Johnsen explains: "Utilising USM as opposed to replace with new will yield significant cost savings but can sometimes be difficult to find. A new HPT blade set for a CFM56 engine will cost around US$2 million, and a repaired HPT blade set with lower, but matching cycles remaining for a specific target build will be significantly less expensive. The challenge is to locate a repaired HPT blade set that matches the service goal. The same principle will apply to LLPs where a typical CFM56-5B-/-7B full-performance restoration cycle goal is around 10,000 cycles dependent on the operational environment." Like many, Bruce Ansell and Anca Mihalache also build a strong case for the cost benefits of USM. "USM is essential for ensuring that mature assets are able to be returned to service, as the engine ages, several parts will go out of production which leaves USM or PMA as

David Williams, Director of Global RB211 Sales, StandardAero

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> *David Williams, Director of Global RB211 Sales, StandardAero*

the only alternatives. USM, from specialist providers like APOC, also allows engines to be rebuilt to fully utilise the remaining life of the engine - no-one should want to invest millions into new LLPs if the engine is going to require a full overhaul in a few years. Similarly, new blades etc., may not be necessary if the LLP life is low, USM can be acquired at a percentage of the new cost and be matched to the remaining LLP life," Ansell says, while Mihalache suggests that: "It is essential from two perspectives. First, USM helps keep maintenance costs under control. Second, in many cases the OEM is no longer producing certain parts, which makes USM not a cost choice but a necessity."

Beyond the above, Virgil D Pizer also delves into the area of the strategic dimension. As he explains: "USM becomes absolutely central to cost management once engines reach the later stages of their lifecycle. At that point, the economics of maintaining platforms like the CFM56, V2500, CF6, PW4000, PW2000, CF34, or Trent 700/800 shift heavily toward material availability, and new OEM parts often become either too expensive or too slow to source to make sense for an ageing asset. USM fills that gap by providing a more affordable, more flexible supply of components that still meet airworthiness and traceability requirements. For most operators, especially smaller and midsized fleets, USM is what keeps shop visits financially viable. Without it, the cost of a heavy visit can easily exceed the remaining value of the engine or aircraft. USM also helps stabilise budgets by reducing exposure to OEM price escalation and by offering more predictable lead times when the new parts supply chain is constrained. In many cases, the difference between a US$3 million shop visit and a US$5 million shop visit comes down to whether USM is available for the hot section, LLP stack, or key rotating parts. There's also a strategic dimension: USM allows operators to tailor their investment to their actual operating horizon. If an aircraft is only planned to fly for another three to five years, it rarely makes sense to install brand-new hardware with a full-life limit. A serviceable part with appropriate remaining life can deliver exactly the on-wing time needed at a fraction of the cost. From Pem Air's perspective, USM is not just a cost lever — it's a planning tool. It gives operators options, helps mitigate the unpredictability of ageing engine findings, and supports more flexible workscopes. For smaller operators in particular, access to reliable, well documented USM can be the difference between maintaining operational stability and facing disruptive, budget-breaking surprises."

Anca Mihalache, CEO AERO CARE

An overview of the overall availability of USM

Most MRO-based businesses feel that there is a shortage of USM and that this is predominantly as a result of the lack of aircraft being offered for teardown. This is likely because many carriers have extended the life of existing aircraft in their fleet as a direct consequence of delays in the delivery of certain preordered aircraft. This is backed up by David Williams, who states that: "The availability of USM varies from platform to platform. Overall, we have seen fewer retirements than expected in recent years – partly due to the service introduction issues affecting new-generation aircraft and powerplants – which has led to USM remaining relatively scarce, as operators retain older platforms in service for longer. This is especially true with regards to LLPs." However, Anca Mihalache, while recognising the shortage in one area, remains slightly more optimistic, depending on what one is specifically referring to. "For certain units, such as LLPs with a certain life-remaining blades and nozzles, availability is at the lowest level I have seen in my career. For other components, availability remains relatively stable. Of course, the specific engine type under consideration plays a major role in this assessment," she admits.

Bruce Ansell seems to be adopting a more cautious approach and, if anything, is not optimistic for the future, commenting that: "USM is in great demand and some parts are now getting scarce, APOC only sees this getting worse as more parts are scrapped during the repair process. The increasing demand for mature engines is leading to engines being repaired or rebuilt instead of being torn down, leading to a shortage of some USM components. Mid-life LLPs are now very difficult to find." Dag Johnsen, on the other hand, is slightly more optimistic as he looks to a time when aircraft delivery numbers improve. "The USM availability is very cyclical and tied to the world fleet's retirements, and MRO availability set up for engine teardowns. We have seen operators extending service of airplanes planned for exit due to new airplane delivery constraints, putting a strain on USM availability, but as new airplane deliveries are picking up the USM availability will improve," he suggests.

Virgil D Pizer sees flexibility as key when it comes to sourcing parts, as well as seeing a viable alternative to USM and OEM parts. He explains: "Overall USM availability is becoming more uneven across the major ageing engine platforms, and that inconsistency is one of the biggest challenges operators face today. Some material flows steadily from teardowns, while other components — especially hot-section hardware and LLPs — have become increasingly scarce or priced at a premium. That's why our focus at PEM-Air is less about relying on any single source of USM and more about building a broad, reliable supplier network that gives us multiple pathways to secure the right material at the right time. Because we're a smaller and more flexible MRO provider, we're not

> **"For certain units, such as LLPs with a certain life remaining, blades, and nozzles, availability is at the lowest level I have seen in my career. For other components, availability remains relatively stable."**
>
> *Anca Mihalache, CEO AERO CARE*

locked into rigid sourcing channels. We can move quickly between teardown partners, brokers, and specialised repair shops, and we can often secure material that larger organisations overlook or can't move on fast enough. That agility is essential when availability shifts month to month, especially for operators with limited spare engine coverage who can't afford long delays. At the same time, we're realistic about the fact that USM alone won't always solve the scarcity problem. In areas where the market is tight or pricing doesn't make economic sense, the PMA [Parts Manufacturer Approval] part becomes an important tool — not as a blanket solution, but as a targeted strategy. When a PMA part is well proven, cost effective, and aligned with the operator's remaining engine life, it can provide stability and predictability that the USM market sometimes can't. So, while USM availability is tightening in certain segments, our approach is to stay flexible, maintain a diverse supplier base, and use PMA where it genuinely supports the operator's business case. That combination allows us to keep shop visits moving, control costs, and give smaller and midsized operators the options they need to stay competitive."

Shane Hennessy is another to identify the knock-on effect of delays in the delivery of brand-new aircraft. The consequence, as he explains, means that: "Overall availability of USM is tightening, particularly for current-generation narrow-body and wide-body engines. Since 2020, the supply of greentime engines such as the CFM56-5B/7B, V2500-A5, and CF6-80E1 are at an all-time low. Rather than selling assets into the teardown market, airlines and lessors are increasingly choosing to rebuild engines or preforming modular swaps, thus extending on-wing life and the economic life of an engine. This has materially reduced the volume of engines available for part out. From an airframe perspective, delayed fleet renewal programmes are compounding the issue. Ongoing delivery delays from the OEMs and capacity constraints are pushing fleet transition plans to the right, resulting in lower-than-normal aircraft retirements. As a consequence, airframe part-out rates are at an all-time low, further constraining the feedstock that traditionally supports the USM ecosystem. Together, these dynamics are placing sustained downward pressure on USM availability. While demand continues to grow—driven by ageing fleets, rising OEM prices, and long lead times—supply remains structurally limited. In this environment, early access to assets, strategic inventory positioning, and strong teardown capabilities are becoming critical differentiators for both operators and material suppliers."

Of course there can be a metaphoric price to pay, as pointed out by Abhijeet Dey. "The USM market is playing catch-up with supply constraints. Recent audits have uncovered numerous production violations related to new parts that resulted in the calling back of many batches of used parts. Delayed retirements also plays a major role in the scarcity of USM. Such dynamics impede access to high-demand parts, thereby undermining operational flexibility during critical repair cycles and emphasising the urgent need for strategic planning. However, this high demand for USM also creates an unsavoury situation where companies try to take advantage of the demand hike of USM and creates an unsafe and unreliable eco system," he tells us.

How should operators define and manage the economic "end of life" for an engine?

The economic "end of life" for an engine isn't defined by a single metric — it's the point where the cost of keeping the engine flying no longer aligns with the value it returns to the operation. For ageing platforms, that moment usually arrives when shop visit costs become consistently higher than the remaining asset value, when LLP exposure can't be justified by the expected on-wing time, or when material scarcity makes future maintenance unpredictable or uneconomical. At that stage, operators have to look beyond technical feasibility and focus on whether continued investment still makes business sense. Virgil D Pizer then explains that: "Practically, this means evaluating each engine against its remaining aircraft life, lease obligations, mission profile, and the operator's broader fleet strategy. An engine nearing retirement might only need a minimal, compliance focused workscope to bridge to a planned phase out, while an engine supporting a long-term fleet may justify a deeper investment. The key is aligning maintenance decisions with the operator's actual operating horizon rather than the theoretical design life of the engine. For smaller and midsized operators, this evaluation is even more critical. With limited spare coverage and tighter capital cycles, a single misaligned shop visit can overcapitalise an asset or create avoidable operational risk. That's why defining end of life isn't just a financial exercise — it's a strategic one that requires a clear understanding of cost exposure, reliability trends, and future material availability."

Abhijeet Dey pays particular attention to the difference between economic and technical end of life (EOL). He explains: "Operators must distinguish between economic EOL, when the costs of the next shop visit exceed the potential revenue the engine could generate, and technical EOL, which is determined by the onset of critical component fatigue or irreparable corrosion. This understanding EOL is pivotal for making informed maintenance and replacement decisions. Understanding where an engine sits on this spectrum helps operators decide whether to repair, replace, or retire it. Using a simple Net Present Value (NPV) analysis ensures these decisions are both financially sound and aligned with long-term fleet goals." David Williams takes a slightly different

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approach to the question, admitting that the differing needs of one customer from another could mean the difference between whether an engine is classed as BER (beyond economic repair) or not. "The calculation of whether an engine is BER will depend on the cost estimation performed after Cycle 1 (i.e., based on estimated new parts, USM and repair costs), and the customer's own assessment of the engine's economics. One customer may consider a repair estimate to render the engine BER, while a second may consider the bill to be acceptable, depending on their respective needs. One obvious goal for operators in terms of managing EOL is to carefully manage the engine's maintenance schedule and LLPs: an operator will ideally 'run out' an engine prior to its retirement, deferring any major maintenance events through module swaps and/or the use of USM and component repairs," he advises.

Both Anca Mihalache and Bruce Ansell have individual parameters that guide their approach to the end of life of an engine. "At present, many operators choose to part-out engines themselves at end of life or to cannibalise multiple engines in order to build one serviceable unit, while retaining remaining parts as stock. Ultimately, the economic decision is driven by the need to keep aircraft flying and to avoid flight cancellation costs," says Mihalache, while Ansell suggests that: "Effective planning will ensure that some LLP and OH shop visits will occur at the same time. At this point it should be looked at as a 'repair or replace' decision, - why pay US$10+ million for an SV when a replacement engine with sufficient life can be acquired for less."

Bruce Ansell, Technical Manager – Engine Division, APOC Aviation

What role does part-out strategy and asset monetisation play in overall cost management?

To a major degree, the overall value of USM and the engine value of an aircraft scheduled for teardown are governed by the volume of parts and demand for the engine type. However, a sound part-out strategy is definitely an essential part of financial optimisation for ageing aircraft. "When engines approach economic end-of-life, part out transforms what would otherwise be a high-cost liability into a valuable source of USM, supporting both financial and operational objectives across the fleet. Part out enables operators and lessors to recover significant residual value from ageing engines by harvesting LLPs, modules, rotables, and high-demand accessories. These components, once overhauled and certified, become monetisable assets that offset prior shop visit costs and generate cash flow. For lessors and operators, harvested components help meet lease return conditions, support engine swaps, and simplify transitions between operators. This reduces downtime, increases asset utilization, and enhances lease portfolio performance. Asset monetisation through part out enhances financial resilience by converting depreciated engines into revenue-generating assets. As a part of fleet planning, it reduces total cost of ownership and provides material support for the broader engine portfolio. By unlocking residual value, part out plays a central role in optimising the economics of aging fleets and ensuring long-term cost competitiveness," Abhijeet Dey advises.

Both Bruce Ansell and David Williams highlight the market factors affecting a part-out strategy. "Part-out strategy and asset monetisation will depend both on the volume of USM remaining in an engine, and on the remaining market demand for the engine. The former will be influenced by the cycles remaining on high-demand parts such as LLPs, and by the engine's operating environment (which will influence the level of corrosion and erosion seen on parts). The latter will depend on the size of the remaining active fleet, utilisation, and the engine's supply chain. Are new parts still available, and how long are lead times? Are PMA parts available? What volume of USM is already available in the market?" suggests Williams. "An engine will have a residual value, this value depends on USM market requirements, as well as the engine condition at part out. As a financial asset the engine can be depreciated to the residual value over the period of operation," Ansell comments.

Additionally, Anca Mihalache has highlighted the changes in the market during the last three years as she tells us that: "In a normal market, the exit value of an engine supports medium- to long-term business projections. Over the past three years, and likely for several more to come, residual engine values have increased significantly and have remained at elevated levels. As a result, projections made five to eight years ago have proven to be understated compared with the actual outcomes. For newer engine types, which are expected to be more reliable and require less repair, the situation may evolve differently. However, for now, the market remains consistently strong." To conclude, Virgil D Pizer points out that there is still a lot of residual benefit that can be extracted from an engine that is no longer viable. "Part-out strategy becomes increasingly important as engines age because it allows operators to recover value from assets that no longer justify a full shop visit. Instead of continuing to invest in an engine whose maintenance costs exceed its remaining economic life, part out provides a way to turn that engine into usable material — either to support the operator's own fleet or to generate cash through resale. In a market where USM availability is tightening and certain components are becoming harder to source, a well-timed part out can be both a cost-avoidance tool and a revenue opportunity. For many operators, especially smaller and midsized fleets, part out is also a way to stabilise future maintenance costs. By harvesting serviceable material from

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their own retired engines, they can reduce dependence on volatile USM markets and secure components with known history and traceability. This can make a meaningful difference when planning for upcoming shop visits, particularly on platforms where hot-section hardware or LLPs are scarce or prohibitively expensive. Asset monetisation goes hand in hand with this. Engines that are no longer viable for continued operation may still hold significant value in modules, accessories, LLPs with remaining life, or even core components. Monetising those assets helps offset the cost of replacement engines, green-time leases, or future shop visits. It also allows operators to avoid overcapitalising ageing equipment and redirect funds toward more strategic fleet needs," he tells us.

How early should maintenance strategy be aligned with fleet renewal or phase-out plans?

Maintenance strategy needs to be aligned with fleet renewal or phase out plans much earlier than many operators realise. Once an engine family enters the aging phase — whether it is a PW4000, CF6, CFM56, V2500, PW2000, CF34, or Trent 700/800 — every major maintenance decision should be viewed through the lens of how long the aircraft is expected to remain in service. The goal is to avoid investing in shop visits or LLP stacks that outlive the aircraft, while still maintaining reliability and regulatory compliance for the remainder of its operational life. Virgil D Pizer goes on to explain further that: "In practical terms, alignment should begin several years before the first aircraft in the fleet is scheduled to retire or transition. That's when operators can still shape shop visit strategy, adjust workscope depth, plan for green time bridging, and secure the right mix of USM, PMA, or module exchanges to match the remaining horizon. Waiting until the final year or two often forces reactive decisions — heavier investments than necessary or, conversely, under investment that risks reliability issues. For smaller and midsized operators, early alignment is even more important. With limited spare engines and tighter capital cycles, a single misaligned shop visit can create avoidable cost spikes or leave an engine with more life than the aircraft it's attached to. Planning ahead ensures that maintenance spend is proportional to the value the aircraft will still deliver. And while defining the renewal or phase out timeline is ultimately an operator or lessor decision, PEM Air sees its role as a partner in that process. With our deep experience across multiple ageing engine platforms, we're more than happy to help customers evaluate remaining economic life, model different maintenance pathways, and tailor workscopes that fit their long term fleet plans. Our goal is always to ensure that maintenance strategy supports—not contradicts—the operator's broader business trajectory."

Abhijeet Dey is more focused on early planning as he feels that it "provides a clear view of engine and aircraft health, helping determine which assets to retain, overhaul, or retire. Aligning maintenance strategy with fleet renewal or phase-out plans 18–24 months in advance enables transitions with minimal disruption by assessing fleet condition, securing parts early, forecasting costs accurately, and maximising remaining asset value. Maintenance schedules can be optimised to extract maximum remaining value from engines. Early planning also ensures teams are fully prepared for new aircraft introductions, reducing operational risk and supporting a smoother transition." However, David Williams is more focused on the timing of the phase-out plan. "The engine fleet's maintenance strategy should be reviewed and adjusted as soon as a phase-out plan is agreed upon. This will enable the operator to ensure that remaining green time is effectively utilized, and that shop visits are customized to avoid unnecessary outlays," he advises. Beyond this, Bruce Ansell and Anca Mihalache are of a similar mind where timing is concerned. "APOC advises that the maintenance strategy should be considered prior to acquiring the engine, this can provide for budget estimates for maintenance events, and also the point where short-build engines can be produced (short build - using USM to provide less than full-life on exit from the shop, i.e. built for a certain number of flight hours or flight cycles)," suggests Ansell, while Milahache believes that: "While it is understood that circumstances can change, with the pandemic being a clear example, maintenance strategy should ideally be aligned at the point of engine acquisition. Early planning helps in managing long-term technical and financial exposure, even if later adjustments become necessary."

MRO and Sustainability

Talking to Pascal Parant, Chief Commercial & Marketing Officer at the Vallair Group

By David Dundas

The commercial aviation industry as a whole is under tremendous pressure to reduce its carbon footprint. This doesn't just apply to the aircraft which fly between destinations, but every aspect of operations which help airlines to transport passengers. That includes aircraft MRO. While engines are more efficient and sustainable fuel is being introduced into the 'mix', electric vehicles such as aircraft tugs and tractors, baggage tugs and belt loaders are helping to transform ground handling services in the drive to become more sustainable. So what has happened within the MRO sector, changes that are not commonly known about or seen by anyone other than technicians and engineers?

To find out more, we approached Pascal Parant, the Chief Commercial & Marketing Officer at the Vallair Group for his take on the situation. Vallair's aircraft MRO & paint services are designed to support aircraft lessors and operators through the provision of a wide range of services, including maintenance, modifications or reconfigurations, paint, as well as aircraft parking and storage. The Group owns a modern, purpose-built facility in Montpellier, France, which has recently seen major investment in refurbishment and upgrade capabilities, which focuses on aircraft MRO and paint services for ATR, A320 and B737 aircraft types (all series), including the BBJ and ACJ.

Maintenance can range from basic line support through to "D" check type maintenance. The team in Montpellier, France, is also capable of carrying out major repairs, skin changes and frame changes (such as frame 16 and 18 on the A320), as well as cockpit window frames. The facility is both EASA and FAA approved and holds multiple additional regulatory approvals from around the world. For composite repairs, minor operations can be carried out at the Montpellier facility, usually while the aircraft is undergoing standard maintenance. However, larger repairs are usually carried out at Vallair's Aerostructures Business Unit in Chateauroux, France, and cover such elements as nacelles, flaps, spoilers, rudders, or thrust reversers.

AviTrader MRO 360°: How significant is the environmental footprint of aircraft maintenance compared with other aspects of airline operations?

Pascal Parant: The There are several ways to look at the environmental

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footprint. If we look at the basics, MRO base maintenance is undertaken in a large hangar into which you bring aircraft and mechanics. We mainly sell labour time: inspection, repair, diagnostics, checks, etc.
In an ideal world, if the climate is temperate, you need to heat and light the hangar during winter and at least provide lighting for the rest of the year. In hot parts of the world, air conditioning is a must, and in cold regions you still need heating in summer. Because of the internal volume to heat or cool and the fact that you regularly open the doors to move aircraft in and out, the main impacts are heating, cooling, and lighting. Things become less environmentally friendly when you need to perform engine tests. An engine test cell can burn several tons of Jet A-1 for a wide-body aircraft.
If we take a holistic approach, we also need to consider all the logistics and transportation of parts that an aircraft may need during its check. The CO_2 footprint can skyrocket if you have to transport an engine, landing gear, or a nacelle. These parts are oversized, sometimes shipped from the other side of the world by air, and here we start going into the red. The last level of CO_2 footprint is related to where the aircraft comes from for maintenance. This can be a major part of the footprint when airlines ferry aircraft long distances - for example, from the Western world to the Far East. A 20-hour ferry round trip has a significant impact.
Going one level deeper: heating or cooling a building will always have an impact. A component's repair will mainly generate transportation-related CO_2. For oversized parts, transport will have a larger impact. Landing gear may require specific surface treatment; the risk here is not CO_2 but chemical contamination in case of failure. Engines are even more complex: as they are stripped to piece-part, logistics to repair them generate CO_2, and the repair itself may be electricity-intensive. Then we still need to perform an engine test cell run that will consume several tons of Jet A-1. So, when speaking of footprint, hangars matter (you can optimize with large windows to allow more natural light, as long as thermal efficiency is maintained). But it is

all the surrounding logistics that can have a much more detrimental impact on the environment.

Where do you see the biggest opportunities for near-term environmental footprint reduction?

Go regional. Keep your maintenance not too far away from your FBO. Set limits to ferry flight (three hours for narrow-bodies, six hours for wide-bodies perhaps). Incorporate the latest technology to build high-performance hangars with a maximum of natural light. And optimize them from isolation standpoint to keep naturally temperature controls. Take advantage of any surface to put photovoltaic panels.

What role do used serviceable material (USM), PMA parts, and DER repairs play in sustainable maintenance strategies?

When a part is manufactured, it generates a certain amount of CO_2. Metallic parts, engine parts, and composite parts are among those that generate the most CO_2: excavating, mining, drilling, refining, melting, forging, producing carbon fibre (from incomplete gas combustion), resins, etc. All of this makes a new part a substantial CO_2 producer (as is the case for most human-made products). In aviation, if you optimize the entire useful life of a part, you produce less CO_2 than if you have to buy a new one. In that sense, USM creates a virtuous cycle. DER can extend the life of a part that might otherwise be scrapped under OEM repair manuals, and therefore also has a virtuous environmental impact. It is less obvious to me how a PMA part directly reduces CO_2.

How can optimised engine maintenance directly improve fuel efficiency and reduce CO_2 emissions?

If you overhaul an engine simply to return it to its initial state, it is difficult to see how you can improve fuel efficiency, unless you optimize through USM and DER. However, if you continue to develop and incorporate new technological standards (Tech Insertion, PIPs, improved 3-D blades, new coatings, etc.,) that improve specific fuel consumption, and you insert them during an overhaul, you will have an impact. Even if SFC is reduced by only one or two percent, for airlines with large fleets - and with fuel being the largest direct operating cost - this translates into millions of dollars and tons of CO_2 saved per year.

Are current regulatory frameworks enabling or constraining greener maintenance practices?

National environmental laws apply to all industries. Most of the relevant decisions are made at a macro level by governments rather than through micro-regulations specifically designed for aviation maintenance.

What innovations will have the greatest impact on reducing the maintenance-related environmental footprint?

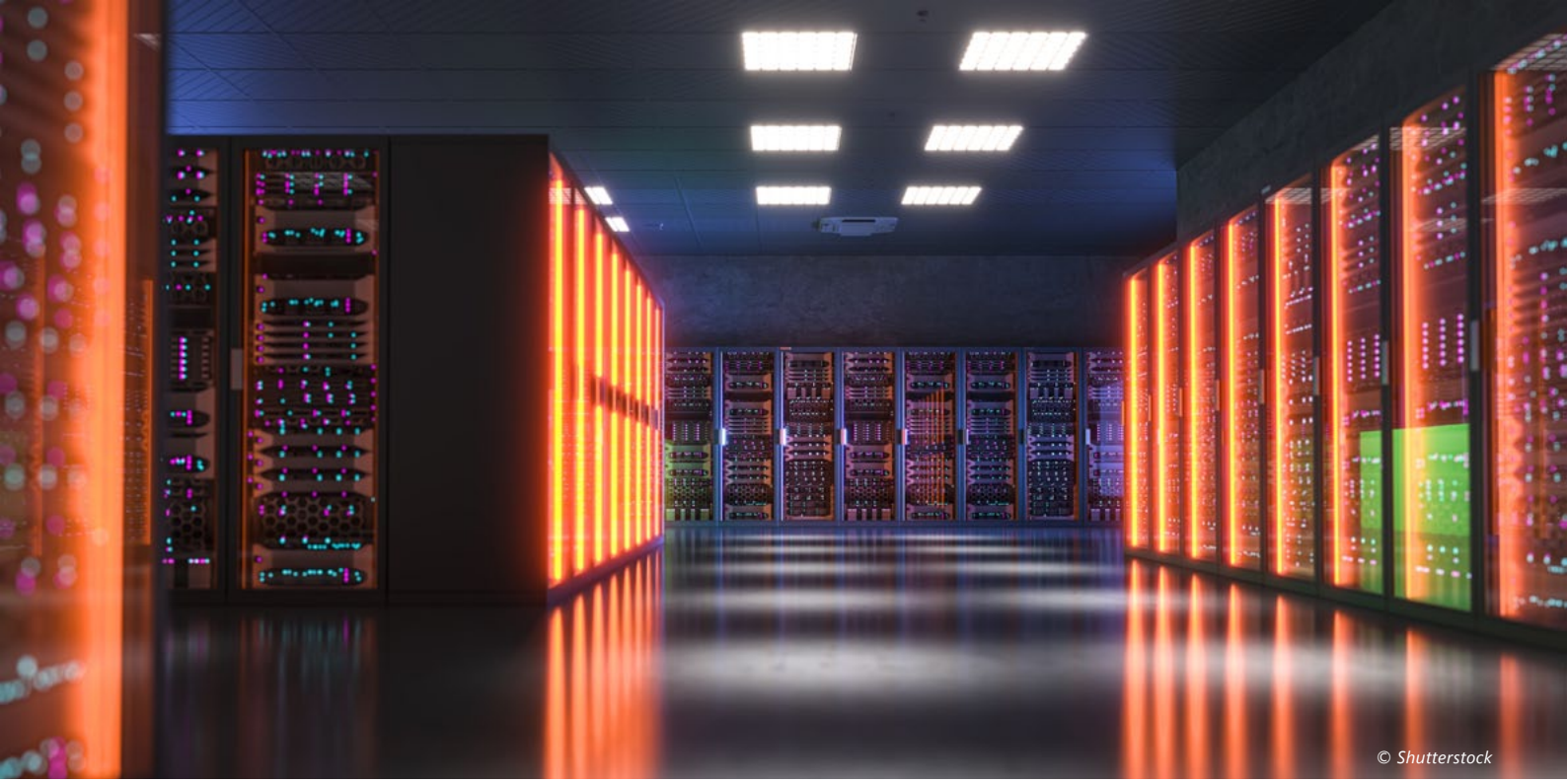
Composite (carbon) airframes have a strong positive impact: less corrosion, less aircraft immobilisation time, less corrective maintenance, and less potential environmental impact. But end of life and recycling will have to be engineered to minimise waste impact. We should also be rational. Accept that paying more for maintenance close to home - even in a high labour-cost region - can reduce your CO_2 footprint compared with flying aircraft to the other side of the world. Labour standards are not the same everywhere: while the norm may be 40 hours per week in Europe or the US, it can be much higher in other regions, often with far lower wages.

Be ethical. Be reasonable. Be responsible.

Pascal Parant concludes: I do not want to compare or advocate aviation to other industries. I simply want to put everything into perspective. Aviation accounts for around 2–2.5% of global CO_2 emissions, while each new aircraft generation delivers roughly a 20% reduction in fuel burn. R&D continuously introduces new materials, extends maintenance intervals, and improves safety at the same time. Fashion and clothing are responsible for more than 10% of global emissions. Streaming video is estimated at an average of around 55 g of CO_2 per hour, and some reports suggest that streaming generates nearly twice as much CO_2 as aviation (4%).

I am not pointing fingers at any industry. But I sometimes feel that Greta was unfair toward aviation and missed her target. We do not need anyone to tell us to reduce our CO_2 footprint: fuel is the largest direct operating cost in the airline industry, so we constantly do everything we can to reduce it - and we are already leaders in this effort. The aviation industry is striving for a better-connected world, for our children, and for the planet.

Pascal Parant, Chief Commercial & Marketing Officer, Vallair Group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Data Quality, Cybersecurity, and Regulatory Acceptance

By David Dundas

The digitisation of virtually all elements of the airline industry is viewed solely as a massive improvement in terms of efficiency. That can certainly be said of the MRO sector, especially with the subsequent digitalisation of volumes of data that previously created a mountain of paperwork. Logbooks are now replaced with electronic tablets and aircraft health monitoring systems now produce a continuous stream of operational data for constant analysis. The question is, how easily is this change accepted when the legacy paper-based system was relied upon so heavily and, here comes the rub, was trusted implicitly. The point we are trying to make here is that today, digital-based maintenance systems only work provided they are trusted, and that trust relates to three linked foundational elements: data quality, cybersecurity, and regulatory acceptance. When any one of these pillars is weak, the value of digitalization rapidly erodes. When all three are addressed together, digital maintenance becomes not only more efficient, but safer and more sustainable.

When Data Becomes a Safety Issue

Aircraft maintenance has always been data-driven, but the nature of that data has changed dramatically. Where engineers once relied primarily on scheduled inspections and pilot reports, they are now supported by vast quantities of sensor data, automated fault messages, and algorithm-driven alerts. This shift has transformed how maintenance decisions are made, but it has also raised a fundamental question: can you really trust the data?

As the saying goes, "Rubbish in : rubbish out" and substandard data quality remains one of the most underestimated risks and challenges where digital maintenance is concerned. The problem results from a problem that can never be fully avoided, and that is human error. And the problem with digitisation is that it has introduced new methods of data input that are foreign to those who have been working for years with a paper-based system. It is only the new engineers and mechanics who have recently qualified who will feel more 'at home' with digital tools. The resultant inaccurate entries, missing fields, inconsistent defect descriptions, or conflicting aircraft configuration records can quickly undermine confidence in these newly implemented digital systems. In a predictive maintenance environment, such issues do more than create inefficiency—they can lead to incorrect maintenance actions or mask emerging technical problems.

Many of these weaknesses originate in everyday operational realities. Maintenance personnel consistently work under time pressure, often across shifts and locations, using multiple systems that do not always communicate seamlessly. Beyond this, you also have highly digital organizations that continue to struggle with legacy data, free-text reporting, and inconsistent coding practices. As maintenance data increasingly moves between operators, MROs, lessors, and OEMs, maintaining consistency and traceability becomes an even greater challenge.

There is some good news though, as organizations that succeed in this new digital environment are those that treat data as a controlled asset as opposed to a by-product of maintenance. They define clear ownership, establish validation and change control processes, and integrate data governance into their quality systems. In doing so, they acknowledge a simple truth that without reliable data, digital maintenance is little more than sophisticated guesswork.

Cybersecurity Moves Into the Hangar

The problem with any business that transitions into a digitally dependent one is that data and operations become more exposed. Cybersecurity is no longer confined to flight decks or corporate

IT departments. Maintenance laptops, wireless data loaders, electronic task cards, and cloud-based MRO platforms all form part of a growing digital ecosystem that interacts—directly or indirectly—with the aircraft. And with this transition comes new vulnerabilities. A compromised maintenance system can corrupt technical records, obscure configuration control, or introduce unauthorised changes to maintenance data. In extreme cases, cybersecurity failures could affect the integrity of aircraft systems themselves, with clear implications for airworthiness.

Maintenance environments present particular challenges for cybersecurity as digital devices are often shared across teams and shifts, while third-party access is common and operational pressure can encourage shortcuts. Many organizations still rely on older, original software and hardware that is nowhere sufficiently robust to cope with modern cybersecurity threats. The result is an attack surface that is difficult to secure without a major disruption to operations. It is fair to say that regulators are increasingly alert to these risks, and while cybersecurity requirements for maintenance organizations are still evolving, authorities already expect organizations to understand their level of exposure to cybercrime and therefore adequeately protect data integrity, control access, and respond effectively to incidents. Cyber threats are also beginning to appear in hazard identification and Safety Management Systems, which is a reflection of the broader recognition that digital risks can translate into safety risks.

The Regulatory Question: Can We Rely on Digital Outputs?

For many maintenance managers, regulatory acceptance remains the most uncertain aspect of digital transformation. Digital tools evolve rapidly, but unfortunately regulatory guidance frequently lags behind. The result means that many organizations remain unsure how far they can rely on automated analyses, predictive alerts, or electronic records when making compliance-critical decisions. In practice, regulators are not opposed to digital maintenance—but they are certainly cautious. Currently, their primary concern is not related to innovation, but instead it is assurance. Authorities want to understand how digital systems work, how data is validated, how errors are detected, and how human oversight is maintained. They are also extremely interested in how software changes are controlled for algorithm updates and system interfaces.

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What is also important is that most digital maintenance challenges can fortunately be addressed within existing regulatory frameworks as requirements for record integrity, configuration control, competence, and independent verification already exist. However, the task still remains for maintenance organisations to demonstrate that their digital systems meet these requirements at least as robustly as traditional processes. For example, electronic signatures must be trustworthy, automated task cards must preserve revision control, and predictive outputs must be properly integrated into approved maintenance programs.

If you look closely, organizations that achieve regulatory acceptance tend to follow a consistent pattern. They engage early with authorities, document their systems thoroughly, and present clear evidence of risk management and internal control, primarily because rather than seeking blanket approval for new technologies, they focus on building confidence step by step.

Three Pillars, One System

What becomes clear is that data quality, cybersecurity, and regulatory acceptance cannot be addressed in isolation as poor data quality weakens regulatory confidence and inadequate cybersecurity undermines data integrity. Limited regulatory acceptance, in turn, restricts the operational use of digital tools and thus, each pillar reinforces—or erodes—the others. Currently, the most successful digital maintenance programmes recognise this interdependency and as a consequence they embed digital systems within existing quality and safety frameworks, train personnel to understand their role in protecting data integrity and treat cybersecurity as a shared operational responsibility rather than a purely technical one.

Trust as the Real Enabler of Digital Maintenance

Digitalisation will continue to reshape aircraft maintenance, driven by economic pressure, fleet complexity, and the demand for higher reliability. However, when you look at everything you soon realise that the true enabler of this transformation is not technology, but trust. Trust in the data that supports maintenance decisions, trust in the systems that protect that data, and trust from regulators that digital processes uphold the same safety principles as traditional ones.

Maintenance organizations that concentrate on building this trust will not only reap the full anticipated benefits of digital maintenance, but they will also set the standard for how innovation and safety can evolve together in a highly regulated industry.

PEOPLE

on the move

Matthieu Louvot

Airbus has appointed **Matthieu Louvot** as Chief Executive Officer of Airbus Helicopters, effective April 1, 2026. He will report to Airbus Chief Executive Officer **Guillaume Faury** and join the company's Executive Committee. Louvot, who currently serves as Airbus Executive Vice-President Strategy, will succeed **Bruno Even**. Even has decided to leave Airbus after eight years at the helm of the Helicopters division to pursue new personal and professional opportunities. Faury paid tribute to Even's leadership, noting that under his tenure Airbus Helicopters expanded its product portfolio, transformed its industrial system and was placed on a sustainable and profitable growth path. He added that Louvot's deep experience in the helicopter sector and strong understanding of the division's strategic and operational priorities would ensure a smooth leadership transition. Louvot joined Airbus Helicopters in 2010 after an early career in the French administration, including a role as industry adviser at the French Presidency. He has since held several senior leadership positions within the business, notably as Executive Vice-President Customer Support & Services and Executive Vice-President Programmes. Airbus said an announcement on Louvot's successor as Executive Vice-President Strategy will be made in due course.

Tom Owen

The HAECO Group has announced the appointment of **Tom Owen** as Group Director Corporate Development, effective January 2026. Owen brings 30 years of aviation leadership experience spanning sales, revenue management, logistics and regional management in Hong Kong and internationally, most notably with Cathay. In his new role, he will help shape HAECO's strategic direction, lead information technology and digital transformation initiatives, and advance the Group's sustainability agenda. He will also strengthen relationships with key stakeholders, including joint venture and government partners, to reinforce HAECO's position as a leading global MRO services provider. Owen joined the Swire Group in 1995 and has built the majority of his career at Cathay, holding senior roles across marketing, sales and distribution, network revenue management and regional leadership in markets including Korea, Canada, the United States and South Asia. In 2015, he was appointed Director People, leading a comprehensive modernisation of the Cathay Group's HR functions. He later became Director Cargo in 2020, overseeing the Cathay Cargo business as it achieved record financial and operational performance, while also delivering significant advances in digital capability.

Air Vice-Marshal (Ret'd) Steve Roberton

Boeing has appointed **Air Vice-Marshal (Ret'd) Steve Roberton**, DSC, AM, as its new President for Australia, New Zealand and the South Pacific. Based in Sydney, Roberton takes up the role immediately and will oversee Boeing Australia Holdings as Chair, lead regional strategic initiatives, strengthen partnerships and act as the company's senior liaison with government stakeholders. Roberton brings more than three decades of senior operational, command and capability development experience from his career with the Royal Australian Air Force (RAAF). A fighter pilot for 26 years, he served extensively within Australian combat units and also undertook an exchange posting with the United States Marine Corps, giving him deep insight into allied and joint operations. His career includes a number of high-profile leadership appointments. In 2014, Roberton commanded the inaugural Operation OKRA Air Task Group in the Middle East, a role for which he was awarded the Distinguished Service Cross in recognition of his leadership and operational effectiveness. He later went on to serve as Commander of the RAAF's Air Combat Group and as Air Commander Australia, positions that placed him at the centre of Australia's air power operations and strategic planning. In addition to his operational commands, Roberton held the role of Head Force Design within the Vice Chief of the Defence Force Group, where he was responsible for shaping future capability development across the Australian Defence Force. His contribution to national service was formally recognised in 2012, when he was appointed a Member of the Order of Australia. Roberton retired from the RAAF in September 2022 and subsequently joined McKinsey & Company as a senior advisor, a position he held for two years. In June 2025, he began consulting for Boeing Defence Australia, further strengthening his understanding of the company's defence and aerospace activities in the region. In his new role, Roberton is expected to play a key part in advancing Boeing's long-term strategy across Australia, New Zealand and the wider South Pacific.

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