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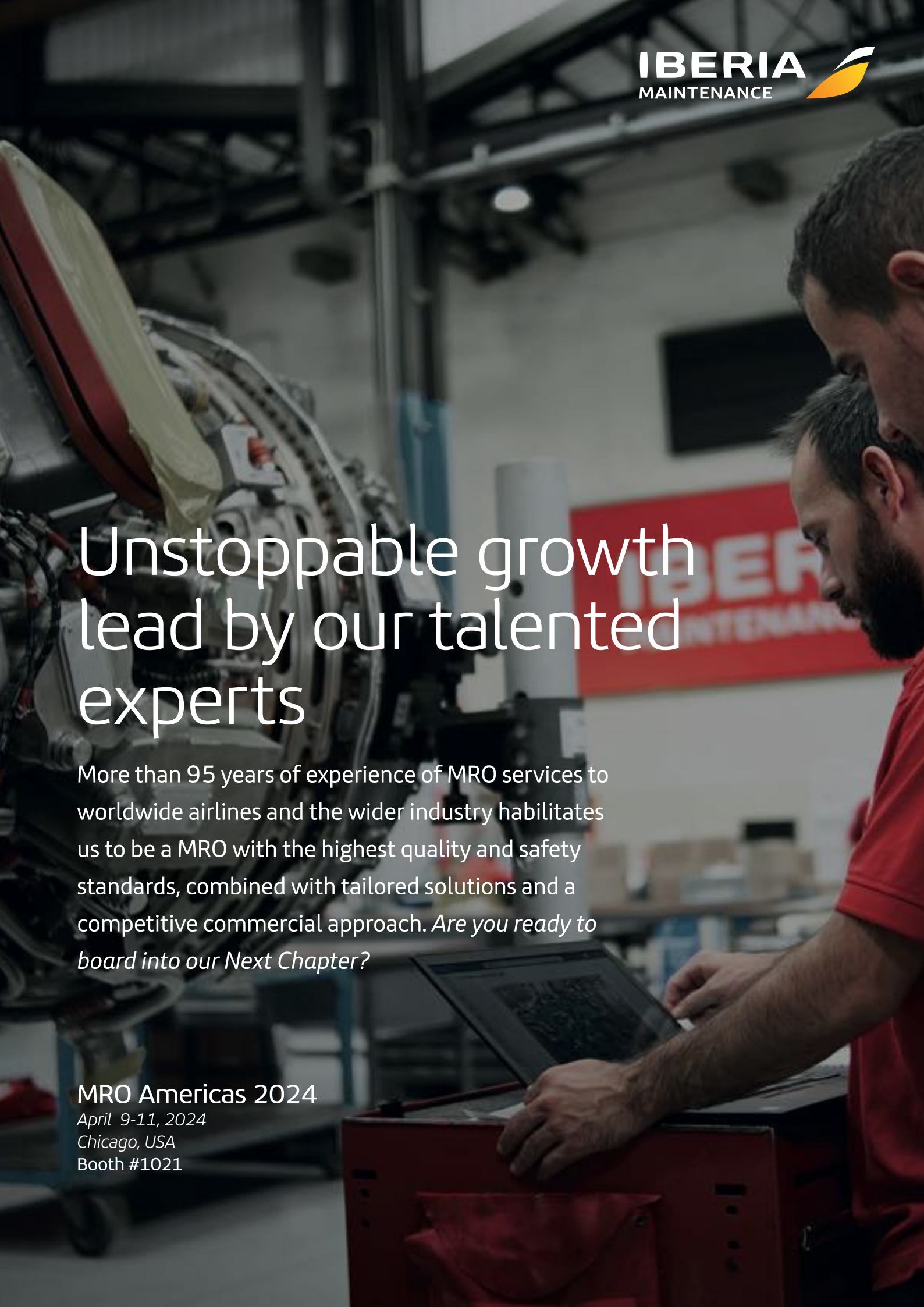

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AVIATION MAINTENANCE magazine.com

+44 (0)20 3892 3050
+1 (920) 214 0140

EDITORIAL
Editor-in-Chief
Joy Finnegan
jfinnegan@avm-mag.com

Contributing Editors
James Careless
Mark Robins
Jason Dickstein
Jeff Guzzetti
Mazzy Beasley
Ian Harbison
Dale Smith
James T. McKenna

ADVERTISING/ BUSINESS
Publisher/Owner
Adrian Broadbent
abroadbent@aerospace-media.com

U.S. Sales Director
Greg Szatko
GSzatko@aerospace-media.com

Key Account Sales Director
Jina Lawrence
jinalawrence@avm-mag.com

International Sales Director
Paula Calderon
pcalderon@aerospace-media.com

DESIGN/PRODUCTION
CPUK Print Publishing
www.cp-uk.co.uk

CLIENT SERVICES
Administration
Maria Hernanz Reyes
maria@asi-mag.com

PRINTER
CPUK Print Publishing
www.cp-uk.co.uk

MAILING
Spatial Global Limited
Derby, UK

AEROSPACE TECH MEDIA LTD
www.aerospace-media.com

1 Coyners Avenue
Southport
PR8 4SZ
UK

abroadbent@aerospace-media.com

www.avm-mag.com or
www.aerospace-media.com

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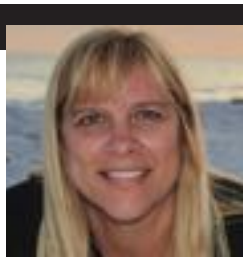

All We Have to Fear is ... AI?

BY JOY FINNEGAN
EDITOR-IN-CHIEF

Artificial intelligence (AI) is being talked about everywhere now, whether related to uses in business, investing, the future or more specifically, how AI will impact our corner of the world. How will AI impact the world of aviation maintenance? Some say it will be by enabling proactive and data-driven approaches to ensure aircraft safety, reliability and cost-effectiveness. As technology continues to advance, we can expect more sophisticated AI applications to be developed rapidly for use in aviation maintenance.

What is AI? AI refers to computer systems that can perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, learning from experience and making decisions. AI encompasses a broad range of techniques and technologies, including machine learning, natural language processing, computer vision and robotics.

Some have asked, isn't it the same as data analytics? Not exactly. Data analytics focuses on extracting insights and knowledge from data through techniques such as statistical analysis, data mining and predictive modeling. Data analytics involves processing large volumes of data to identify trends, patterns, correlations that can inform decision-making and drive business outcomes.

AI does rely on data analytics techniques for tasks such as learning from data or making predictions, but it extends beyond data analytics to include capabilities such as reasoning, planning and perception. In other words, AI encompasses data analytics as one component of its broader scope.

AI may bring significant advantages to aviation maintenance, but there are concerns about potential risks and challenges. One of those concerns is the reliability of the data quality. AI systems rely on data quality and accuracy for effective operation. Errors or biases in the data can lead to incorrect predictions or decisions, posing safety risks in aviation maintenance. AI has already caught off guard some folks in different business areas but here is one aviation adjacent example.

Recently, a lawsuit was filed by a passenger who claimed to have been injured by a drink cart on a flight on Avianca Airlines. The passenger's lawyers asked the court to throw out the airlines' defense because it contained references to precedented cases that, upon their research of them, proved to be non-existent. How did this happen? The attorney for the airline admitted to using ChatGPT to conduct his legal research. He even asked ChatGPT if the cases referenced in its response were real, to which ChatGPT replied that they were real. But in fact, ChatGPT had made up the cases it referenced.

Another concern is cybersecurity. AI systems used in aviation maintenance could be vulnerable to cyber threats, such as hacking or malware attacks, which could compromise the integrity of data and operations. This is a real threat that needs to be addressed but that threat already exists in all technology.

The use of AI has also raised ethical concerns related to privacy, accountability and transparency. Ensuring ethical AI practices in aviation maintenance is essential to maintain trust and safety. The public trust is crucial to our industry. Although EASA has a published document called "Artificial Intelligence Roadmap 2.0," that "sets the pace for conceptual guidance deliverables and anticipated rulemaking activities … [and] serves as a basis for discussions with all of the Agency's stakeholders," a search of the FAA website yielded no policy guidance at all on the topic.

Then there is the possibility of job displacement. The automation of some maintenance tasks through AI may lead to job displacement but AI is more likely to augment human capabilities rather than replace them entirely. This may create new roles and opportunities in the field.

There is some fear of the unknown surrounding AI. AI represents a new, rapidly advancing technology. Portrayals in pop culture have shown AI in dystopian, apocalyptic scenarios where intelligent machines rise up against humans. Fear of the unknown can lead to anxiety about the potential implications of AI, but as President Franklin D. Roosevelt once said, "The only thing we have to fear is fear itself." However, legitimate concerns about the implications of AI in aviation maintenance do exist.

AI systems can operate autonomously and make decisions based on complex algorithms and data analysis. This loss of human control over decision-making processes can feel unsettling, particularly when it comes to critical domains like aviation. People may fear the misuse of AI systems for surveillance, manipulation, discrimination or other unethical purposes, especially when decisions with significant consequences are delegated to algorithms.

Loss of human control over decision-making processes in critical domains like healthcare, transportation, or national security should be looked at carefully and systems designed with redundancies and checks and balances.

There is the pace of AI development that could lead to exponential growth. The potential of AI to surpass human intelligence in the future has raised concerns about the ability to control or contain AI systems once they reach a certain level of sophistication.

While these fears are understandable, it's essential to approach AI development and deployment with a balanced perspective, acknowledging both the benefits and risks. Responsible AI development involves addressing concerns related to ethics, transparency, accountability and impact to society to ensure that AI technologies serve the best interests of people.

Even without policy guidance from aviation administrative agencies, proactive measures can be taken to mitigate the risks and maximize the benefits of using AI technology in our industry. What is your company doing right now to ensure it is ready and protected as the use of AI becomes de rigueur? AVM

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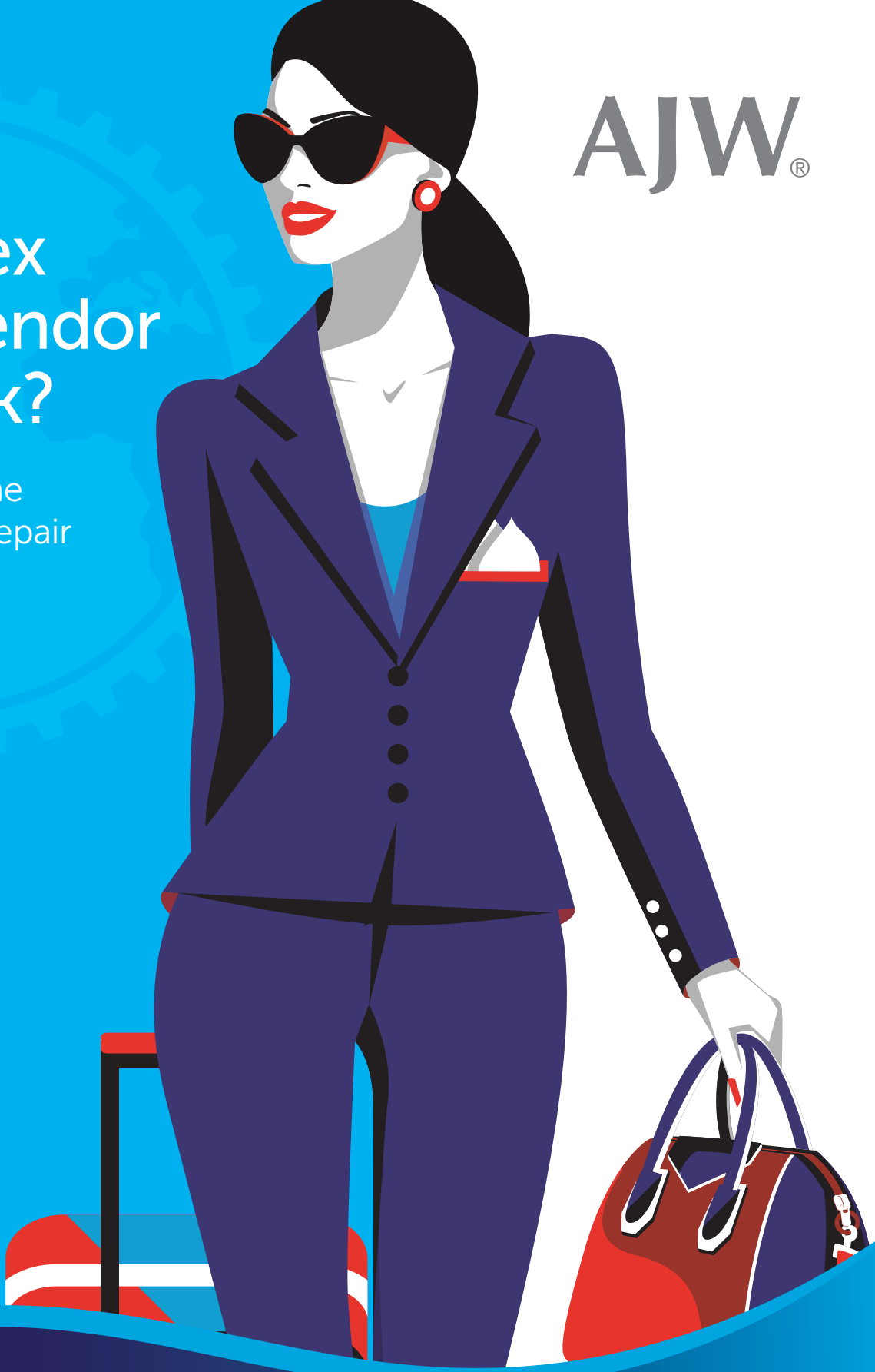

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Turkish Technic Inks Component Pool Services Deal and Reaches Milestone in Its First A330P2F Conversion

MRO provider Turkish Technic has recently signed a component pool agreement with Silk Way West Airlines, one of the youngest Boeing 777F fleet operators with ongoing orders. Through this agreement, Silk Way West Airlines will have access to spare parts pooling and MRO services for the required components. Additionally, the operator will benefit from short and fast transport routes within Turkish Technic's global supply chain network, including AOG (Aircraft on Ground) support for time-critical components.

"We are delighted to have taken the first step towards a long-term cooperation with Silk Way West Airlines," said Mikail Akbulut, CEO of Turkish Technic. "With decades of experience in component maintenance and large inventory of components, we are proud to be a leading solution center for Boeing 777 component pooling. We are excited to work closely with the operator to ensure the highest level of safety and reliability for their Boeing 777F fleet."

Wolfgang Meier, president of Silk Way West Airlines emphasized the significance of the agreement, stating, "We are delighted to join forces with Turkish Technic to enhance our operational capabilities and uphold our commitment to excellence in air cargo transportation. This collaboration reflects our dedication to providing reliable and efficient services to our customers worldwide."

Operating as a one-stop MRO company with high-quality service, competitive turnaround times, comprehensive in-house capabilities at its state-of-the-art hangars, Turkish Technic provides maintenance, repair, overhaul, engineering, modification, tailor-made PBH and reconfiguration services to many domestic and international customers at five locations.

Additionally, Turkish Technic recently embarked on A330P2F conversions in collaboration with Elbe Flugzeugwerke GmbH (EFW), the center of excellence for Airbus Passenger-to-Freighter (P2F) conversions.

As the first MRO company to operate as a conversion house directly collaborating with EFW for A330P2F, Turkish Technic has recently achieved a key milestone by performing the Upper Frame Shell (UFS) cut-out and successfully locating the new UFS, which is a key step for the installation of the main deck cargo door. The first conversion is part of a series of P2F conversion projects, and it is planned to be completed by the middle of 2024.

"We are happy to reach a major milestone on the first conversion as we partner with EFW to meet high level demand in the market," said Akbulut. "Passenger-to-freighter conversions require a combination of industry-leading expertise, structural skills and operational excellence. Leveraging our extensive know-how and strong collaboration with our partners and suppliers, we are fully equipped to deliver technical services and innovative solutions. We're looking forward to successfully completing the conversion and providing the best possible performance for our customers with our extensive structural and avionic modification capabilities."

Lufthansa Nabs Engine Maintenance Contract for Smartwings' Boeing 737NG and MAX Fleets

Smartwings and Lufthansa Technik have signed an agreement to support the largest Czech airline with comprehensive Engine Maintenance Services for LEAP-1B engines for its Boeing 737 MAX fleet. The first induction is planned at the beginning of 2025. In addition, the existing service contract for the CFM56-7B engines powering 30 of Smartwings' Boeing 737NG aircraft has been extended until 2030.

"Based on our successful cooperation, the newly signed long-term agreement for Engine Maintenance Services of our Boeing 737 NG and MAX fleet shows our continued trust in Lufthansa Technik's expertise and will further optimize our technical operations," said Jiri Juran, chairman of the board of directors at Smartwings.

"We are grateful for the continued trust of our partner Smartwings. The new contract is another major milestone in our cooperation. With our capacity growth supporting the LEAP-1B engine, our customers can significantly benefit from our commitment to deliver world-class engine MRO services," added Harald Gloy, chief operations and HR officer of Lufthansa Technik.

Lufthansa Technik already provides Smartwings with Total Component Support services for its Boeing 737NG and MAX 8 aircraft, including component MRO services and pool access as well as component delivery to selected international airports within Europe.

SIA Engineering Company Secures Component Program With Air India

SIA Engineering Company (SIAEC) recently signed an Inventory Technical Management (ITM) agreement with Air India Group. Under this 12-year agreement, SIAEC will provide extensive component support coverage for Air India Group's current fleet of Airbus A320 family aircraft. Besides access to its inventory pool, SIAEC (together with its subsidiaries and joint venture companies with Original Equipment Manufacturers) will also provide repair and overhaul services for airframe and on-wing engine components.

"We are honored to be selected as Air India Group's component service partner, and appreciative of their confidence in our ITM program," said Chin Yau Seng, CEO of SIAEC. "Our Airbus A320 ITM program will support Air India Group's commitment to delivering world-class service. Together with our network of component shops and joint venture companies, we are confident in providing high quality and reliable component services to Air India Group."

Campbell Wilson, CEO and managing director, Air India, said, "We are delighted to have SIAEC as our partner. The collaboration will further bolster our repair and maintenance competencies for the Airbus A320 family of aircraft and enhance our reliability and availability of components for aircraft operations."

AAR Completes Acquisition of Triumph Group's Product Support Business

AAR announced that it has completed its acquisition of Triumph Group's product support business. Triumph Group's product support business provides specialized maintenance, repair and overhaul capabilities for critical aircraft components in the commercial and defense markets.

AAR previously announced on December 21, 2023, that it had entered into a definitive agreement to acquire Triumph Group's product support business for an aggregate purchase price of $725 million in cash, subject to customary adjustments. The transaction was financed with proceeds from AAR's previously announced $550 million notes offering and borrowings under its amended revolving credit facility.

"The completion of this acquisition scales AAR's repair capabilities, expands our footprint in the APAC region, and enhances our ability to serve our global customers," said John M. Holmes, AAR's chairman, president and CEO. "We're excited to welcome more than 700 team members from the product support business who bring expertise in key areas to the AAR team."

MESA Expands Maintenance Capabilities With New Certifications

Portuguese maintenance provider MESA, based in Lisbon and Beja, is expanding its service portfolio. Portugal's civil aviation authority ANAC has issued two new certifications to MESA. The MRO provider is now authorized to perform an enhanced scope of base maintenance on the Airbus A330 equipped with Pratt & Whitney PW4000 engines.

For Airbus A340 aircraft, MESA can now offer to conduct base maintenance in intervals of up to 48 months. This distinction allows the company to undertake more detailed and comprehensive repairs on A340 airliners, which includes an exhaustive inspection of structural components, systems and various other crucial elements. This accomplishment enhances its ability to handle a broader spectrum of aircraft types and engine configurations, further strengthening its position as a versatile MRO partner.

MESA is an aircraft line and base maintenance provider based in Lisbon International Airport and Beja Airport. The company is an EASA Part-145 Maintenance Organization, approved by Portuguese civil aviation authority ANAC with Certificate PT.145.020. The company performs maintenance worldwide on Airbus A318, A319, A320, A321, A330, A340, A380 and BOMBARDIER CL-600-2B16 aircraft. MESA also has maintenance stations worldwide to support the growing operations of its airline customers, providing temporary line and base maintenance services.

Nova Systems Selects FreeFlight Systems' Advanced Weather and Airborne Aircraft Alerting System To Increase Crew Awareness

Nova Systems selected FreeFlight Systems' Dual-Band ADS-B receiver as part of an upgrade program for their customers to provide more efficient and better decision-making systems during flight. FreeFlight Systems' Dual-Band ADS-B receiver provides critical weather and airborne traffic, significantly improving crew situational awareness and providing a well-informed operation, even under extreme conditions.

"We are thrilled to continue delivering a world-class mission system, and we are excited to have FreeFlight's Dual-Band ADS-B system on board," says Ronnie Trasler, general manager for Aerospace Integration for Nova Systems. "We selected FreeFlight's Dual-Band ADS-B receiver because of leading-edge ADS-B technology for maximum crew situational awareness during critical life-saving work for search and rescue operators."

FreeFlight Systems' Dual-Band ADS-B receiver is a TSO-certified device designed to perform in critical environments, making it a strong choice for SAR activities. It provides pilots in all jurisdictions with critical ADS-B information while in flight, drastically improving situational awareness.

"Nova Systems is a leader in modernization efforts for aircraft used for SAR programs, and this selection strengthens our collaborative partnership for creating safer skies," says Anthony Rios, president, FreeFlight Systems. "Our ADS-B Dual-Band solution is a key component of our mission to provide progressive companies, like Nova Systems, the ability to upgrade critical aircraft with the most advanced technologies, bestowing crews with the most sophisticated airborne situational awareness."

With its all-new air-to-air capabilities, FreeFlight Systems' Dual-Band ADS-B receiver leads the way with its small form factor, low weight and power, and multi-interface design. This compact device can provide all the required safety information for critical operations while keeping its footprint on the aircraft's resources low.

BermudAir Chooses Cobalt Spectrum LED Lighting

BermudAir says it is dedicated to providing an elevated travel experience for its passengers, with a strong focus on convenience, comfort and exceptional service. With that in mind, the company has chosen Cobalt Spectrum LED drop-in mood lighting for their Embraer 175 fleet.

Cobalt Spectrum mood lighting is an innovative system, designed to meet the needs of commercial airlines. Deployed and flying with multiple carriers worldwide, Cobalt Spectrum delivers multiple features and provides high reliability, the company says.

"We are delighted BermudAir have selected our class-leading LED mood lighting system, to assist in providing a superior travel experience for their passengers. They will be using our Cobalt Spectrum lighting to illuminate the interior of each aircraft with the BermudAir brand colors, plus additional light settings for boarding,

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meal services, sleeping, waking, and more. It is this ability to distinguish between different stages of flight which assists passengers with a heightened feeling of wellbeing throughout their journey," a company announcement said.

Cobalt Spectrum is a 'plug and play' system and a direct replacement for fluorescent tubes. Lightweight and long-lasting, it offers operators weight and fuel savings while requiring no changes to the aircraft wiring, the company stresses.

"The installation took four technicians one full 12-hour shift," said Adam Scott, founder and CEO of BermudAir. "We were very happy with the quality and support the Cobalt team provided to BermudAir."

The collaboration with BermudAir was approved under Cobalt Aerospace's own Design Organization Approval (DOA).

Columbia Helicopters Signs LOI With Heliswiss for First International Customer of 234SP Model Chinook

Columbia Helicopters has signed a Letter of Intent (LOI) with Heliswiss International, marking the first international customer of the Model 234SP (Special Purpose) Chinook.

"Securing Heliswiss International as our first international customer for the Model 234SP underscores the global demand and recognition of the revolutionary capabilities this aircraft brings to the market," said Mike Tremlett, president and CEO at Columbia Helicopters. "We are thrilled to partner with Heliswiss in introducing this game-changing aircraft to international operators."

European customer Heliswiss International, a Swiss helicopter operator specializing in heavy-lift long-line precision work and disaster relief, will also be a customer for the 234SP. Severin Riedi, chairman of Heliswiss's parent company, Swiss Helicopter Group, stated, "For over 60 years, Heliswiss International has developed an expertise in the construction and assembly of complex structures worldwide with the help of 10-ton category aircraft. In the frame of its development strategy and the global development plan of the Swiss Helicopter Group, Heliswiss International has assessed the European market and confirmed the need for such a helicopter."

CEO of Heliswiss International, Stéphane Delaye, added, "With the signature of a Letter of Intent to purchase a 234SP, Heliswiss makes a further step and secures its project to operate this helicopter as a utility-purposed Super Heavy Helicopter, and to support the ambitious development plan of Power Grids in Europe with an unmatched lifting capacity of more than 10 tons. We are happy to have the support of Columbia Helicopters to operate a Model 234UTin early 2025, independent from the certification process of the Model 234SP."

Norse Atlantic Airways Selects ULTRAMAIN ELB for Paperless Operations

Norse Atlantic Airlines has selected Ultramain Systems electronic logbook, ULTRAMAIN ELB, to fully replace the aircraft paper technical log, cabin log, journey log and fueling logs on their fleet of 15 Boeing 787 Dreamliners.

Upon implementation, Norse Atlantic's Flight Crews will operate ULTRAMAIN ELB iOS version on iPads. This transition from paper to digital line maintenance operations marks a significant step forward for Norse. Real-time Flight and Cabin Crew reports, selected from ULTRAMAIN ELB's on-device B787 tailored fault repository, will enable enhanced planning and defect clearance. This will lead to lower deferral rates, increased operational service levels and lower maintenance costs across their Dreamliner fleet, ULTRAMAIN says.

"Going paperless has been a goal for Norse Atlantic´s technical department since our start up, as it will help streamline our operations, improve cost efficiency, and contribute to our sustainability goals. Choosing Ultramain represents a significant milestone in realizing our paperless vision," expressed Ahmad Abu-Nima, VP technical operations at Norse Atlantic Airways.

"We are delighted to welcome Norse Atlantic to the ULTRAMAIN ELB user community, marking a significant milestone in our expansion into Norway. At Ultramain Systems, we take pride in delivering solutions that not only streamline workload and enhance operational efficiency for our customers but also contribute to their environmental sustainability efforts, and we're excited to support Norse Atlantic in their journey," said Mark McCausland, president and CEO of Ultramain Systems.

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PSA Airlines Offering Up to $32,500 in Sign-on Bonuses for Mechanics

PSA Airlines has announced a series of bonuses totaling up to $32,500 for aircraft mechanics who join PSA at its Dayton, Ohio or Savannah, Georgia, maintenance base by April 30, 2024. Bonus opportunities include a $15,000 sign-on bonus for joining as an aircraft maintenance technician or lead in Dayton or Savannah. A $5,000 sign-on bonus is being offered for those who join at other PSA maintenance bases, including Canton/Akron, Ohio; Charlotte, N.C.; Cincinnati; Pensacola, Fla.; Norfolk, Va.; Greenville, S.C.; and Dallas-Fort Worth, Texas.

Other bonuses applicable to all PSA maintenance bases include an experience bonus for qualified aircraft maintenance technicians ($12,500 bonus for over three years of experience; $10,000 bonus for over two to three years of experience; and $7,500 for one to two years of experience) as well as a $5,000 toolbox or cash-in option. The company also offers $7,500 in relocation assistance for non-local candidates who are hired.

"At PSA, we place safety above all. Adding more experience and depth to our maintenance team will not only ensure we remain among the safest airlines in the industry, but it will also further drive reliability and our ability to operate more planes, providing customers with greater access to air travel," said Richard Ugarte, vice president, maintenance and engineering at PSA. "Anyone who loves working on iconic planes like our all-CRJ jet fleet and who wants to be part of a driven, reliable and caring culture that provides unlimited career growth opportunities should apply today to join PSA's maintenance team."

In addition to lucrative sign-on and experience bonuses, like all PSA team members, PSA maintenance team members receive flight benefits for them and their eligible family and friends on American Airlines' global network.

PSA Airlines is a wholly owned subsidiary of American Airlines and operates an all-jet fleet consisting of exclusively Bombardier regional jet aircraft. PSA owns 51 Bombardier CRJ700 aircraft and 80 Bombardier CRJ900 aircraft. To apply, go to PSAairlines.com/mechanics-maintenance.

AERO CARE Announces New Miami HQ as it Joins Forces With Alchemy Aero Corporation

AERO CARE has opened new headquarters in Miami, Fla. AERO CARE says the new facility is strategically positioned to support its rapidly expanding global customer base and it will house the organization's stock of engine parts for CFM56 and V2500.

Focused on enabling operators to fly their engines for as long and as economically as possible, AERO CARE concentrates on mid- to late-life engines, providing solutions that cover green-time leasing, parts supply, and asset management.

"Miami is the commercial aviation engine hub of the Americas, so it is logical for AERO CARE to be based here, however we will be supported by our European office in Bucharest, Romania, to ensure our global reach and 24/7/365 service is faultless," said Anca Mihalache, managing director, who has spearheaded this strategic move to the U.S.

"As a portfolio company of Alchemy Aero Corporation, the specialist aviation investment and trading platform, we have the secure financial support we need to acquire the engine assets our customers need. We have an ambitious growth target and look forward to cementing our position as a respected mature aircraft assets solutions provider."

AERO CARE aims to stock inventory to help minimize fleet downtime and promote profitable operations, however Mihalache goes on to say that AERO CARE is more than just an engine trading and parts business. "We are passionate about aviation and ultimately what an aircraft represents – taking someone to their next adventure, or to a meeting that will build their business, or to visit family and friends. Our role is to make sure that these journeys can happen – that crucial business deals get signed, or that the open arms don't go unhugged."

Mihalache adds that AERO CARE's business objective is to be an integral part of the team. "We don't see ourselves as separate from our customers, when they work with us, it is no different to dealing with any other internal department. Our desire is to develop truly symbiotic relationships – so picking up the phone and calling us simply becomes the natural thing to do."

StandardAero Expands Global Rolls-Royce M250 Helicopter Engine MRO Leadership

StandardAero has expanded its service offerings for Rolls-Royce M250 helicopter engine MRO services. The company has invested in maintaining the largest pool of rental and exchange engines/modules of any provider in the Rolls-Royce FIRST Network.

StandardAero says it has also developed material planning models to support customer requirements. The company is closely tied in with Rolls-Royce and Boeing to aid in mitigating ongoing supply chain challenges. In addition, the company continues to expand its shop capability and capacity both in North America and around the world. Moreover, StandardAero says it will continue to expand its component repair capability,

and offer "more economical solutions to customers and greater control over turn time." StandardAero is also investing in a second M250/RR300 test facility at its Winnipeg, Manitoba, location. This new facility will create additional capacity as well as capability redundancy, the company says.

"One of the things we are really proud of is the unparalleled level and scope of service we provide for M250 helicopter operators," stated Neena Gill, vice president and general manager of StandardAero's Helicopters business unit. "All of the actions we've taken in the past twelve months have improved our industry leadership and are paying off in the solutions we're providing for our customers."

StandardAero provides tip-to-tail services for Airbus and Bell model helicopters including engine MRO, complete engine accessory overhaul, airframe maintenance, avionics, structural repairs, AOG and field service support and various dynamic component at five facilities located in the U.S., Canada and the U.K.

"Our team works hard with customers. We listen to them. We work to increase the reliability of their engines. We ensure the quality is always above par, and that is something we stress. Through our engineering-heavy focus we work on customizing solutions for our customers for their specific needs — not just providing cookie-cutter answers," Gill added.

Delta is Using NAVBLUE's Mission+ for Entire Fleet of Airbus and Boeing aircraft

NAVBLUE and Delta Air Lines have signed a long-term agreement for Mission+, NAVBLUE's Electronic Flight Assistant, which provides pilots with all the data and information they need to perform their mission via one modular digital solution.

The agreement includes the deployment of Mission+ on the global airline's entire fleet of over 900 Airbus and Boeing aircraft and represents one of the biggest transitions from paper to an Electronic Flight Folder (eFF) digital solution in the aviation industry. In addition, NAVBLUE and Delta will work on further enhancing the application for pilots by adding new functionalities.

Delta has been involved in the development of Mission+ since its inception. This digital solution is now considered the most intuitive eFF on the market that minimizes pilot interactions. Delta has also been part of the early adopter program, together with other major airlines from different regions and with diverse types of operations. The airline provided feedback to build a tool adapted to pilots' tasks for mission management in all flight phases (briefing, in-flight follow-up, reporting).

The agreement between Delta and NAVBLUE considers the airline's requirements and community-driven needs. As a scalable and reliable solution, Mission+ FLIGHT, the integrated flight folder module of Mission+, is seamlessly integrated with its existing ground environment ensuring business continuity.

The full implementation process across Delta's fleet has been achieved in less than two years, covering deployment, testing, and operational usage by the airline's entire pilot community (more than 17,000 pilots), who are now using Mission+.

Mission+ removes the need to print paper flight plan information for every Delta flight, which represents saving more than 77.5 million pages annually (or around 4,000 trees), further supporting Delta's ongoing efforts to embed sustainability across its business.

"On behalf of the NAVBLUE teams, I would like to thank Delta for their trust in this product and our people," said Marc Lemeilleur, CEO of NAVBLUE. "By choosing Mission+ they are enabling their pilots to benefit from all the data and information they need to perform their mission via a unique modular digital solution. Working together we enabled the deployment of Mission+ on the entire fleet in less than two years, which is a great success for all of us."

Ryan Gumm, flight operations senior vice president of Delta, added: "Achieving this major milestone is part of our commitment to removing operational complexities, as well as moving toward a more digital, sustainable future. Mission+ allows our pilots more time to focus on what Delta people do best – expertly serve our customers with safety top of mind."

TrustFlight Introduces Smarter Workflows for Maintenance and Flight Ops Teams With Traxxall Integration

TrustFlight, a technology innovator focused on digitization of the aviation industry, has announced a new integration with JSSI's Traxxall, an aircraft maintenance tracking and inventory system. The company says the integration will bring flight operations and maintenance teams closer through TrustFlight's Electronic Logbook (ELB) software.

"At TrustFlight, we place a significant importance on developing integrations that lead to improved data reliability for smarter decision making and improved safety," said Luke Franklin, product manager at TrustFlight. "Our collaboration with JSSI exemplifies our commitment to an open platform within our suite of solutions and we're excited to introduce our Traxxall integration so operators can get more from the technologies they rely on daily."

The integration enables seamless two-way data syncing for maintenance checks (due lists) and workpacks (workplanners), as well as one-way syncing for defects (snags) and totals (actuals) for enhanced data accuracy, improved safety and efficiency, better compliance management and improved aircraft availability. It also links user accounts for seamless traceability, meeting compliance and audit requirements.

Prior to the integration, there was a delay for data to populate into Traxxall as users were required to manually enter and cross-check data between the electronic logbook and maintenance tracking system. The integration of TrustFlight's ELB with Traxxall streamlines these workflows, the companies say, which will lead to enhancing data accuracy, improving safety, and increasing operational efficiency by automating the exchange of information.

"Aircraft management begins with accurate data and technology to make decision making easier and smarter," said Mark Steinbeck, chief commercial officer, JSSI Maintenance Software. "Through this integration, our joint customers benefit from real-time data feeds between systems, and we're excited about this collaboration."

TrustFlight's ELB enables fully-digital workflows for crew and maintenance personnel by automating vital information to greatly enhance speed and accuracy while reducing man-hours required. The TrustFlight Integration Platform today hosts more than 20 integrations from leading applications used by operators around the world.

CIRCOR Announces Partnership With FLYING WHALES for the LCA60T Program

CIRCOR's subsidiary, CIRCOR Industria, has been chosen by FLYING WHALES as its partner for the development and production of critical helium valves essential for the LCA60T airship. These valves facilitate the controlled release of helium from the airship's cells as needed during operations. A total of twenty-eight such valves will be integrated into the airship's helium cells.

This strategic collaboration is the culmination of an extensive and collaborative effort spanning more than a year between the dedicated teams at CIRCOR and FLYING WHALES. A crucial co-engineering phase in 2021 allowed for precise specification and alignment regarding this pivotal helium management component within the airship and the contract was signed in 2023.

"We are delighted to seal this partnership with a major aeronautical industrial player. The proactivity of CIRCOR's teams was decisive in our choice. For example, the creation of a scale model of the valve allowed us to anticipate the problems related to the size and optimization of the equipment," explains Benoit Beaubier, program director at FLYING WHALES.

Furthermore, CIRCOR has been entrusted with providing a comprehensive integrated fuel distribution, storage, control, monitoring, and gauging system for the LCA60T turbine generators. The fuel management system will also be compatible with the use of Sustainable Aviation Fuels (SAF). The collaboration discussions commenced in August 2021 to evaluate potential synergies for the fuel management system supply. Extensive dialogue and assessments led to the identification of optimizations to harness the innovations presented by CIRCOR. The proposal put forth by the CIRCOR team emerged as the most effective, ultimately resulting in the contract's signing in September 2023.

"We are really proud to be given the opportunity to be on board of such a disruptive project whose development represents a major step for us," said Frédéric Gréhal, VP and general manager at CIRCOR. "All our employees are excited about it, and we have full support from our corporate."

SKYSERVICE AND FONTAINEBLEAU PARTNER TO DEVELOP NEW FBO

Skyservice Business Aviation announced the completion of its investment in Fontainebleau Aviation's fixed-based operator (FBO) development project at Fort Lauderdale-Hollywood International Airport (FLL). This exciting venture marks the first co-development project between Skyservice and Fontainebleau Development as the companies join forces to create a private aviation gateway for leisure and business travel.

"The collaboration between Skyservice and Fontainebleau in developing the new era of FBOs has been remarkable," said Skyservice CEO Benjamin Murray. "Today's clients expect the amenities and conveniences of an FBO to match those of the best hotels, as well as efficiency and safety that exceed any standard or policy. We're pleased to work with FLL and Broward County to meet these expectations and provide the best of what business aviation has to offer."

The Fontainebleau Aviation FBO at FLL is expected to be complete by early 2025 and will include an 80,000-square-foot hangar, a 25,000-square-foot lobby and hangar offices, as well as an executive suite that includes an AV-equipped boardroom accommodating groups up to 20 people. The facilities have been expertly engineered to support the largest of business aircraft. Fontainebleau Aviation is now accepting hangar lease agreements.

"We are thrilled to partner with Skyservice to develop a one-of-a-kind luxury FBO grounded in 37 years of aviation thought leadership and award-winning service and safety," said Jeffrey Soffer, Fontainebleau Development chairman and CEO. "This is a first in our expanding portfolio of premier destinations and best-in-class luxury experiences to bring to the aviation industry."

Home to five of the top 25 busiest business aviation airports in the United States, Florida is one of the most significant markets in the industry. Upon completion, the Fort Lauderdale FBO positions Skyservice, through its joint venture with Fontainebleau Development, at two of the state's busiest business aviation airports: Fort Lauderdale-Hollywood International Airport and Miami-Opa Locka Executive Airport.

Liebherr and J-Air Sign Landing Gear Overhaul Agreement

Liebherr-Aerospace and Japan Airlines (JAL) have signed a long-term service contract for the overhaul of landing gears. With this contract, Liebherr-Aerospace becomes the exclusive service provider for J-Air, a subsidiary of the JAL Group, for the maintenance, overhaul and repair of the landing gears of the airline's E170 and E190 fleet.

Following the completion of the initial landing gear overhaul program which had started in 2019, this new contract renews the profound partnership between JAL and Liebherr-Singapore by extending the earlier landing gear overhaul program by another 17 landing gear sets. The new overhaul program is planned to start in mid-2024 and will extend until 2028.

"It is with great excitement that we embark on this continuous journey with Japan Airlines," said Ekkehard Pracht, general manager aerospace at Liebherr-Singapore Pte Ltd. at the contract signing. "We are honored and grateful for their decision to once again entrust Liebherr-Aerospace with the overhaul of the landing gears for the remaining E170 aircraft and the entire E190 fleet. The contract is also proof of our continuous efforts to expand our footprint in the Asia-Pacific region."

"JAL Group valued the high-quality maintenance standards that was provided by Liebherr-Aerospace and had chosen once again to collaborate with Liebherr-Aerospace. JAL Group is convinced that this partnership will further strengthen our long-term relationship," commented Kojiro Yamashita, vice president of procurement at Japan Airlines.

The complete landing gear system for the E-Jet family (E170/175, E190/195) was developed and manufactured by Liebherr-Aerospace Lindenberg GmbH (Germany), Liebherr's center of competence for flight control, actuation, gears as well as gearboxes and landing gear systems.

AFI KLM E&M to Support Australian Airline Bonza

AFI KLM E&M and Bonza announced that an agreemen to provide component support for the growing Australian airline's Boeing 737 MAX 8 fleet. The support defined by AFI KLM E&M covers a broad scope tailored to Bonza's requirements, including repair services, pool access and the provision of a Main Base Kit (MBK), as well as logistical and AOG support for airframe and LEAP-1B engine LRU's. It will be managed and delivered from AFI KLM E&M's logistics and distribution centers in Amsterdam, Miami and Kuala Lumpur.

AFI KLM E&M already supports a number of customers in the Asia Pacific & Oceania regions, with a local infrastructure – notably in Kuala Lumpur – enabling it to efficiently serve airlines in the region, not to mention its customer support teams already present on Australian soil.

"For a growing airline like ours that currently has a smaller fleet, we need to ensure that all our aircraft are operational so that we can deliver the best performance and experience for our customers," said Tim Jordan, CEO of Bonza. "AFI KLM E&M's equipment solutions, including the pool access program, are a response to this requirement, and we are confident that their know-how and global experience of the 737 product will be invaluable in delivering smooth operations for our fleet."

Tommaso Auriemma, VP Sales Asia & Pacific at AFI KLM E&M, added: "We are honored by the trust placed in us by Bonza. By signing this agreement, AFI KLM E&M is extending its footprint in the 737 market in Oceania, and also enhancing the relevance and attractiveness of its solutions on all generations of the 737, including the MAX. We look forward to supporting the development of Bonza's operations, a young and dynamic airline, through a long-term cooperation, starting with component support for their fleet".

The New Terminal One at JFK Launches first RFP for Operations With Ground Service Equipment Procurement

The New Terminal One at New York John F. Kennedy International Airport has issued a request for proposals (RFP) for an all-electric fleet of ground service equipment, launching the first RFP for operations of the world-class, all-international terminal scheduled to open in 2026 in partnership with the Port Authority of New York & New Jersey as part of its $19 billion transformation of the airport.

An all-electric fleet of ground service equipment will play an important role in supporting the Port Authority's strategy for reaching net-zero greenhouse gas emissions across the agency's airports and facilities by 2050.

The New Terminal One is seeking vendors to provide, manage and maintain ground service equipment for a period of five years with two renewal options of two years each, for a possible total term of nine years. To optimize the efficiency of airport operations, ground service equipment will be pooled at the common-use terminal for use by all airlines.

Ground service equipment plays a crucial role in airport operations by ensuring that flights are loaded and ready to depart on time. Typical ground service equipment includes portable ground power units, mobile baggage conveyors, baggage carts, tugs, and aircraft steps.

In line with The New Terminal One's deep commitment to sustainability, charging stations will be available at each gate to support an all-electric fleet of ground service equipment. Vendors interested in submitting proposals should offer an all-electric equipment solution with equipment that is currently available or will be available by January 2026.

"As The New Terminal One continues to advance, we are excited to begin to shape our operations with the launch of this first RFP. An all-electric fleet of ground service equipment underlines our strong commitment to operational efficiency, while reducing emissions and making air travel more sustainable," said The New Terminal One president and CEO Gerrard P. Bushell.

"Ground service equipment is an essential part of airport operations and will play an important role behind the scenes to ensure that our customers have a seamless experience when arriving and departing from our terminal. We look forward to partnering with our chosen provider to deliver world-class service at The New Terminal One when it opens, ensuring that every experience is an extraordinary moment to remember," said The New Terminal One executive vice president and chief operating officer Simon Gandy.

When complete, the New Terminal One will be the largest terminal at JFK International Airport, offering 23 gates in a 2.4 million square-foot space. The terminal's first phase, which includes a headhouse and an initial 14 gates, will open in June 2026.

In 2022, the Port Authority established the Zero-Emission Airside Vehicle (ZEAV) rule, requiring the transition to zero-emission ground service equipment at the region's three major airports, with the bulk of the GSE fleet required to be zero-emission by 2030. The Port Authority is also demonstrating its commitment to support the transition to electric GSE by the provision of charging infrastructure, requiring GSE charging at all new gates, and working with tenants on charging infrastructure plans.

Interested participants in the ground service equipment RFP may contact The New Terminal One's procurement team at procurement@onejfk.com to request a copy of the RFP and additional details. Proposals are due on April 22, 2024. The New Terminal One anticipates selecting a vendor in the second quarter of 2024.

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MAKING MROs MORE SUSTAINABLE

By James Careless

What does it mean to be sustainable? Well, according to the United Nations Brundtland Commission, sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Hence, when it comes to MROs and their suppliers, being sustainable means serving their customers today while reducing their impact on the environment over time.

So, how does this form of sustainability translate into action? To find out, Aviation Maintenance consulted MROs and their suppliers who are taking steps to be sustainable. Their actions provide a roadmap for others in the industry to become sustainable themselves.

How Two MROs Are Becoming More Sustainable

MROs AJW Technique and Lufthansa Technik are both actively pursuing sustainability today. And they are doing so in concrete, practical ways that are delivering results right now.

Let's start with AJW Technique. In a general sense, "AJW is driving sustainability by implementing more environmentally friendly

Louis Mallette, SVP Operations, AJW Technique

AJW's Montreal headquarters has installed a rainwater harvesting system and solar panels at the facility. AJW images.

Lufthansa Technik's Cyclean Engine Wash system. Lufthansa Technik image.

products and practices into our operations," said Louis Mallette, the company's SVP Operations. "The inclusion of sustainable alternatives in our warehouses, such as eco-friendly packaging tape and materials, showcases our dedication to minimizing our environmental impact. This choice not only reduces waste but also aligns with the broader goal of creating a greener aviation industry."

On the plant floor, "we are exploring innovations in materials used in the operations at our MRO facilities in Montreal, Canada, and Slinfold, U.K.,, ensuring the entire life cycle of aviation components is eco-friendly," said Mallette. "This involves initiatives like recycling, repurposing, or using materials with lower environmental impact. We select and use the most eco-friendly alternatives available for chemical products, whilst ensuring these are equivalent to the materials used by the OEM and are OEM approved. Where parts cannot be repaired or re-used and disposal is necessary, we ensure segregation of materials to maximize recycling opportunities."

Electricity consumption is another area where AJW is working to become more sustainable. They're lucky to have a built-in head start in this area: "Our AJW Technique facility in Montreal is located in Quebec, Canada, where virtually 100% of electrical power is generated from renewable sources (primarily hydro power), making it the ideal location for Technique's more energy intensive activities," Mallette said.

Even with this advantage, AJW Technique is continuously reviewing opportunities to reduce its energy consumption. "Recent examples include the full retrofit of lighting at our 220,000 square foot facility, and the replacement of our air compressors, which were notably oversized for the requirement with optimized units to meet our needs," said Mallette. "Both energy saving practices have resulted in a significant reduction in energy usage in the facility."

Becoming more sustainable also means reducing carbon dioxide (CO2) emissions. To this end, AJW's Montreal headquarters has installed a rainwater harvesting system and solar panels at the facility. These efforts and other efforts have reduced AJW's annual CO2 emissions by 425 tonnes. "Alongside this, we are well on the way to powering AJW Technique Europe (in Slinfold, UK) with solar energy, enabling the Battery Centre of Excellence to recharge aircraft batteries sustainably," Mallette

Lufthansa Technik has developed AeroSHARK, a bionic film developed in collaboration with BASF, that reduces aerodynamic drag on aircraft. They hope it will significantly reduce fuel consumption and emissions. Lufthansa Technik image.

Cyclean Engine Wash system injects vaporized hot water directly into the core engine, removing combustion residues and contaminants. Regular use leads to a reduction in fuel consumption, cutting up to 80 metric tons of CO2 emissions per aircraft annually. Lufthansa Technik image.

said. "We also take numerous measures to reduce operational power usage including scheduling plants and machinery to turn off when not in use and utilizing PIR (Passive Infrared) sensors on office lighting, which are set to the lowest timer."

In a bid to expand sustainability beyond AJW's four walls, this MRO's Procurement Teams actively seek suppliers and partners who share similar sustainability principles. "Collaborating with like-minded partners ensures a more comprehensive approach to sustainability throughout our business operations," Mallette said. "It's not just about the product but about the entire process leading to it."

AJW Technique is even applying sustainability to its housekeeping services by seeking more environmentally friendly cleaning solutions in its MRO facilities in Canada and Europe. "The use of aqueous cleaning agents wherever possible is standard practice within our facilities," said Mallette. "Sustainable cleaning products contribute to a healthier environment and align with our commitment to the United Nations Global Compact (UNGC)."

The bottom line: When it comes to becoming more sustainable, AJW Technique is 'walking the talk' across its entire operation — positioning this company as a leader in fostering sustainability within the aviation sector.

Headquartered in Hamburg, Germany, with MRO facilities around the globe, Lufthansa Technik is equally committed to becoming more sustainable. "To enhance efficiency and conserve resources, we have integrated various products, practices, and solutions into our own operations," said company spokesperson Lea Klinge. "Our commitment encompasses the implementation of energy-efficient facilities, waste reduction initiatives, and recycling programs within our maintenance processes."

Another environmentally conscious solution developed by Lufthansa Technik (LHT) is its 'Cyclean' aircraft engine wash. "A cleaner engine operates more efficiently, requiring less fuel and maintenance, contributing to environmental preservation," Klinge said. "Lufthansa Technik's Cyclean Engine Wash system injects vaporized hot water directly into the core engine, effectively removing combustion residues and contaminants. Regular use of this system leads to a notable reduction in fuel consumption, cutting up to 80 metric tons of CO2 emissions per aircraft annually. Furthermore, customers benefit from increased on-wing time and decreased maintenance costs." One nice feature: LHT ensures the clean and safe disposal of all wastewater generated by the Cyclean process, she noted, without causing any adverse effects on the environment.

LHT is also working to extend sustainability to the aviation world as a whole. To this end, this company provides MRO solutions that help its clients in minimizing their environmental footprints. "This includes innovative products like AeroSHARK, a bionic film developed in collaboration with BASF," said Klinge. "AeroSHARK, featuring 'riblets' inspired by sharkskin, can be easily applied to large areas of commercial aircraft surfaces. By reducing the aerodynamic drag, this technology significantly reduces fuel consumption and emissions. Our observations on Boeing 777s treated with the currently certified expansion stage of the AeroSHARK modification already indicate a one percent reduction in fuel consumption, and initial calculations suggest potential savings of up to three percent at its maximum expansion level."

What Suppliers Are Doing To Help

Aerogility and Aerotrax Technologies are two aviation suppliers who are supporting sustainability in their own right.

With offices in Atlanta and London, Aerogility uses model-based AI and enterprise digital twin technology to give aircraft operators a holistic overview of their operations. Its sector-specific AI models allow fleet and maintenance planners to simulate real-world scenarios to generate reliable insights for forecasting, planning and decision making. "The simulations can be used to assess the impact of a scenario and why the AI technology made a particular decision before they are implemented," said Phil Cole, Aerogility's airline business manager. "This can include the impact of bringing in a new fleet, changing maintenance schedules, or introducing sustainable aviation fuels (SAF)."

Aerotrax Technologies is a Dallas, Texas-based enterprise software company focused on data sharing and visibility in the aviation/aerospace supply chain. "We are a cloud-based software vendor, so the delivery of our products has negligible impact

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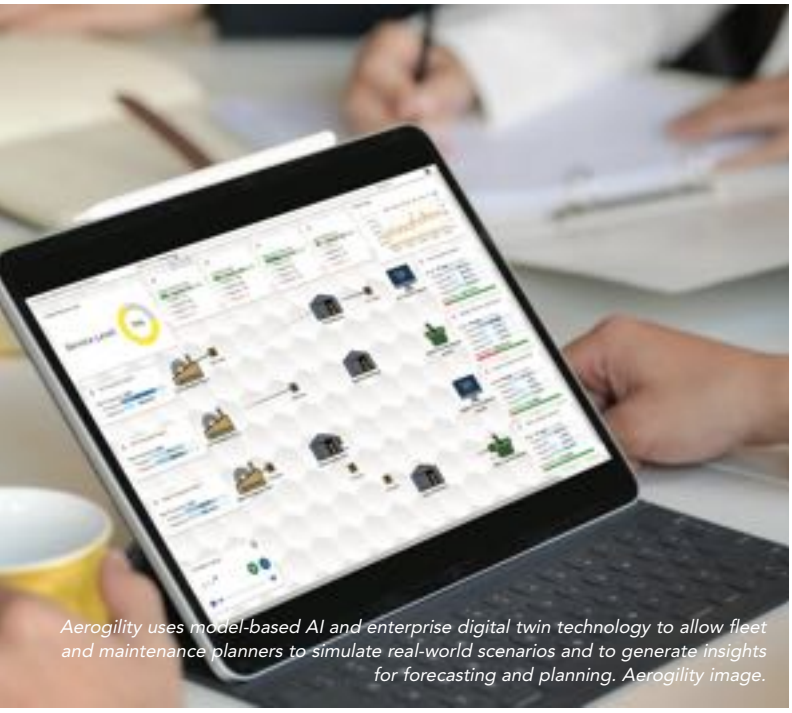


Aerogility uses model-based AI and enterprise digital twin technology to allow fleet and maintenance planners to simulate real-world scenarios and to generate insights for forecasting and planning. Aerogility image.

on the environment," said David Bettenhausen, the company's founder and CEO. "By focusing on small improvements on a daily basis, we drive positive, incremental change across the supply chain organization — which, as a business function, is the beating heart that drives all aftermarket success."

In addition to helping its clients become more sustainable, Aerotrax is applying sustainability to itself. "We run a lean operation, continuously looking for ways to be more efficient," Bettenhausen said. "When sustainability is embedded in your culture, it's the little things that you commend. Whether it's rearchitecting the system design from a blockchain-based, energy intensive platform to a serverless, pure cloud implementation, or if it's prioritizing flight choices based on total carbon emissions rather than only convenience or only price as the sole decision-making driver — we are constantly holding ourselves accountable to our own internal bar. In both these decisions, our software and our people are able to perform better."

"The picture I'm trying to paint is that sustainability is multi-faceted," he added. "No single pledge, policy, product, or person automatically makes an organization sustainable. It's the little things that are done on a daily basis. I also personally do not believe it is wise to look at sustainability in a vacuum of environmental sustainability, which is oftentimes the case. The most thoughtful decisions in this context artfully balance environmental and economic alignment in both the short term and long term."

Airlines Want Sustainable MRO Solutions

There is no doubt that becoming more sustainable is a responsible social policy for MROs. But it is also good business. This is because airlines and other aircraft operators want to be more sustainable to satisfy environmentally conscious customers who pay their bills, and the governments that regulate their industry.

"Passengers are the lifeblood of our industry, and if operators do not listen to the needs of their customers, they may opt for a greener airline," said AJW's Mallette. "Our customers, being operators and those supplying operators, are looking for MRO operations that feed into their sustainability goals."

"We are seeing a growing demand for more sustainable MRO solutions from our clients," agreed LHT's Klinge. "Airlines and aircraft operators are increasingly focused on reducing their environmental impact and operating more sustainably. This has led to a greater interest in MRO solutions that can help them achieve their sustainability goals."

There are other ways that MROs can become more sustainable, at least from a regulatory standpoint. For instance, airlines have been strong buyers in the Carbon Credit markets to offset their CO2 emissions. "I have some friends over at Green Trade Solutions in the U.K., who have been supporting big, new carbon capture projects and helping airlines find projects they can get excited about that are in line with regulatory requirements," Bettenhausen said. "While the MRO industry certainly recognizes the importance of sustainability, I haven't seen as much activity or appetite for these carbon offset initiatives in the same way that I see airlines pursuing."

A Necessary Commitment

"According to NOAA's 2023 Annual Climate Report the combined land and ocean temperature has increased at an average rate of 0.11° Fahrenheit (0.06° Celsius) per decade since 1850, or about 2° F in total," said the U.S. government website climate.gov (full link at end of article). "The rate of warming since 1982 is more than three times as fast: 0.36° F (0.20° C) per decade."

With facts like these, there is no doubt that industry needs to take climate change seriously and address it through sustainability initiatives. "In 2022 aviation accounted for 2% of global energy-related CO2 emissions, having grown faster in recent decades than rail, road or shipping," said the intergovernmental International Energy Agency at www.iea.org (full link at end of article). "Many technical measures related to low-emission fuels, improvements in airframes and engines, operational optimization and demand restraint solutions are needed to curb growth in emissions and ultimately reduce them this decade in order to get on track with the Net Zero Emissions by 2050 (NZE) Scenario."

LHT takes its role in addressing climate change seriously. "It is vital for every company in the industry to use or even offer solutions for a more sustainable aviation," Klinge said. "For us, this also means to engage in research activities that provide important impulses for a carbon-neutral and potentially hydrogen-powered future. To investigate the effects of the use of liquid hydrogen (LH2) on maintenance and ground processes already at an early stage, and to provide valuable impulses for the designers of future aircraft, Lufthansa Technik is partnering with renown research and industry institutions and will jointly operate a comprehensive LH2 field laboratory based on a decommissioned Airbus A320."

The good news? In a very fundamental sense, "MRO and sustainability are actually quite harmonious concepts," said Bettenhausen. "By choosing to maintain, repair or overhaul a part, purchasing managers are actually choosing the more sustainable solution than buying new. (In the Defense world, MRO is literally called Sustainment.) If we continue to find novel ways to extend the life of parts and aircraft — from more accurate aftermarket measurement and reporting, to feedback loops and data sharing with OEMs, to new breakthroughs in material and systems design — we can move the needle on ambitious sustainability goals. I believe these innovations are imperative to ensure the long-term economic health of the industry."

The Big Picture

By actively pursuing sustainability, MROs and their suppliers are aligning themselves with the aviation industry as a whole, where achieving sustainability has become a priority. After all, being held responsible for 2% of global energy-related CO2 emissions is not a good position for any industry, whether on a social,

environmental, or regulatory level.

"This is why "the International Civil Aviation Organization (ICAO) set a goal in October 2022 to achieve net-zero carbon dioxide emissions from aviation by 2050, prompting a shift towards sustainability in the aviation sector," Mallette said. "If we are to ensure the economic health of our industry going forward, MROs such as AJW Technique must adopt and provide sustainable solutions within their business and MRO operations. The world and passengers are demanding it from the industry."

"As the aviation industry continues to focus on sustainability and environmental responsibility, MROs that can offer innovative and more eco-friendly solutions will be well positioned to attract and retain clients," added Klinge. "Additionally, sustainable practices can lead to improved operational efficiency and long-term cost savings."

A case in point: "By using safe and trusted AI solutions, MROs can model carbon outputs for example, enabling them to meet carbon emissions targets," Cole said. "MROs and airline maintenance departments can also use the insights generated by AI to efficiently implement optimized maintenance schedules, reducing unnecessary part wastage or aircrafts operating without the latest emission-reducing technologies."

If there is a lesson to be drawn, it is that sustainability is a necessary commitment for the MRO industry, and a requirement that will shape its economic viability going forward. Thankfully, the sincere efforts of the MROs and suppliers noted above, along with those of others in the aviation industry, offer a good chance of delivering on this promise.

"Remaining economically viable in the MRO industry requires staying at the forefront of sustainable practices," concluded Mallette. "Collaboration will drive the health of the industry while also protecting the planet and its people." AVM

Phil Cole, Aerogility

By James Careless

THE STATE OF WIDEBODY AIRCRAFT/ENGINE MAINTENANCE

The number of widebody commercial aircraft in the world is increasing, and so is the need for these aircraft and their engines to be serviced by MRO shops.

"We see the widebody fleet growing at about 2.6% over the next five years and widebody overall MRO growing at 3.9%," said Derek Costanza, a partner in Oliver Wyman's Aviation and Aerospace Practice. "Widebody engine MRO will approach 4.3%, and engines will represent almost 50% of the total MRO dollars spent in the next five years, so that brings up the average. Growth will come mostly from China and the Middle East."

"For mature widebody engines such as the GE90, MRO demand has increased significantly in the past year and will continue to grow over the next few years as passenger flying returns to normal," added Alistair Forbes, senior market analyst with the MRO MTU Maintenance. "These engines are very reliable, with the vast majority of shop visits being scheduled."

At the same time, grasping the full profit potential of the widebody maintenance market is apparently out of reach for airframe and engine MROs. The reason: "The WB (widebody) MRO market recovery is slower due to slower recovery of long-haul traffic" after Covid-19, said the 2023 VZM Market Outlook for Commercial Aviation & Maintenance. But it could be worse: The pandemic also slowed down the production of new widebodies, forcing airlines to keep older aircraft like the A380 in service, it said. More older widebodies flying means more business for MROs, even with a slower-than-expected return to normal airline traffic levels.

Alistair Forbes (MTU Maintenance)

Derek Costanza Oliver Wyman

"Airlines are struggling to get new widebody aircraft from Airbus and Boeing," said Gilles Fossecave, CEO of the MRO Vallair. "That's why they are asking for maintenance on their existing widebodies, in order to keep their fleets as large as possible and able to fly."

The State of the Industry

There is no doubt that Covid-19 disrupted the growth of the world's widebody aircraft fleet. According to Oliver Wyman's 'Global Fleet and MRO Market Forecast 2023–2033' report (the Market Forecast report), "we project the worldwide commercial fleet to expand 33% to over 36,000 aircraft by 2033 — a compound annual growth rate of 2.9%. Today it numbers almost 27,400, just short of its size in January 2020 — the last month before Covid changed the economy and everyday lives around the globe."

Shown here is an A350 at AFI KLM E&M's Paris Charles de Gaulle Airport (CDG) base maintenance operation. AFI KLM E&M image

This report then observed, "while aviation is most assuredly on a growth trajectory after a devastating two years of losses, it's currently carrying a lot of baggage that can't be easily checked. With Covid-19 ostensibly behind us, the [airline] industry will be dealing with a series of new and old challenges over the next 10 years that will test its resilience and may temper how fast it continues to expand." The same is true for the MROs that serve them.

Let's look at these challenges in depth.

Giles Fossecave Vallair

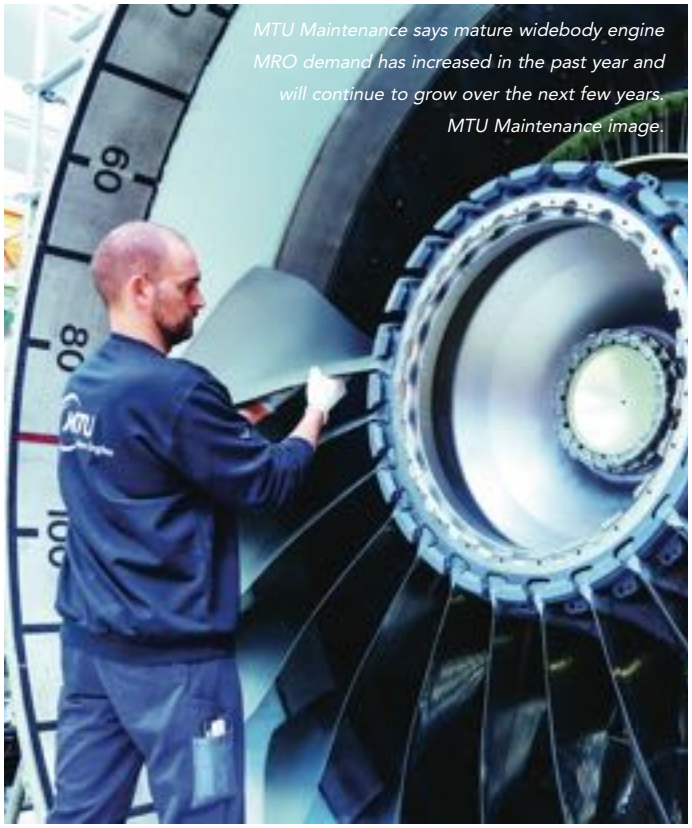
The Impact of Slowed Widebody Production

When Covid hit in 2020, airlines delayed their widebody purchases with Airbus and Boeing in order to save money. "The greatly reduced levels of passenger traffic impaired airlines' ability to pay for aircraft and so they often requested deferred delivery dates," explained Forbes. This, in turn, slowed widebody production, which put the OEMs and airlines in 'catchup' mode once the crisis eased and normal air travel started to resume.

The same penny-pinching mentality also guided airlines' approach to widebody maintenance during the worst of the pandemic. "I think all the airlines in the world were trying to save cash as much as they could," said Derk Nieuwenhuijze. head of strategy, marketing and communication with Air France Industries KLM Engineering & Maintenance (AFI KLM E&M). "So they postponed their narrowbody and widebody maintenance as much as they could."

But there were a few exceptions: "Widebody MRO for the GE90-115B and CF6-80C2 engines remained strong during the pandemic, driven by the cargo market," MTU's Forbes noted. "Other engines that mainly catered to the passenger market

AFI KLM E&M expects widebody fleets to grow significantly going forward. Shown here, a Boeing 787-9. AFI KLM E&M image.



MTU Maintenance says mature widebody engine MRO demand has increased in the past year and will continue to grow over the next few years. MTU Maintenance image.

suffered much larger MRO demand reductions, particularly for older less efficient aircraft."

Even today, the impact of Covid-19 lingers on. "We expect an average of 240 new widebodies to be produced each year over the next five years, which is considerably lower than the annual average of 370 produced across 2018 and 2019," said Costanza. "We do not see widebody production recovering to 2018/2019 levels until the end of the decade."

The Impact on Widebody MROs

As mentioned above, the slowdown in new widebody deliveries has forced airlines to keep their older widebodies in service longer. The result: "Lack of widebody replacement definitely has created more MRO demand," Costanza said.

Demand for widebody maintenance services is likely to increase further when world airline travel matches and then exceeds pre-pandemic levels. "This is one reason why MTU is confident that we will continue to see strong widebody growth over the next few years as passenger activity returns to the long-term growth trend," said Forbes.

This said, there are a number of post-pandemic problems that are taking the bloom off this particular rose. One of these problems is inflation, which is affecting all aspects of MRO operations.

"Inflation is a huge issue for all MROs," Constanza said. "Depending on the parts, inflation has been right about the double-digit level. The trouble is that many airline operators cannot afford those increases while many MROs are trapped in contracts that limit price escalation due to inflation, so yes, it's a big issue for everyone involved. In response, airlines and MROs have opened up to using more USM (used serviceable material) and PMA (parts manufacturer approval) parts rather than new OEM parts, but the historical savings are not there due to increased buyer demand."

Derk Nieuwenhuijze AFI KLM E&M

Inflation is also driving up labor costs, due to "consumer inflation leading to demands for higher wages across the supply chain," said Nieuwenhuijze. "This is affecting everyone from the mechanics who are working on the aircraft to the people who make the parts, and those who gather the raw materials that these parts are built from."

Then there's the costs of keeping the lights on and the MRO hangars heated, which also keeps going up. At MTU Maintenance, "Energy is one of the drivers for cost increases, especially at our German locations," Forbes said. "Further, we have experienced increased cost for material and outside vendor services, both reflecting the overall inflation trend in combination with scarce resources — the latter being driven by worldwide capacity adaptations in the supply chain and caused by Covid-19. Naturally, the share of material cost represents a major portion of our maintenance services and is therefore a significant driver for overall cost increase."

In a bid to drive down at least some of these inflationary costs, MTU is investing in self-sustainable energy infrastructure such as photovoltaic technology and dual-use heat pumps. "These measures do not only help to better manage energy cost but also support MTU's strategy towards a lower carbon footprint," said Forbes.

Unfortunately, the only way for MROs to survive rising costs and stay in business is to pass on those costs on to their widebody customers. According to Vallair's Fossecave, raising prices is a necessary move, but not a popular one. "Some airline customers don't understand why prices have gone up to service widebodies, and we have to explain it to them," he said. "Other airlines do understand, but they don't like it because they have inflationary issues of their own to deal with."

Supply Chain Issues Remain

Supply chains were seriously disrupted when the pandemic hit in 2020, and they have yet to fully recover. This is why "Supply chain challenges have hindered aerospace production lines, causing both Airbus and Boeing to fall short of production and delivery targets for 2022," said the Market Forecast Report. "2023

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According to Vallair, operators are asking for maintenance on their existing widebodies in order to keep those fleets operating while there are backlogs for new aircraft at the OEMs. Vallair image.

is unlikely to be different for either, given that the two rely on many of the same suppliers and sources of raw materials, and the conditions remain about the same this year. Of course, many of the same parts are used on the A320 and Boeing 737, meaning that the pressure on some suppliers is multiplied."

"For the older widebodies, the challenge is always getting parts," Costanza observed. "For these older widebodies, engine maintenance continues to be a particular challenge as does landing gear, both of which are very dependent on the OEMs."

"A strained supply chain is an issue that is currently affecting the entire industry, including OEMs, MROs and suppliers," said Forbes. "At MTU, we are working closely across our entire network and in all regions to limit the impact on customers as much as possible.

As for the immediate future? "Supply chain issues will limit OEMs' ability to ramp up production quickly to match the rapidly rising demand from airlines," said Alton Aviation Consultancy's 'Skyward Bound: 2023-2033 Commercial Aircraft and Engine Fleet Forecast'. "As a result, OEMs have substantial order backlogs which stretch until late in this decade for most of the popular in-production aircraft families. It is not expected that OEMs will bring into service additional new cleansheet aircraft designs in this decade beyond the 777X, despite industry sustainability commitments."

Ironically, the only reason this situation isn't worse is due to the current level of widebody flights. They still haven't recovered from Covid-19 either.

"At a global level, the amount of widebody flying in Q3 this year was only 92% of the Q3 2019 level (with Q3 usually being the busiest quarter of the year for flying), so the widebody market overall still has a little way to go to get back to pre-pandemic levels of flying," Forbes said. "This shortfall is even more marked if you consider that the market was growing quickly before the pandemic hit. If 2019's flying had continued to grow 4% per year, we would have had global flying at 117% of 2019 levels this summer, so the 92% figure mentioned earlier reflects a significant reduction compared to where the market would have been without the pandemic."

A Lack of Labor

It is difficult to service any aircraft if you don't have the technicians on hand to do the work. This also applies to flying commercial airliners if you don't have the pilots.

According to Oliver Wyman's Market Forecast report, this one-two 'lack of labor' punch is knocking the entire aviation industry for a loop.

A case in point: "In North America, the industry is facing two potentially severe shortfalls in the ranks of commercial airline pilots and aircraft mechanics," said the Market Forecast report. "By our analysis, the supply gaps will amount to 18% of the total pilot workforce in 2023 and 14% of aviation mechanics. The outlook is for those deficits to grow or at least linger through 2033. The gap between the number of pilots needed and those available has already led to reductions in service to less popular and more rural destinations and has hit regional airlines hardest."

Worse yet, "the shortfall of aviation workers is a global problem," the Market Forecast report continued. "European ground crew shortages were so ubiquitous and severe in 2022 they led to the imposition of capacity limits at some European airports, including London's Heathrow and Amsterdam's Schiphol. In India — the fastest-growing aviation market, according to our latest Fleet and MRO Forecast — the desperate need is for more air traffic controllers. But because so many aviation jobs are critical to operations, any ongoing shortage can eventually result in the industry's growth being limited not by a lack of demand but by supply constraints."

According to MTU's Alistair Forbes, hiring enough qualified personnel and managing parts supplies are the two main challenges facing MROs today. "The skilled and experienced workforce shortage will be around for some time mirroring the demographic development — especially in the Western world," he said. "MTU was fortunate enough to retain its workforce during Covid and we are now partnering with schools, colleges and universities to recruit and train new hires on a continual basis all over the world. We also continue to invest into our in-house mechanic apprentice programs and training centers: For instance, MTU Maintenance opened a dedicated training center at its facility MTU Maintenance Zhuhai earlier this year and announced its training academy, a collaboration with the British Columbia Institute of Technology, at MTU Maintenance Canada in Delta, BC."

The Impact of Cargo Conversions

When passenger traffic fell off during the pandemic, many airlines converted their idle widebody airliners into cargo carriers, in a bid to capitalize on growing traffic in this area.

For a while this worked. But in 2022 "the cargo market started to soften while capacity increased further," said the VZM Market Outlook 2023. During most of that year "demand was declining despite higher world trade than the year before," it said. To make matters worse, "cargo revenues remained almost flat, supported by even higher yields than the previous year."

As a result of these trends, VZM is not bullish about the air cargo market as a money-maker for airlines post-pandemic. "Air freight demand is expected to be weaker in 2023 but to recover in later years," the VZM Market Outlook said. "Global cargo revenue will decrease 25% in 2023 but still be 50% above pre-corona revenues. [The] main reason is the still strong cargo yield expected in 2023, although also sharply declining. The weaker market is forcing cargo airlines to cut costs after very profitable corona years."

So what does this mean for those MROs who convert widebody passenger aircraft to freight (P2F) carriers? "Over the next five years we expect widebody P2F conversions to double to an annual average of just below 40," said Costanza. "This is about double what we have seen yearly since 2018. These conversions

drive more demand for MRO services, but it's fairly minimal in the context of the overall MRO market."

"I would expect the demand for cargo conversions will be a little bit lower going forward than it has been," Nieuwenhuijze said. "And I'm always a little bit skeptical about the importance of cargo conversions in the overall MRO market: Of course, the numbers we saw the past years were huge comparatively to what we've seen before. But as a whole, the cargo aircraft market is relatively small if you compare it to commercial airlines."

The Bottom Line

Clearly, the widebody MRO industry is facing a number of challenges in the wake of Covid-19. However, these challenges don't change the fact that global air travel is increasing, and on track to exceed pre-pandemic levels in the future.

As a result, "we see a huge appetite of airlines worldwide to buy new aircraft," said Nieuwenhuijze. "So the world's widebody and narrowbody fleets will grow quite significantly going forward. This means that MROs such as AFI KLM E&M will have to ramp up capacity. My only concern is that we will have enough suppliers to support us in our work, especially in the area of widebody engines."

"The big challenge for airlines will be to find widebody MROs with enough available slots to service their aircraft in a timely manner," Fossecave concluded. "Our challenge will be to find and retain sufficient skilled technicians to do the work." AVM

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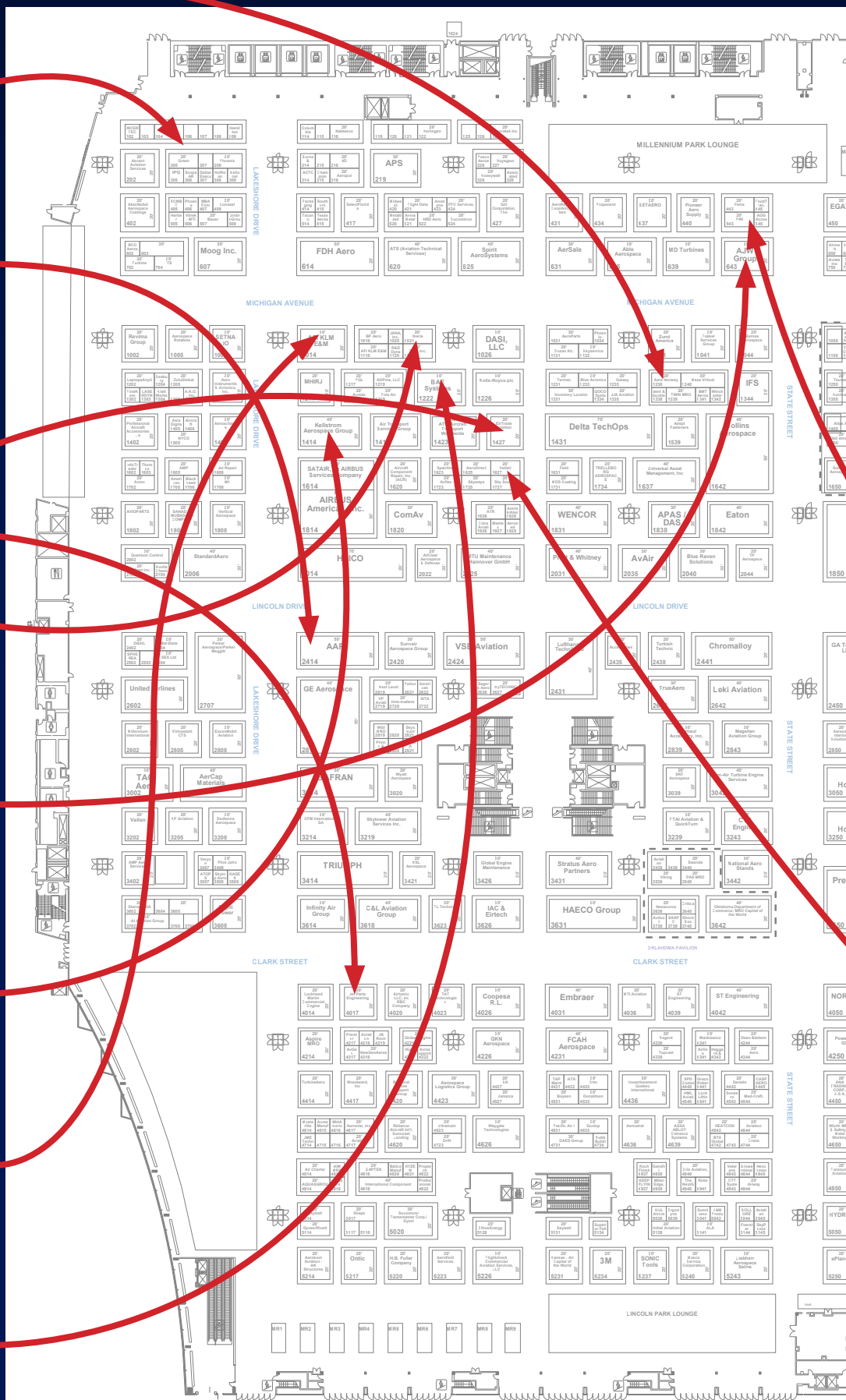

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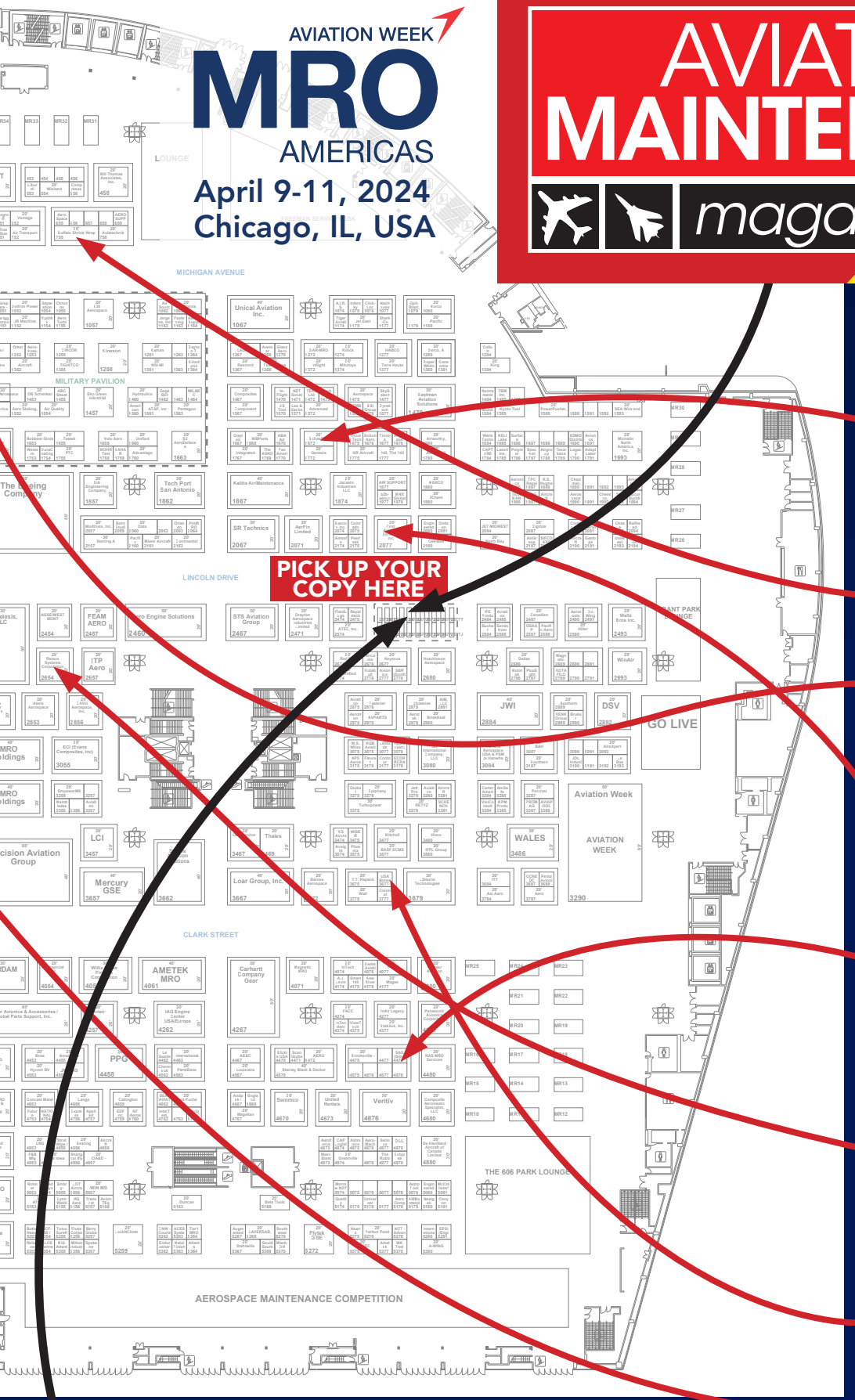

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By James Careless

AIRCRAFT COMPOSITE REPAIRS:

WHAT'S POPULAR, WHAT'S NEW AND WHAT'S COMING

The days of aircraft composite repairs being unique and exotic are over. The popularity of carbon fiber and other composite materials in aircraft means that repairs to these structures are becoming standard procedures at MROs worldwide.

So, what kinds of composite repairs are common, what advances have been made to these repair techniques, and what future advances are coming? To find the answers to these and other questions that matter to MROs, Aviation Maintenance magazine spoke with three composite repair experts. They are Eitan Danan, head of the composites department at the IAI Bedek Aviation Group; Lorenzo Marandola, president of M1 Composites Technology; and Louis C. Dorworth, direct services division manager at Abaris Training Resources, which teaches technicians how to work


Lorenzo Marandola

with aircraft composite materials and perform repairs.

Common Composite Repairs

To put aircraft composite repairs into context, we began by asking about the most common aircraft composite repairs and the challenges associated with them.

At the IAI Bedek Aviation Group (IAI), "our focus is on repairing structural elements such as fuselage skins and wing structures that have been affected by wear and environmental factors," said Eitan Danan. "The B-767-300 is the most commonly serviced aircraft in our hangars. IAI performs heavy maintenance for many airlines, which involves removing all interior components, including seats, galleys, lavatories and overhead bins, inspecting them and sending them to the composite or sheet metal shops."

Finding damaged aircraft composites during maintenance inspections is a regular occurrence. To address them, IAI's composite shop performs repairs in accordance with the structural repair manual, using hot bonder consoles, heat blankets, and vacuum bags. "In some cases, significant damage can occur during in-flight maintenance," Danan said. "These repairs require engineering support and Boeing responds with structural composite repairs using advanced equipment and in-house expertise."

Worth noting: Aircraft lavatories are often the most problematic areas encountered during composite repairs, due to severe corrosion on the lower metal fittings. To address this issue, IAI's composite and sheet metal shops collaborate to manufacture new fittings and fasteners that adhere to the manufacturer's technical specifications.

M1 Composites Technology's expertise lies in composite structure repairs, with a focus on remedying common issues encountered in components like radomes and leading edges. "These repairs are often necessitated by factors such as bird strikes, hail, and environmental wear," said Lorenzo Marandola.

As well, water penetration into aircraft composite materials and subsequent delamination are frequent problems that M1 addresses, particularly in nacelles and cowls subjected to significant vibration and stress. "To tackle these challenges, we employ advanced non-destructive testing (NDT) methods to identify areas of concern and undertake precise restoration work, often involving the careful removal and rebuilding of damaged sections to ensure optimal structural integrity and performance," Marandola said.

To prepare MRO technicians to fix these and other aircraft composite repairs, Abaris Training Resources primarily teaches taper-scarf repair methods in their courses. "This is because these methods are preferred by original equipment manufacturers (OEMs) for a majority of composite structures and are called for in their structural repair manuals (SRMs)," said Dorworth.

When it comes to doing these repairs successfully, education is a must. "This is because problems mostly occur due to personnel that may have on-the-job training skills but greatly lack the fundamental knowledge required to be proficient with composite materials and processing," Dorworth said. "Unlike metals that already have given mechanical properties, composite materials require that the properties of the patch are developed by choosing the right resin, orienting the fibers, and curing the resin/adhesive properly. This is where formal training fills the void, providing competent and confident mechanics and technicians that understand the underlying material and process knowledge necessary to provide airworthy repairs."

Recent Advances

According to the experts, the science of aircraft composite repair has progressed considerably as composites have achieved widespread acceptance in the aviation industry.

"Recent years have seen notable advancements in repair equipment, particularly in terms of precision and control during the curing process of composite materials," said Marandola. "With the shift towards larger aircraft structures constructed from composites, such as the A320 NEO and B737MAX, there has been an increased demand for autoclaves to effectively cure these components. These developments have enabled more precise and efficient repairs, ensuring the integrity and longevity of composite aircraft structures."

According to Dorworth, the quality of adhesives, resins, and 'prepregs' (pre-impregnated materials) used in composite repairs is where the biggest advances have occurred over the last 20 years. These improvements support the use of lower temperature hot bonding processes, resulting in higher performance properties in the final repair. "Today's focus is on achieving the best performance from cobonded repair patches for primary structures, versus what was acceptable for the secondary structures of yesteryear," he said.

Ongoing Challenges

Even with advances in aircraft composite repairs, challenges remain.

A case in point: Detecting damage to composites that is not visible externally remains a significant challenge. "Consequently, ongoing research efforts are focused on developing improved methods for detecting heavy internal damage, which may be concealed from plain view," said Marandola. "However, it's worth noting that the OEMs responsible for designing and manufacturing these aircraft are best positioned to assess whether their assumptions regarding damage occurrence have been accurate. As they continue to gather data and refine their understanding of composite material behavior in real-world scenarios, insights gained from OEMs will be crucial for shaping future repair strategies and advancements."

Being able to repair damage after it has been detected can also be a challenge. The reason? "As with everything, the original lab level studies that go into the repair design instructions do not always translate to the challenges found in the real world for many reasons," Dorworth said. "Because of this, there have been a number of 'issues' that have popped up as new aircraft with carbon fiber reinforced polymeric (CFRP) structures have found their way into service. For the most part these challenges have been dealt with accordingly and are now mainstream."

Then there's the challenge of dealing with composite repair issues that are much larger than usually encountered. For example, there was the case of the Ethiopian Airlines 787 that experienced a battery fire in 2013. Fixing this Dreamliner required "a new piece of the composite fuselage to be fabricated, sectioned, and replaced at the upper aft section near the vertical stabilizer," said Dorworth.


Louis Dorworth

Of course, just the fact that composite materials are still comparatively new to aviation

The use of carbon fiber and other composite materials in aircraft means that repairs to these structures are becoming standard procedures at MROs worldwide. Abaris image.

(compared to metal) explains why unexpected repair issues are still occurring. "As always, every time a new component or technology comes into the picture, it brings with it new problems and challenges," Danan observed.

Tackling the Challenges

Fortunately for composite aircraft operators and owners, the companies interviewed for this article are taking action to address the repair challenges noted above, and many others. AT IAI, for instance, "we have developed comprehensive repair procedures, combining standard and innovative methods, focusing on international standards compliance and staff training," said Danan.

The same is true for M1 Composites Technology. "Our company has undertaken several initiatives to develop repair procedures for composites," Marandola said. "We utilize reverse engineering techniques to understand the original manufacturing processes and materials used in composite components. Additionally, we have assembled a specialized team of composite technicians and a dedicated engineering team with expertise in composites. Our extensive experience working on legacy platforms informs our approach to repairs on newer aircraft, allowing us to adapt and innovate effectively."

This being said, finding ways to address composite repair challenges comes with challenges of its own. For example, "composite material properties are often proprietary to OEMs, making it challenging to ascertain original strength and manufacturing methods. As a result, substantiating repairs can be more complex," said Marandola. "Moreover, the specialized tooling required for composite repairs, such as autoclaves, can be costly. Additionally, higher inspection and non-destructive testing (NDT) requirements further contribute to the challenges associated with composite repairs."

To help MRO technicians successfully remedy composite issues through education, Abaris Training Resources has been working closely with organizations such as SAE/PRI and aircraft OEMs to develop relevant repair methods and standards for commercial/general aviation repairs. "We currently have a representative on the PRI Composite Repair Review Board, developing training and testing standards for aerospace composite repair technician certification," Dorworth said. "In the past we have worked directly with OEMs in developing repair methods for higher altitudes over 8,000 feet. We have also worked with organizations and customers to develop and deploy repair methods within their own facilities by offering Repair

Design, Analysis, and Substantiation courses to engineers."

All this being said, our experts believe that composite aircraft OEMs could be doing more to improve the aircraft composite repair process.

One way OEMs could help is by standardizing repair procedures and materials across different aircraft platforms, which could significantly improve the efficiency and effectiveness of composite repairs. "Currently, variations in materials and procedures present challenges, as each material may have different characteristics and shelf life," said Marandola. "By OEMs adopting common materials and procedures, MROs would be able to streamline their operations and reduce costs. Additionally, investing in the development of alternative materials that require less complex curing processes, such as heat blankets or room temperature cures, would simplify the repair process and increase flexibility."

Another way is suggested by IAI's Danan. "To simplify composite repairs, we propose creating a unified database of repair types based on SRM (structural repair manuals)," he said. "Based on our experience, we believe that this approach can expedite and streamline such repairs."

If adopted, these suggestions would ensure that "MRO stations don't have to stock different products and learn too many different methods," said Dorworth. This would lead to faster and more affordable repairs.

What's Coming

As exciting and innovative as today's aircraft composite materials are, the future holds even greater possibilities — and new considerations for the MROs who will repair them. Here are some ideas from our experts about what is coming next.

"One promising area of development is the emergence of self-healing composites, offering the potential to autonomously repair minor damages and extend the lifespan of components," Marandola said. "As well, additive manufacturing technologies present new opportunities for rapid prototyping and production of specialized repair parts, leveraging our existing capabilities in this field. Looking ahead, the future of composite repairs holds exciting possibilities, driven by advancements in materials and manufacturing processes."

"Future developments will include a system based on global repair experiences that uses optical equipment for precise defect analysis and repair method selection," predicted Danan.

"In addition to new and better performing materials and processes that evolve on almost a daily basis, there is a trend in aerospace design where quickly-formable thermoplastic composites (TPCs) are replacing standard thermoset composite structures in primary and secondary structures," Dorworth said. "There are numerous efforts underway to develop repairs to TPCs as they will be necessary to the aerospace community within the next 5-10 years. In addition, machine builders are looking to automate many processes in repairs that are currently done by hand. This includes automatic taper-scarf machining, plasma surface treatment, and post-repair inspection using nondestructive methods."

The bottom line: "The use of composites in aircraft structures is only going to increase in the coming years," concluded Dorworth. "From our point of view, formal composite repair training is paramount to a new generation of competent aircraft mechanics in their effort to maintain airworthiness in every composite repair they perform. It is vital to the success of the industry."

By Ian Harbison

WHEEL IN THE SKY: KEEPING AIRCRAFT LANDING GEAR TURNING

The landing gear MRO business is in a state of flux at the moment. With a typical overhaul interval of 10 years or 25,000 cycles, demand can be forecast with some accuracy based on historical aircraft delivery patterns. However, while the high utilization of low-cost carriers means that the period can be reduced to eight years, the pattern has been further distorted by many airlines having delayed maintenance during the pandemic but are now back flying at previous rates. As a result, demand is extremely high at the moment but, on the MRO side, companies are still facing post-Covid staff shortages and replacement training requirements as well as some supply chain issues, extending turnaround times. Looking further ahead, it seems likely that the 10-year limit may be extended to 12 years.

Revima

Olivier Legrand, Revima

Olivier Legrand, group president and CEO of Revima, says the main facility at Caudebec-en-Caux, in northern France, which handles landing gear for Airbus (A300-600R, A320 Family and A330) and Boeing (747-400 F/ER/ERF, 747-8, 777, 787 and MD-11), overhauled 350 legs last year. Two thirds of these were for widebodies, which require 2.5 times as many man-hours as narrowbody landing gears. This year, the forecast is a throughput of 420 legs, a 20% increase.

He says the A300-600R and MD-11 markets are pretty flat, although the company has long-term contracts with cargo operators that are keeping the aircraft in service. The MD-11 work may receive a boost with the closure of Hawker Pacific Aerospace (see below), as Revima will be the only MRO source. The 747 market, again mostly cargo aircraft, has stayed around longer than expected but will probably start to decline in the near future.

The largest volume of work comes from the 777-300ER, with the number of contracts probably making the company the largest MRO provider. However, the 787 is set for significant growth, not least because Revima is a member of the Boeing Landing Gear Program. It will replace the 747 and will eventually become the main product in place of the 777. Overhauls now are from the 787-8 but the first 787-9 overhauls will start appearing in the next two years.

Introduction of the 787 has required significant investment. The legs are chrome free, using High Velocity Oxygen Fuel (HVOF) spraying to provide a greener and tougher surface. As machines have become due for replacement, the new equipment must be able to deal with the harder surface. Last year, this included a brand new CNC grinding machine and lathe, while a large grinder is scheduled for delivery in 2024 and a large boring machine in 2025. He notes that the surface on legs coming back for overhaul has been in good condition so investing in HVOF spraying equipment is not a priority at the moment. Another environmental initiative under development is the replacement of cadmium plating with zinc nickel plating, in accordance with the EU REACH program.

Turning to the post-Covid challenges, he feels the company could have handled more than 350 legs last year but for supply chain issues, where components that had always been available were suddenly unavailable. As a result, the company has had to spend an increased amount of time chasing suppliers, developing and proposing workarounds, sourcing used serviceable material, developing repairs and requesting OEM engineering assistance for consideration of adjusted tolerances. In addition, while some 500 people work on landing gear and the company suffered relatively few personnel losses because of its rural location, there was still a training requirement for new hires.

To complement its landing gear MRO services, Revima's Normandy Aerospares business (the Used Serviceable Material entity of the Group) devoted a portion of its Yainville facilities (7 miles away from the Caudebec site) to carry out landing gear overhaul, especially with mid-life solutions. The market demand for these services is high, but, by its nature, is opportunistic, which did not work well with more planned MRO flow at the main facility.

Rémy Maitam is president, Asia Pacific at the company's satellite facility in Thailand, at Chonburi, 60 miles north of U-Tapao–Rayong–Pattaya International Airport. It specializes in Airbus A320 Family and Boeing 737NG landing gear, although an agreement signed with Liebherr-Aerospace in April 2023 will see it expand into Airbus A350 nose landing gear MRO in Asia-Pacific. Construction of the 120,000ft2 facility began in February 2019 and was completed in March 2020. In parallel, there was a significant staffing and training program, with local recruits being trained at Revima headquarters. Staff from France also relocated to Chonburi to oversee initial maintenance. Now, he says, the staff are almost entirely Thai, supplemented by specialists from Hong Kong, the Philippines and Singapore.

The $40 million facility is equipped with the latest machinery and tooling, fully connected for smart monitoring and maintenance processes. It is environmentally friendly, with wide use of green chemicals and no waste rejection for its plating facilities. It is also equipped with brand-new machining and test equipment, to high performance non-destructive equipment. Annual capacity is up to 600 legs.

Part 145 certification (Civil Aviation Authority of Thailand, EASA, FAA) was achieved in early 2021 but capabilities were limited to disassembly and assembly, parts repair being outsourced to France. By mid-2022, full capabilities were available after plating and machining shops were added, including five-axis milling and grinding machines, hydraulic test benches and NDT.

Since then, operations have been in full swing, with 140 legs overhauled last year and 240 forecast for this year. The company

This image shows the Revima Asia Pacific facility, located in Chonburi, Thailand. Previous page shows an A320 landing gear at Revima's main gear site in Caudebec-en-Caux, France. Revima images.

Lufthansa Technik Landing Gear Services also performs AOG and on-wing support. Lufthansa Technik image by Jan Brandes.

counts low-cost carriers amongst its more than 30 regional customers, such as Citilink in Indonesia, AirAsia and its affiliate airlines AirAsia Cambodia, Thai AirAsia, Indonesia AirAsia, and Philippines AirAsia. As a result, he expects high throughput until early-2026, followed by a drop until work picks up again in late 2026/7. To fill the gap, it needs what he calls 'spot opportunities', such as a smaller airline or a single aircraft, even a single leg, perhaps after a hard landing. Again, aircraft delivery patterns can help identify potential clients.

The company has noticed increased corrosion levels on some recent landing gear, which may be related to aircraft grounding during the pandemic. He explains that, after removing corrosion, oversized bushings have to be installed in the leg barrels to keep the required diameter.

The facility is environmentally friendly, with widespread use of green chemicals and no waste rejection for its plating facilities. It will follow the lead from France in the future and replace cadmium plating with zinc nickel plating and hard chrome by HVOF coatings.

LTLGS

For Lufthansa Technik's Landing Gear Services division (LTLGS), part of the Aircraft Component Services business segment, a major change is coming. Work is carried out at three locations at present:

- LTLGS UK in London, located near Heathrow airport: predominantly Boeing (737, 767 and 777, the last 747 and 757 gears having been overhauled last year. The exception is the Airbus A380, with Collins wing- and belly-mounted main gear (four legs in total). Nose gear MRO for the A380 is the exclusive preserve of the OEM, Safran.
- LTLGS Hamburg: predominantly Airbus (A320 Family, A330 and A340). The A350 is missing as, assuming the same 12-year replacement cycle as the A380, and with entry into service in early 2015, there is no need to build up landing gear overhaul capabilities just yet.
- Hawker Pacific Aerospace in Sun Valley, California, which specialized in Airbus A300, A320, Embraer E-Jets and McDonnell Douglas DC-10/MD-11.

Unfortunately, Hawker Pacific Aerospace, which was acquired in 2002, has suffered years of financial difficulties, primarily because of work on legacy aircraft and a small market share. It has now been decided to wind down and eventually close it by 2025. The facility will stop taking in new gears in March at the latest, with closure in the summer months of 2024 after work is completed. The final closure is planned for some time in 2025. The aim is to fulfil all customer orders until the end of operations and to reach agreements on existing contracts. Lufthansa Technik's management made sure that the company has established a comprehensive separation and incentive program for its employees, with the possibility to transfer to any other Lufthansa Group company.

Christian Rodarius, Lufthansa Technik Landing Gear

Christian Rodarius, managing director/

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Jad Kaakani, Lufthansa Technik Landing Gear

CEO of LTLGS UK points out that despite the difficult decision to wind down the operation of Hawker Pacific in the U.S., , the rest of the Lufthansa Technik Landing Gear network in London and Hamburg is flourishing. With work coming in from almost all the Lufthansa Group airlines (Lufthansa, Austrian Airlines, Eurowings and SWISS) as well as a worldwide customer base of passenger and cargo airlines, leasing companies and MROs, the workload is high, with around 350 legs processed last year in each of both locations. In addition, LTLGS also offers AOG support, an exchange pool for gear legs and a spares pool.

He says Covid caused some problems but a good throughput was maintained. This was helped by the size of Lufthansa Technik and its market power; even with supply chain problems, having a centralized purchasing process for the whole group is a huge advantage.

The Heathrow facility was previously owned by British Airways, dating back to Concorde days, although it has been extensively redesigned and upgraded since then, using Lean principles to form a U-shaped line inside the building, from goods inward to dispatch. Jad Kaakani, head of product line landing gear at LTLGS UK, explains that gears are cleaned, stripped and disassembled before inspection. Initially, they are placed on black trolleys, switching to yellow for inspection and purple for the rest of the process. Once the workscope has been established, piece parts are sent to various sections for repair and overhaul. They are accompanied by paperwork at every stage to avoid any omissions and to build a database that can help predict what will be required on a leg of a similar age.

The machine shop, with CNC grinders, can manage a range of tasks, including the manufacture of bushes and thread repair. The plating shop uses cadmium, chrome, Alucrom and nickel. Although the Heathrow facility is no longer in the EU, it still follows REACH program requirements. After final paint and inspection, the components come back together in an assembly area that has eight widebody and four narrowbody bays.

Kaakani says it is important to keep the facility constantly loaded and, indeed, the empty goods inward area at the start of the walkround had received a 777 main landing gear by the tour's end. AVM

Overhaul of an A330/340 nose landing gear in Lufthansa Technik's landing gear shop in Hamburg. Lufthansa Technik image by Jan Brandes

By Mark Robins

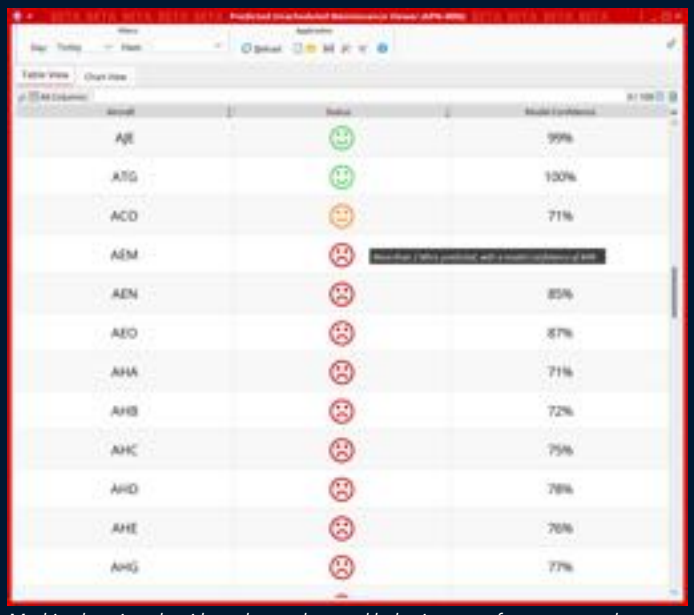
AI/ML IS A-OK FOR AVIATION MAINTENANCE TRACKING AND PREDICTIVE MAINTENANCE

AI/ML's role in aviation maintenance software systems for maintenance tracking and predictive maintenance offers enhanced safety, cost savings, real-time insights and tailored maintenance strategies

According to Ottawa, Ontario, Canada-based research firm Precedence Research, the global artificial intelligence (AI) in aviation market size was estimated at $653.74 million in 2021 and it is expected to surpass $9 billion by 2030 with a registered CAGR of 35.38% from 2022 to 2030. This "super-smart" aviation software is changing operations and shaping the industry's future, in addition to modernizing operations.

Artificial intelligence and machine learning (ML, a subset of AI) improves aviation services and smooths operations like maintenance tracking and predictive maintenance. An AI-powered system can inspect an aircraft for signs of wear and tear, such as cracks or corrosion, and then generate a report and schedule for necessary repairs. Generative AI can analyze data from sensors and other sources, comparing it to historical data to predict potential failures and optimize maintenance schedules. Because of its machine-learning

Nicolas Decroix



Machine learning algorithms detect abnormal behavior or performance trends, alerting maintenance crews to potential issues before they escalate. Swiss AS image.

algorithms, which can suggest optimal maintenance actions, such as repair, replacement, or adjustment, expensive delays can be minimized and passenger safety is guaranteed.

With real-time monitoring, Nicolas Decroix, product manager at Swiss Aviation Software, Basel, Switzerland, agrees that AI-powered systems can indeed continuously monitor the performance of various aircraft components, identifying deviations from normal operating parameters. With anomaly detection, "Machine-learning algorithms detect abnormal behavior or performance trends, alerting maintenance crews to potential issues before they escalate. [Also,] these technologies revolutionize traditional practices by providing data-driven, proactive and automated solutions. For maintenance scheduling and documentation, AI optimizes schedules based on historical data, reducing downtime and errors in documentation through automated logging."

AI is really getting recognized for its ability to bring another level of aviation maintenance prediction. At the recent 2023 National Business Aviation Association's NBAA Business Aviation Convention & Exhibition (NBAA-BACE) in Las Vegas, Elza Brunelle-Yeung, senior director, aftermarket products, digital and pricing, at Montreal, Canada-based Bombardier says, "AI can help analyze big data and predict when a part will fail. No human can really analyze that volume of data and that's where AI comes in." What follows is how that is being accomplished.

Elza Brunelle-Yeung

Maintenance Schedules, Documentation

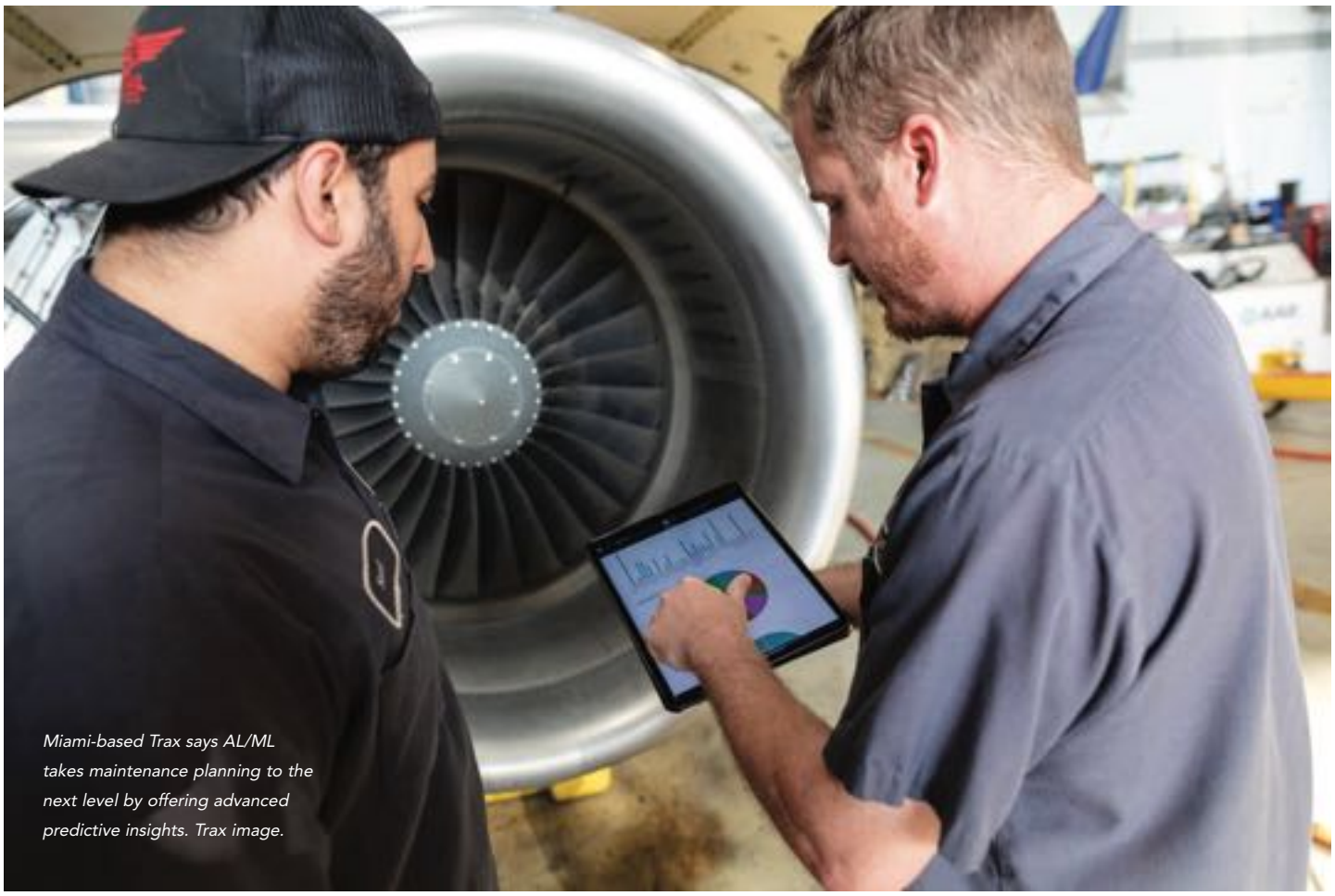
AI can play multiple roles via constructing efficient and robust maintenance schedules. AI-powered MRO software can detect patterns and anomalies by analyzing performance data from various sources. "MROs also track supply chain issues and inventory to ensure aircraft parts are available when needed, significantly improving efficiency and reducing downtime for aircraft," says Atal Bansal, founder and CEO of Bansi Aviation, Sunrise, Fla.

Monica Badra

The power of AI/ML comes when large datasets are aggregated to derive patterns and behaviors. Hundreds and thousands of theoretical models can be combined to define a logic with the lowest absolute error. "AI/ML algorithms can analyze historical maintenance data to optimize scheduling for routine checks and repairs," says Monica Badra, MRO expert and founder of Aero NextGen Inc., Montreal, Canada. "This predictive scheduling helps prevent maintenance overruns and reduce aircraft downtime. In the case of documentation, AI/ML models can write and automate the generation and retrieval of faults found, symptoms and corrective actions in the teardown report, before the technician even performs the repair due to commonalities in historical data. The models can decipher what condition the part must be repaired to (test, repair, overhaul) based on the cycle times, repair history contained in the MRO's data infrastructure and the customer's repair order. Instead of prescribing these data points, the technician will be in a position to validate and edit the model's outputs after the completion of the inspection,

Machine learning-driven prediction allows more accuracy than OEM guidance or simple averages, but prediction alone is not enough, says Aerogility. Interactive reasoning using model-based AI that can automatically plan from encoded knowledge of specific constraints yields better results. Aerogility image.

Below: Simon Miles



Miami-based Trax says AL/ML takes maintenance planning to the next level by offering advanced predictive insights. Trax image.

Justin Daugherty

reducing administrative burden exponentially, and increasing component touch-time, ultimately making MROs more efficient."

Simon Miles, head of AI, Aerogility, London, U.K., says AI offers two primary predictive maintenance features: prediction from patterns in data and reasoning over complex constraints. "Machine-learning-driven prediction allows the inputs to scheduling to be more accurate than OEM guidance or simple averages, for example, with turnaround times or likely costs. By itself, prediction doesn't meet the challenge of constructing optimized schedules that fit maintenance into the capacity constraints of the coming months and years and optimize against key KPIs, such as cost. For this, interactive reasoning using model-based AI is valuable, automatically planning and replanning from encoded knowledge of an organization's specific constraints and allowing what-if analyses to ensure robustness to anticipated future issues."

Artificial intelligence and machine learning take Miami-based Trax customers' maintenance planning to the next level by offering advanced predictive insights. Analyzing historical data and external factors, ML foresees trends and outcomes, providing a foundation for informed decisions and intelligent MRO forecasting. This empowers prompt responses to shifting conditions, and gives the ability to adapt strategies and allocate resources optimally.

Most planning solutions utilize a fixed schedule for checks and maintenance due dates. But Justin Daugherty, senior director of sales and marketing at Trax says the Trax eMRO solution incorporates real-time data and advanced analytics to anticipate and optimize maintenance requirements. "The full system integration with all relevant modules (including web applications and iOS mobile apps) results in planning queries that considers variable factors like available manpower, site capacity, and availability of spares and tools. By analyzing real-time and historical maintenance data and usage patterns, the eMRO software can foresee a customer's maintenance needs before they arise, allowing for proactive planning and reduced downtime. Since in aviation maintenance the unexpected is always to be expected, this data-driven capability — which manages variables — ensures our maintenance customers experience minimal disruption, reduced costs, and higher aircraft utilization."

Mechanical Failure Prediction

In order to understand when a component onboard an aircraft will fail, Bobby Anderson, VP/GM, Aviation at Shift5, Rosslyn, Va., asserts that operators today too often rely on incomplete datasets to make maintenance decisions. "Mechanical failure predictions are informed by data from tools that take guesswork out of maintenance, but that don't capture all data from all on board components. Machine learning is the lynchpin to making mechanical failure predictions possible. And, when we talk about what makes ML most powerful and accurate, it's the data that's fed into the model. Simply put, the more and better the data fed into ML models, the more precise the outcomes will be."

Bobby Anderson

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Aero NexGen Tests AM/ML

Aero NexGen has successfully tested the use of AM/ML to enable maintenance providers to better serve their airline customers. The solution designed by Aero NextGen and their ecosystem of technology partners predicts the level of part inflow coming into a maintenance provider's facility and the level of inventory and manpower required to fulfill these repairs, accounting for supplier lead time. This system reduces the downtime for the maintenance provider, and in turn, the airline, leading to cost savings and increased efficiency across the aerospace ecosystem.

The algorithm successfully uses AI/ML to identify the volume of parts coming off aircraft for scheduled and unscheduled maintenance, the work scope of the predictive volumes of repairs (inspect/test, repair, or overhaul), the bill of materials needed in order to repair the parts and recertify the component to airworthiness requirements, the quantity of piece parts for the procurement teams to order in advance of supplier lead times to ensure inventory is available at 100% fill rate when the technician needs to perform the repair, and the level of manpower and technician qualifications needed, which can take over six months of on-the-job training to achieve.

The predictive maintenance solution has three parts:

1. Cloud-based integrated pricing model for higher assembly component repair per workscope with exclusion management and external benchmarks, detailing the bill of materials and replacement factors per piece part.
2. Sales predictive model per department, per part number for visibility of volume of work, revenues, labor hours for better shop-floor management, proactive cross-training planning, and sales targeting.
3. Procurement predictive model per department, per part number, per piece part number for reduced reactive purchasing, better service level management, reduced roadblocks on part holds, and enhanced inventory provisioning.

The end goal is to enable maintenance providers to proactively manage their operations and streamline their workflow using smart analytics and robotic process automation which are elements of the predictive solution developed. As a result, airlines will suffer fewer AOG (aircraft-on-ground) events preventing them from flying until parts are replaced, enabling cost savings and better efficiencies for the aerospace ecosystem.

Information provided by Aero NextGen Inc.

and data bus on an aircraft generates its own set of data, at a consistently high volume, during a flight. For predictive maintenance to be effective, airlines need observability that includes data from the entire spectrum of onboard components, not just a selected few or at intervals that can't provide a sufficient context of system operations. "Once maintainers and operators have observability from a complete and enriched dataset and apply ML to that data set, they can use it to understand the historical baseline of optimal system performance and identify anomalies that may signal a compromise from operational issue or a cybersecurity threat," Anderson adds.

Maintenance-data Analysis

AI/ML's ability to analyze massive datasets matches aviation maintenance needs because aircraft generate huge amounts of information like speed, altitude, fuel consumption, historical maintenance data, flight paths, engine parameters, manuals and much more. As aircraft become more technologically advanced and fleet sizes grow, the data generated by the components and data buses on board aircraft grow by orders of magnitude. For example, a Boeing 787 produces 0.5 terabytes of data per flight. That volume, paired with data flowing from other onboard avionics, can be fed into a solution designed to automate collection, analysis, and reporting.

"AI-driven aviation maintenance programs can evaluate all this data in real or near-real time," Bansal says. "When trained on high-quality data, AI programs can find equipment operation anomalies and alert pilots and ground crews of potential problems."

By analyzing large datasets, AI can uncover trends, predict part life cycles and recommend inventory stock levels. Not only streamlining maintenance tasks but also optimizing the supply chain. "There has been a huge transition toward digital solutions to proactively manage and forecast repairs on life-limited parts," Badra says. "The development of predictive and preventative maintenance aggregates historical and real-time data, enabling just-in-time parts replenishment and manpower capacity planning for MROs. Also, predicting the condition of the part, based on historical behaviors driving efficiencies for MROs, as well as helping airlines provision for timely removals, reducing parked aircraft intervals and maintenance costs."

Anderson contends, "Sifting through that kind of dataset to identify normal component performance and anomalous performance that could indicate failure — or impending failure — simply isn't possible manually. However, many operators lack access to the complete set data generated by the onboard components and serial buses on aircraft, leaving them with an incomplete dataset to feed into machine-learning tools. Predictive maintenance is only truly predictive when maintainers have complete observability into aircraft — the ability to derive real-time, context-rich insights from refined onboard data. This enables operators with a more comprehensive understanding of their maintenance standing and needs, and also enables them to make smarter, faster decisions and actions. Simply put, access to onboard data in real time can provide operators and maintainers with a depth and completeness of insights about performance health that can assist in predicting and scheduling maintenance effectively."

Trax has incorporated predictive analytics into its maintenance software. "Predictive maintenance enables airlines to plan maintenance schedules more accurately, minimizing downtime and reducing costs associated with unscheduled repairs," Daugherty says. "Furthermore, AI-driven analytics can optimize the inventory management process, ensuring that airlines have the necessary parts and equipment available when needed. This level of efficiency not only saves resources but also ensures that aircraft are ready for service, thereby increasing overall operational performance."

Rising Maintenance Costs

Rising maintenance costs are a significant concern for major airlines. In 2022, American Airlines, United, and Delta reported substantial increases in maintenance spending, with American

Trax says AI's data-driven capabilities which help manage variables like the unexpected aspects of aviation maintenance, will help ensure their customers experience fewer disruptions, reduced costs and higher aircraft utilization. Trax image.

Airlines spending $2.68 billion, a 35.6% increase from the previous year; United dedicating $2.15 billion, a 20% increase; and Delta reporting $1.98 billion, up from $1.40 billion in 2021.

AI/ML can help lower these costs. "Powered by AI and ML, predictive maintenance technology allows airlines to identify maintenance needs in real time, and locate potential failures before they happen," Anderson says. [AI's observability] allows leaders, pilots and maintainers to make informed decisions that can help ensure safety, protect valuable assets, reduce costs, and increase on-time flights. Getting ahead of failures can help reduce unscheduled downtime and work order cycle times, lowering costs, reducing delays and cancelations, and improving customer satisfaction. Done correctly, predictive maintenance can be a boon to airlines; commercial air leaders expect predictive maintenance to lower maintenance costs by 22%. However, less than half of airlines are benefitting or leading the charge when it comes to predictive maintenance deployments."

A Learning Curve

Just like other software programs, there will be a learning AI/ML curve. However, software developers understand that the programs must have intuitive interfaces so that many people can learn how to use the programs. Bansal explains that steeper learning curves may be required for highly specialized AI tools. "These programs are designed for ground-crew aircraft maintenance workers, not just data scientists or developers. The more advanced programs can be highly automated, while others require customization and manual adjustments. Data collection, which will always be ongoing, may be the most important part of setting up and maintaining a reliable AI platform. This task could be quite an undertaking, but if the data is reliable and bias- free, and the program is properly integrated into your existing systems, it can promote higher reliability of the output."

Daugherty says Trax believes the industry has just begun to tap into the AI and ML possibilities. "While AI and ML technology is relatively easy to learn and apply, we also believe that knowledge of aviation maintenance processes, terminology, datasets, and regulations is crucial for effectively applying these techniques in the aviation context. Ensuring compliance with safety standards and regulations adds complexity to the development and deployment process."

Alan Sternberg

AI and Safety

In the investigation of the January 7 Alaska Airlines-Boeing incident, AI played a key role analyzing the data for identifying hazards and defects. Human-written reports, from pilots to passengers, unfortunately are still manually checked by humans, risking oversights. Every year, billions of human-written reports land on the desks of safety teams. However, human analysis is time-consuming, averaging 30 minutes per report, leading to inefficiencies and overlooked risks. For decades safety teams have been looking for solutions that not only automate their repetitive work but also that enable them to identify new risks and manage them at scale. Beams is at the forefront of the aviation industry in providing AI technologies to enhance safety management practices. Airlines use AI algorithms to analyze and process safety-related issues, paving the way for automated processes and simulations that can help predict potential hazards in the future.

Information provided by Alan Sternberg, CEO of Beams, Berlin, Germany

Bridging a Gap

Miles explains an interesting consideration of AI in aviation maintenance is how it may help bridge the understanding of maintenance needs and constraints between otherwise disparate departments of large organizations. "AI technologies of diverse kinds are helpful in managing a complexity of data and knowledge in augmenting both long-term strategic and immediate tactical decisions. This means that well-engineered AI software should be able to accommodate more and larger varieties of perspectives because it can model and reason things not just in isolation. For example, planning to maximize aircraft availability or maintenance yield, but including factors relevant to a variety of viewpoints, such as supply chains, budgeting constraints, staff availability and management. Ultimately, AI-driven software should provide an enterprise digital twin allowing diverse stakeholders to see different views on the same virtual model and make strategic decisions that are complementary and well-coordinated."

Decroix believes AI/ML's role in aviation maintenance software systems for maintenance tracking and predictive maintenance is transformative, offering enhanced safety, cost savings, real-time insights, and tailored maintenance strategies. "As these technologies continue to evolve, they represent a fundamental shift towards proactive, data-driven maintenance practices that are shaping the future of aviation maintenance and ensuring safer skies for all."

Shown here is Trax's eMobility task card on an iPad. Trax image.

Software development company Chetu says AI solutions have the potential to revolutionize the airline industry by optimizing revenue management, flight management, predictive maintenance and more. The company says AI-driven systems provide real-time insights, streamline workflows and ensure regulatory compliance. The company also believes AI solutions can empower airlines, MROs and flight operators to enhance operational efficiency and deliver superior customer support. Chetu image.

Who's Afraid of AI/ML?

There's some fear around using AI/ML in maintenance tracking and inspection processes, according to Nicole Tibbetts, chief engineer for MRO at GE Aerospace, Cincinnati. "In response to those concerns, we're sponsoring an industry advisory board to make recommendations about how you provide safeguards to ensure AI, automation and new robotics solutions are applied responsibly in ways that don't enhance but rather reduce risks," Tibbetts said. "Equally important is the overall strategy and approach for how you integrate AI into your maintenance and inspection processes. At GE Aerospace, we have a service engineer centric viewpoint when it comes to MRO. For us, the focus is on how technologies like AI, robotics and automation can enhance the quality and productivity of our service engineers. The Advanced Blade Inspection Tool (BIT) we deployed is a great example of this approach, where the AI is complementing and providing new insights for the service engineer to utilize beyond what they're already doing to enhance inspections."

Nicole Tibbetts

As the aerospace industry heads into a

This is the AI-enabled Advanced Blade Inspection Tool (BIT) that GE Aerospace is using for the GEnx Engine as part of an on-wing inspection kit. The company says it is enabling faster, more accurate inspection assessments for GEnx engines with this AI technology. They are also developing a similar BIT using AI that is specifically tailored to support on-wing inspections for the CFM LEAP engine, manufactured through their 50/50 JV with Safran and CFM International, as well. GE Aerospace image.

decade of unprecedented growth, Tibbetts stresses, "It's critically important that we support the growing installed base globally with technology advancements which allow additional maintenance providers to readily scale and accelerate the training of the next generation of aircraft maintenance engineers with safety and quality at the forefront. AI and machine learning can play a crucial role in the repair and overhaul industry, when governed appropriately and drive consistency across intrinsically variable inspection modalities where human judgement can be augmented with advanced image analytics to drive insights into a single maintenance event captured across a full fleet's worth of data." AVM

airBaltic and AI

airBaltic believes in artificial intelligence and machine learning, and we are looking optimistic toward a wider use of it. While we are currently making the first small steps in the exploration of application areas in aircraft maintenance, we plan to invest more in this in the coming time. One of the examples is a pilot project we are running using optimization to teach computers to allocate available fleet of aircraft to planned flights in the most efficient manner. [This includes] taking into consideration a large number of factors such as aircraft utilization and utilization limits, aircraft leasing fees, maintenance reserves, fuel flow factor, crews' connection between aircraft, aircraft limitations, and more. Already on a solution prototype level, we see the economic benefit of transferring aircraft allocation tasks from human to machine. A similar principle and model is planned to be applied in, for example, maintenance event, hangar slot, and staff planning. As an airline, we see the greatest benefit of AI as being able to analyze and take into consideration many more factors and variables, providing much more efficient and errorless results.

Information provided by airBaltic, Mārupe municipality, Latvia

By Steve Staedler

THE COMPETITION... AND SO MUCH MORE...

While the premier aviation maintenance skills competition shows who is best in their field, the sense of camaraderie and networking take center stage.

One of the things U.S. Air Force Master Sgt. Robert Paradis likes about fielding a team to compete in The Competition presented by Snap-on is offering an opportunity for his airmen to broaden proficiencies beyond their specific area of expertise.

"It's a huge training opportunity for us because in the Air Force, we're very focused on our Air Force Specialty Code. For example, an engine troop will always work on engines," Paradis said. "But this is a chance for our multi-capable Airmen to try their hand at sheet metal work and other areas of maintenance that they normally would not see on the day-to-day mission. That's a great benefit The Competition gives to military teams."

This will be the third year in a row Paradis and his team from the 86th Maintenance Group, based at Ramstein AB, Germany, are participating in The Competition, an aviation maintenance skills event that attracts more than 80 teams from around the world.

Avianca in Action at 2023 AMC

Aerospace Maintenance Council President John Goglia

The Olympics of Aircraft Maintenance

Entering its 11th year, The Competition has been described as the Olympics for the aviation maintenance industry as it provides a venue for professional aviation mechanics and students to come together in friendly competition, test their skills against each other and give a loud shout-out to their presence in the industry.

"The Competition tests the multiple skills required for both basic and very detailed performance-based tasks," said John Goglia, president of the Aerospace

Avianca Gustavo Aristizabal

Maintenance Council and a former National Transportation Safety Board member. "There are also events that require techs to use their minds. In aviation, it's not just mechanical dexterity that gets you through the day, you must use your head and think. That's what aviation maintenance is all about, using your hands and head to come to a solution."

The Competition kicks off April 9 at the MRO Americas convention at McCormick Place in Chicago. This year's field includes 90 maintenance teams from around the world competing in six divisions: Commercial Aviation, General Aviation, Space, Military, MRO/OEM and School, which attracts teams from the country's top A&P schools. Events include a wide range of skills that technicians face every day on the job, including airframe damage inspection, composite repair, engine fan blade removal, fuel tank entry precautions, and others. Each event has a 15-minute time limit, resulting in exciting, fast-paced action and great drama for spectators to watch.

Snap-on Industrial Bill Willetts

Expanding Aircraft Maintenance in Colombia

One of the teams fans will see in action is Avianca. A relative newcomer to The Competition, Avianca, the flag carrier of Colombia, is hoping its presence in Chicago will serve as an inspiration to people back home, showing them that aviation maintenance is a great career option to pursue.

"We are starting to see a shortage of technicians. Colombia is a country of 51 million people, and we're trying to show to people in Columbia what they can achieve working at Avianca," said Gustavo Aristizabal, production director, Avianca. "Going to The Competition allows our technicians to see and learn new things that they can bring back to Avianca, which will make all of us stronger."

This is the second consecutive year Avianca, which flies a mix of both Airbus and Boeing aircraft to more than 70 destinations in North America, South America and Europe, has fielded a team in The Competition.

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Aristizabal credits strong support from Avianca leadership in being able to field a team. Avianca, which has a staff of more than 1,000 technicians stationed at bases throughout its system, held internal competitions with the top performers selected to represent the airline in Chicago. Aristizabal believes Avianca will continue supporting The Competition and will soon become one of the top teams vying for the O'Brien Award.

All teams in Chicago are chasing the top prize in aviation maintenance: The William F "Bill" O'Brien Award for Excellence in Aircraft Maintenance. Presented by Snap-on, the O'Brien Award is a traveling 5-foot-tall trophy bestowed to the team with the best overall winning score. In addition to the trophy, teams will also be vying for tooling and equipment prizes. Last year, FedEx Express captured the O'Brien Award for a second straight year.

The Competition / Snap-on Partnership

Contributing to the continued success of The Competition is its long-standing partnership with Snap-on, a company that strongly believes in encouraging professional development of aircraft mechanics and student technicians.

"The Competition and Snap-on share the values of teamwork, dedication and professionalism embodied by all aircraft technicians," said Bill Willetts, vice president of Snap-on Industrial and AMC board member. "Together with The Competition we have helped shine a spotlight on the critical role technicians perform every day, while also advocating career paths in aviation and all skilled trades.

"We are looking forward to making the 2024 Competition the best yet for both participating teams and the aviation maintenance industry as a whole."

A Two-Day Job Interview

The Competition is a great proving ground for the nation's top A&P schools, including Salt Lake Community College. For students preparing to graduate, there is no better venue to demonstrate their skills and work ethic than competing alongside airlines and MROs, all of which are looking to hire.

"The Competition really acts as a two-day job interview for students," said Dee Thornton, associate professor/aviation maintenance at Salt Lake Community College. "Participating in The Competition is certainly a reward for students' hard work throughout the year, but the added bonus is many walk away with job offers. It's a fantastic opportunity for students that certainly gives them a leg up in starting their career."

In addition to competing, Thornton said walking through the MRO Americas convention gives students a greater view and appreciation of just how vast the aircraft maintenance industry is and all the opportunities that are available to them.

Admission to The Competition is free with your MRO Americas convention credentials. If you cannot be in Chicago, you can still catch the action through the AMC live stream at www.mroamc.live. AVM

Steve Staedler is a senior account executive at LePoidevin Marketing, a Brookfield, Wisconsin-based business-to-business marketing firm that specializes in the tooling and aerospace industries. Steve has been covering aeronautical maintenance for nearly 15 years. He can be reached at steve@lepoidevinmarketing.com.

NBAA Just Updated Their Guidelines on Digital Record Management:

Here's What You Need to Know

By Roy Gioconda, Vice President, Solutions, Bluetail

As the world of business aviation continues to change, leveraging digital technology is becoming more and more important.

And, let's face it — evolution in our world is nothing new. Think about it. The analog multimeter was replaced by the digital version (and quickly became the standard). Communicating with your team via letters and post-its became cellphone. And even clocking in to start the workday went from paper to a computer.

In-kind, the NBAA's Management Guide recently underwent an evolution itself — adding new sections to help business aviation teams take the leap toward electronic recordkeeping.

As is the case with other organizations, the NBAA is made up of committees and subcommittees with volunteer industry experts (full disclosure here: I'm lucky enough to be one of them). Even cooler? Cumulatively, these subcommittees have hundreds of years of collective industry experience.

The subcommittee responsible for the digitization updates, the Regulatory and Operational Control Subcommittee, definitely took their job seriously. We spent countless hours surveying operators, talking, debating, weighing, and editing to land on some solid recommendations moving forward.

The end product? The newly revised NBAA Management Guide now contains information about how to utilize electronic recordkeeping in your operation. This update is timely, and will definitely help direct operators to transition from paper-based aircraft maintenance records to modern, digitized records (aka the future).

Details include the many benefits and advantages electronic recordkeeping provides for all types of operators, and more, how operators can obtain FAA approval if required. So, what are the changes to the NBAA Management Guide that you need to look out for? What's next?

Section 3.8.4.1

This section highlights new information and details of the regulatory guidance, including the benefits, FAA approval for operators, methods to digitize your records, and implementation processes to guide you forward.

Why should you care?

The trend to digitization is accelerating in aviation. While change is a bit slower than in other industries, there is steady progress. There are many benefits to utilizing electronic recordkeeping for your aircraft maintenance records including security, searchability, and shareability. All of this reduces the risk of loss or damage to these vital records and ensures the value of your managed asset. Plus, the compliance status alone is of the utmost importance.

Additionally, if you're using a vendor that provides aviation-specific software, integrations with other software that you use can make the process simpler. Searching for a word or a part number manually can be a painstaking exercise, and software offers quick searching of all records to locate that "needle in the haystack" record.

What actions should you take?

- Obtain buy-in from all departments and groups involved within your operation to go digital.
- Make a plan. Determine if you will take this on internally or hire a vendor.
- When starting, have routine check-ins with all individuals and groups involved (and vendors if used) to keep on track.

Best practices

The new "Best Practices" section of the guidelines summarizes the entire project to ensure repeated success when adding additional aircraft or team members. This sets the standard within your organization and ensures continuity and peace of mind.

Why should you care?

Having a documented process to follow, whether included in your manual system or as a stand-alone SOP, will ensure continued success as your fleet and team grows and/or changes.

What actions should you take?

- Document your processes and procedures so that they're easily repeatable.
- Perform a retrospective after completing your digitization efforts.
- Learn what worked (and change what didn't).

Expanded Section 3.8.1.8

This revised section gives added information around when and how to use electronic signatures. This also details the benefits, regulatory guidance, info on FAA approval for operators, and methods to implement an electronic signature process.

Why should you care?

As with electronic recordkeeping, using electronic signatures for both approval for return to service records (logbook entries) and additional workflow documentation (work orders, task cards, etc.) can greatly increase efficiencies within your maintenance department.

What actions should you take?

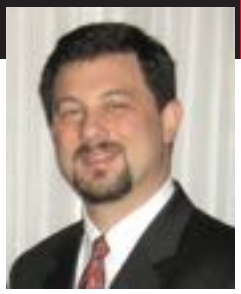
- Much like electronic recordkeeping, obtain buy-in from all departments and groups involved within your operation.
- Check with your current, and possibly other, maintenance tracking programs for their availability and useability of an electronic signature function.
- Document your processes and procedures to ensure future success.

The NBAA is recognizing the technological shift in our industry. And with the updated guidelines and processes, it's never been easier to go digital. Even better? When it comes to taking the leap to electronic recordkeeping, there are definitely options out there that offer minimal disruptions to you and your business while things are moving full speed ahead.

So, if you were ever thinking of going digital (and hint, hint: you should be!), there is no time like the present to make it happen. AVM

Roy Gioconda is currently the vice president, solutions at Bluetail, where he helps to shape the current and future state of Bluetail's SaaS platform. With more than 40 years of experience in the aviation industry, he has done everything from directing quality assurance and leading customer success, to roles as a director of maintenance. Gioconda is an Embry-Riddle Aeronautical University graduate, and holds an FAA Airframe & Powerplant certificate.

By Jason Dickstein



U.S. Government Continues to Focus on Aviation Exports

It is becoming increasingly important for our industry to pay attention to United States export laws. There are several reasons for this statement, including (1) the increase in export enforcement by the U.S. government, (2) the increase in attention being paid to aviation, and (3) the rapidly increasing number of aviation companies who are sanctioned under U.S. laws. Recent legal actions show that export violations can destroy an aviation business!

Export laws affect companies that are exporting aircraft parts but then can also affect repair stations whose customers are outside the United States. Returning an overhauled component from the United States to a non-U.S. customer is an export. A non-U.S. repair station may also be subject to U.S. export laws because it is "re-exporting" or "transferring-in-country" in each of its transactions.

Increased Enforcement

The United States government has been signaling for a while that it intends to increase the enforcement of the United States export laws. Several policy documents were published last year that warned about increased enforcement; more importantly, we spoke with representatives from various agencies, like the Homeland Security Investigations and the Bureau of Industry and Security, who let us know that they were actively pursuing investigations and enforcements.

An important focal area for increased enforcement is the set of sanctions targeting Russia and Belarus. There has been a tremendous effort to circumvent those sanctions, and U.S. aviation companies are getting caught in these circumvention efforts: often with no knowledge of the true destination for the parts.

I am an aviation lawyer and I have been providing export compliance support (and defense) to aviation companies for over twenty years so I can recognize patterns in my own interactions with the government that illustrate where the government is going in their enforcement regime. Through 2023, I was starting to see more and more seizures of aircraft parts by Customs and Border Protection (CBP). Many of these seizures involved companies that were not yet sanctioned in any formal way by the U.S. government. In many cases, this is a signal that those companies may be under investigation and that the U.S. government believes that the articles could be illegally diverted. In some cases, the target companies whose goods were seized in 2023 have since been added to either the BIS Denied Parties List or the OFAC Specially Designated List. Both of these are sanctions lists that forbid certain types of transactions (including exports).

Enforcement Against Aviation Businesses

Examine the U.S. sanctions lists and you are going to see a growing number of aviation businesses being added. In February, the Treasury Department added aircraft parts companies from Russia and from outside Russia to the list of specially designated nationals (SDNs). This includes aircraft parts companies in places like the United Arab Emirates. Last year, the government fined 3D Systems (an additive manufacturing company) $2.77 million for sharing export-controlled plans for aerospace components with a Chinese customer.

In some cases, the export sanctions are just part of the puzzle, with U.S. companies like Kanrus and MIC P&I, LLC, having been indicted under U.S. criminal laws. Kanrus is accused of selling avionics to Russia and also of managing repairs of avionics units from Russia. MIC P&I is accused of lying to aircraft parts suppliers about the end users and destinations for the aircraft parts it purchased, and then exporting the parts to Russian airlines through intermediaries.

Executives from both companies are facing potential for both fines and jail time in the criminal actions related to their alleged export offenses. In the MIC P&I case, the freight forwarder was identified as a specially designated national, which effectively precludes the freight forwarder from operating in, or out of, the United States.

Aviation as a Focus

Aviation was identified as a focus for increased export scrutiny. It is one of a small number of industries identified by the U.S. government as special areas of examination because of a belief that aircraft parts are being illegally exported to Russia. Exports arise somewhat frequently in aviation, whether it is sales and exports of new parts to customers, or acceptance, maintenance, and return of units from non-U.S. customers. For repair stations and those managing repairs in the U.S., it is important to recognize that even if you are merely returning the goods to the owner following work like an overhaul, the fact that the parts are crossing the U.S. border means that they are being exported and thus they are subject to all of the regulations that apply to exports (and when they are processed abroad there are re-export and transfer standards that still apply to many transactions).

One of those regulations is the foreign aircraft rule that is found at 15 C.F.R. § 744.7. If you are exporting an aircraft part for eventual installation on a foreign registered aircraft then this rule imposes additional restrictions and analysis requirements that effectively require the exporter to know the destination aircraft and its owner.

Luckily there are a number of very useful license exceptions that one can use to circumvent license requirements. In order to use those exceptions, though, you have to (1) know that you meet the requirements for the exception and (2) explicitly declare the exception in the electronic export information that is filed with

the U.S. government (Looking for training on exports and export license exceptions? These topics will be covered at the ASA/AFRA annual Conference in Scottsdale in June).

The fact that exported goods are being seized before the customer has been added to a sanctions list is a problem for U.S. exporters. If you've extended credit to the customer then there is a strong likelihood that your customer will not pay you for parts that were seized by the U.S. government. But even if you were pre-paid for the goods, there is still a chance that your customer may seek a refund or even damages related to those seized parts. Even if the claims are specious, you could still find yourself expending resources to defend your company. Lately, we've been recommending a suite of protective measures to companies to protect themselves against illegal diversion efforts. We highlight two in this article.

Protecting Your Company

One measure we've recommended is a strong hazard identification and risk mitigation strategy. Your company needs to identify its appetitive for risk, but you also need to identify effective ways to mitigate that risk.

In the case of export sales, we've advised companies to carefully assess their customers (especially brand-new customers) for export risks. This can mean performing some background checks on customers to help identify whether they pose a potential risk of diversion. A risk of diversion is not a deal killer if you take steps to prevent diversion. For example, insisting on direct shipment to end users can mitigate the potential for harm from exporting to an unknown supplier. Having effective controls that will verify that the aircraft parts are installed on the expected aircraft can be useful. An effective background check can also help identify companies with whom you'd rather not do business in cases where you do not trust the potential business partner to conform to the legal requirements.

Another measure we've recommended is commercial controls to protect your company in the event of fraud or misrepresentation about the end use or end user. Getting paid in advance by customers to whom you are not willing to extend credit is a smart approach. The government has highlighted the fact that end use statements are sometimes completed fraudulently, so having a regular pattern of verifying end use statements is also a good idea. A risk mitigation strategy can include selling articles using the incoterms term "ex works" which means that risk of loss passes when the goods are made available at the named location (typically you would name your own location as the "ex works" location). When CBP seizes export goods at the U.S. border, if the paperwork is clear that you got paid and that risk of loss passed to the customer before the seizure, then it puts you in a more legally defensible position when you want to keep the money that was paid (because the transaction was complete when the aircraft part left your facility). AVM

Driving Throughput: The Blueprint for Rapid Scaling in Defense Production

Overcoming bottlenecks, constraints and workforce issues to meet demand.

By Chris Brumitt, Managing Director, Aerospace & Defense, SGS Maine Pointe

With conflicts arising across the world, defense companies are being pressed to meet greater demand increases than have been seen in many years. The defense industrial base (DIB) has struggled to increase throughput, keep their supply chains moving, and still keep their costs under control. Missed deliveries, rising lead times, quality issues, and contract penalties are common.

This increased demand is underlined by the nearly unprecedented increases in defense funding, from about $775 billion in 2022 to over $830 billion in 2024. Although the immediate opportunities and benefits of meeting demand are clear (higher revenue, stronger margins, stock growth), higher demand also comes with certain long-term risks: what if the budget suddenly contracts, what if shifting technologies and market dynamics make a product obsolete or even more desirable, what if the supply chain is disrupted? Any changes that increase throughput must be cost effective and also allow for flexibility as the company ramps up and down along with the ebb and flow of business conditions.

In a typical case, an innovator in developing and producing composite parts for the aerospace and defense industry struggled with a major ramp up in production across three different production programs in the defense and business aviation sectors. They needed to more than triple their manufacturing capabilities over the next two to three years and switch their manufacturing mindset from engineering/prototype to a much higher production process. They suffered from high overrun costs, excessive rework/waste, bottlenecks, poor work instructions, inefficient use of space, and nonconformance of parts. By working closely with senior management, engineering and production, more than 100 identified improvements were categorized into 19 value creation initiatives, allowing them to focus on the most critical issues and begin transforming the business to meet strategic objectives.

The initiatives they implemented increased both the capacity and the capability of existing facilities. In doing so, the C-suite controlled capital expenditure, strengthened and de-risked the supply chain, identified opportunities for further improvement, expedited implementation, and drove sustainable change. The initiatives that delivered those results included:

- Data analytics to identify process issues and constraints.
- Asset utilization and footprint rationalization.
- Production readiness.
- Cultural change and leadership and organizational improvement.

For companies manufacturing highly engineered products as in aerospace and defense, these and other Operational Excellence initiatives drive greater productivity within the same footprint without compromising EBITDA, quality, and on-time, in-full (OTIF) delivery, the essentials of customer satisfaction.

Data Analytics

The lack of information about and visibility into production processes and metrics creates a roadblock to increased throughput. Data is often managed through multiple disparate systems and manual spreadsheets, not standardized and not supportive of company goals. Creating a single source of truth from a collection of data sources brings multiple elements into a cohesive approach to process change, including:

- Hands-on, "day-in-the life of" observations and studies.
- Value-stream (process) mapping
- Standardization of company-wide KPIs and metrics in alignment with goals
- Alignment of strategic and operational goals with processes, tools, and systems.
- Cross-functional collaboration, accountability, and continual feedback loops.

Once the data is available and clean, in-depth data analytics reveal any roadblocks in equipment utilization, gaps in planning, and issues with manufacturing quality, waste and rework, and supplier quality.

That data can also be used to build a digital twin of the supply chain that accesses current information to drive accurate decision making. With greater visibility, companies can control spend while continuing to find areas to improve production and increase throughput even while production needs escalate.

Asset Utilization

Asset utilization and overall equipment effectiveness (OEE) are key components of throughput. By tracing the critical path of equipment and people, a company keeps everyone operating to plan, reduces downtime, and avoids shortages. That strategy requires a company to:

- Track uptime and utilization of tools and equipment
- Use preventive and predictive processes to establish maintenance, repair and overhaul (MRO) schedules
- Use predictive analytics to maintain adequate inventory for MRO.
- Drive a standard OEE program to monitor how assets operate based on demand and production schedules.

Footprint rationalization enhances a company's facilities in order to reduce redundant or inefficient operations and potentially delay or avoid the cost of building or adding on to existing facilities during high demand.

A global provider of high-tech systems for the transportation and defense industry needed to drive revenue recognition in the final quarter of their fiscal year. A footprint rationalization analysis combined with a labor productivity and cost analysis showed that the company would benefit from moving entire product lines from their U.S. plant to their Mexico plant. Because they also moved equipment no longer needed in the U.S., they created more space in the U.S. plant to focus on newly contracted product lines.

The shift lowered overall labor costs by about $2.7 million in just six months; brought some manufacturing in-house for a 35% cost reduction; enabled more cohesive systems for managing production; and accelerated delivery of billable product. As the CEO stated, these strategies not only reduced costs in operations and increased throughput, but also allowed them to increase revenue recognition by 70% in under 80 days.

Eliminate Bottlenecks, Increase First Pass Yield and Quality

Increasing throughput begins with the key fundamentals of eliminating bottlenecks, increasing first pass yield and quality, and reducing downtime on the production floor. Bottlenecks have many underlying causes but are made apparent by the low production of a machine or cell, usually on a continual basis. Bottlenecks can be traced to poor maintenance, lack of clear work instructions (too many "red lines"), poor technician training, and lack of direct engineering support on the floor, among other causes. The key to eliminating bottlenecks lies in proper process mapping, accurate data, and reduction of gaps.

One of the best KPIs for understanding throughput comes from tracking first pass yield and quality (rework, waste, COPQ). Often, first pass yield percentage is the first early warning indicator for poor throughput and quality and shows up quickly as a cost when tracked properly. Sometimes, there may be design or engineering changes that create a problem for production resources; however, it is very common for bottlenecks and waste/rework to result from tooling issues, training, and even a poor supplier quality process that allows sub-par parts and materials into production.

Downtime can come from many sources, including:

- Excessive engineering change orders (ECOs).
- Lack of predictive maintenance and scheduled MRO.
- Inconsistent or poor root cause corrective action (RCCA) and material review board (MRB) processes.
- Lack of cross-training of technicians which limits the ability to shift resources and optimize uptime.
- Front-line supervisors spending too much time on non-value added activities as opposed to being hands-on and available to workers on the floor

LOI to Motivate the Workforce

A specialist in advanced component manufacture for DOD prime contractors was driven to achieve a significant increase in labor productivity and throughput. Although the company was already profitable with greater than 20% margins, its new owners needed to achieve threefold growth over the next five years. To achieve this goal, they needed to dramatically lower costs in operations and procurement while maintaining high quality and accelerating delivery standards. This would allow them to be more competitive and innovative in existing and new commercial markets. A boots-on-the-ground analysis revealed that the company could reduce its workforce by more than 30%, while improving quality and delivery to customers. They achieved a 31% productivity improvement, improved direct labor productivity by 25% to 53% at each client site, improved quality, and drove leadership and organizational improvement (LOI) to support workforce commitment to change.

The bottom-line benefits were enabled by cultural change and LOI strategies that engaged all levels of the company to eliminate silos and create cross-enterprise collaboration. Among other effects, the new management operating system and workforce communication led to a reduction in engineering changes, a company-wide commitment to saving costs, and a continuous improvement mindset.

Cultural change and LOI strategies include:

- Management operating systems.
- Owner, responsible, consult, and inform (ORCI) accountability.
- Formal training.
- On-the-floor coaching of supervisors and managers.
- Clear work instructions.
- Sales, inventory, and operations planning (SIOP).
- Root cause corrective action (RCCA).

Stabilize, Enhance and Accelerate Change

Aerospace and defense companies are being challenged every day to meet escalating demand. By deploying a three-stage approach — stabilize, enhance, accelerate — they have the opportunity to move on from being reactive to external demand forces and begin driving the business through strong processes and accurate data, increasing throughput, and improving quality, delivery and customer mindshare. Using a total value optimization process at each stage, aerospace and defense companies can keep planning, procurement, operations and logistics aligned, so that the entire supply chain is focused on initiatives that meet demand and create long-term value.

Beyond meeting current increased demand, the approach of focusing on process analytics, asset utilization, footprint rationalization, production readiness, cultural change, and leadership and organizational improvement prepare aerospace and defense companies for future growth and fast adaptation to a changing world. AVM

Chris Brumitt serves as the managing director of aerospace & defense at SGS Maine Pointe, bringing over 36 years of experience in supply chain and operations consulting. Specializing in guiding CEOs and senior management, he helps clients drive measurable and sustainable EBITDA, cash and growth improvements across the end-to-end supply chain. With a background collaborating with Fortune 500 companies, Brumitt's experience spans aerospace-defense, aviation, industrial manufacturing, electronics, high tech/computer systems, energy, airlines, and financial services. Contact him at cbrumitt@mainepointe.com.

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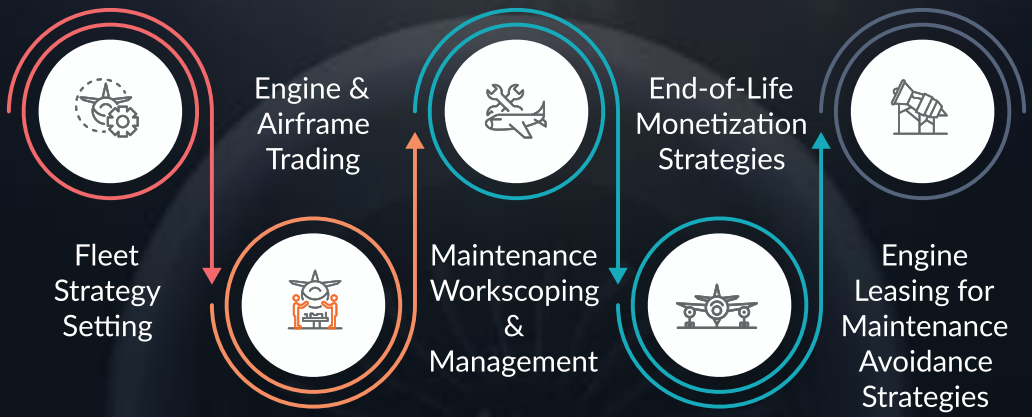

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