UTED 1968 INTERNATIONAL

ISSUE 6• 2025

AIRCRAFT MAINTENANCE MAGAZINE

FLOW EXPERIENCE AND ITS REFLECTIONS IN THE WORKPLACE

HOW AI IS REVOLUTIONIZING AIRCRAFT MAINTENANCE AND REPAIR INDUSTRY

HANDS TOUCHING THE SKY: THE STORY OF FEMALE AIRCRAFT MAINTENANCE TECHNICIANS

GAME OF PLANES

Dear Colleagues and Valued Aviation Professionals,

It is a distinct pleasure to greet you all in the spirit of our shared passion for aviation as we present the latest issue of UTED International.

This is a period of special significance for the Turkish aviation industry. We are currently marking the 102nd year of our nation's modern aviation vision. This journey, spanning more than a century, is a living testament to how a local ambition can evolve into a global success story. Today, with its strategic location, growing fleets, and world-class Maintenance, Repair, and Overhaul (MRO) centers, Türkiye is not merely a crossroads of the world; it is an integral and robust part of the global aviation ecosystem. This progress itself is a success story of international collaboration and shared standards a journey we are all part of.

As we take the pulse of our industry, we can see just how dynamic the MRO sector has been over the past three months of August, September, and October.

During this period, the sustained surge in global travel demand has necessitated that fleets operate at maximum efficiency. While this has undoubtedly increased the workload on our shoulders as MRO professionals, it has also acted as a powerful catalyst for technological adaptation. We have witnessed the significant rise of AI driven Predictive Maintenance. The ability to foresee potential issues before they arise is no longer a future goal; it is becoming a new standard for operational continuity and, paramount to all, flight safety.

August and September were months where we saw tangible steps in the digital transformation we call "MRO 4.0." The implementation of Augmented Reality (AR) in maintenance tasks and the use of "digital twins" to simulate complex procedures are fundamentally transforming both our training methodologies and our on the ground applications. These innovations are reinforcing our collective safety culture by minimizing human error in complex tasks.

As we moved into October, sustainability was firmly on the agenda. The growing adoption of Sustainable Aviation Fuels (SAF) is introducing new procedures and competencies for engine and component maintenance.

As MRO facilities, we are also reevaluating our own operations to reduce our carbon footprint and embrace "green maintenance" practices.

Of course, at the heart of these technological leaps remains the human element. Highly skilled, internationally certified, and dedicated aviation technicians regardless of nationality are the true pillars of this global system. At UTED, we believe in the profound importance of continuous training and global partnerships to ensure our colleagues can continue to serve at these exacting high standards.

In the light of this 102 year vision, I extend my gratitude to all our international partners who strengthen Turkish aviation's role on the global stage, and to you, our esteemed colleagues around the world, who work tirelessly for safety every single day.

Together, we will continue to build a safer, more efficient, and more sustainable sky.

Wishing you all safe and successful operations.

Sincerely,

Ömür CANİNSAN
UTED President

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Turkish Airlines A321neo Fleet Expands!

Three Airbus A321neo aircraft currently being built for Turkish Airlines (THY) have been spotted at Airbus's Hamburg facility.

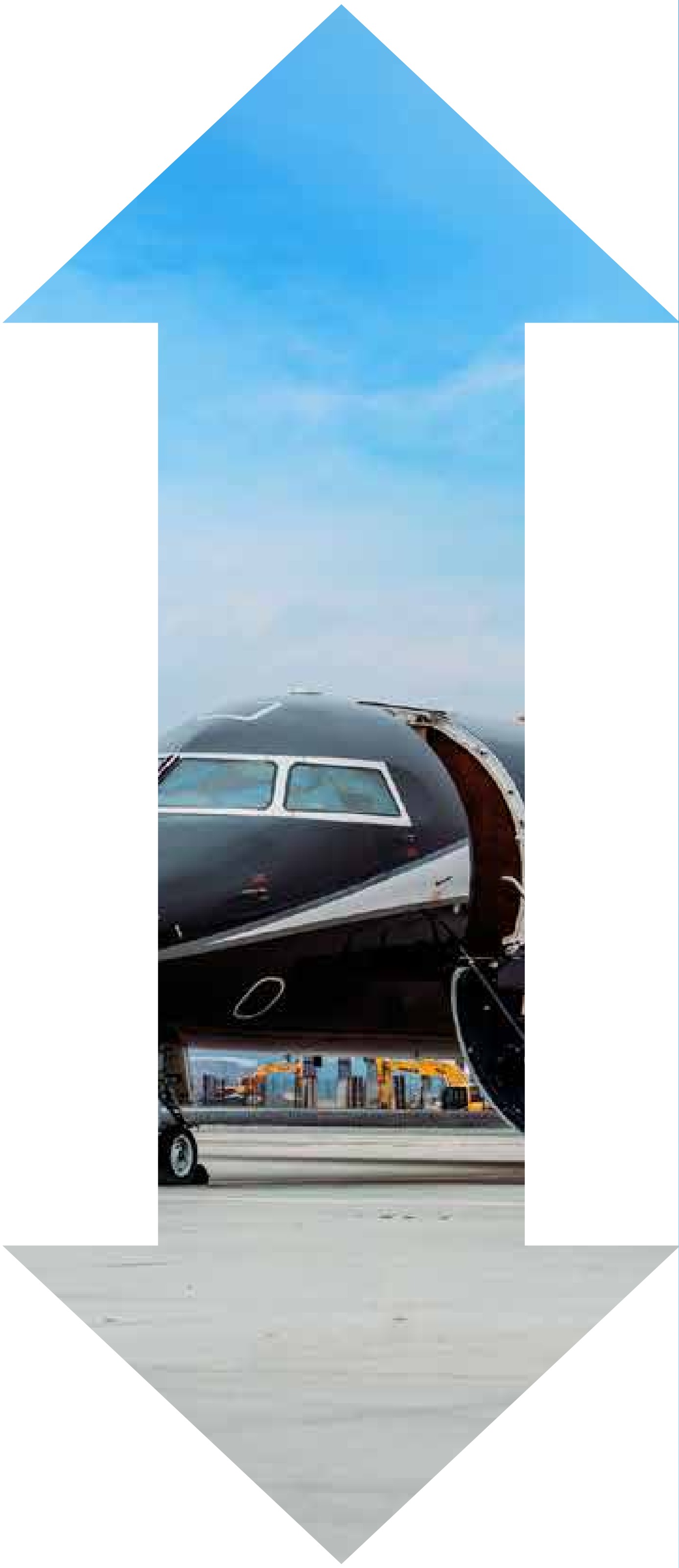
- The A321neo with registration TC-LPU has begun its test flights, while TC-LRA has completed painting and is now undergoing engine installation. Another newly assembled, yet-to-be-registered A321neo for THY was seen entering the paint hangar.
- The aircraft, powered by Pratt & Whitney engines, are configured with 16 Business Class and 174 Economy Class seats.
- Turkish Airlines has a total order of 238 A321neo aircraft.

WLFC Lands Big Investment at Teesside Airport

Willis Lease Finance Corporation (WLFC) has opened its second hangar at Teesside International Airport through its subsidiary, Willis Aviation Services Limited (WASL). The £13.5 million (US$18 million) twin-bay facility, completed in October 2025, can accommodate Boeing 737 and Airbus A320-family aircraft, expanding WLFC's MRO capacity and services. As the largest private investment at Teesside in decades, the new hangar boosts the airport's role as a key aviation hub while creating skilled jobs and strengthening the local economy. This expansion reinforces WLFC's commitment to technical excellence, customer service, and sustainable operations in the global aviation industry.

TEI Develops Over 20 Indigenous Super and Titanium Alloys

Turkish aircraft engine manufacturer TUSAŞ Engine Industries (TEI) has developed more than 20 original super and titanium alloys for use in fighter jet and helicopter engines.
TEI General Manager Prof. Dr. Mahmut Faruk Akşit stated that the company has established a fully integrated domestic production chain from raw materials to finished engines, marking a critical milestone for Turkey's defense industry. The developed alloys are already being used in Aksungur, Anka, and TB3 UAVs, while production preparations for the T625 Gökbey helicopter engine have been completed, and the TF6000 fighter jet engine is currently in testing. Akşit emphasized that Turkey has now achieved self-sufficiency in engine technologies.



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Turkish Technic Secures Major Landing Gear Contracts with Garuda Indonesia

The MRO provider has signed two long-term agreements covering the Airbus A330 and Boeing 777 fleets, significantly expanding its strategic footprint in the Asia-Pacific market. Turkish Technic, a leading global provider of maintenance, repair, and overhaul (MRO) services, has signed two significant long-term agreements with Garuda Indonesia, the flag carrier of Indonesia. The contracts cover comprehensive landing gear maintenance services for the airline's Airbus A330 and Boeing 777 fleets Company officials stated that the agreements not only expand the scope of cooperation but also reinforce the mutual trust and strong collaboration built between the two companies. As part of this cooperation, Turkish Technic's expert maintenance teams will service the landing gear for Garuda Indonesia's wide-body fleet, adhering to the highest possible safety and quality standards. These agreements are highlighted as being of strategic importance, enabling Turkish Technic to meet the growing demand in the highly competitive Asia-Pacific aviation market and solidify its presence in the region.

Mikail Akbulut, CEO and Board Member of Turkish Technic, commented on the partnership:

"We are very pleased to strengthen our long-term cooperation with Garuda Indonesia. Our expert teams will continue to provide maintenance services to the Garuda fleet without compromising on aviation safety and quality standards." These deals stand out as a significant indicator of Turkish Technic's ongoing objective to expand its global customer portfolio and cement its position as a key MRO player in the Asia-Pacific.

Honeywell and ITP Aero Launch Europe's First F124 Engine Service Center in Madrid

Honeywell and ITP Aero have inaugurated a new maintenance, repair, and overhaul (MRO) facility in Madrid, establishing the first authorized service center in Europe for the F124-GA-200 engine. The new center is now operational at ITP Aero's Ajalvir facility. This strategic move provides localized support to European operators, aiming to significantly shorten repair turnaround times and reduce the logistical burdens associated with servicing the engines. The inauguration follows months of close cooperation and comes just one year after ITP Aero was officially granted the F124 license. The fully-equipped facility is now prepared to offer comprehensive repair and overhaul services for the more than 150 F124 engines currently in operation across Europe. This milestone is a key part of ITP Aero's growth strategy and reinforces Spain's role in supporting NATO-aligned defense capabilities.

Falcon Technic Secures GCAA Approval for 120-Month Maintenance on Bombardier Global Series

The Dubai-based MRO has significantly expanded its Approved Maintenance Organization (AMO) certificate, adding new base maintenance capabilities, wheel shop services, and NDT testing. The UAE's General Civil Aviation Authority (GCAA) has granted Falcon Technic approval to conduct 120-month base maintenance inspections on Bombardier BD-700 Global Express and Global 5000 jets at its Dubai facilities. The company announced the major expansion of its Approved Maintenance Organization (AMO) certificate last week. This new approval covers all essential maintenance tasks and detailed inspections required after an aircraft reaches 120 months of service or 4,500 flight hours. Falcon Technic was previously certified and successfully conducting 60-month maintenance checks on Bombardier aircraft, including the Global Express XRS.

Lufthansa Technik Expands Cyclean Network in Europe with ACC Columbia Jet Service

The new partnership authorizes ACC Columbia Jet Service to deploy mobile teams, offering rapid and eco-friendly engine core wash services across Germany and the wider European continent. Lufthansa Technik is expanding the availability of its innovative Cyclean Engine Wash solution across Europe through a new cooperation agreement with ACC Columbia Jet Service. Effective since August, ACC Columbia Jet Service now provides authorized engine core wash services via mobile teams, serving customers throughout Germany and greater Europe. The Cyclean technology is celebrated for its significant operational and environmental benefits. It is proven to enhance engine performance, which in turn reduces fuel consumption. The system is also highly sustainable, cutting water usage by 50% and reducing the total wash time to under 45 minutes.

HAECO Secures Three-Year A330 Base Maintenance Contract with Brussels Airlines

HAECO has entered into a significant three-year base maintenance agreement with Brussels Airlines, covering the carrier's Airbus A330 wide-body fleet. The contract, which commences in September 2025 and runs through 2028, will encompass comprehensive C checks, including C1 and six-year inspections. This new partnership underscores the trust placed in HAECO's extensive EASA-approved A330 capabilities by a prominent Lufthansa Group member. The agreement highlights Brussels Airlines' confidence in HAECO's ability to enhance the operational performance and reliability of its wide-body fleet. For HAECO, this contract reinforces its global reputation for safety, quality, and competitive turnaround times, which are key factors in attracting leading international airlines to its service network in Hong Kong, the Chinese Mainland, Europe, and the Americas.

Trax and Aeroxchange Deepen Partnership to Enhance MRO and Supply Chain Integration

Trax and Aeroxchange have announced a new agreement aimed at significantly bolstering the integration between their respective industry-leading software solutions. This initiative builds upon a long-standing collaboration, with the primary goal of engineering a more unified, end-to-end digital workflow for aviation maintenance and supply chain management. As a result of this expanded partnership, users within the Trax environment will gain direct, native access to Aeroxchange's extensive network of suppliers for parts, repair services, component pooling, and consignment. The enhanced interoperability is expected to yield significant operational gains, including reduced aircraft downtime, more rapid troubleshooting, and streamlined implementation processes, ultimately driving greater efficiency and superior value for users. This agreement is a key component of Trax's strategy to deliver a fully integrated digital ecosystem. The partnership is designed to offer enhanced supply chain flexibility, unlock new process automation opportunities, and allow mutual customers to maximize the combined value of their investments in both platforms. By synchronizing their technology roadmaps, the two companies will also accelerate the delivery of new features and innovations. This proactive alignment will better equip airlines, MROs, and their suppliers to stay ahead of evolving industry demands.

Airbus Opens Second A320neo Assembly Line in Tianjin as Part of Strategic Expansion

Airbus has inaugurated a second final assembly line (FAL) for its A320neo family in Tianjin, China, in a strategic move to meet surging global demand for narrow-body aircraft. This new facility is the company's tenth FAL worldwide and its second in China. This strategic expansion is critical to Airbus's goal of reaching a production rate of 75 A320-family aircraft per month by 2027. The company currently produces approximately 60 aircraft per month. The Tianjin opening closely follows the recent launch of a second FAL in Mobile, Alabama (USA). By increasing capacity simultaneously in both the US and China, Airbus is seen as balancing its global manufacturing footprint and mitigating geopolitical risks.The new Tianjin facility, which will focus on the best-selling A320neo and A321neo models, is expected to be fully operational by early 2026.

ExecuJet MRO Middle East Secures DGCA Approval for Falcon 6X Heavy Maintenance

The approval from India's aviation authority is timed perfectly with the first delivery of the long-range business jet to an operator in the country.

ExecuJet MRO Services Middle East has received authorization from the Directorate General of Civil Aviation (DGCA) of India to conduct heavy maintenance checks on Dassault Falcon 6X business jets. The DGCA approval comes at a strategic moment, coinciding with the delivery of the first Falcon 6X aircraft destined for India; a second aircraft is expected to be delivered to the country before the end of the year. The Falcon 6X is rapidly gaining popularity in the Indian market due to its exceptionally wide cabin, impressive short-field landing and take-off capabilities, and extensive long-range performance. With a range of 10,186 km (5,500 nm), the aircraft can fly non-stop from hubs like Mumbai to numerous destinations across Europe, the Middle East, and Asia. This new certification from India adds to an already comprehensive list of approvals for the Falcon 6X at the Dubai-based facility. ExecuJet MRO Services Middle East is also authorized to service the aircraft by the European Union Aviation Safety Agency (EASA), the UAE's General Civil Aviation Authority (GCAA), and the US Federal Aviation Administration (FAA).

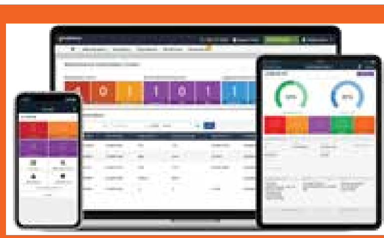
Joramco Announces New Collaborations and Expanded Partnerships at MRO Europe 2025

Joramco, the Amman-based maintenance, repair, and overhaul (MRO) provider operating as the engineering arm of Dubai Aerospace Enterprise (DAE), demonstrated a strong presence at MRO Europe 2025, held in London from October 15-16. As a main sponsor of the event, which convened over 11,500 aviation professionals and more than 500 exhibitors, Joramco hosted an interactive booth that attracted significant attendee interest. The company utilized this platform to showcase its newly operational Hangar 7 facility and highlight its expanding technical capabilities. The exhibition served as a venue for significant commercial announcements by Joramco. The company expanded its portfolio by signing new agreements with mas, the Mexican cargo airline, and World Star Aviation, a global aircraft leasing company. Joramco also reinforced its existing business by renewing and expanding long-term maintenance contracts with key incumbent partners, including TUI and MNG Airlines.These new and expanded agreements are seen as a reflection of the company's technical expertise and its growing role in the global airline and leasing markets. MRO Europe, one of the industry's most significant annual gatherings, once again proved to be a critical platform for senior decision-makers to explore innovations and opportunities within the global MRO sector.

Safran Raises 2025 Guidance After Strong Q3 Performance Expansion

Safran has upgraded its full-year financial guidance for 2025 following a third-quarter performance that exceeded expectations. The strong results were primarily driven by a significant surge in LEAP engine deliveries and robust, high-margin revenue from the civil engine aftermarket. The company reported Q3 2025 revenue of 7.85 billion, an 18.3% increase year-over-year, which surpassed analyst consensus. For the first nine months of the year, total revenue climbed 14.9% to 22.62 billion. The Propulsion division was the standout performer, with its revenue climbing 25.6%. This growth was fueled by two key areas:

1. **Original Equipment:** LEAP engine deliveries saw a remarkable 40% year-over-year jump, reaching 511 units in the quarter.
2. **Aftermarket:** Civil engine spare parts sales (for CFM56 and high-thrust engines) and service revenue continued their strong momentum, underpinning the company's profitability.



Veryon Launches AIRE, an AI-Driven Platform to Optimize Aircraft Maintenance

Veryon, a key provider of aviation software and information services, has launched Veryon AIRE, a new AI-powered data intelligence platform set to transform aircraft maintenance by boosting availability, airworthiness, and reliability. By utilizing the industry's largest de-identified dataset, Veryon AIRE integrates data science with deep aviation expertise. It offers predictive, agentic, and conversational AI capabilities designed to convert unplanned maintenance events into predictable, scheduled outcomes. This approach empowers maintenance teams with enhanced foresight and greater efficiency.

Key benefits for operators include:

Accelerated Repairs: The platform suggests the most probable solutions to improve first-time fix rates and provides technicians with direct access to specific troubleshooting steps.

Intelligent Fleet Operations: Automation streamlines routine tasks, lowers maintenance costs, and optimizes inventory management for critical operations.

Predictive Reliability: Advanced insights identify chronic issues and component degradation trends early, helping to prevent costly aircraft-on-ground (AOG) situations.

Mystery Strike at 36,000 Feet!

A United Airlines flight diverted to Salt Lake City last week after an object struck the plane's windshield at 36,000 feet, causing it to crack and injuring the pilot, according to the airline and officials. Amid the mystery of what could have hit the plane's windshield, on Monday night, WindBorne Systems, a long-duration smart weather balloon company, released a statement saying the object that hit and cracked United flight's windshield may have been a weather balloon from the company. The company said it is working with FAA and the NTSB on the investigation.The windshield is being transported to the National Transportation Safety Board's laboratory as the investigation continues.
Data from flight tracking website Flight Radar24 shows the plane was 36,000 feet in the air when an object hit the windshield. The flight then descended to a lower altitude, following standard protocol, before making an emergency landing at Utah's Salt Lake City International Airport. Aircraft windshields are designed with multiple layers to be able to sustain damage caused by things like a bird strike, weather or even debris, but experts say it's rare for it to be a bird strike that high in the sky.

Netherlands Joins USAF's Collaborative Combat Aircraft Program

The Netherlands Ministry of Defence has formally signed a letter of intent on October 16, 2025, to enter the Collaborative Combat Aircraft (CCA) Program led by the United States Air Force. This move places the Netherlands at the forefront of trans-Atlantic cooperation in autonomous combat aircraft development The CCA initiative aims to develop autonomous "loyal wingman" drones capable of flying alongside manned fighters like the F 35 Lightning II. These drones are designed to extend sensor reach, augment weapons systems, and take on high-risk missions in contested airspace while being faster and more cost-effective than traditional aircraft. With this agreement, the Netherlands not only secures a strategic seat in a key defence programme but also commits to strengthening its high-tech industrial base. A parallel deal with General Atomics Aeronautical Systems and Dutch contractor VDL Groep envisions the development of smaller ISR drones entering service as early as 2026.

Shield AI Unveils the X-BAT Autonomous VTOL Fighter

Shield AI has introduced its new autonomous fighter jet, the X-BAT, designed with vertical take-off and landing (VTOL) capability and a range exceeding 2,000 nautical miles.

- The aircraft adopts a tailless blended-wing-body design, ~11.8 m wingspan and ~7.9 m length, with internal weapons bays and a single jet engine.
- It's engineered to launch from land or sea and recover vertically on a wheeled launch/recovery trailer eliminating the need for traditional runways.
- Powered by Shield AI's "Hivemind" autonomous system the technology that previously controlled a modified F-16 in dogfight tests the X-BAT aims for near-fully autonomous operations, even in GPS- or comms-denied environments.
- Development began approximately 18 months ago, with vertical-launch demonstrations planned for late 2026 and full flight testing targeted for 2028.
- This platform positions Shield AI at the forefront of next-generation combat aviation by combining VTOL flexibility, deep autonomy, and long-range strike capability a potential game-changer for future air warfare.

StandardAero Expands Augusta MRO Facility

StandardAero has completed a significant expansion of its business aviation MRO facility in Augusta, Georgia, adding 80,500 sq. ft. of new space an increase of approximately 60% in capacity. The project aims primarily to boost the company's Honeywell HTF7000 engine maintenance and overhaul operations. StandardAero remains the exclusive independent overhaul provider for this engine type, which powers several Bombardier, Cessna, Embraer, and Gulfstream aircraft. The $33 million investment includes new hangars, engine shops, and customer service areas designed to support larger business jets and accommodate increasing service demand. This expansion will not only enhance operational efficiency but also create around 100 new skilled jobs in the Augusta region. Once fully operational, the facility will strengthen StandardAero's position as a leading global provider of business aviation maintenance solutions, delivering faster turnaround times and broader service capabilities.

Pegasus and Iberia Join Forces to Connect Turkey with Spain and Beyond

Pegasus Airlines has expanded its network through a new codeshare partnership with Iberia Airlines. With this agreement, Pegasus passengers can now access Spain, Portugal, and Latin America more easily. In addition to Pegasus' current direct routes from Turkey to Madrid, Barcelona, Bilbao, Seville, and Lisbon, the new partnership enables connections via Madrid to:

- 11 destinations in Spain (including Málaga, Tenerife North, Palma de Mallorca, Gran Canaria, Ibiza, A Coruña, Asturias, Lanzarote, Fuerteventura, Vigo, and Seville),
- Lisbon in Portugal, and
- São Paulo in Brazil.

Meanwhile, Iberia passengers can reach Turkey directly via the Madrid–Istanbul Sabiha Gökçen route, and connect through Pegasus' domestic network to major Turkish cities such as Izmir, Ankara, Antalya, Kayseri, Dalaman, Bodrum, and Adana.

Two Small Aircraft Collide Midair in Colorado: 1 Dead, 3 Injured

On the morning of August 31, 2025, two small aircraft collided midair near Fort Morgan Municipal Airport in Colorado. One pilot aboard an Extra EA-300 aircraft tragically lost their life, while a passenger in the same plane and two individuals in a Cessna 172 sustained minor injuries. The Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB) have launched an investigation into the cause of the collision. Following the midair collision, one aircraft was completely engulfed in flames, while debris from the other scattered across the runway area. According to the International Aerobatic Club (IAC), the accident occurred during an aerobatic event held in Fort Morgan, which also served to honor a pilot who had passed away the previous year. Reports from CNN and the Aviation Safety Network (ASN) highlight the incident's impact on the aviation community, emphasizing the inherent risks associated with small aircraft and aerobatic flights. This tragic accident serves as a stark reminder of the importance of stringent safety procedures in aviation operations.

Tragic Touchdown in Hong Kong: **Emirates SkyCargo Jet Veers Off Runway, Two Dead**

An Emirates SkyCargo Boeing 747-481 freighter operating flight EK9788 from Dubai veered off the runway and skidded toward the sea while landing at Hong Kong International Airport on the morning of October 20, 2025. During its landing roll, the aircraft struck an airport security vehicle, killing two ground personnel inside. All four crew members onboard escaped unharmed. The incident occurred at 03:53 local time, and according to initial statements, the aircraft operated by Turkish carrier ACT Airlines on behalf of Emirates was not carrying any cargo at the time. Authorities have officially classified the event as a runway excursion, but the root cause remains under investigation. Witnesses reported that the plane drifted sharply to the left during the final moments of landing, while surface conditions on Runway 07R were suspected to be slippery. The Hong Kong Civil Aviation Department (HKCAD), working in coordination with ICAO experts, has launched a full-scale investigation to determine whether factors such as runway contamination, crosswind influence, braking system malfunction, or directional control issues played a role. Preliminary findings indicate that no distress call was made before touchdown, and weather conditions were calm at the time. Emirates has confirmed that a detailed technical analysis is underway, while experts emphasize that despite major technological advances in modern aviation, the landing phase continues to be one of the most critical and vulnerable moments of flight operations.

Joby Completes First Piloted eVTOL Flight Between Public Airports

Joby Aviation has successfully completed its first piloted electric vertical takeoff and landing (eVTOL) flight between two U.S. airports, Marina (OAR) and Monterey (MRY), California. The 12-minute flight demonstrated vertical takeoff and landing, integration into controlled airspace, and full ground support operations, marking a key milestone toward commercial air taxi service. Didier Papadopoulos, Joby's Aircraft OEM President, said the flight validated the aircraft's performance and readiness for public service, highlighting progress in safety, operations, and FAA certification. Joby plans to begin commercial service in Los Angeles and New York City following final certification.

S 70 U Hawk: **The Uncrewed Cargo Variant of the Black Hawk**

The aerospace company Sikorsky Aircraft has developed the U-Hawk an uncrewed cargo version of the venerable UH 60L Black Hawk helicopter. By removing the cockpit and crew stations, the U-Hawk gains approximately 25 % more internal cargo space.

Key Specifications & Capabilities

- Internal cargo payload: ~3,175 kg (7,000 lb)
- External sling-load capacity: ~4,082 kg using cargo hook
- Combined internal + external load: up to ~4,536 kg
- Can carry up to four standard Joint Modular Intermodal Containers (JMICs), compared to two for a standard UH-60.
- Self-deployment range: up to ~1,600 nautical miles (~2,963 km), or loiter time up to ~14 hours without refuelling.
- Entry into autonomous operation enabled by the company's MATRIX™ autonomy suite and complete fly-by-wire conversion.

Why It Matters

The U-Hawk offers a cost-effective way to leverage the existing UH-60 Black Hawk logistics and maintenance infrastructure while upgrading for unmanned cargo missions. Its enhanced payload capacity and autonomous capability position it for roles in contested environments, logistics support, and new mission sets including deployment of "launched-effects" payloads like small drones or UGVs from its cargo bay.

Drone sightings at Munich Airport disrupt air traffic

Unidentified drones spotted near Munich International Airport on the night of October 2, 2025, caused major disruptions to air traffic. Following reports from witnesses and radar detections, air traffic control temporarily suspended all departures and arrivals for safety reasons. Seventeen departing flights were canceled, while fifteen inbound flights were diverted to other airports. Around 3,000 passengers were directly affected. A similar incident the following night increased the number of impacted passengers to approximately 6,500. German police launched a large-scale search operation to locate the drones, but no physical devices have been recovered so far. Authorities are investigating whether the incident was a deliberate act. The event has sparked renewed debate over the adequacy of current drone detection and response measures at major airports across Europe. Munich Airport is one of the busiest in the region, and this disruption highlights the growing security risks posed by unauthorized drones.

Global Air Passenger Traffic Expected to Reach 9.8 Billion in 2025

Airports Council International (ACI) World forecasts that global air passenger traffic will reach 9.8 billion in 2025, representing a 3.7% increase compared to 2024. International travel is expected to account for 4.3 billion passengers, while domestic traffic is projected at 5.5 billion passengers. The Asia-Pacific region is expected to have the highest traffic, with 3.6 billion passengers, driven by growth in South and Southeast Asia. In Europe, passenger numbers are projected to reach 2.5 billion, with international flights leading growth while domestic traffic grows more slowly due to competition from rail transport.

Massive fire at Chevron refinery in Los Angeles disrupts jet fuel supply

On the night of October 2, 2025, a major explosion triggered a significant fire at Chevron's El Segundo refinery, specifically in the Isomax 7 jet fuel production unit. The blaze was swiftly contained, and fortunately, no injuries were reported all refinery personnel were accounted for. The refinery plays a critical role in supplying Southern California: approximately 20% of motor fuel and 40% of the region's jet fuel come from this facility. Several processing units were taken offline due to the fire, though the main crude distillation units remained operational. Officials noted that Los Angeles International Airport (LAX) hasn't experienced direct disruptions to its operations. Local authorities urged residents to stay indoors while air quality is monitored. The incident has renewed concerns about the vulnerability of fuel supply in California, especially given the state's isolated fuel market. Analysts warn that jet fuel prices may spike, and the time required to restore full production may intensify market pressure.

A Boeing 747 aircraft veered off the runway in Hong Kong.

A Boeing 747-400 cargo plane took off from Al Maktoum International Airport near Dubai and landed at its destination, Hong Kong International Airport, at around 3:50 a.m. It then veered off the runway and entered the sea. After landing, the aircraft suddenly veered off the runway while taxiing. It collided with a security patrol vehicle on the left side of the runway, and both vehicles were swept into the water. Two ground personnel in the patrol vehicle were killed in the incident; four crew members on the aircraft were rescued with injuries. It was announced that weather and runway conditions were "operationally suitable" at the time of the accident. Authorities launched an investigation into numerous aspects, including the flight system, landing gear, brakes, and maintenance history. This accident is considered one of the most serious incidents at the airport, which has been known for its safety in the region for many years.

AEI's Boeing 737-900ERSF Conversion Project Targets 2029 Certification

Miami-based Aeronautical Engineers Inc. (AEI) has begun a project to convert Boeing 737-900 aircraft into freighters, known as the 737-900 Extended Range Special Freighter (B737-900ERSF). The company plans to obtain FAA certification by early 2029, followed by EASA and CAAC approvals.As a Boeing-licensed third-party STC provider, AEI has the authorization to perform these conversions under its existing agreement with Boeing. Although AEI had been researching the project for years, Boeing's internal setbacks especially the 737 MAX grounding and the January 2024 Alaska Airlines door-plug incident had delayed progress. The conversion will include a large cargo door (86 x 137 inches) on the aircraft's left side and a Class E main deck cargo compartment. The freighter will be able to carry 12 full-height containers or pallets plus one smaller container, achieving a main-deck payload capacity of up to 26,170 kg (57,700 lb) higher than AEI's 737-800SF model. The design will also include a reinforced floor, 9g barrier, and an optional 180-minute ETOPS rating for extended operations. AEI's Vice President of Sales and Marketing, Robert Convey, described the initiative as a strategic response to rising global demand for larger narrowbody freighters, particularly driven by e-commerce and express delivery growth. Once operational, the 737-900ERSF will be AEI's largest and most capable narrowbody freighter, offering superior payload, volume, and operating economics.

Aims Community College Announces New Aviation Maintenance School

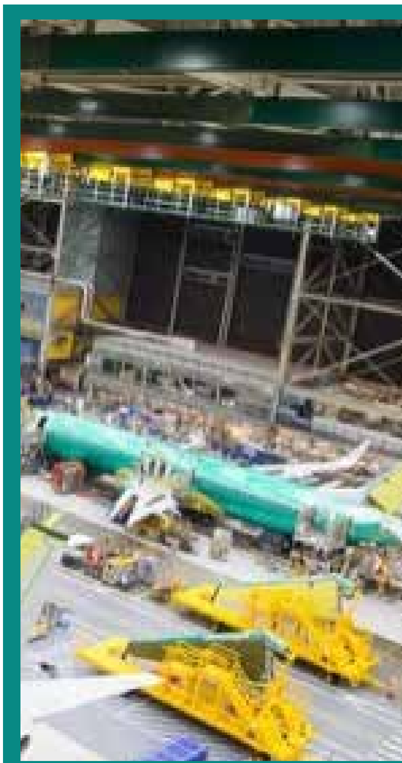
Aims Community College has announced the opening of its new aircraft maintenance training center at the Northern Colorado Regional Airport in Loveland. The 60,000 sq. ft. facility features fully equipped aircraft repair hangars, classrooms, and specialized laboratories for avionics, hydraulics, and electronics. It also includes dedicated shops for composites, brakes, tires, paint, and parts, providing students with a comprehensive hands-on learning environment. Classes are scheduled to begin in January 2026, with the program designed to address the growing demand for skilled aircraft maintenance technicians in the aviation industry. The new training center reinforces Aims Community College's commitment to workforce development and positions Northern Colorado as an emerging hub for advanced aviation education and technical training.

Airbourne Colours Expands with a Second Hangar

Hangar at Teesside Airport later this year. The new facility will accommodate narrowbody aircraft such as the Airbus A321 and Boeing 737 MAX, significantly expanding the company's capacity to serve both commercial and private aviation clients. This development follows the successful opening of Airbourne Colours' first Teesside hangar in October 2024, which marked the company's strategic expansion into northern England. The second hangar will enhance operational flexibility by allowing for simultaneous projects. This investment also strengthens Teesside Airport's growing role as a regional aerospace hub and supports continued growth in the UK's aviation maintenance and refurbishment sector.

Safety Alert: **Cathay Pacific A350 Returns After Engine Fuel Leak**

On September 5, 2024, the European Union Aviation Safety Agency (EASA) issued an emergency directive requiring inspections of the fuel manifold hoses on Rolls-Royce Trent XWB-97 engines installed on Airbus A350-1000 aircraft. This action followed an incident involving a Cathay Pacific A350-1000, which experienced a fuel leak in one of its engines and had to return safely to Hong Kong on September 2, 2024. Investigations revealed that the leak originated from a damaged fuel manifold hose in the Trent XWB-97 engine. Under the directive, airlines operating the A350-1000 are required to inspect these hoses and carry out any necessary repairs. The issue has not only affected Cathay Pacific but also had global implications for A350-1000 operators, with Malaysia Airlines identifying a similar problem on its A350-900 fleet. This incident serves as a significant reminder of aviation safety priorities and highlights EASA's commitment to continuously updating and enhancing industry safety standards.



FAA Approves Higher 737 MAX Production for Boeing

Boeing has been granted approval by the Federal Aviation Administration (FAA) to boost its 737 MAX production from 38 to 42 aircraft per month. The increase comes after previous production limits, imposed following the January 2024 Alaska Airlines Flight 1282 incident where a cabin door panel detached mid-flight, were lifted. The FAA conducted a detailed review of Boeing's manufacturing processes and safety protocols before authorizing the higher rate. Boeing has finalized supply chain and workforce preparations to meet the new production target. The FAA reiterated that safety remains the highest priority and will continue to closely oversee Boeing's operations.

In the era of the 1980s and early 1990s, Boeing held the iron-throne of commercial large aircraft, especially in the single-aisle (narrow-body) market, with its 737 family having been introduced in 1967 and gradually upgraded through Classic and NG variants. (Wikipedia, 2025) The rival, Airbus, only entered the narrow body sweepstakes in earnest with its A320 family, first delivered in 1988, which introduced fly-by-wire controls and fresh European engineering credentials. (Airbus, 2024)

At this stage the market was dominated by Boeing. Airbus was the newcomer challenger, with leaner lineage and less track record. But in the quiet, strategic corners of Europe, Airbus was building incremental momentum they were playing a long game.

CHAPTER I

The Battle for Orders and the Narrow-Body Frontier (1990s–2000s)

As the aviation world globalised, low-cost carriers burgeoned, deregulation expanded markets (especially in North America, Europe and later Asia), and demand for efficient single-aisle jets soared. The 737 family was deeply entrenched: airlines knew it, there were plentiful support/maintenance ecosystems, and Boeing held strong brand familiarity. (Wikipedia, 2025)

Airbus, meanwhile, leveraged the A320 family's innovations fly-by-wire, common type rating across its A318/A319/A320/A321 siblings, efficient operations and targeted both full-service carriers and the rising low-cost segment. (Airbus, 2024)

During the 1990s and 2000s, Airbus steadily increased order shares. According to analysis of the duopoly competition, by the early 2010s Airbus had achieved a meaningful backlog lead in the single-aisle realm. (Woo, 2021) The shift was subtle but relentless: IKEA-style accumulation of strategic advantage (common cockpit, production locations in multiple countries, global assembly lines).

In this phase the Boeing 737 remained dominant, but the cracks were showing: the A320 family was becoming the credible contender, and airlines began to factor not only price and fuel efficiency but also flexibility of fleets and lifecycle cost.

CHAPTER II

Innovations, Crises and Cusp-Shifts (2010s)

The decade of the 2010s brought key turning points.

Airbus's leap
Airbus made bold moves: the A320neo (new engine option) launched in ~2016, delivering significantly better fuel burn and airline economics.

(Airbus, 2024) The manufacturer also pushed the A321neo, which offered higher capacity in the narrow-body space allowing Airbus to enter the "middle size" narrow-body domain that Boeing's 737 series struggled to match exactly at that shift. (SimpleFlying, 2025)

Boeing's crisis
Meanwhile Boeing faced headwinds. The 737 Max crisis (after two fatal accidents in 2018 & 2019) shook airline confidence, caused regulatory groundings, cancellations, delays, and reputational damage. (Woo, 2021) Production and delivery rates for Boeing dropped, while Airbus maintained momentum.

Market and backlog dynamics
According to the duopoly data, by mid-2020s Airbus had secured net orders of roughly 8,950 aircraft versus Boeing's 5,012 over a recent 10-year span. (Wikipedia, 2025) In effect, Airbus began to pull ahead in the backlog and in the narrow body war.

One striking datum: by 2019 the A320 family had overtaken the 737 in total orders (15,193 vs 15,136). (Wikipedia, 2025) This was a symbolic moment: the challenger had caught the incumbent.

CHAPTER III

The Climax – "Airbus Overtakes Boeing" (2020s)

This chapter is the turning of the tide in full.

Delivery crown stolen
On October 7 2025, Airbus delivered the 12,260th A320 family aircraft (to Saudi carrier Flynas), thereby surpassing Boeing's 737 family as the most delivered jetliner in history. (Reuters, 2025; AeroTime, 2025) That is a monumental moment a throne change.

Orders and momentum
Beyond deliveries, Airbus continues to dominate yearly orders and backlog share. For instance, Airbus achieved

superior delivery and order numbers in consecutive years, taking share away from Boeing. (Reuters, 2025) Analysts attribute this not only to Boeing's missteps, but to Airbus's strategic positioning: the A320 series, the A321neo variant, global production flexibility, and capturing growth in Asia & low-cost carriers. (AP News, 2024)

Why Airbus succeeded
Key reasons:

- **Market timing:** fuel-efficient narrow-bodies matter to airlines facing cost pressures, and Airbus delivered that faster.
- **Variant breadth:** The A321neo allowed Airbus to capture higher-capacity narrow-body segments.
- **Global footprint:** Multiple assembly sites (Europe, US, China) helped Airbus scale.
- **Boeing's distraction:** Wide-body struggles (787 delays), 737 Max crisis, regulatory issues drained focus.
- **Backlog build-up:** Airbus entered the 2020s with a growing backlog lead.
- Strategic wins with low-cost carriers and Asian growth markets.

The Game of Planes metaphor
In our "Game of Planes", you imagine two kingdoms Boeing's long reigning empire, Airbus's ambitious upstart realm. For decades the throne of narrow-body dominance sits with Boeing. Airbus quietly forges alliances (airlines, low-cost carriers, production nations), improves its castle (A320 family innovations). Then Boeing stumbles: scandal, production issues, lost trust. Airbus presses the attack: wins orders, accelerates delivery, controls supply chains. The moment of coronation comes when Airbus delivers its 12,260th A320 and seizes the delivery crown. Boeing, once unassailable, watches the crown pass.

CHAPTER IV

The Sectors and External Forces – The Broader Battlefield

It's not just about two manufacturers it's the entire aviation ecosystem. Over the last 40 years, several trends have shaped this duel.

Growth of low-cost carriers (LCCs)
The rise of LCCs globally (Europe's Ryanair, EasyJet; Asia's AirAsia; Middle East's others) created huge demand for efficient narrow-body jets. These carriers favoured aircraft like the A320 family and 737 family. Airbus capitalised well by offering attractive deals with its A320 family, gaining share.

Emerging markets & middle-class growth
Asia, the Middle East, Latin America witnessed explosion in traveller numbers. New airlines and fleet expansions added to demand.

The strategic location of delivery and production (Airbus in China & US) helped capture these markets.

Fuel cost and environmental/ regulatory pressures
Airlines increasingly demanded fuel efficiency and lower emissions. Airbus's neo variants were well-timed. Boeing's delay in fielding the 737 Max and other programs hurt its competitive edge.

Production, supply chain and globalisation
Assembling jets is massively complex, with thousands of suppliers. Airbus's distributed model (Europe, US, China) gave some flexibility. Boeing's problems (production bottlenecks, regulatory suspensions) hampered its ramp-up.

Hoarding backlogs & deterrence
A large backlog means production orders locked in. Airbus built a sizeable backlog (7,000+ for the A320 family) by the mid-2020s, which gives both capacity to fulfil and barrier for competitors. (Airinsight, 2025)

CHAPTER V

The Orders Profiles of A320 & 737 – Key Numbers and Trends

Let's zoom into the two main families: the A320 family (Airbus) and the 737 family (Boeing).

A320 family

- The A320 programme turned 40 in March 2024. (Airbus, 2024)
- The A320 family has achieved total orders nearing ~19,000 by 2025, with backlog over ~7,000. (Wikipedia, 2025)
- The A320 family became the most-delivered jetliner as of 2025, with 12,260 deliveries recorded for its family. (AeroTime, 2025; Reuters, 2025)
- It out-ordered the 737 by October 2019 (15,193 vs 15,136). (Wikipedia, 2025)

Boeing 737 family

- The Boeing 737 family had been the best-selling commercial airliner for decades. (Wikipedia, 2025)
- As of 2025, roughly 17,040 orders for the 737 family and some 12,255 deliveries (per Wikipedia) though numbers vary by source. (Wikipedia, 2025)
- The 737's backlog and order intake in recent years shrank relative to Airbus especially due to the Max crisis and COVID.

Snapshot of shift

- In 2016, Airbus overtook Boeing in annual orders for the first time. (Guardian, 2016)
- By the early 2020s, Airwwbus had a market-backlog share of about 60% compared to Boeing's ~40%. (Wikipedia, 2025)
- The delivery crown shift in 2025 is the symbolic high-point of this battle.

CHAPTER VI

Why Airbus passed Boeing – Strategic Lessons

What are the tactical and strategic lessons from this high-stakes duel?

1. Product platform flexibility & variant depth – Airbus's A320 family, spanning A318 to A321, with the neo upgrade, allowed it to serve many airline needs.
2. Timing & risk – Airbus avoided the kind of massive reputational crisis Boeing suffered with the Max, meaning fewer disruptions to orders/deliveries.
3. Global production footprint – Airbus's multinational assembly and supply chain (Europe, US, China) gave resilience and access to growth markets.
4. Focus on narrow body growth – While Boeing had strong wide body heritage, the biggest growth segment was narrow body (single aisle) jets, and Airbus captured it.
5. Building backlog as defence – A large backlog locks in future cash flows and binds carriers, making it harder for the competitor to poach business.
6. Market development & carrier alliances – Airbus aligned well with low-cost carriers and emerging market airlines, enhancing volume orders.
7. Boeing's self inflicted wounds – Safety/regulatory incidents, production delays, and loss of confidence amplified Airbus's opportunities.

CHAPTER VII

The Narrow-Body Throne and the Future of "Game of Planes"

With Airbus now holding the narrow body throne (delivery crown, backlog lead, order momentum), what lies ahead in this epic saga?

- Boeing is attempting a comeback: ramping up 737 Max production, addressing quality/regulatory issues, and developing new variants.
- Airbus must defend its throne: scale production safely, manage supply chain stress, innovate further (such as hydrogen/next-gen aircraft), and fend off any disruptive competitor.
- Emerging challengers may rise: For instance, Chinese manufacturer COMAC with its C919 is slowly building orders in its domestic market; though globally it remains a minor player by comparison. (Wikipedia, 2025)
- The battlefield remains narrow body single aisle jets, but wide-body growth in Asia, sustainability thrusts, and new business models (e.g. ultra-low-cost, regional jets) may reshape the fight.
- **The accumulation of advantage matters:** backlog, variant flexibility, global service network, brand trust; Airbus currently holds many of these levers.

In our Game of Planes metaphor: Airbus sits on the Iron Seat of narrow-body aircraft. Boeing, bruised and regrouping, still commands vast resources but must rebuild trust and momentum. The next chapters will test whether Airbus can convert its narrow body dominance into a longer-term empire (across categories) or whether Boeing can rally and reclaim its crown.

CHAPTER VIII

Implications for the Aviation MRO and Metrics-Driven Practitioner

Since you're working on "Developing a Framework for Comprehensive Key Performance Metrics Integration in Aviation MRO Organizations," this duel offers several rich implications:

- **Fleet commonality and maintenance metrics:** Airbus's success with the A320 family and its variants implies airlines running more homogenous fleets, so MRO organisations servicing these fleets need comprehensive metrics for fleet availability, turnaround, engine shop visits, fleet-wide reliability – all of which become even more critical when one family dominates.
- **Backlog and order book impacts on MRO planning:** Large order backlogs (as Airbus has) mean predictable fleet growth, which influences spare-parts inventory metrics, hangar planning, workforce forecasting, turnaround time targets.
- **Supplier and production-chain metrics:** The contest between manufacturers stresses supply-chain resilience, production quality, and on-time delivery metrics, which propagate downstream into MRO metrics (spares lead-time, vendor performance, quality incident rate).
- **Competitive shift and strategic risk metrics:** The Boeing vs Airbus battle shows how strategic incidents (safety or regulatory) can trigger ripple effects in maintenance and aftermarket service demand so MRO metrics should incorporate risk indicators tied to manufacturer health, market shifts, and fleet lifecycle transitions.
- **Variant proliferation and maintenance complexity:** Airbus's variant breadth (A318/A319/A320/A321 + neo) implies MROs must manage variant specific metrics (engine mix, avionics version, update retrofit cycles).

The manufacturer that wins also shapes the ecosystem MROs must measure.

- **Geographic growth and new-market metrics:** Growth in Asia/Middle East fueled Airbus's climb MRO organisations must track regional fleet mix change metrics, growth rates, regional reliability, logistical lead times with new carriers entering from scratch.

So, the "Game of Planes" isn't just about manufacturing it frames a larger architecture: orders → deliveries → fleet mix → maintenance ecosystem → performance metrics. Your framework can use this duel as a case study: how the shift in manufacturer leadership altered MRO planning, metrics prioritisation, and performance expectations.

Epilogue: The Crown Changed Hands
Thus, in the epic saga of commercial aviation, the narrow body crown has passed: Airbus has overtaken Boeing in many key metrics (orders, backlog, deliveries) and now holds the throne for the A320 family. Boeing remains a powerful house, but battered, with a long road to rebuild dominance. For airlines, MROs, leasing companies, and the broader aviation ecosystem, this shift reverberates across fleet strategy, maintenance planning, supply chains, and performance metrics.

And so the game continues new variants, new challengers, sustainability pressures, and demand surges await. In the realm of sky-kings, only preparation, innovation, and operational excellence will keep the throne secure.

MRO EUROPE 2025:

INNOVATION, SUSTAINABILITY, AND DATA TRANSFORMATION TAKE FLIGHT IN LONDON

MRO Europe 2025, held from 14–16 October at ExCeL London, brought together over 11,500 aviation professionals and nearly 600 exhibitors. The event served as a hub for airlines, OEMs, suppliers, lessors, and MRO providers to explore innovations in maintenance, efficiency, safety, and sustainability. Digitalisation was a key focus, with predictive analytics, digital twins, and real-time fleet monitoring enabling predictive maintenance and advanced data-driven KPIs. Sustainability initiatives, such as energy-efficient hangars, recyclable materials, and optimized repair processes, highlighted MRO's role in aviation decarbonisation.

The aviation maintenance, repair, and overhaul (MRO) community gathered in one of its most significant global meet-ups: MRO Europe 2025, which took place from 14 to 16 October 2025 at ExCeL London. Organized by Aviation Week Network, the conference and exhibition brought together more than 11,500 professionals and nearly 600 exhibitors from across the aviation industry, creating a dynamic platform for sharing innovations, strategies, and future-shaping visions in aircraft maintenance.

More than just a trade show, MRO Europe acted as the beating heart of Europe's aviation aftermarket. It united airlines, OEMs, suppliers, lessors and MRO providers in a collaborative environment where industry leaders explored solutions for efficiency, safety and sustainability. The event combined a two-day senior-level conference and a two-day exhibition, including the popular "Go Live!" theatre sessions where experts discussed digital transformation, data analytics, workforce development and supply-chain resilience.

Digitalisation took centre stage at this edition. Airlines and maintenance organisations increasingly adopted predictive analytics, digital twins and real-time fleet monitoring, shifting the focus from reactive maintenance to predictive operations. This change not only enhanced reliability but also re-defined performance

measurement moving away from traditional cost and turnaround time indicators toward advanced data-driven KPIs. Predictive accuracy, data quality and time-to-detection metrics emerged as new standards of operational excellence.

Sustainability was another cornerstone of MRO Europe 2025. The aviation industry, under mounting pressure to reduce its environmental footprint, witnessed how MRO organisations responded by developing energy-efficient hangars, using recyclable materials and optimizing repair processes to minimise emissions. Exhibitors showcased eco-friendly technologies supporting the circular economy, reflecting how maintenance activities can contribute to aviation's broader decarbonisation goals. Environmental performance had clearly become a defining factor of competitiveness in the global MRO market.

Supply-chain stability also took a spotlight in London. With ongoing global challenges such as parts shortages and logistical bottlenecks, the sector revisited procurement and inventory-management strategies. Experts explored how digital platforms and collaborative forecasting can improve visibility, agility and resilience across complex supply networks ensuring maintenance operations remain uninterrupted even during turbulence.

The human element remained central to the MRO business. Europe's aviation industry continued to face a shortage of qualified engineers and licensed technicians, making workforce attraction and retention a top priority. Training programmes, apprenticeships and digital-learning tools were expanded to prepare a new generation of aviation professionals. As one industry leader put it, “We need to rebrand maintenance as high-tech, sustainable and data-driven.” This highlights a key reality: human capital is as essential to MRO success as technology and infrastructure.

Across the exhibition halls and conference stages, MRO Europe 2025 showcased the technologies redefining aircraft maintenance from robotic inspections and smart materials to artificial intelligence and digital repair-tracking systems.

For participants, the event offered not only networking opportunities but also a forward-looking vision of how aviation maintenance will evolve in the coming decade.

Ultimately, MRO Europe 2025 stood as a symbol of transformation within the aviation industry. It reflected the sector's determination to integrate innovation, sustainability and digital intelligence into every aspect of maintenance and repair. The conversations held in London this October helped shape how airlines, OEMs and MRO providers define and achieve performance in an era of rapid change. The future of aviation maintenance is not only about keeping aircraft aloft it is about reimagining how efficiency, safety and sustainability are achieved on the ground.

M.Murat BAŞTÜRK
Part -147 Type Training Instructor

BRIDGING THE DATA GAP FROM THE HANGAR FLOOR TO THE BOARDROOM

MRO's mission is no longer just to keep aircraft flying and costs low it's to turn operational data into strategic value. Modern maintenance organizations operate through balanced KPI systems that integrate safety, operational excellence, financial alignment, and supply chain performance. Powered by AI and big data, maintenance is shifting from reactive to predictive and profitable, measured not by MTBF, but by MTBOI – Mean Time Between Optimal Interventions. At the center of this transformation stands the digitally fluent, data-driven technician, whose accuracy and insight fuel enterprise performance. In short: from wrench to data, from data to strategy MRO now drives profitability, not just compliance.

The New Bottom Line for MRO

For decades, the Maintenance, Repair, and Overhaul (MRO) function operated under a simple premise: keep the aircraft airworthy and keep the costs down. Today, that premise is insufficient. As global air traffic returns and competitive margins tighten, MRO is being recast from a necessary cost center into a strategic profit enabler. This transition is driven entirely by our ability to precisely measure, manage, and predict operational performance.

The new mandate for MRO leaders is to speak the language of the executive suite. We must connect technical metrics like Mean Time Between Failures (MTBF) to financial metrics like Cost per Available Seat Kilometer (CASK). This connection requires moving past isolated data points and implementing an integrated performance ecosystem rooted in strategic Key Performance Indicators (KPIs).

This analysis delves into the advanced frameworks and technological tools that leading MRO providers and technical operations (Tech Ops) departments are using to map operational success to enterprise value.

The Four-Way Compass: A Holistic View of Performance

Focusing on a single metric is like navigating a vast ocean using only a single piece of instrumentation; it shows direction but misses all the crucial terrain. If we only chase cost reduction, we inevitably compromise on safety or quality. Therefore, successful MRO organizations employ a Balanced Scorecard (BSC) approach, ensuring performance is measured across four integrated domains.

Domain 1: Safety and Quality (The Non-Negotiable Core)
This is the bedrock of our profession. Measurement here must be proactive and preventative.

Maintenance Error Rate (MER) and Repeat Defect Rate (RDR): These two metrics are the pulse of our Human Factors management. RDR the recurrence of a fault soon after a fix doesn't just point fingers; it indicates deep-seated flaws in troubleshooting methodology, training efficacy, or the quality of components from the C-Shop. High-performing MROs use MER not to discipline staff, but to ask: "What systemic failure or environmental pressure forced this error?" This is the core of a Just Culture.

Maintenance Procedure Compliance: Tracking the percentage of work cards completed exactly as written. Deviations are leading indicators of procedural risk. Advanced Insight: Modern digital systems now track time spent on specific segments of a procedure. If a technician spends suspiciously little time on a complex critical step, it may flag the record for quality assurance review, moving QA from reactive checks to proactive audits.

Domain 2: Operational Excellence (Valuing Time)
In aviation, time is literally money. Every minute an aircraft sits idle is a minute of lost revenue. Operational KPIs are designed to maximize asset utilization.

Technical Dispatch Reliability (DR): The MRO industry's ultimate external scorecard. While critical, it is a lagging indicator. To improve it, we must focus on its leading indicators.

Scheduled Task Completion Rate (STCR): If our planning team promises to finish 95% of scheduled work, but only hits 85%, that deficit often turns into deferred defects or AOG events down the line. STCR measures the accuracy and realism of our resource projections (man-hours, tools, and parts).

Productive Utilization Rate (Wrench Time): This ratio calculates the time spent actively working versus total time available. Improving this rate even by a few percentage points translates directly into millions saved on external contract labor and increased workflow stability. [Visual Suggestion: A pie chart comparing 'Productive Time' vs. 'Non-Productive Time (Waiting, Searching, Admin)' on the hangar floor, showing the high percentage of hidden waste.]

Domain 3: Financial Alignment (The CASK Bridge)
Our challenge is to ensure that cost control decisions on the hangar floor align perfectly with the airline's overall financial health.

DMC vs. CASK: This is the strategic crux. Direct Maintenance Cost (DMC) per flight hour tells us what we spend. Cost per Available Seat Kilometer (CASK) tells us how efficiently the entire airline operates. The trap is short-term cost-cutting: reducing maintenance quality to lower DMC now only leads to unscheduled delays later, skyrocketing CASK because revenue potential is destroyed. Strategic MRO leaders prioritize Availability over short-term DMC reduction.

Emergency Work Order (EWO) Ratio: A high EWO rate signifies a deeply reactive, and therefore expensive, maintenance culture. Emergencies incur peak costs: premium AOG freight, overtime labor rates, and costly schedule disruptions. Systematically reducing the EWO ratio is the most tangible benefit of shifting towards preventive and predictive maintenance.

Domain 4: Logistics and Supply Chain Performance

Maintenance is a supply chain problem. If the required part is not at the wrench tip, the aircraft stays grounded, regardless of technician skill.

Inventory Accuracy & Stockout Rate: If our Maintenance Information System (MIS) says we have five of a critical valve but the shelf is empty, we have a crippling problem. Stockout Rates are the great destroyer of STCR and a primary cause of technician downtime. The most efficient MRO is often simply the one with the best logistical data. [Visual Suggestion: Graphic: Correlation between the Stockout Rate and the Mean Time to Repair (MTTR).]

The Digital Horizon: From Prediction to Prescription

The real power of modern measurement lies in the ability to transcend historical data. The future is not just descriptive (what happened) or predictive (what will happen), but prescriptive (what should we do about it, and when?).

The combination of Big Data streaming from aircraft sensors and sophisticated AI algorithms is enabling this shift.

Prediction: AI analyzes flight profiles, maintenance history, and environmental data to give a precise probability of failure. (e.g., "Turbine Blade Seal X shows degradation patterns indicating 90% failure probability within 45 cycles").

Constraint Modeling: The system then models the operational environment. It determines: What is the longest scheduled layover where a qualified team and the part are available? What is the weather forecast at the deployment station?

Prescription: The AI-driven system issues the optimal, cost-benefit balanced directive: "Perform the replacement of Seal X during the planned 10-hour maintenance window in Singapore next Friday. This prevents the likely failure on the long-haul sector to New York and provides the maximum component life extension, yielding an estimated $75,000 saving over a reactive repair."

This turns the maintenance task from a scheduled chore or an emergency response into a profit-driven action. Our core metric is no longer MTBF (Mean Time Between Failures), but MTBOI (Mean Time Between Optimal Interventions).

Conclusion: Empowering the Data Generator

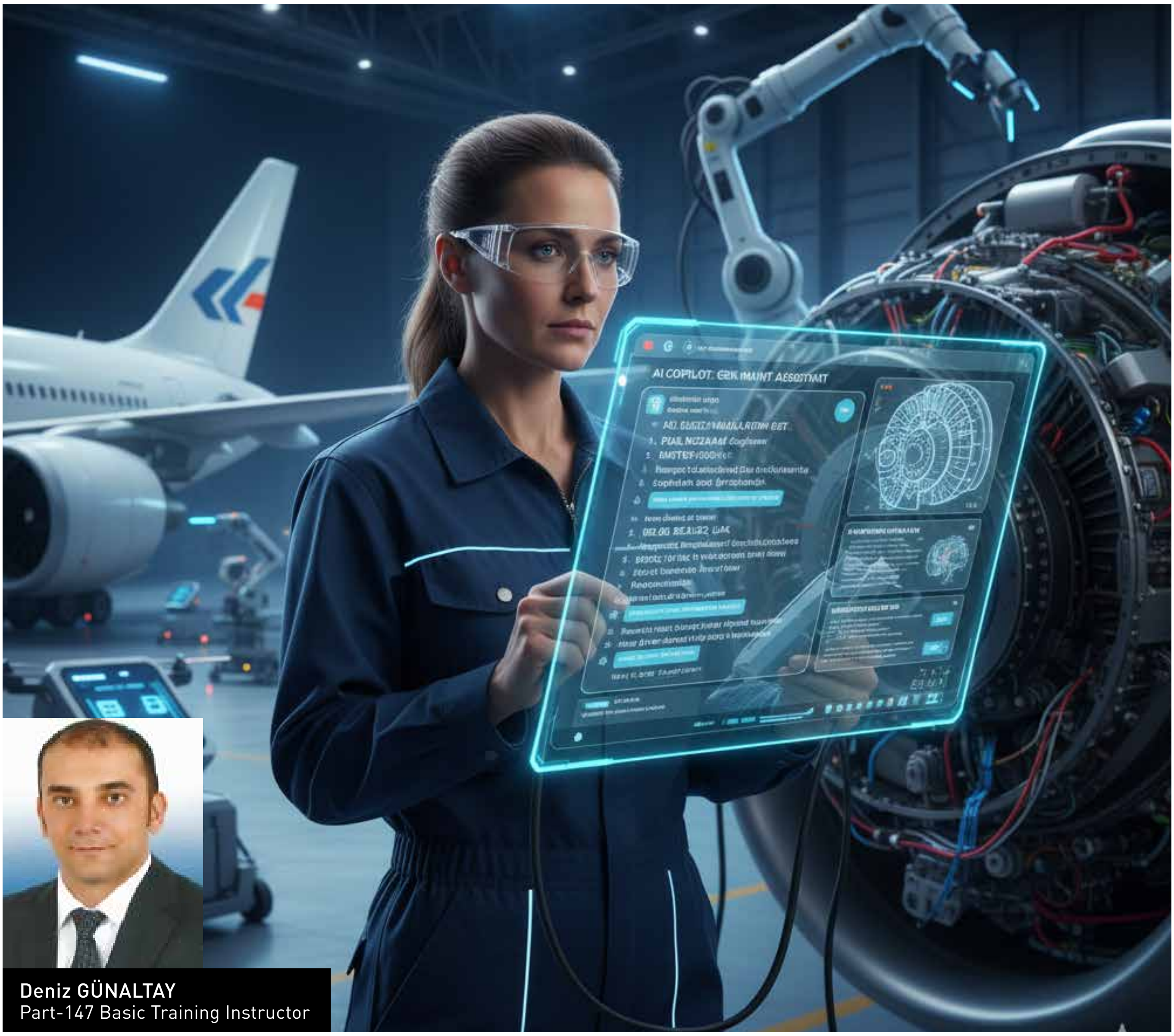
No matter how smart the algorithm, the entire system relies on the aircraft maintenance technician the person who captures the initial data and executes the final prescription.

For the MRO organization to thrive in this environment, we must cultivate a culture of trust and data literacy.

Trust the Wrench, Trust the Data: We must ensure that performance metrics are used to identify process flaws (e.g., supply chain breakdowns, outdated tooling), not to assign personal blame. When data is used punitively, it goes underground; records are falsified, small defects are unreported, and the entire performance measurement effort becomes worthless.

The Digital Technician: The modern AMT must be fluent in the language of data. This means being proficient in interpreting diagnostic output, using Augmented Reality (AR) overlays that present step-by-step instructions directly onto the component, and validating data feeds from the aircraft. The skilled hands that perform the work must also be the keen minds that safeguard the integrity of the performance ecosystem.

The maintenance industry is at a pivotal moment. By embracing this performance imperative by strategically balancing safety with efficiency and investing in both the digital tools and the human capital we will ensure that the MRO function not only supports the airline but decisively drives its profitability and future success.



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HOW AI IS REVOLUTIONIZING AIRCRAFT MAINTENANCE AND REPAIR INDUSTRY

Artificial Intelligence is transforming MRO from a reactive, manual process into a proactive, data-driven ecosystem. Through predictive maintenance, automated inspections, and generative AI copilots, aircraft downtime is minimized, safety is enhanced, and operational efficiency soars. By combining human expertise with intelligent automation, AI is not just optimizing maintenance it's revolutionizing how aviation ensures reliability, safety, and profitability.

The aircraft maintenance and repair (MRO) industry is the unseen foundation of global aviation safety and efficiency. Traditionally reliant on fixed schedules, manual inspections, and paper-based logs, this sector has long faced challenges related to unexpected downtime, high operational costs, and the need for precision in a high-stakes environment. The advent of Artificial Intelligence (AI) and its associated tools is now creating a paradigm shift, moving the industry from a reactive model to a proactive, data-driven system. AI is primarily developing the MRO sector through two critical pathways: the adoption of predictive maintenance and the automation of complex inspection and diagnostic tasks.

The most transformative application of AI is in Predictive Maintenance (PdM). Modern aircraft are equipped with thousands of Internet of Things (IoT) sensors that continuously generate massive volumes of data regarding the performance of critical components, such as engines, hydraulics, and avionics. AI-driven machine learning models analyze this “big data” in real-time to identify subtle anomalies or patterns that precede equipment failure. Unlike traditional maintenance, which dictates part replacement based on fixed flight hours, PdM forecasts the exact moment a component is likely to fail. This foresight enables maintenance teams to schedule interventions precisely when needed, thereby optimizing the lifespan of expensive parts, minimizing unnecessary inspections, and drastically reducing the risk of unexpected aircraft-on-ground (AOG) situations, which cost airlines millions.

In addition to intelligent forecasting, AI tools are also automating and enhancing physical maintenance processes. Computer vision systems, often mounted on autonomous drones, are now used to inspect the exterior surfaces of aircraft. These drones can complete a full fuselage inspection in minutes a task that typically takes aircraft maintenance technicians hours and their AI algorithms are trained to spot defects like tiny cracks, corrosion, or paint damage with greater consistency and accuracy than the human eye. Furthermore, Generative AI is streamlining administrative “busywork.” Maintenance Technicians can use conversational AI interfaces (often called “copilots”) to query maintenance manuals, troubleshoot complex issues, and automatically generate detailed maintenance log entries and work orders, converting hours of paperwork into minutes. Finally, AI dramatically improves resource allocation and supply chain efficiency. By predicting exactly which parts will be needed and when, AI-powered systems can optimize inventory management, ensuring critical components are available without the cost of overstocking. This enhanced operational efficiency, combined with significant cost

The Aircraft Maintenance, Repair, and Overhaul (MRO) industry is being transformed by Artificial Intelligence (AI), shifting from reactive maintenance to predictive, data-driven operations. AI enables Predictive Maintenance (PdM) by analyzing sensor data from aircraft systems to forecast component failures before they occur, reducing downtime and costs.

savings from preventing unplanned downtime, is driving the widespread adoption of AI tools across the MRO ecosystem. In conclusion, AI is not merely optimizing the MRO industry; it is fundamentally redefining it, making air travel safer, more reliable, and ultimately more cost-effective.

Generative AI on the Hangar Floor: A Technician’s Copilot

Generative AI (GenAI), such as large language models (LLMs), is being integrated into Maintenance, Repair, and Overhaul (MRO) operations to act as a real-time, knowledgeable assistant for Aircraft Maintenance Technicians (AMTs). Instead of replacing the technician, GenAI is augmenting their capabilities by minimizing manual “busywork” and accelerating troubleshooting. The primary role of GenAI is to provide context-aware, immediate access to structured and unstructured information, allowing technicians to spend more time performing maintenance tasks (often called “wrench time”) and less time on documentation and research.

The Virtual Troubleshooting Expert (“The Copilot”)

The most impactful application of GenAI is the creation of a “virtual expert” or AI Copilot. Technicians can now interact with a conversational chat interface to ask complex, technical questions.

Intelligent Documentation Retrieval: Maintenance manuals, service bulletins (SBs), airworthiness directives (ADs), and historical repair logs are typically unstructured and spread across thousands of pages. GenAI systems are trained on this vast corpus of documentation, allowing a technician to ask a natural language question (e.g., "What's the procedure for resetting the hydraulic pump after an intermittent low-pressure warning on a Model X?"). The AI responds instantly with the exact, relevant section of the manual, often summarizing the steps. This process reduces documentation search time from hours to seconds. Root Cause Analysis: When a reported fault is ambiguous (e.g., "Engine vibration detected"), the technician can describe the symptom to the copilot. The GenAI reviews historical data from similar faults across the fleet and suggests the most probable root causes, potential troubleshooting steps, and past successful resolutions, effectively coaching a less experienced AMT through a complex diagnosis.

Automated Reporting and Administrative Assistance

Technicians traditionally spend a significant portion of their shift on mandatory documentation, which is crucial for regulatory compliance but takes away from repair time. GenAI takes over much of this "busywork."

Automated Work Log Generation: After a repair is complete, the technician can dictate their actions via voice or enter a few bullet points. The GenAI instantly generates a structured, compliant maintenance report, correctly classifying the work performed and filling in required technical data (like ATA chapters) based on the context.

Automatic Part Ordering: Once a technician determines a part needs replacement, the copilot can automatically generate and submit the necessary work orders and purchase orders, checking against current inventory and compliance rules without manual data entry.

Visual and Multimodal Inspection Assistance

GenAI systems are evolving beyond text to process images and video, adding another layer of efficiency to the inspection process.

Image-Based Query: Instead of typing a description of a component, a technician can take a picture of a complex assembly or a damaged part. The GenAI instantly recognizes the component, matches it to the correct diagram in the maintenance manual, and retrieves the relevant inspection procedure or repair instruction.

Component Recognition and Validation: During a procedure, the AI can use computer vision to ensure the technician is working on the correct part. For safety-critical steps (like torque settings), the system can provide real-time visual validation, ensuring 100% adherence to the documented procedure and reducing human error.

Enhanced Training and Upskilling

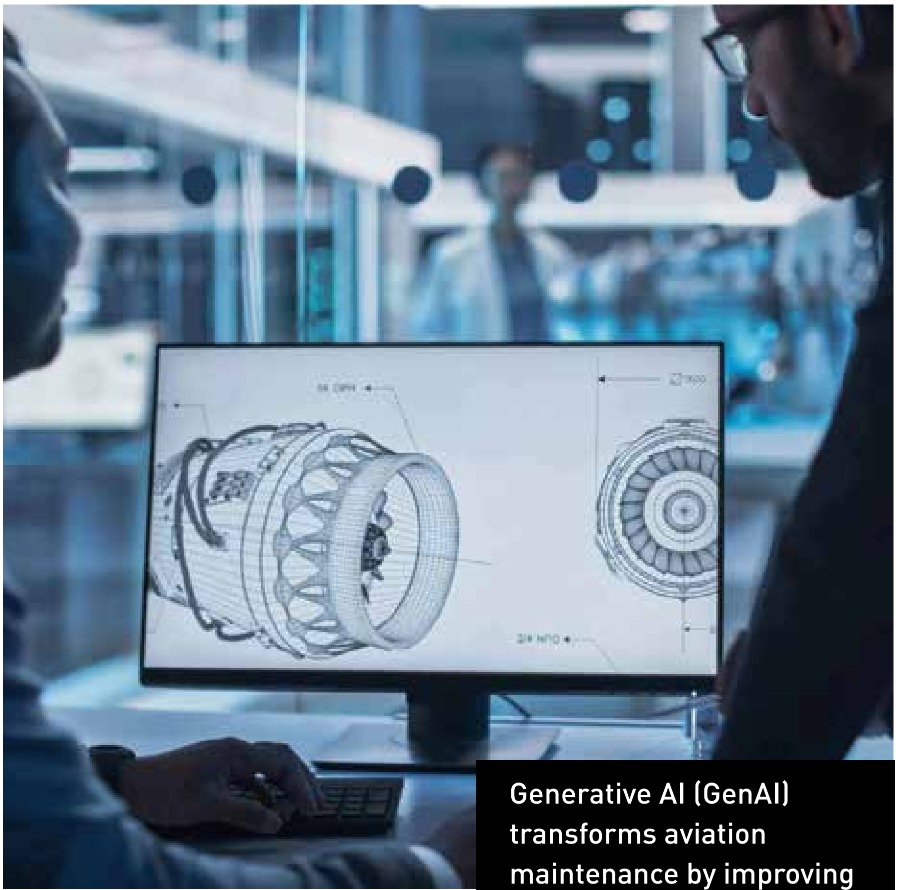
Given the projected shortage of experienced AMTs, GenAI is vital for rapidly bringing new technicians up to speed.

Customized Training Materials: GenAI can take standard, complex maintenance protocols and automatically generate customized, simplified training guides, step-by-step videos, or interactive quizzes tailored to the experience level of the trainee.

On-the-Job Knowledge Transfer: The "copilot" acts as a persistent mentor, providing instant access to the collective knowledge of the organization, ensuring that expertise from retiring veterans is codified and immediately available to the next generation of technicians. This framework highlights how GenAI is moving maintenance from a reactive, document-heavy process to a proactive, highly efficient, and human-centric workflow.

The adoption of Artificial Intelligence (AI) in aviation Maintenance, Repair, and Overhaul (MRO) promises huge gains in efficiency and predictive maintenance. However, given the safety-critical nature of the sector, AI systems face severe supervision. Integrating AI requires overcoming three core areas of challenge: regulatory approval (EASA/FAA/NAA), technical model assurance, and ethical/operational concerns.

Nowadays, so many tools generated by Artificial Intelligence have been utilized in MRO Industry. Revised safety enhancements and minimized downtime. The application of AI in aviation maintenance has the capability to avert unexpected repairs, thus lessening the chances of aircraft being grounded and delays in flight schedules. Furthermore,

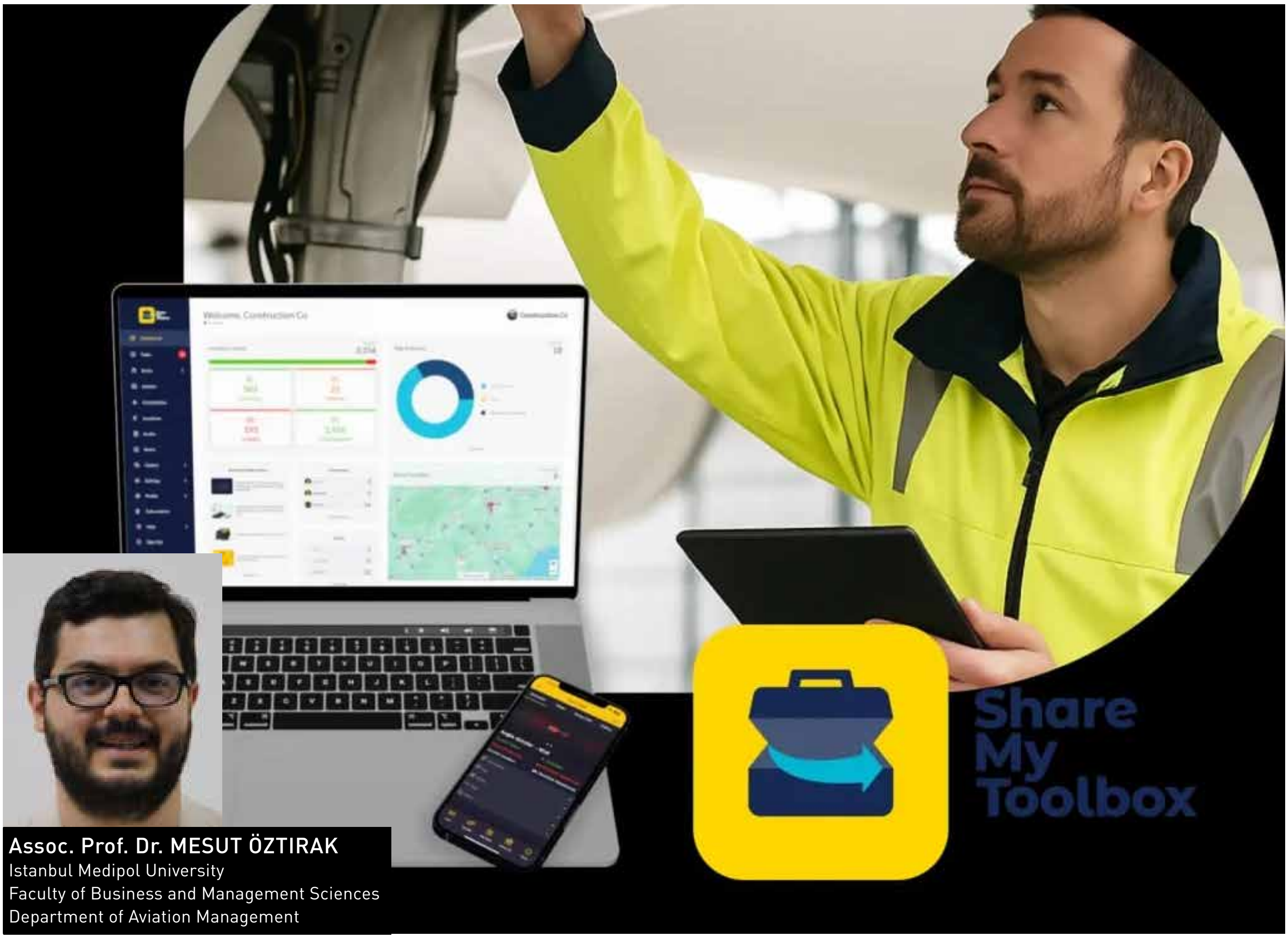


real-time predictive maintenance powered by AI allows for the early identification of possible problems, enabling timely interventions before they turn into safety risks.

AI-driven algorithms assist airlines in accurately predicting potential complications, such as equipment malfunctions and maintenance requirements. They accomplish this by examining extensive datasets derived from aircraft systems, sensors, and past maintenance history. Consequently, this leads to a decrease in unscheduled maintenance and reduces the time aircraft spend out of service. So, AI improves safety and reduces downtime. At the same time AI provides cost-effective maintenance management by detecting all faults in the aircraft system and analyzing historical maintenance data to predict the demand for components or parts. Besides them, AI empowers decision-making and workload optimization and generates in-depth analysis and reporting.

Generative AI (GenAI) transforms aviation maintenance by improving technician training, enabling predictive maintenance, and reducing downtime. It acts as a digital mentor, creates tailored learning materials, and helps detect faults early. While AI boosts safety and efficiency, its adoption faces challenges in regulation, model assurance, and ethics.

In summary, while the technology is powerful, the industry must fundamentally shift its safety assurance philosophy moving from certifying deterministic products to validating adaptive processes that involve continuous monitoring and human-AI collaboration.
This necessity for robust testing, transparency, and collaboration among regulators, airlines, and tech providers is what makes AI adoption in aviation maintenance so challenging and critical.



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DIGITAL TWIN AND PREDICTIVE ANALYTICS: **AIRCRAFT CAN NOW SEE THEIR OWN FUTURE**

The aviation industry has long been recognized as a pioneer of technological innovation. Yet today's transformation is unlike any other in its history. Digital twin and predictive analytics technologies are enabling aircraft not only to fly through the skies but also to navigate the vast world of data. Aircraft can now anticipate their own behavior, predict potential failures, and continuously learn from every flight.

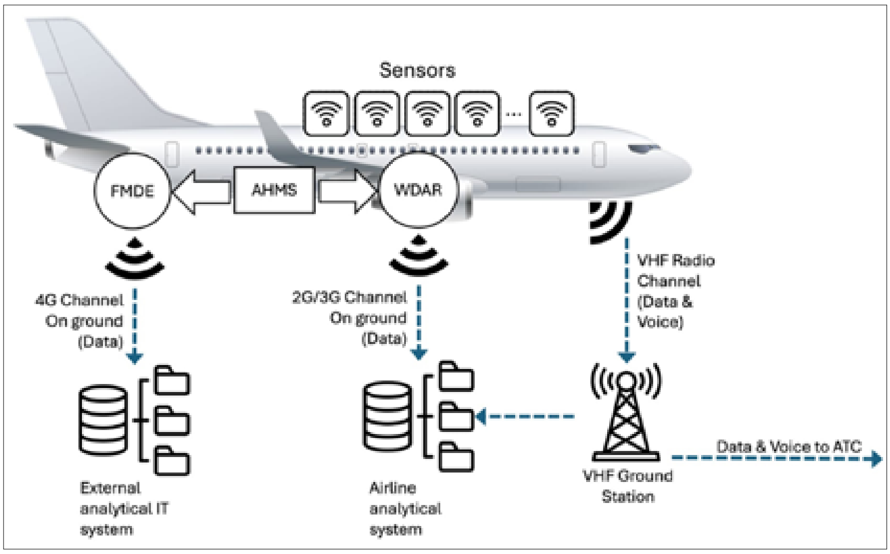
From Physical Aircraft to Digital Twins
A digital twin is a virtual replica of a physical asset an aircraft, an engine, or a landing gear system. This model is continuously updated with real-time data collected from onboard sensors. Operational data such as engine temperature, fuel flow, pressure, and vibration are streamed into the digital environment, creating a "living copy" of the aircraft. Engineers can monitor and analyze potential issues in simulation before they ever occur in reality.

Digital twins allow maintenance and engineering teams to understand how every component behaves under specific conditions. They bring the unseen dynamics of flight to the surface, offering predictive insights that were once impossible.

The Predictive Power of Data
Predictive analytics acts as the brain behind the digital twin. Machine learning algorithms analyze historical flight and maintenance data to forecast when specific components might fail. Maintenance teams can therefore act before a malfunction occurs rather than after.

This proactive model transforms maintenance culture. Instead of time-based schedules, aircraft are now serviced according to real-time conditions. Every plane follows its own data-driven maintenance plan a concept known as condition-based maintenance. The result: reduced downtime, lower costs, and higher operational safety.

Training and Simulation Reinvented Digital twins also
revolutionize technical training. Virtual models built on real flight data allow maintenance technicians to practice in safe, simulated environments.



Rare fault scenarios can be replicated without risk, helping technicians gain deeper understanding before facing them in the hangar.

This approach minimizes human error, enhances knowledge retention, and accelerates the development of new skills especially vital as next-generation aircraft systems become more complex and digitalized.

Real-World Applications Taking Off
Today, major manufacturers such as Airbus and Boeing are building digital twins to monitor entire fleets throughout their life cycles. Rolls-Royce, for instance, gathers thousands of data points per second from its engines and uses AI-powered analytics in its TotalCare service model to predict and prevent performance degradation.

By integrating predictive analytics with digital twin data, companies can foresee when and under what conditions an engine might require intervention a level of foresight that redefines efficiency and reliability across aviation operations.

AI: The Mind Behind the Machine
At the core of this transformation lies artificial intelligence (AI). AI connects data analytics with digital twin technology, creating an intelligent feedback loop. Machine learning models detect subtle anomalies and trends that humans might overlook.

AI-driven systems are already optimizing fuel efficiency, flight safety, and maintenance planning. They make sense of the overwhelming data volume that modern aircraft generate transforming raw information into actionable insights that keep aviation moving safely and efficiently.

A Cultural Shift in the Hangar
This transformation is not only technological but also cultural. Aviation is shifting from a reactive mindset to a proactive, data-oriented philosophy. Technicians and engineers now need to combine traditional mechanical expertise with data literacy and digital awareness.

A modern maintenance professional doesn't just handle tools; they also interpret dashboards, analyze predictive alerts, and interact with AI-driven decision systems. The hangar of the future will be as much a digital workspace as a mechanical one.

The Connected Aviation Ecosystem
Looking ahead, the integration of AI, predictive analytics, and digital twins will create a connected aviation ecosystem. Aircraft, maintenance bases, air traffic systems, and manufacturers will continuously exchange data. This ecosystem will strengthen flight safety, enhance cost efficiency, and contribute to environmental sustainability through optimized operations.

Yet this digital revolution also raises important questions: How will data privacy be protected? How transparent will AI's decision-making be? And where does the human factor stand amid increasing automation? The answers to these questions will define the ethical boundaries of aviation's digital future.

Seeing the Future Before It Happens
In essence, digital twin and predictive analytics technologies mark a turning point for aviation from reactive maintenance to predictive intelligence. Aircraft now fly not only through the air but also through endless streams of data.

Every sensor reading and every algorithmic insight brings aviation one step closer to safer, smarter skies. A new era has dawned above the clouds aircraft can now see their own future.

Mihaly Csikszentmihalyi (1934–2021), via Leadership & Flow.

Arif TUNCAL PhD
Aviation Research Association

FLOW EXPERIENCE AND ITS REFLECTIONS IN THE WORKPLACE

The flow experience, introduced by Mihaly Csikszentmihalyi, is a state of deep focus where action and awareness merge, time fades, and the activity itself becomes intrinsically rewarding. Flow arises when challenge and skill are perfectly balanced, goals are clear, and feedback is immediate creating motivation from within rather than external rewards. In workplaces like aviation, engineering, or medicine, flow enhances focus, learning, and performance, while strengthening autonomy, competence, and engagement. Ultimately, flow transforms work from a task to be completed into an experience of mastery, meaning, and fulfillment.

The flow experience is defined as a psychological state in which an individual becomes fully engaged in an activity, external stimuli and self-awareness fade into the background, and the perception of time and space is altered. In this state, a person directs complete attention to the task at hand and experiences a sense of awareness where the activity itself becomes intrinsically rewarding. The concept of flow was first introduced in the 1970s by Mihaly Csikszentmihalyi, one of the pioneers of positive psychology. Csikszentmihalyi observed that individuals engaged in creative processes such as artists, musicians, athletes, and scientists became so deeply involved in their activities that they lost track of time, and he described this phenomenon as "flow". The theory has since evolved beyond art or sports and has been applied in various fields such as business, education, leadership, engineering, and aviation, disciplines that require high levels of attention and focus.

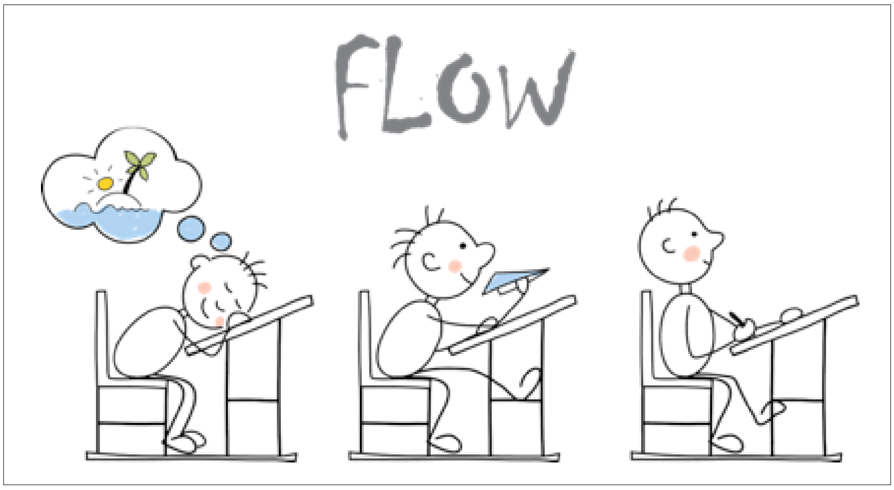
Core Characteristics of the Flow Experience

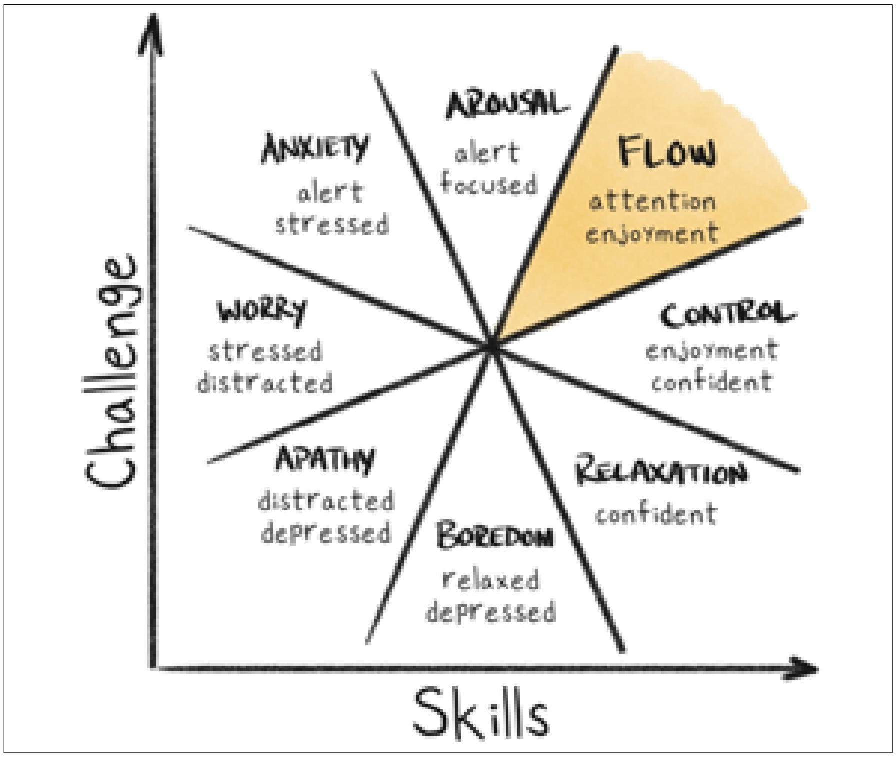
Flow is more than a state of intense

concentration, it is a condition in which the individual derives intrinsic satisfaction from the activity and perceives the act itself as a reward. In this sense, flow represents one of the most visible and dynamic forms of intrinsic motivation. According to Csikszentmihalyi, flow occurs when individuals engage in an activity not for external rewards (e.g., money, status, or approval) but because they enjoy the activity itself. This enables a deep sense of meaning and connection between the person and their work.

The foundation of intrinsic motivation lies in choosing to participate in an activity voluntarily, finding it meaningful, and experiencing a sense of competence through it. This perspective is directly related to Self-Determination Theory (SDT), which proposes that intrinsic motivation emerges when three basic psychological needs are satisfied: autonomy, competency, and relatedness. The flow experience supports all three needs simultaneously. When individuals feel control over their actions, autonomy is strengthened; when challenges and skills are balanced, competence increases; and when interactions with others or the environment are meaningful, relatedness is enhanced.

In a flow state, individuals focus their attention entirely on the activity and maintain a balance between task difficulty and personal skill. This balance is essential for both flow and intrinsic motivation. If a task is too easy, boredom arises; if too difficult, anxiety emerges. When challenge and skill are matched, the person becomes self-motivated, requiring no external incentive. At this point, the autotelic experience, which refers to the sense that the activity is rewarding in itself, represents the essence of flow. Flow not only enhances performance but also deepens emotional engagement with the task. Rather than focusing on external evaluation, the individual concentrates on the process itself, which promotes self-determination, self-actualization, and learning motivation. As a result, work is not perceived merely as a task to be completed.





The Nine Components of Flow
Csikszentmihalyi identified nine components necessary for the occurrence of flow during an activity. These elements form the cognitive, emotional, and behavioral foundations of the flow experience:

Challenge–Skill Balance: One of the primary conditions for flow. When the challenge of a task matches the individual's skills, it is neither overly difficult nor too easy. Excessive challenge leads to anxiety, while insufficient challenge causes boredom. The optimal balance allows full engagement.

Merging of Action and Awareness: The individual becomes one with the activity, and the distinction between the "doer" and the "action" disappears. This unity prevents distraction and fosters total involvement.

Clear Goals: For flow to emerge, individuals must understand what they are doing and why. Clear goals provide direction and focus energy toward a specific purpose.

Unambiguous Feedback: Individuals must be able to perceive or feel the outcomes of their actions immediately. This feedback loop allows awareness of progress and sustains motivation.

Total Concentration on the Task: Attention is completely focused on the task, and external stimuli temporarily fade from awareness. This focus forms the cognitive foundation of flow.

Sense of Control: Individuals feel a sufficient level of control over their actions and outcomes. This sense reduces anxiety and reinforces confidence.

Loss of Self-Consciousness: The individual forgets the self and no longer focuses on external evaluation. Questions such as "How do I look?" or "What do others think?" disappear, leaving only the act itself.

Transformation of Time: Perception of time changes minutes may feel like hours or vice versa. The person becomes unaware of the passage of time due to deep concentration.

Autotelic Experience: The activity becomes rewarding in itself. Flow is associated with intrinsic satisfaction derived from the process rather than external rewards.

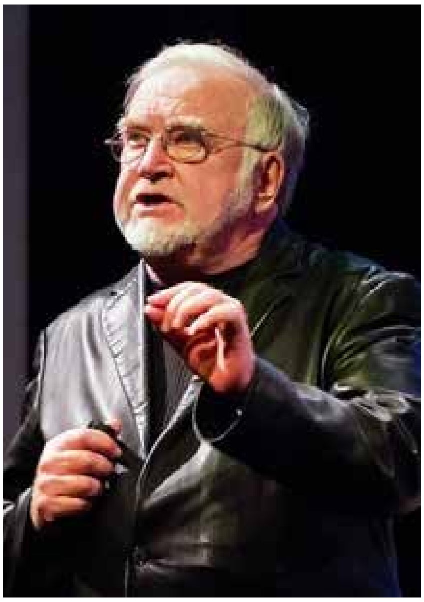
When these nine elements coexist, individuals experience complete immersion in their work, and the activity becomes self-sustaining without external pressure or reward.

Generated by Gemini AI.

Flow Experience in the Workplace

In the work context, flow directly influences employees' motivation, performance, engagement, and creativity. When the balance between skills and task difficulty is maintained, goals are clearly defined, and immediate feedback is available, flow is more likely to occur. In such cases, individuals focus entirely on their tasks, derive satisfaction from their work, and perform naturally at higher levels.

For example, an engineer solving a complex design problem, an air traffic controller managing heavy traffic, or a surgeon performing an operation may lose awareness of time. The common element in these examples is that individuals experience high attention, meaningful challenge, competence, and intrinsic motivation during their tasks. The flow state reduces the risk



of burnout, strengthens organizational commitment, and supports learning processes.

Flow Experience in Aviation

The aviation industry represents one of the professional domains where the flow experience can be most clearly observed. Pilots, air traffic controllers, aircraft maintenance technicians, and cabin crews operate in environments that demand high mental concentration, rapid decision-making, and minimal tolerance for error. In this context, the challenge–skill balance is critical. When tasks are overly complex, cognitive load increases and error probability rises; when too simple, attention declines and monotony sets in.

Furthermore, clear goals and unambiguous feedback are essential in aviation operations. However, excessive flow can also be risky: in such cases, an individual may become over-immersed and fail to perceive environmental cues. Therefore, maintaining strong team communication, ensuring transparent automation management, and having backup control mechanisms in place are crucial.

In aviation training, flow also plays a key role. In simulation-based learning, when the balance between the learner's skills and task difficulty is achieved, the quality of learning improves. Training conducted in a flow state enhances not only knowledge transfer but also decision-making speed, situational awareness, and stress management. Consequently, flow contributes to both performance and safety.

Flow and Organizational Structure

Organizational structures that support flow are those where employees can effectively use their competencies, receive clear feedback, and work toward meaningful goals. Managers should not only assign tasks but also clearly define their purpose, goals, and levels of challenge. Furthermore, organizational cultures that nurture autonomy, competence, and relatedness sustain the continuity of flow. Within this framework, flow becomes not merely an individual experience but also a fundamental dynamic for organizational learning and development.

The flow experience is a powerful psychological model that explains the relationship between human beings, time, attention, and motivation. Balancing challenge and skill, using time meaningfully, and deriving satisfaction from the process enhance both individual well-being and organizational productivity. Flow transcends emotional states and functions as a pathway for learning, creativity, decision-making, and the realization of human potential. Understanding the components of flow and integrating them into work processes can enhance individual productivity and enable organizations to achieve sustainable success across diverse fields, including aviation, engineering, education, and the arts.

Have you ever been in flow?

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ADDITIVE MANUFACTURING TECHNOLOGIES AND THEIR IMPACTS ON THE AVIATION INDUSTRY

THE FUNDAMENTALS OF ADDITIVE MANUFACTURING

Additive Manufacturing (3D printing) is revolutionizing aviation by building parts layer by layer enabling lighter, stronger, and more efficient aircraft components.- Through weight optimization, part consolidation, and complex geometry design, AM reduces fuel consumption, enhances reliability, and shortens supply chains. From GE's single-piece fuel injectors to 3D-printed turbine blades with internal cooling channels, AM has moved from prototyping to full-scale production. With advances in materials, real-time quality control, and digital certification, Additive Manufacturing has become a cornerstone of next-generation aerospace engineering.

Additive Manufacturing (AM), commonly known as 3D printing, represents a radical departure from traditional subtractive manufacturing methods. This technology is based on the principle of creating three-dimensional objects by adding material layer by layer from a digital model. This technology can be used not only for rapid prototyping but also for final product and functional part manufacturing, meaning "Direct Digital Manufacturing." The aviation industry is at the forefront of sectors where this transition has been most evident and successful. High-performance requirements, complex geometries, the need for lightness, and increasing part consolidation reliability have made AM an ideal solution for aviation.

General Additive Manufacturing Process

The process begins with the creation of a three-dimensional digital model in CAD software. The CAD model is converted into formats understandable by additive manufacturing machines (e.g., STL - Standard Triangle Language). Specialized software slices the STL file into layers and defines the movement path of the print head/beam. Depending on the selected technology, the material is manufactured layer by layer. Post-processing steps may include removal of support material for overhanging structures, sanding, polishing to improve surface quality, heat treatment to relieve internal stresses and improve mechanical properties. Painting may be applied for corrosion resistance and aesthetic appearance. The process is completed with dimensional control, visual inspection, followed by functional tests and certification.

Classification of AM Technologies and Importance for Aviation

AM processes are generally classified based on material:

- Powder Bed Fusion,
- Material Jetting,
- Directed Energy Deposition,
- Sheet Lamination,
- Vat Polymerization,
- Binder Jetting.

In the aviation industry, particularly for metal part production;

Powder Bed Fusion (PBF)
Directed Energy Deposition (DED)
technologies stand out.

PBF (SLM- Selective Laser Melting and EBM- Electron Beam Melting) is used for producing high-resolution, complex internal structures;

DED is used for repair or manufacturing of large parts. These technologies enable the production of single-piece components with optimized internal lattice structures that are impossible or very costly to manufacture with traditional methods.

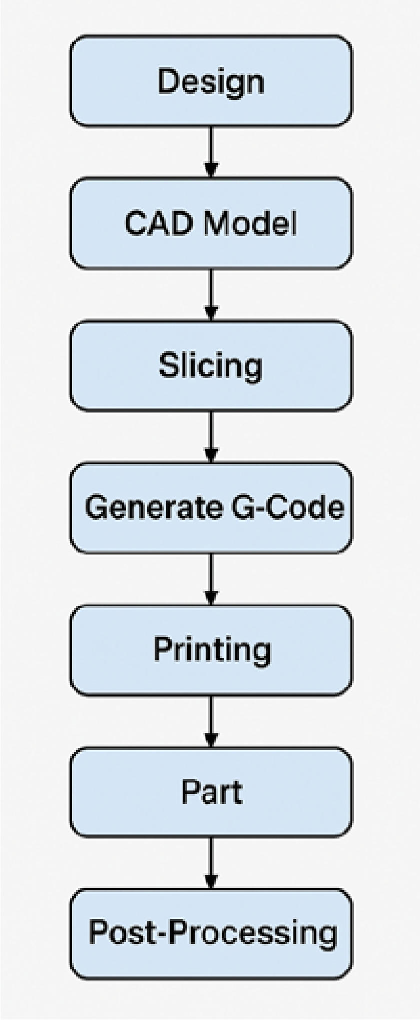
Key Advantages of AM in Aviation – Weight Optimization

In aviation, every gram of weight saved provides significant operational cost advantages and environmental benefits by reducing fuel consumption. AM's greatest contribution lies here. A part produced by traditional milling results in a large portion of the material being wasted as chips and is typically a solid block. However, with AM, material can be placed only at critical points where structural loads are carried.

Using an algorithmic design method called **"Topology Optimization,"** a part's weight can be reduced by 50-70% while maintaining its strength. This is a factor that directly and dramatically increases aircraft fuel efficiency.

Key Advantages of AM in Aviation – Part Consolidation

Traditionally, a complex assembly (e.g., a fuel injector or wing hinge) is created by joining dozens or even hundreds of separate parts. This involves processes like welding, riveting, bolting, and consequently, risks of leakage, increased failure points, and assembly costs. AM makes



Flowchart of a typical Additive Manufacturing process.

Titanium cabin bracket produced by a) Traditional and b) Additive Manufacturing methods (Airbus A350 XWB. Copyright 2023, Elsevier.)

it possible to convert these multi-part assemblies into a single, monolithic structure. For example, an assembly consisting of dozens of parts can be printed in one go with AM. This simplifies the production process, eliminates the risk of assembly error, increases reliability, and improves overall system performance.

Example Part – GE LEAP Fuel Injector

The fuel injector produced by General Electric (GE) for the LEAP jet engine is one of the most iconic examples of AM's commercial success in aviation. Traditionally manufactured by assembling 20 separate parts, this injector is now printed as a single piece thanks to AM. This change reduced the part's weight by 25%, increased its durability fivefold, and lowered costs. Today, each LEAP engine contains 19 fuel injectors produced by AM, and these parts are printed in tens of thousands annually, proving the maturity of AM in serial production.

Key Advantages of AM in Aviation – Complex Geometries and Internal Structures

The layered nature of AM provides designers with geometric freedom. Internal channels, closed cells, and organic, bio-inspired lattice structures that traditional tools (mills, drills, etc.) cannot access can be created. This means the production of cooling channels, lightweight yet extremely rigid structures, and aerodynamically optimized surfaces in aviation. For example, complex cooling labyrinths, impossible to manufacture with traditional casting, can be integrated inside a turbine blade, allowing the blade to operate at higher temperatures and thus increasing engine efficiency.

Example Part – Turbine Blades and Cooling Channels

Turbine blades, among the most critical and challenging parts of jet engines, showcase all the advantages of AM. Using DED and PBF technologies, complex serpentine cooling channels can be integrated inside the blades, enabling the engine to operate at higher temperatures and with greater efficiency. Furthermore, blade tips or damaged blades can be repaired using AM, extending part life and providing cost savings.

Fuel injector for the GE LEAP engine, produced as a single piece using AM, which traditionally consisted of 20 parts (Source: General Electric)

Materials Used in Aviation

Material development for AM processes in aviation is of vital importance. Commonly used metallic materials include:

- **Titanium Alloys (especially Ti-6Al-4V):** Used in airframe, wing connection parts, and turbine components due to high strength-to-weight ratio and excellent corrosion resistance.
- **Nickel-Based Superalloys (such as Inconel 718, 625):** Used in hot sections of jet engines (turbine blades, combustion chambers) due to high-temperature strength and corrosion resistance.
- **Aluminum Alloys (such as AlSi10Mg, Scalmalloy®):** Used in structural parts, especially in space applications where lightness and strength are critical.
- **Stainless Steels and Cobalt-Chromium Alloys:** Preferred for various fasteners and durable parts.

Cross-section of a turbine blade produced by AM using Laser Powder Bed Fusion (LPBF), showing internal cooling channels.(Source: https://doi.org/10.1007/s12541-024-01177-3)

New Approaches for Design

To fully leverage the potential of AM, the principles of "Design for Additive Manufacturing" (DfAM) must be adopted. This involves not just printing an existing part, but designing the part from scratch, considering the freedoms offered by AM (lightweighting, consolidation, complex geometry). This approach includes topology optimization, use of lattice structures, forms requiring minimal support structures, and design of functionally graded materials.

Challenges and Limitations
Although AM technology is maturing, some challenges persist.

- **Surface Quality:** The layered structure can cause a surface roughness called the "stair-stepping effect," which can be problematic, especially on aerodynamic surfaces.
- **Anisotropy of Mechanical Properties:** The mechanical properties of the part can vary depending on the build direction of the layers.
- **Production Speed and Scalability:** Competing with traditional methods for large-volume production of simple parts remains difficult.
- **Qualification and Certification:** In a high-risk industry like aviation, proving that each AM part is consistently of the same quality and reliability (especially for agencies like FAA, EASA) is a complex and lengthy process.
- **High Equipment and Material Costs:** Industrial-level metal AM machines and powder materials are very expensive.

Quality Control, Certification, and Process Validation
It is evident that quality assurance is central in a critical field like aviation. The complete digital traceability of the AM process is a major advantage. The fusion of each layer can be monitored in real-time using sensors, high-speed cameras, and thermal imaging systems. Furthermore, produced parts are thoroughly inspected for internal structural defects (porosity, cracks) using non-destructive testing methods (CT Scanning, X-ray). These processes are vital for part certification and reliability.

Future Perspective and Discussion
It clearly demonstrates that AM is a permanent and transformative technology in the aviation industry.

In aviation, Additive Manufacturing (AM) is transforming production with lightweight, high-strength materials like titanium, Inconel, aluminum, and cobalt-chromium alloys Through Design for Additive Manufacturing (DfAM) using topology optimization and lattice structures engineers achieve unprecedented efficiency and part consolidation. Despite challenges in surface quality, certification, and cost, AM ensures digital traceability, real-time quality control, and on-demand part production. Far beyond prototyping, AM has become a cornerstone of modern aerospace engineering, shaping lighter, safer, and more sustainable aircraft for the future.

In the future, the direct production of larger parts (wing sections, fuselage panels), multi-material usage, "4D Printing" (structures that change shape over time), and digital inventory concepts will become more widespread. AM also has the potential to radically change aviation logistics by shortening the supply chain and enabling part production "on demand, where needed."

We are witnessing how Additive Manufacturing has evolved from being just a prototyping tool to a central role in final product manufacturing, especially in high-tech sectors like aviation. By enabling weight reduction, part consolidation, and design freedom, it has paved the way for the development of more efficient, safer, and more environmentally friendly aircraft. This technology has become one of the cornerstones of aviation engineering and will continue to play a critical role in shaping the future of aircraft and spacecraft.

Source:
Gibson, I., Rosen, D. W., & Stucker, B. (2015). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (2nd ed.). Springer Science

Sermet GÜNDÜZCÜ
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A321 NEO RADOME:
WHAT COULD THIS STRANGE STRUCTURE BE?

The Airbus A321neo EVO-5 radome enhances flight and maintenance safety through advanced S2-glass composites, titanium hardware, and external segmented lightning strips. Replacing toxic cadmium reduces health risks for technicians, while optimized composite curing and inspection-friendly design improve radar performance and impact resilience. EVO-5 combines engineering innovation, environmental responsibility, and human factors training, ensuring safer work environments, clearer weather-radar signals, and overall operational reliability.

Understanding the EVO-5 Composite Radome and Its Impact on Maintenance Technician Safety and Flight Safety

When observing an aircraft from the ramp, few structures draw as much curiosity as the smooth, rounded nose of the Airbus A321 neo. To most, this dome-shaped section appears simply as an aerodynamic shell. Yet, the radome short for radar dome is an essential part of the aircraft's safety ecosystem. It protects the weather-radar antenna, localiser antenna and glideslope antenna while ensuring minimal signal distortion, and it must simultaneously withstand aerodynamic, environmental, and electromagnetic stresses.

In 2025, Airbus introduced the EVO-5 radome, the latest generation in its single-aisle aircraft family. This new design combines advanced S2-glass composites, titanium hardware, external segmented lightning strips, and refined manufacturing processes to improve both flight safety and maintenance safety. The EVO-5 program also reflects a broader

Figure 1. *Airbus A321neo EVO-5 radome – external view on ramp (Source: Author's collection, 2025).*

Figure 2. *Close-up of segmented lightning strip on EVO-5 radome (Source: Author's collection, 2025).*

evolution in the aviation maintenance ecosystem linking human health protection, environmental sustainability, and operational reliability.

This paper examines the EVO-5 radome through the lenses of engineering innovation, technician safety, and flight operations, incorporating the latest data from Airbus (2025), the Airbus SafetyFirst series (2024–2025), Engineering Pilot (2024), and academic studies on cadmium toxicity (Öktüren Asri et al., 2007). The goal is to illustrate how structural design, material science, and safety culture together determine the reliability of both the machine and the human maintaining it.

Evolution of Airbus Radome Technology

Since the first Airbus A300 in the 1970s, the manufacturer has continually improved its radome designs to meet the increasing demands of high-frequency radar systems and all-weather operations.

Early radomes consisted of glass-fiber composite shells light, inexpensive, but limited in strength and dielectric stability. The 1980s introduced Kevlar composites, offering higher impact resistance but prone to moisture absorption. Later, quartz-fiber radomes improved radio-frequency (RF) transparency but were heavier and more expensive.

By the early 2000s, Airbus standardized the S2-glass composite system an optimized balance between mechanical strength and dielectric uniformity. The EVO-3 and EVO-4 models implemented refined lay-up techniques and better lightning-protection meshes.

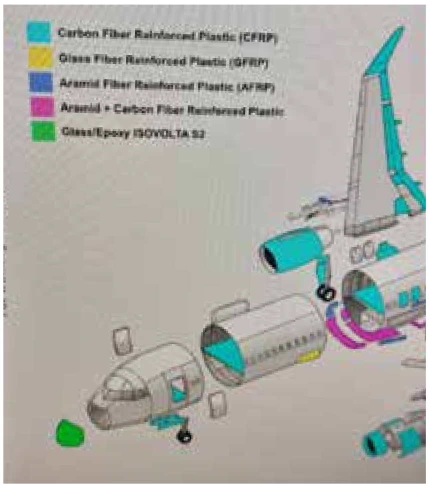
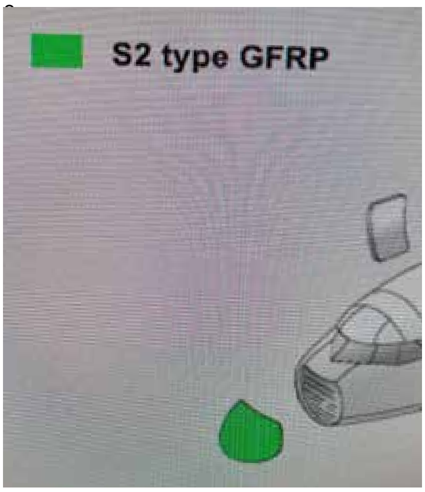


Figure 3. *Airbus A320 Family composite material distribution – CFRP, AFRP, and S2-type GFRP regions (Source: Airbus Type Training Presentation, 2025).*

In 2025, Airbus released the EVO-5 radome (Modification 172848, P/N E531-32310-000), which marks the most comprehensive redesign in decades. Its innovations respond to two main drivers:

1. Enhancing flight-safety performance under lightning and hail events;
2. Improving maintenance safety by eliminating toxic metals and simplifying inspection tasks.



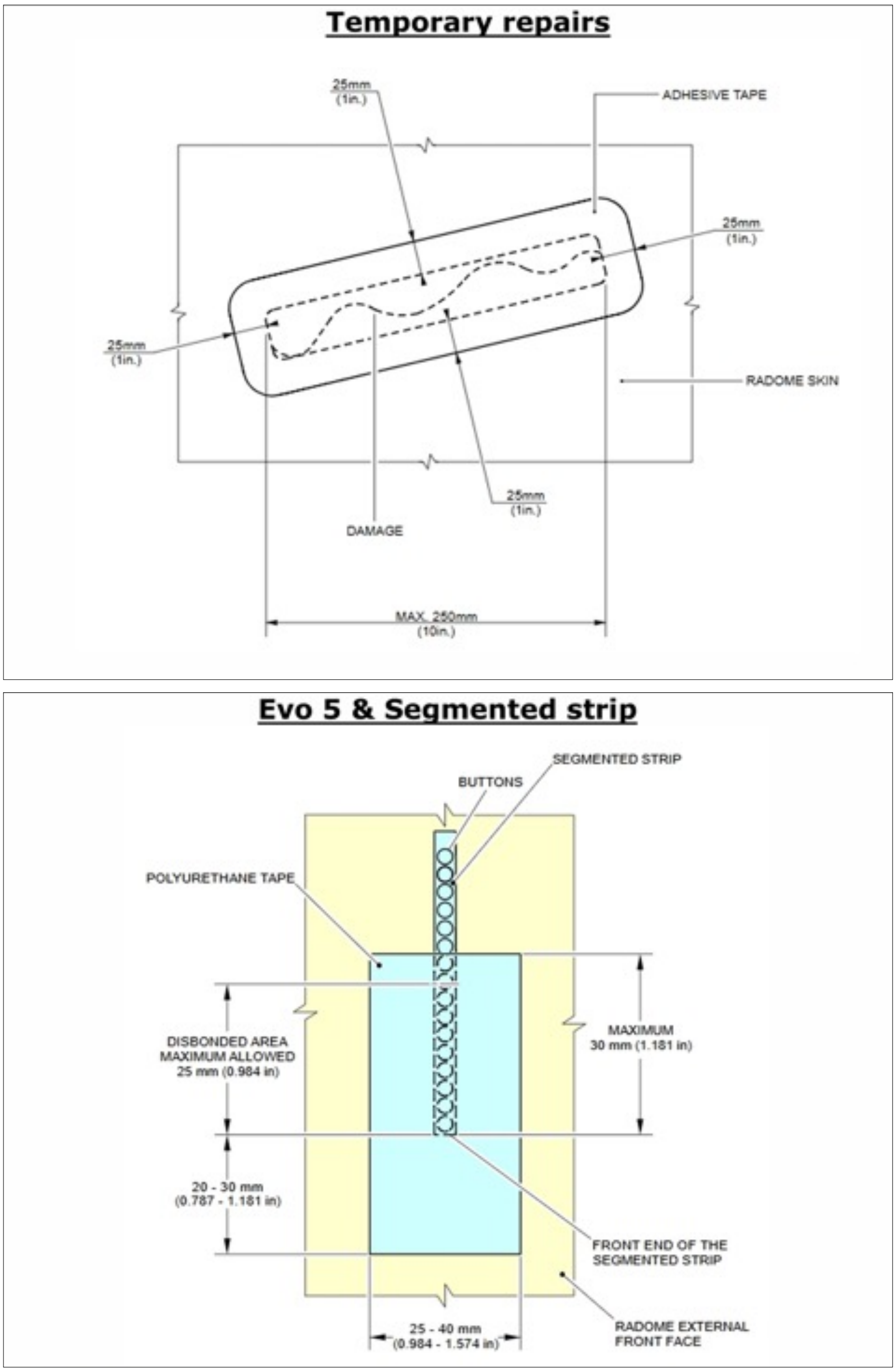


Figure 4. *S2-type Glass Fiber Reinforced Plastic material indicator – radome region (Source: Airbus Training Material, 2025).*

According to the A320 Family Radome Information manual (Airbus, 2025), EVO-5 introduces several key advancements:

Titanium Lightning Studs
Previous generations used cadmium-plated studs to connect the radome's lightning diverter strips to the aircraft structure. Although cadmium offered corrosion resistance, it posed serious toxicity risks for maintenance personnel. EVO-5 replaces these with titanium studs, which are corrosion-resistant, lightweight, and non-toxic. This change eliminates cadmium dust exposure during removal, sanding, or bonding operations.

External Segmented Lightning Strip
Unlike fully internal designs, the EVO-5 incorporates a 25-centimeter external segmented lightning strip, visible on the nose surface. When lightning strikes, this strip creates an ionized, low-resistance path that channels the electrical discharge into the broader aircraft protection network. The visible segmentation also allows quicker inspection and ensures predictable conductivity.

Optimized Composite Curing and Sealing
The EVO-5 is cured at 2 bar autoclave pressure (compared to 1.2 bar in EVO-4), producing tighter resin matrices and improved cohesion. Revised seal designs and metallic spacers reduce the risk of water ingress one of the main causes of radar-signal attenuation and internal corrosion.

These refinements support compliance with RTCA DO-213A standards for radome RF transparency and structural performance.

As highlighted by Engineering Pilot (2024) in "The Radome: More than an Aerodynamic Housing", a radome must reconcile three conflicting requirements: aerodynamic smoothness, RF transparency, and structural toughness. Each parameter directly affects radar system reliability.

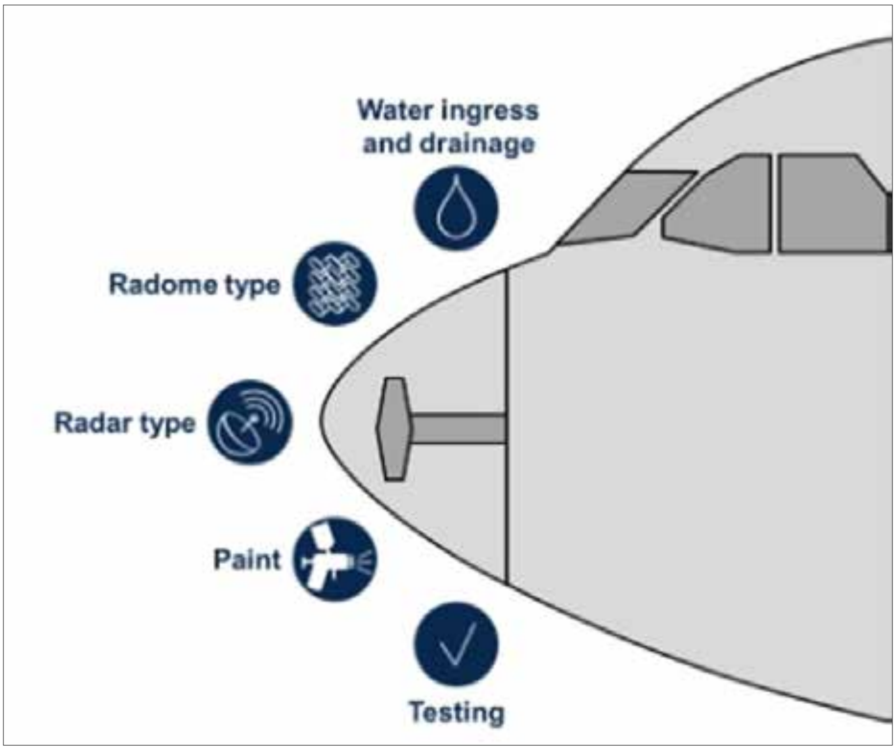


Figure 5. *The five affective parameters influencing radome RF performance: water ingress, radome type, radar type, paint, and testing (Source: Airbus SafetyFirst, 2024).*

Even a thin layer of paint, trapped moisture, or micro-delamination can alter the dielectric constant of the composite, leading to signal distortion or false echoes. Over-thick paint layers can also absorb or reflect radar energy. EVO-5 addresses these challenges through precise composite lay-up control, uniform wall thickness, and improved surface finishing.

The Engineering Pilot analysis further notes that damage from bird impacts, hail, or ground-handling may remain invisible on the surface yet cause internal honeycomb collapse or bond failure. Therefore, advanced non-destructive inspection (NDI) methods ultrasonic pulse testing, thermography, or tap-tests must complement visual inspection. EVO-5's internal honeycomb core is optimized for such assessments, providing clearer acoustic signatures for damage detection.

Aircraft maintenance technicians are at the frontline of aviation safety, yet they are also exposed to various occupational hazards. One of the most insidious is chronic exposure to heavy metals like cadmium, historically used in anti-corrosion coatings and electrical bonding components.

Research by Öktüren Asri, Sönmez, and Çıtak (2007) at Akdeniz University established that cadmium:

- Is a Group 1 carcinogen (IARC classification);
- Accumulates in the liver, kidneys, and bones, with a biological half-life of 10–38 years;
- Causes osteoporosis, respiratory damage, and renal failure upon long-term exposure;
- Is absorbed through inhalation of dust and fumes, particularly during grinding or soldering processes.

In MRO environments, technicians may inadvertently inhale cadmium particulates when repairing or stripping legacy radomes.
By replacing these components with titanium, EVO-5 significantly reduces this health risk.

Nonetheless, composite workshops remain environments of potential chemical exposure resin vapors, fiber dust, and adhesive solvents require strict personal protective equipment (PPE): respirators, nitrile gloves, and local exhaust ventilation. Organizations must enforce EASA Part-145 and OSHA compliance to monitor airborne contaminants and protect technicians' health.

From an operational viewpoint, the EVO-5 radome is integral to the aircraft's weather-radar system performance. It acts as the first interface between the environment and the antenna, and any loss of transparency can compromise pilot decision-making in convective weather.

The external segmented strip on EVO-5 ensures lightning energy is distributed uniformly, preventing localized thermal damage and delamination. Its titanium hardware reduces galvanic corrosion and maintains grounding reliability over the aircraft's service life. Together, these features contribute to a more stable maintenance cycle and fewer unscheduled repairs.

Airbus data show that radome-related weather radar faults have decreased by over 30 % in EVO-5 installations compared with EVO-3 variants (Airbus, 2025). Fewer faults translate into better operational availability and reduced human-factor risks associated with repetitive troubleshooting and rework.

Radome Integrity and Weather Radar Performance

Airbus SafetyFirst's article "Optimum Use of Weather Radar" (2024) emphasizes that radar performance depends not only on the equipment itself but also on the integrity of the radome through which electromagnetic waves must pass.

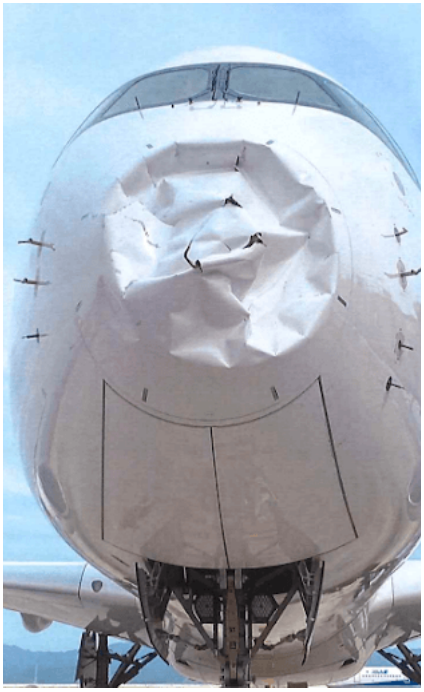
A radome with surface imperfections or moisture trapped in its composite layers can cause beam scattering and signal attenuation, leading to underestimation of storm intensity or false echoes. The EVO-5 design minimizes these risks through uniform thickness, precision curing, and hydrophobic sealants.

For technicians, this means that every painting, cleaning, and inspection task is a safety-critical operation. Excess paint thickness or improper sealant selection can alter the radome's RF response. Thus, maintenance crews must adhere strictly to manufacturer specifications in the SRM and AMM to preserve weather-radar precision.

Ultimately, the EVO-5's contribution to flight safety lies in its ability to allow modern radars to "see clearly" through the storms an advantage that depends on both sound engineering and skilled maintenance.

Bird and Hail Strike Resilience
The Airbus SafetyFirst document "Bird or Hail Strikes on the Radome" (2025) details the unique vulnerability of forward structures to impact events. Even minor surface marks can mask severe internal delamination within the honeycomb core.

The recommended post-event procedure includes both external and internal inspections using non-destructive techniques. Technicians must pay special attention to lightning diverter strips, stud integrity, and paint layers. Failure to detect hidden damage may lead to radar signal distortion or even structural failure under pressure loads.



EVO-5's improved seal design and titanium studs enhance impact resistance and simplify inspection. Moreover, proper containment and PPE are essential when handling debris, since broken composite fibers or resin dust can irritate the respiratory system and skin.

For flight crews, the importance is equally clear: a compromised radome can reduce the range and accuracy of the weather radar, potentially delaying storm avoidance maneuvers. Hence, regular training and prompt communication between pilots and maintenance teams after hail encounters are vital to overall safety continuity.

Environmental and Regulatory Dimensions
Aviation maintenance safety now extends beyond individual health to environmental responsibility. Cadmium waste disposal and composite dust management are regulated under European REACH and EASA Part-145 Annex II standards.

Cadmium can remain in soil and water for hundreds of years, bio-accumulating through plants and entering the food chain (Öktüren Asri et al., 2007). Replacing cadmium in EVO-5 hardware directly reduces the aircraft's ecological footprint. Technicians must treat cadmium-containing legacy components as hazardous waste, store them in sealed containers, and use certified disposal channels.

This environmental aspect aligns with Airbus's broader sustainability agenda, which emphasizes "Design for Environment (DfE)" principles engineering choices that protect both people and planet throughout the product life cycle.

Training, Human Factors, and Safety Culture

Engineering advances achieve little without human discipline. The transition to EVO-5 radomes requires continuous learning in three key domains:

1. Composite Repair Competence – Technicians must master modern bonding, patching, and painting techniques specific to S2-glass materials. Training should include hands-on modules and OEM certification.
2. Human Factors (HF) – Fatigue, communication, and organizational pressures remain leading contributors to maintenance errors. Integrating HF training with EVO-5 maintenance curricula strengthens situational awareness and risk recognition.
3. Safety Management System (SMS) – Proactive hazard reporting and data-driven safety metrics enable organizations to detect patterns of exposure or defects before they lead to incidents.

By combining technical and behavioral competence, the aviation maintenance community ensures that new materials and designs translate into real-world safety benefits.

Conclusion

The EVO-5 radome of the Airbus A321 neo embodies a comprehensive approach to aviation safety one that recognizes the inseparable link between technological innovation and human well-being.

By replacing cadmium with titanium, introducing segmented lightning strips, and optimizing composite manufacture, Airbus has reduced maintenance hazards while improving operational performance. Each design decision addresses a specific dimension of safety: physical, chemical, and procedural.

For maintenance technicians, EVO-5 symbolizes a safer and cleaner work environment. For flight crews, it ensures clearer radar vision and greater confidence in adverse weather. And for the industry as a whole, it illustrates that the future of airworthiness depends on integrating engineering excellence with sustainability and human factors.

Flight sSafety begins with technician safety and technician safety begins with awareness.

The Airbus A321neo EVO-5 radome advances aviation safety, environmental responsibility, and technician well-being. By replacing cadmium with titanium, implementing segmented lightning strips, and optimizing composite construction, it reduces health hazards, improves radar performance, and supports sustainability. Effective maintenance relies on continuous training, human factors awareness, and Safety Management Systems, ensuring innovations translate into safer operations for both crews and technicians.

Through continuous education, precise workmanship, and respect for materials, the aviation community ensures that innovations like EVO-5 fulfill their ultimate purpose: protecting both lives and missions.

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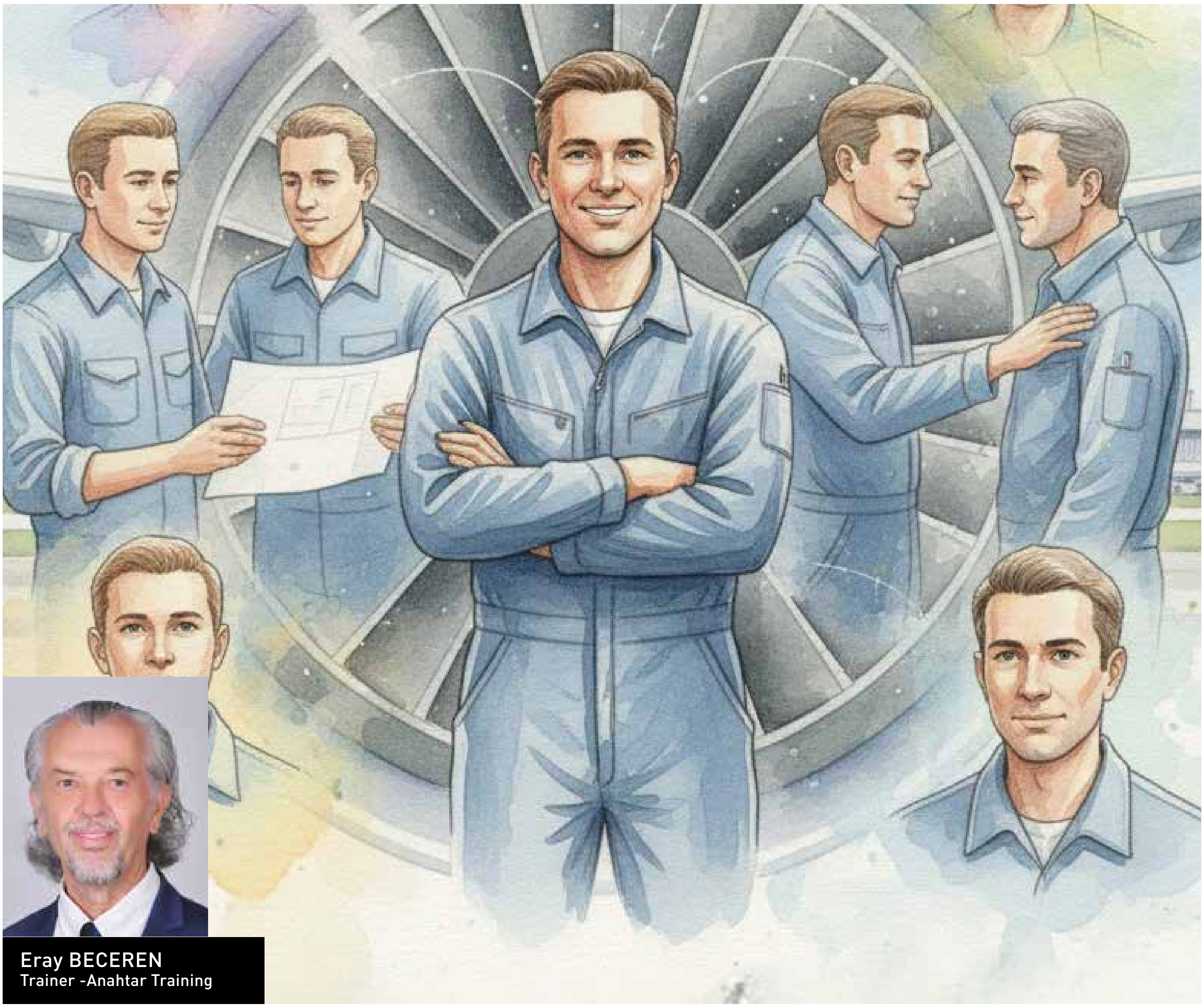

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BEYOND THE WRENCH:

WHY EMOTIONAL INTELLIGENCE IS THE UNSUNG HERO OF AIRCRAFT MAINTENANCE

In aviation maintenance, technical skill keeps aircraft flying but emotional intelligence (EI) keeps them safe. By fostering self-awareness, self-management, social awareness, and relationship management, EI helps technicians manage stress, communicate effectively, and prevent the human errors behind most incidents. An emotionally intelligent AMT is not just a mechanic, but a guardian of safety and teamwork, blending precision with empathy.

In the high-stakes world of aviation, the image of an Aircraft Maintenance Technician (AMT) is often one of pure technical prowess: a individual clad in coveralls, armed with a wrench, and immersed in complex schematics. Their value is measured in certifications, years of experience, and an encyclopedic knowledge of manuals and systems. While these technical skills are undeniably the bedrock of the profession, a silent, more human factor is increasingly being recognized as a critical component of safety and efficiency: Emotional Intelligence (EI).

For decades, the focus in maintenance training has been almost exclusively on the cognitive and psychomotor domains. However, a string of incident investigations and human factors research has consistently pointed to a different source of error the socio-emotional landscape of the team and the individual. Emotional Intelligence, the ability to recognize, understand, and manage our own emotions and those of others, is no longer a "soft skill" for corporate leaders. On the hangar floor and the flight line, it is a hard, non-negotiable necessity for safety.

The Pillars of EI in the AMT Environment

Emotional Intelligence can be broken down into four core competencies, each with a direct and powerful application to the daily life of an AMT.

1. Self-Awareness: The Foundation of Professional Composure

An AMT must be aware of their internal emotional state. Are they feeling rushed because of a tight turnaround? Are they frustrated with a stubborn component or a confusing technical directive? Are they fatigued after a long night shift? A lack of self-awareness turns these internal states into hidden threats.

A self-aware technician recognizes the onset of frustration. Instead of forcing a part and risking a stripped thread or a self-inflicted injury, they pause, take a breath, and recalibrate. They understand that fatigue impairs judgment and are more likely to double-check their work or seek a second pair of eyes. This internal check is the first line of defense against performance-degrading emotions.

2. Self-Management: From Emotion to Action

Awareness alone is not enough; the ability to manage those emotions is what separates a good technician from a great one. Self-management is about channeling emotions constructively.

Consider pressure. A delayed aircraft means financial loss and passenger inconvenience. The pressure to "get it done fast" can be immense. A technician with strong self-management skills feels this pressure but does not let it compromise their methodology. They adhere to the prescribed procedures, understanding that a safe, correct repair is the only acceptable outcome. They manage their stress, preventing it from morphing into recklessness. This emotional discipline is as crucial as the discipline to follow a manual.

3. Social Awareness: Reading the Room and the Team

Aircraft maintenance is rarely a solo endeavor. It is a complex, collaborative effort. Social awareness, or empathy, is the ability to accurately perceive the emotions and dynamics of others in the team. Is a colleague unusually quiet or irritable? Do they seem distracted? A socially aware AMT picks up on these cues.

This awareness is vital for effective communication. It allows a technician to tailor their message perhaps approaching a stressed colleague with more patience or offering help without condescension. Furthermore, it fosters a sense of psychological safety, where team members feel seen and supported. This is the bedrock of a Just Culture, where individuals are not afraid to speak up about mistakes or concerns.

4. Relationship Management: The Art of Communication and Conflict Resolution

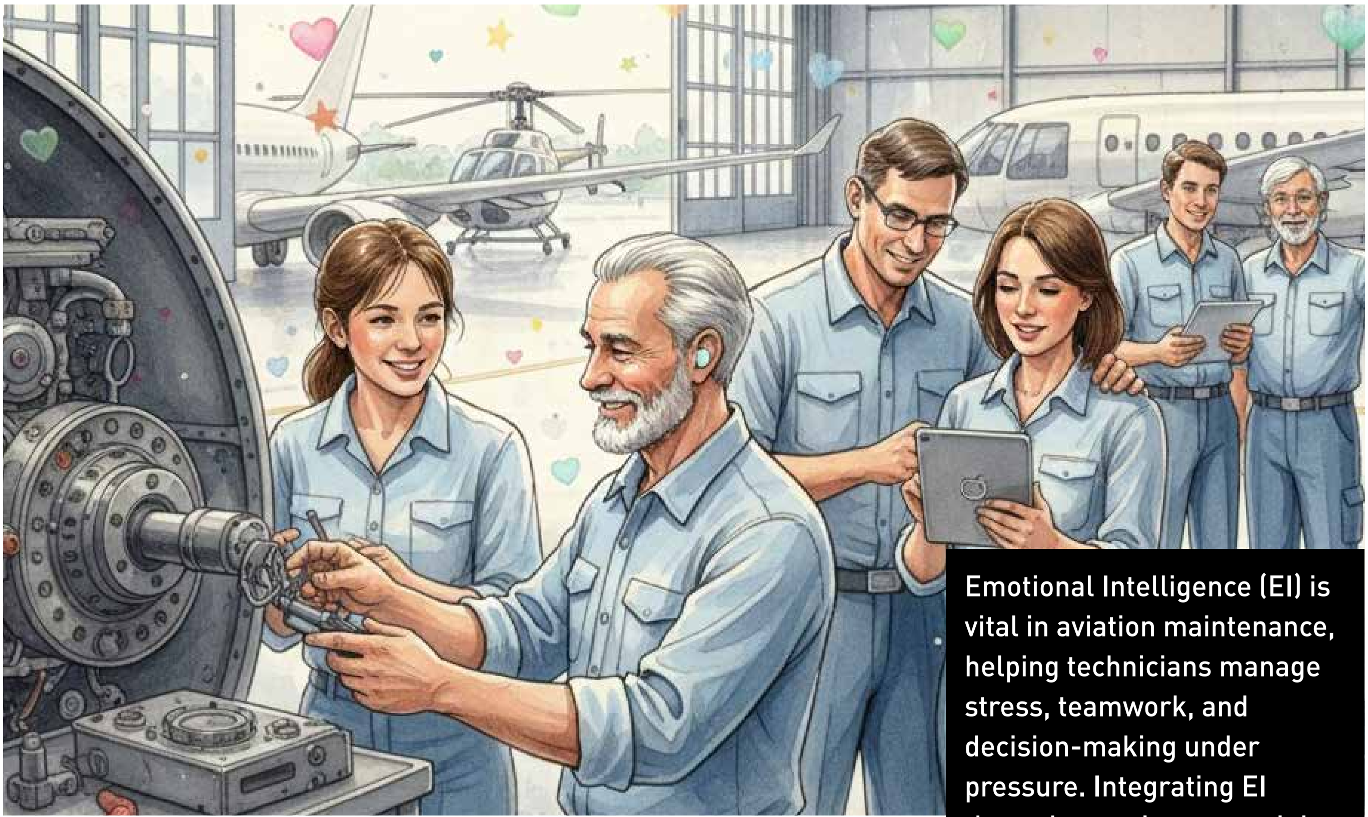
This is where all the components of EI come together to influence interactions. For an AMT, relationship management is about clear, assertive, and respectful communication. This is most critical during tasks like shift handovers or when challenging a superior's decision. The "sterile cockpit" rule for pilots has a parallel in maintenance: communication must be clear and unambiguous. An EI-equipped technician can assert a safety concern to a lead engineer without being aggressive or dismissive. They can navigate the interpersonal dynamics to ensure the technical truth is heard. They can de-escalate a conflict between colleagues, ensuring the team's focus remains on the shared goal of airworthiness.

EI as a Direct Counter to the "Dirty Dozen"

The link between EI and aviation safety is perfectly illustrated by its power to mitigate the "Dirty Dozen" the twelve most common human factors precursors to maintenance errors.

Lack of Communication: EI fosters open, effective dialogue.

Complacency: Self-awareness helps technicians recognize when they are



> **Emotional Intelligence (EI) is vital in aviation maintenance, helping technicians manage stress, teamwork, and decision-making under pressure. Integrating EI through recruitment, training, and leadership builds safer, more empathetic teams. In aviation, safety relies not only on technical skill but also on emotional awareness and collaboration.**

slipping into automatic, unthinking mode.

Lack of Knowledge: The social awareness and relationship management skills to ask for help without shame.

Distraction: Self-management allows a technician to consciously refocus after an interruption.

Lack of Teamwork: EI is the very engine of effective collaboration.

Fatigue: Self-aware technicians can recognize their own performance limitations.

Lack of Resources: The ability to manage frustration and communicate needs effectively.

Pressure: As discussed, self-management is key.

Lack of Assertiveness: EI provides the tools to be respectfully assertive when safety is on the line.

Stress: EI offers a toolkit for emotional regulation.

Lack of Awareness: This applies to both technical and social awareness, both strengthened by EI.

Norms: Socially aware technicians can identify and challenge unsafe cultural norms within the team.

Cultivating the Emotionally Intelligent Hangar

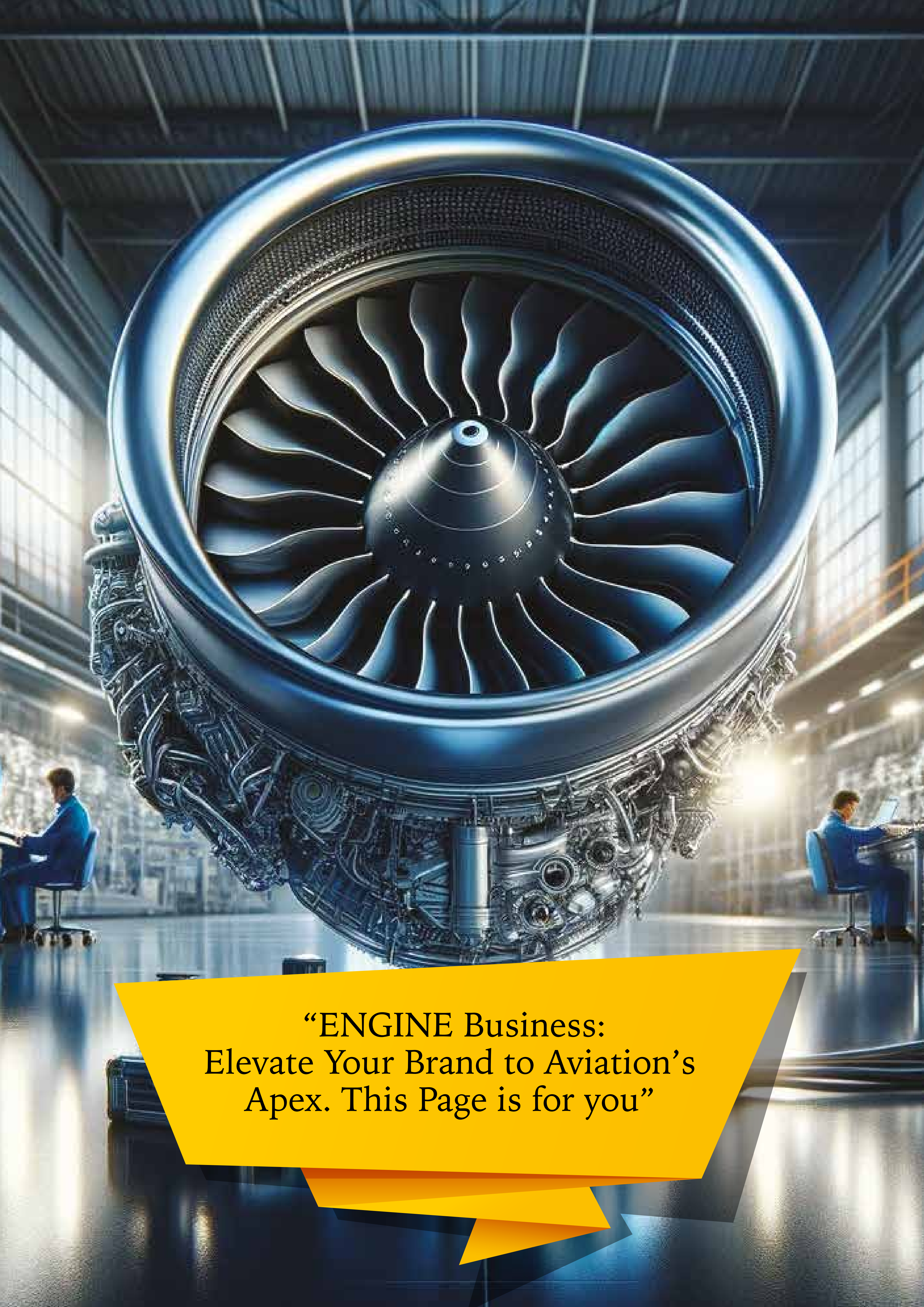
Integrating EI into the aviation maintenance culture requires a deliberate shift. It begins with recruitment. Behavioral interview questions can help identify candidates who naturally demonstrate empathy, self-regulation, and teamwork.

More importantly, EI must be woven into initial and recurrent training. Workshops that move beyond theoretical human factors into practical, scenario-based exercises are essential. Technicians can role-play difficult conversations challenging a peer's work, reporting their own mistake, or managing an impatient flight crew. Debriefing real-world events through an EI lens can provide powerful, tangible lessons.

Finally, leadership must model emotionally intelligent behavior. When supervisors demonstrate self-awareness, manage their own stress effectively, and show genuine empathy for their teams, they create an environment where these skills are valued and replicated.

Conclusion

The modern AMT is more than a mechanic; they are a guardian of safety in a complex, human-technical system. Their toolkit must contain more than calibrated instruments. By embracing and cultivating Emotional Intelligence, the aviation industry empowers its maintenance workforce with the most critical tool of all: the human capacity to navigate the emotional complexities that underlie every task, every decision, and every interaction. In the relentless pursuit of zero incidents, investing in the emotional skills of the women and men on the front line is not just beneficial it is imperative. The safety of millions depends not only on their skilled hands but on their mindful hearts.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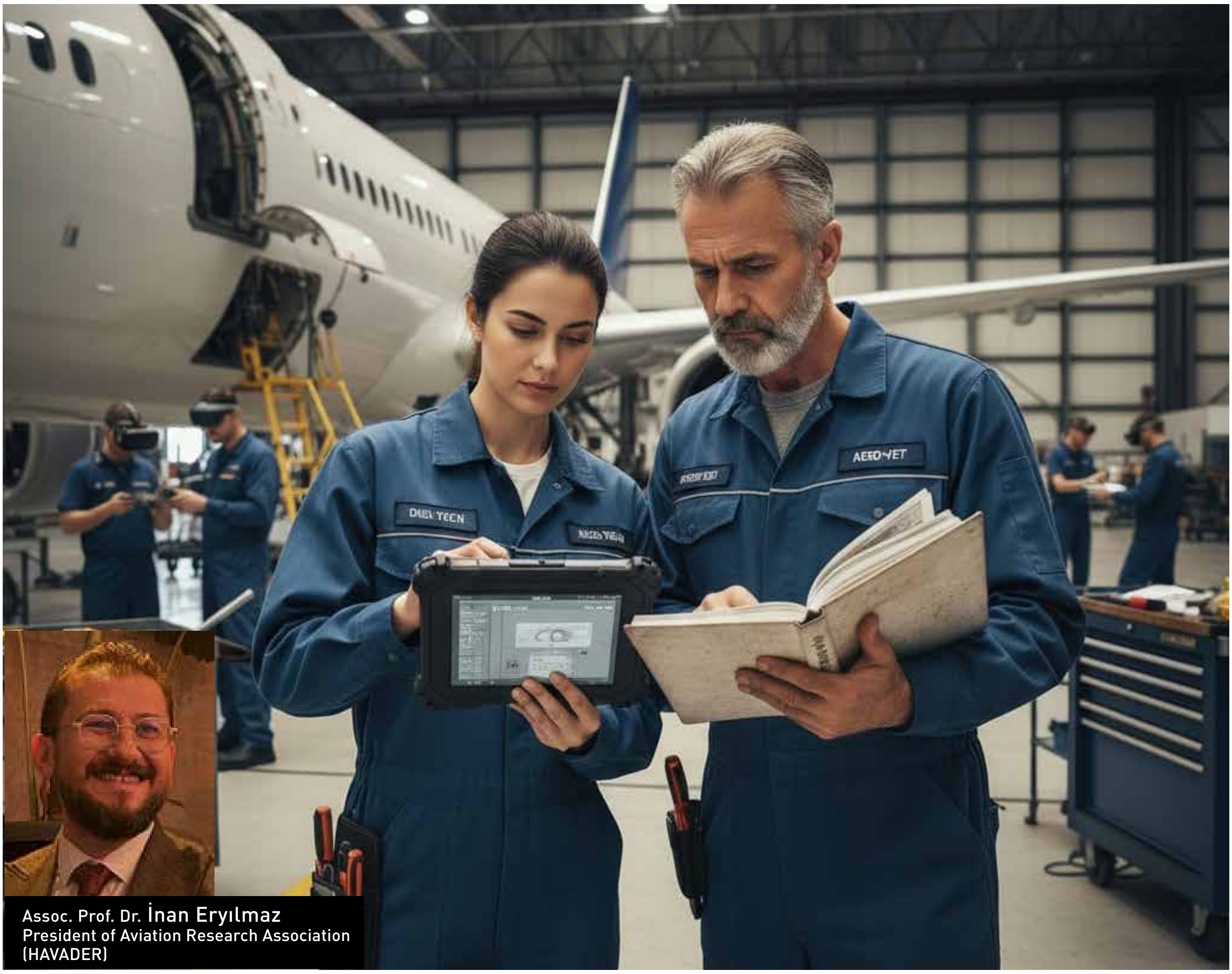

Assoc. Prof. Dr. İnan Eryılmaz
President of Aviation Research Association (HAVADER)

SELF-DISCIPLINE IN AVIATION IN THE DIGITAL AGE: THE INVISIBLE POWER OF MAINTENANCE SAFETY

As aviation rapidly digitalizes, safety still depends on one timeless factor: Human discipline. From maintenance to operations, digital competence must be balanced with self-discipline checking, verifying, and taking responsibility beyond what software can ensure. In hangars, digital natives bring speed, while experienced technicians bring procedural rigor; together, they form the foundation of modern safety culture. Because in aviation's digital future, technology delivers precision but disciplined humans deliver safety.

Technology in aviation is advancing rapidly. Flight management, maintenance planning, fault detection, and logistics management are now conducted entirely in digital environments. However, this entire digitalization process does not change one fact: the security of systems is still determined by the discipline of the people who use them. From aircraft maintenance to flight operations, the "human factor" remains the weakest yet most critical link at every stage. Digital systems process data, and software reduces errors; however, without technicians, pilots, or engineers with high self-discipline, the reliability of those systems is also at risk.

Technology is Fast, Humans are Responsible!

Recent studies reveal that two distinct digital identities have emerged, particularly among maintenance technicians: "digital natives" and "digital immigrants." Digital natives are young personnel who were born into technology, grew up in front of screens, and move quickly through systems. For them, operating on digital platforms is extremely natural. Digital immigrants, on the other hand, are experienced, highly skilled, knowledgeable about procedures, but are a generation that learned technology later in life.

The difference between these two groups is not just an age difference; it is also a difference in their understanding of discipline. Digital natives typically produce quick and practical solutions, while digital immigrants proceed in a more planned and procedural manner. However, the foundation of safety in aviation relies on the balanced use of both skills.

Double-checking a torque value during maintenance, re-verifying the serial number of a part entered into the digital system, or confirming the revision used on the work card all of these are acts of self-discipline. And they are often invisible barriers that prevent accidents.

Digitalization Does Not Reduce Discipline, It Makes It More Necessary

Some maintenance workers believe that digital systems eliminate the risk of error. However, digitalization can make errors invisible. Choosing the wrong module, missing an approval, or skipping a signature in the system can disrupt the entire process. The golden rule of aviation, "check, double-check, then sign," applies equally in digital systems.

At this point, self-discipline is not just a personal virtue, but a cornerstone of safety culture.

Intergenerational Balance in Hangars

In today's maintenance hangars, two worlds work side by side:

The young technician who checks the MEL on a tablet and the experienced technician who checks every step of the repair against physical documentation. In fact, these two approaches complement each other. Young people bring speed; experienced technicians bring safety. Therefore, the most appropriate strategy for maintenance organizations is to encourage a culture of intergenerational learning.

While young technicians learn work discipline, error awareness, and attention management from experienced personnel, digital immigrants can also adapt to the speed and ease of new systems. The common goal is to turn individual differences into advantages. Because the primary responsibility of everyone working in maintenance is to ensure that the aircraft is safely prepared for its next flight.

Stepping Safety into the Future: Digital Competence + Self-Discipline

Aviation is one of the sectors where digitalization is applied at the most advanced level. However, technological competence alone is not enough. Every new system brings new responsibilities. For a maintenance technician, self-discipline means completing the correct documentation on time, double-checking every input in the system, and considering the safety implications of every action taken.

In short, digitalization brings speed; self-discipline ensures safety.

The sustainability of aviation depends on the balance between these two concepts

In the hangars of the future, artificial intelligence, augmented reality, or digital twin systems may be used. However, no algorithm can fully replace the attention, responsibility, and discipline of the technician managing those systems.

Aviation safety is measured not by how advanced the technology is, but by how disciplined the people using it are.

For today's digital technicians, self-discipline is not just a personal virtue, but a professional necessity.

Technology makes flight possible; self-discipline makes it safe.

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Istinye University

IF IN DOUBT- REPORT.

The Occurrence Reporting System is one of aviation's strongest safety tools used by flight crews, maintenance teams, and air traffic controllers alike. Its purpose is not to assign blame, but to identify root causes and prevent recurrence. Every event that endangers or could endanger flight safety must be reported within 72 hours, even if it doesn't fit standard categories. The Southwest Airlines incidents highlight why reporting matters failing to report delayed vital safety actions across multiple aircraft types. In aviation, the rule is simple: "If in doubt REPORT." Reporting protects lives and drives continuous safety improvement.

This article is written to emphasize the importance of Occurence Reporting. One of the most important mechanisms for enhancing safety in civil aviation is the Occurrence Reporting System.

Occurrence Reporting is not solely the responsibility of the flight crew. In addition to the flight crew, all units that may affect flight safety, such as Aircraft Maintenance and Air Traffic Control, are required to report significant events.

Subsequently, most incidents that led to changes in the Flight Operations Manual (FOM), Quick Reference Handbook (QRH), or the issuance of Airworthiness Directives were reported to the competent authorities using Occurence Reporting.

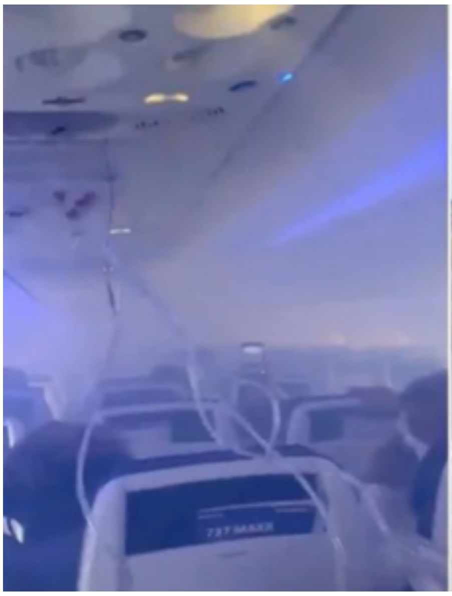
For the Occurence Reporting System to be used effectively and to ensure that reporting is carried out, the rationale behind the system must be explained to employees and adopted by them. The Occurence Reporting System requires that events that endanger or could endanger flight safety be reported to the competent authority within 72 hours at the latest when they are identified.

The purpose of reporting is not to punish the person who caused the significant event. The purpose is to find the root cause of the occurence and prevent its recurrence by implementing preventive measures.

To facilitate the review of Occurence Reports and enable classification for statistical purposes, the competent authorities provide examples of Significant Events in their manuals. If the occurence you wish to report falls under one of these headings, you should reference that heading when submitting your Occurence Report.

However, if the occurence you wish to report is not listed under any of the main headings, this does not mean you should not file an Occurrence Report. In this case, you should select the OTHER heading to file the Occurence Report.

In 2023, two similar incidents occurred on two different B737-8 MAX aircraft belonging to the US



airline Southwest Airlines. In the first incident, the aircraft returned after taking off from Havana, the capital of Cuba, due to a sharp-smelling white smoke filling the cabin. Cuba launched an "Accident-Significant Event Investigation" in relation to this incident.

In the second incident, another B737-8 MAX aircraft took off from New Orleans, USA, and returned due to a sharp-smelling white smoke filling the cockpit, raising suspicion of an engine fire. The pilots followed the engine fire procedure by cutting the engine's fuel supply, silencing the engine. Since the air intake from the engine into the cockpit was cut off, the white smoke also stopped. The aircraft landed on one engine. After landing, it was determined that there was no fire in the engine. A mechanical system called LRD (Low-Rise Damper) had engaged to separate the load after bird feathers entering the engine during takeoff caused damage.

During the separation process, oil inside the engine was exposed and turned into white vapor due to heat, and this white vapor entered the cockpit through the ventilation system.

outhwest Airlines did not report to the NTSB after the incident in which the aircraft was forced to land at the airport with only one engine.

Southwest Airlines' failure to report indicated that the incident was not included in the Significant Event Report Headings.

Failing to report to the NTSB an incident involving dense smoke in the cockpit obscuring flight instruments, the need to shut down one engine in flight, and landing at the airport with only one engine indicates that the airline did not understand the logic of this system.

The incident was reported to the NTSB by some other source, and the NTSB determined that the load separator system, known as LRD, was also present in other LEAP engines manufactured by CFM.

Consequently, the NTSB issued warnings to the relevant civil aviation authorities not only for the Boeing B737-8 MAX but also for the Airbus A320 NEO family and the Chinese COMAC C919 aircraft.

Therefore, we say "IF IN DOUBT-REPORT," meaning if you are unsure whether to report or not, REPORT.

Let the institution you report to evaluate your report.

N. Temuçin GÜREL
Instructor/Author

THE HUMAN FACTORS

SAFETY MANAGEMENT SYSTEM AND THE HUMAN FACTOR

This paper examines the relationship between safety management and the human factor in aviation, emphasizing how both have evolved together throughout aviation history. The understanding of safety has progressed through four main stages: the Technical Era of the 1960s, which focused on technological improvements; the Human Factors Era of the 1970s and 1980s, which centered on reducing human error through training and awareness; the Organizational Era of the 1990s, which recognized that errors often result from multiple organizational causes rather than individual mistakes; and the Total System Era from the 2000s onward, which adopts a data-driven, integrated approach to managing safety across all system components. The study underlines that true safety can only be achieved through a holistic approach, where machine, method, material, environment, and human factors work in coordination.

In order to understand the relationship between safety management and the human factor in flight operations and the importance of this relationship it will be useful to briefly review the chronological evolution of the concept of safety in aviation. Throughout aviation history, the concept of safety and, accordingly, the approach and culture of safety have evolved and developed over time. In each phase it has passed through to reach its present state, the concept of safety has been strengthened and has become more effective in the sector. As the understanding of safety has strengthened, the sense of confidence it generated led to an increase in flight operations, investments, and interest, thereby making this development sustainable.

In the remaining part of this paper, we will examine together the global evolution and transformation of the concept of safety in the aviation industry, and then discuss its relationship with the human factor both during this transformation and at the present stage.

CHRONOLOGICAL DEVELOPMENT OF THE CONCEPT OF SAFETY IN THE WORLD

The Technical Era

The period of awareness in aviation history in terms of safety management is known as the Technical Era, which dates back to the 1960s. During this period, the most important factor for ensuring safety was considered to be technical regulations and improvements. It was believed that technical enhancements made to the aircraft the vehicle that humans use to fly would contribute to safety. Thanks to these efforts, we now fly fifth-generation jet aircraft, and the developed technology has been designed in a way that largely prevents human error. The technological advancements achieved during the technical era made a highly significant contribution toward enhancing safety.

The Human Factors Era

The Human Factors Era refers to the period that followed the technical improvements and focused on the human element. This period covers the 1970s and extends to the mid-1980s. The main objective was to create an interface between the human and the aircraft and to reduce human-induced errors. Other factors affecting safety were somewhat overlooked, and the primary focus was placed on the human element. The human factors era is characterized as a period in which significant progress was made in elevating human awareness of safety issues.

The Organizational Era

The Organizational Era is significant as it represents the transition of the safety management system from a single-factor to a multi-factor perspective. Up until the beginning of the 1990s, the prevailing view generally sought the cause of an error in a single domain. From this point onward, it became understood that errors often have multiple sources. Accordingly, the concept of organizational error was introduced into the safety agenda, and proactive/reactive approaches began to be applied. One of the most important error management models in aviation history the Swiss Cheese Model was proposed by the renowned psychologist James Reason during this era.

The Total System Era

From the early 2000s onward, the understanding of safety was carried to a completely different dimension. The Total System approach, which we are now well acquainted with, became central and found wide practical application. This approach based on interaction among different interfaces, data collection and analysis, root-cause analysis, and data-driven decision-making has become the main axis of safety management.

THE HUMAN FACTOR IN THE DEVELOPMENT OF THE SAFETY MANAGEMENT SYSTEM

Let us now examine how the human factor has played a role in the transformation and evolution of safety management summarized above.

In the Technical Era, human involvement was, of course, inherent in the process. However, as the focus was primarily on technical improvements and developments, technical personnel (technicians, engineers, and the like) played the most active roles.

This study discusses the relationship between safety management and the human factor in aviation by reviewing the historical development of the safety concept. Aviation safety has evolved through several key stages: the Technical Era of the 1960s, which focused on technological improvements to aircraft; the Human Factors Era of the 1970s and 1980s, which emphasized reducing human error and improving awareness; the Organizational Era of the 1990s, which recognized that safety issues often arise from multiple organizational sources rather than individual mistakes; and the Total System Era from the 2000s onward, which introduced data-driven, integrated approaches to managing safety.

During the Human Factors Era, as the name suggests, the focus of safety was on the human being. Attention was directed particularly toward those working in units that have a direct impact on flight safety. Significant progress was made in the training and development of individuals working in these departments. Mandatory training programs were introduced for employees in certain operational units. In addition to technical training, non-technical skills were identified and corresponding training programs were implemented. Through such efforts, significant momentum was gained in minimizing human error.

In the Organizational Era, as mentioned earlier, it became recognized that every part of the organization could have an impact on safety. Acting upon this principle, all departments and personnel within the organization were included in safety management, and efforts were made to create a shared culture. The goal was to develop individuals within the organization who perceive and interpret safety in the same way essentially, to establish an effective safety culture through a shared mindset.

Finally, in the Total System Era, efforts have focused on developing systems that are integrated with one another, exchange data, evaluate multiple possibilities, and help humans make data-based decisions. The aim has been to guide humans who are inherently inclined to make intuitive decisions toward rational decision-making within a systemic framework. To achieve this, emphasis has been placed on analyzing data from different systems, transforming it into meaningful information, and facilitating human decision-making.

WHAT IS A HOLISTIC (TOTAL SYSTEM) APPROACH AND WHY IS IT NECESSARY?

Human beings have, for centuries, attempted to explore and understand the world they inhabit by breaking it

down into parts. Consider the human body, for example: to understand it, humans have studied it in segments. When we visit a hospital, we see departments such as pulmonology, surgery, otolaryngology, cardiology, ophthalmology, and so forth. Each of these has its own specialists. This division of labor is entirely normal and necessary. However, the effort to understand the whole by dissecting it into parts entails a serious risk: the weakening of the ability to connect the parts and view them holistically.

If each part focuses solely on its own field without adequate integration, communication, cooperation, or coordination among them, the likelihood of accurate diagnosis and treatment diminishes. To understand how a brain condition affects the muscular system, or how a blockage in a vessel impacts heart function, a holistic approach connecting these distinct domains is essential.

Peter M. Senge addresses this issue in his book The Fifth Discipline, stating:

"From an early age we are taught to break down problems, to divide the world into fragments. Although this makes it easier to handle complex issues, we pay an invisible but enormous price. We can no longer see the consequences of our actions, nor connect them with the broader context. When we try to see the whole picture, we attempt to reassemble the pieces to arrange them into a complete form. But this is futile; one cannot recreate the real image by piecing together fragments of a broken mirror."

Applying this to the aviation sector and particularly to flight operations we observe a similar structure. Like many other industries, aviation also divides the whole into specialized parts. Departments such as sales, marketing, human resources, planning, flight operations, technical services, finance, and cargo are examples of this division. Such specialization is both natural and necessary.

This is equally valid within flight operations: pilotage, maintenance, dispatch, ground operations, cabin crew, and loading functions are all parts of the whole. When these parts operate in harmony, we achieve the fundamental objective safety. However, if each part focuses solely on its own area without proper coordination, it becomes difficult for them to serve a common purpose. In such a case, establishing a genuine safety culture is not possible. As we all know in aviation, the ultimate objective is flight safety, with other important goals following behind it. If different departments and personnel fail to work in coordination as members of a team pursuing the same goal achieving safety becomes a major challenge.

THE ROLE OF THE HUMAN BEING IN THE HOLISTIC APPROACH

To ensure both safety and quality in any field, the following five factors must all be present simultaneously:

- Machine
- Method
- Material
- Environment
- Human

Consider an airline company as an example. The machine refers to the aircraft being used. The method represents how we operate these aircraft. It is crucial that the fleet is utilized effectively, efficiently, and safely. Owning a modern and flawless fleet but failing to plan and operate it safely and productively would be highly problematic.

Material refers to the tools, equipment, and resources we use in performing our work. When we use reliable materials and apply our methods properly, we can achieve satisfactory results.

Now let us turn to the fifth factor the human.

A company can acquire the first four factors through investment and resource allocation. However, the same cannot be said for the human factor; humans cannot be "purchased," developed, or made productive merely through resource allocation. Moreover, it is the human being who combines, coordinates, and extracts value from the other four factors.

Thus, although all of these components are important, the influence and power of the human factor are unique.

In the current Total System Era of safety management, humans are the planners and managers of all system components. In aviation, the human factor contributes both by effectively managing the processes within their

own units and by cooperating and integrating with other units across the organization, thereby enhancing overall safety and efficiency.

For example, a maintenance technician working in line maintenance not only performs maintenance tasks competently and safely to deliver the aircraft to the line in proper condition and on schedule, but also interacts appropriately with other components of the airline system, thereby contributing to the overall operational efficiency. In this regard, the human factor is at the very center of safety within the system and represents its most valuable element.

CONCLUSION

The understanding, approach, and culture of safety management both globally and in our country are evolving with time. The individuals who must adapt to these changing systems, sustain them, and ensure their continued improvement are human beings. The more swiftly and accurately humans adapt to these changes, the more effectively and correctly the system's requirements will be implemented. This, in turn, results in a safe flight operation.

For this reason, every aviation organization must prioritize people first and invest in its human resources. Such investment includes continuous training, development of incentive systems, and the creation of appropriate working conditions.

The more an organization places the human being at its center, the more the human will place safety at the center in return.

THE NEW FACE OF MAINTENANCE REGULATION:

HOW EASA'S 2025 UPDATES ARE REDEFINING THE MRO LANDSCAPE

EASA's 2025 reforms mark the start of a "predictive era" in MRO regulation, shifting maintenance from scheduled to data-driven and risk-based practices. New Airworthiness Directives and the mandatory Safety Management System (SMS) requirement embed predictive safety and real-time risk monitoring into daily operations. Though compliance costs rise, benefits include reduced unplanned maintenance, enhanced safety, and stronger digital integration. In this new framework, regulation becomes a driver of innovation, rewarding MROs that adapt quickly and use data intelligently.

The European Union Aviation Safety Agency (EASA) has long been the guardian of airworthiness in the European aviation ecosystem. Yet, in mid 2025, the Agency initiated a new phase of transformation that goes beyond mere compliance checklists and dives deep into the operational DNA of maintenance organizations. Since July 2025, a series of critical Airworthiness Directives (ADs), procedural updates, and management requirements have marked the beginning of what many in the industry now call "the predictive era of MRO regulation" a landscape where maintenance is no longer only reactive or scheduled, but data driven, risk sensitive, and performance oriented.

This transformation's first wave arrived through new technical revisions. Two directives, in particular, stand out for reshaping traditional maintenance cycles. EASA AD 2025-0142R1, for instance, withdrew previous maintenance instructions for a series of engine subassemblies after fatigue analysis revealed accelerated wear under variable load conditions. The practical implication for MROs was immediate: a mandate to revise maintenance task cards and check intervals, especially for medium haul aircraft using the affected components.

Similarly, AD 2025-0154R1 focused on wing-beam inspection, mandating repeat inspections for corrosion and micro-cracking at shorter intervals using enhanced non-destructive testing (NDT) techniques. This has already led several European carriers to update their heavy-check schedules, extending dock time by an average of 8–12 hours per aircraft. When EASA consolidated over 40 individual ADs across major fleets in its August Digest (Sass Sofia, 2025), the message became undeniable. Maintenance intervals are no longer just time or cycle based; they are fundamentally usage- and risk based. This transition represents the core of what EASA terms "condition driven airworthiness."

Perhaps even more transformative than these technical shifts is the managerial and cultural revolution underway. Under Maintenance Annex Guidance (MAG) Change 10, all U.S. based Part 145 repair stations holding EASA approval must implement a fully operational Safety Management System (SMS) by December 31, 2025. This requirement expands far beyond procedural documentation; it embeds predictive safety intelligence into daily operations.

This new SMS mandate forces the integration of hazard identification and risk assessment (HIRA) directly into maintenance event planning. It requires mandatory data reporting channels between line maintenance teams and the accountable manager, coupled with continuous safety performance monitoring (SPM) using trend analysis. For EASA, this is a governance shift. Maintenance organizations must now measure safety as a performance variable tracking metrics like a Safety Risk Index (SRI) or Corrective Action Closure Rate (CACR) not merely as a passive outcome. In short, what gets measured, gets improved and now, safety itself is being measured.

The ripple effects of these regulatory updates are already being felt across the MRO ecosystem. The introduction of more frequent inspection cycles has increased average maintenance man-hours per aircraft by roughly 6–10%, according to early estimates. While this adds short term workload, it simultaneously enhances the predictive maintenance data pools that allow for better long term optimization. EASA's push has also accelerated digitalization, with many organizations now integrating Maintenance Information Systems (MIS) with Flight Data Monitoring (FDM) to dynamically adjust inspection intervals. This, in turn, demands enhanced training. Maintenance engineers must now be as comfortable reading a dataset as they are reading a torque chart.

This leads to a new strategic and economic calculus. While compliance costs are projected to rise by 8–12% in the coming fiscal year, analysts

expect a reduction in unplanned maintenance events by up to 20% by 2027. This reflects a crucial shift from a corrective to a preventive cost structure. Early adopters are already reaping tangible rewards; one Scandinavian MRO group reported a 15% reduction in annual safety audit observations after piloting a data driven SMS aligned with MAG 10, leading to lower insurance premiums. "Regulatory agility " the ability to integrate new directives within 30 days versus the industry average of 90 is emerging as a powerful competitive differentiator.

Ultimately, EASA's new framework forces a redefinition of what performance means in aviation maintenance. The next generation of MRO metrics must align technical reliability (like post maintenance defect rates) with regulatory responsiveness (such as average AD implementation time) and a robust organizational safety culture (measured by safety reporting participation).

By late 2025, the European maintenance sector stands at the threshold of an era where regulatory intelligence and data integration merge. EASA's directives are no longer static constraints; they are dynamic inputs for continuous improvement. Forward-looking MROs are already embedding AI driven risk assessment tools into their planning and integrating SMS outputs directly into enterprise KPI frameworks.

This regulatory wave is more than an administrative update. It represents a philosophical realignment of aviation maintenance from rule following to risk forecasting, from corrective inspection to predictive assurance. Success in this new landscape will not be defined by how well organizations comply, but by how fast and intelligently they adapt. Regulation is no longer the ceiling; it is the framework for innovation.

HANDS TOUCHING THE SKY:

THE STORY OF FEMALE AIRCRAFT MAINTENANCE TECHNICIANS

Female aircraft maintenance technicians play a vital role in flight safety. Phoebe Omlie, born in 1902, was the world's first licensed female maintenance technician and transport pilot, inspiring women globally. In Turkey, pioneers like Nursel Ünden Ortaç have increased female representation in the field. Despite challenges such as prejudice and limited opportunities, women continue to excel, performing critical maintenance tasks and symbolizing resilience. From past pioneers to today's professionals, female technicians remain the silent heroes of aviation.

While aeroplanes glide through the sky, a great deal of effort is expended on the ground to ensure they can take off and land safely. Much of this effort is carried out by aircraft maintenance technicians, who often work behind the scenes but play an extremely critical role. Among these technicians are women who have made their mark on history with their courage and determination.

Phoebe Omlie:
A Woman's Journey to the Skies

Born in Iowa in 1902, Phoebe Fairgrave Omlie was still a young woman when she discovered aviation. In 1927, she made history by not only becoming a pilot but also obtaining an aircraft technician licence. She was the world's first licensed female aircraft maintenance technician. She was also the first female transport pilot and the first woman to be appointed to a federal position in aviation. Omlie could dismantle and reassemble aircraft engines, check fuel systems, and manage maintenance processes. Not content with just technical knowledge, she also meticulously followed procedures and maintenance records to ensure

that aircraft could operate safely in the hangar. The inspiration affected women around the world, not only job, also the determination of her.

The Rise of Women in Aviation in Turkey

Women in Turkey are also taking significant steps in the aviation sector. Nursel Ünden Ortaç served as chief technician at the Calibration Workshop at Turkish Airlines Technical Inc. and has been an important figure in paving the way for women in this field. She states that when she started working, there were very few female technicians, so working alongside men was both challenging and interesting. However, over time, the number of female technicians increased and the role of women in the aviation sector grew stronger.

The Role of Women in the Sector and the Challenges They Face

Female technicians undertake many critical tasks to ensure the safe operation of aircraft. These include

maintaining engines and mechanical systems, checking fuel and hydraulic systems, inspecting landing gear, testing avionics systems, and managing repair processes. They are also responsible for organising maintenance programmes and ensuring that pre-flight checks are carried out thoroughly. By successfully performing all these tasks, they guarantee aviation safety from both a technical and operational perspective. However, female technicians have not had an easy path in this sector. They have faced challenges such as social prejudices, limited educational opportunities, exclusion in the workplace, and a lack of mentorship. While the proportion of female maintenance technicians

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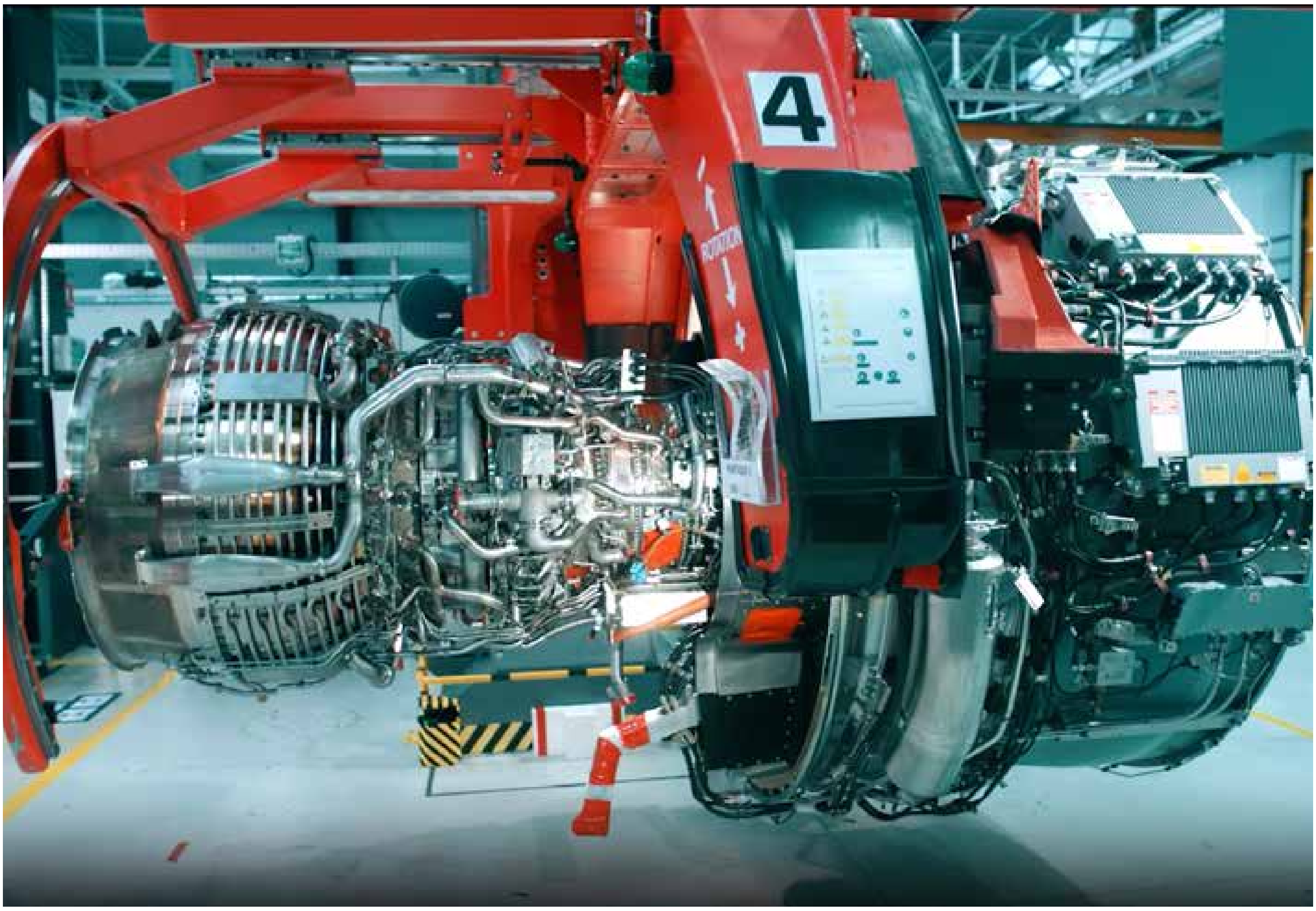


ADVANCING THE BOUNDARIES OF TURBOFAN TECHNOLOGY:
MATERIAL AND DESIGN INNOVATIONS IN THE LEAP ENGINE

CFM International, a 50–50 joint venture between GE and Safran, developed the LEAP engine as a modern successor to the CFM56 series. The LEAP-1A, -1B, and -1C power the Airbus A320neo, Boeing 737 MAX, and COMAC C919, respectively. Featuring advanced technologies such as composite fan blades, blisk compressors, TAPS II combustors, CMC materials, and 3D-printed fuel nozzles, the LEAP engine is 226 kg lighter, 15% more fuel-efficient, and significantly cleaner and more durable, offering faster 25-minute turnaround times.

The CFM company is a 50–50 joint venture between the American company GE (General Electric) and the French company Safran. The CFM56-5A/B engines are used on the Airbus A320 family, the CFM56-5C engines on the A340 aircraft, the CFM56-7B engines on the Boeing 737-800, and the CFM56-3 engines on the Boeing 737-400. The LEAP engines can be described as a modernized version of the widely used CFM56 series. The LEAP-1B version powers the Boeing 737 MAX, the LEAP-1C version powers the COMAC C919 (Commercial Aircraft Corporation of China), and the LEAP-1A version is used on the Airbus A320neo. The acronym LEAP stands for "Leading Edge Aviation Propulsion." In the LEAP program, Safran is responsible for the air inlet section, low-pressure turbine (LPT) section, oil system, accessory drives, and engine indicating system, while GE is responsible for the high-pressure compressor (HPC) section, high-pressure turbine (HPT) section, combustion diffuser section, fuel and control system, air system, ignition system, and starting system. The core architecture of the lighter and more durable LEAP engine includes a scaled-down version of the low-pressure turbine used in the GEnx engine. The fan section has 18 composite fan blades with titanium leading edges, manufactured using 3D woven RTM (Resin Transfer Molding)

technology, making them lighter and much more durable. Each engine is approximately 500 lbs (around 226 kg) lighter than its predecessors. The bypass ratio of the engine is about 9:1. The N1 shaft rotates at approximately 4,500 RPM, while the N2 shaft spins at 20,000 RPM.

Although the LEAP engine was designed to operate at higher pressures than the CFM56 (to achieve greater efficiency), the operating pressure is intentionally kept below maximum limits to maximize service life and reliability. The high-pressure compressor (HPC) uses "blisk" (bladed disk) technology. In the combustion chamber, second-generation Twin Annular Pre-mixing Swirler (TAPS II) burners are used, resulting in about a 50% reduction in NOx emissions. The bearing section incorporates ceramic hybrid bearings, which are 40% lighter and longer-lasting. For the first time in this engine type, 3D printing (additive manufacturing) was used to

produce fuel nozzles, making them about 25% lighter. Ceramic Matrix Composites (CMC) are used in the turbine shrouds; these materials withstand higher temperatures compared to conventional alloys and reduce the need for cooling airflow. The engine achieves an approximate 15% improvement in fuel efficiency. Additionally, the LEAP engine supports a 25-minute ground time (gate turnaround time), providing a significant operational advantage over competitors.

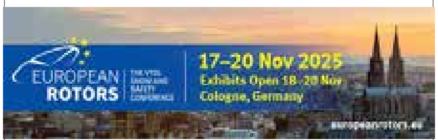
CFM International is a 50–50 joint venture between GE (USA) and Safran (France). Its LEAP engine family is the modern successor to the widely used CFM56 series. The LEAP-1A powers the Airbus A320neo, the LEAP-1B powers the Boeing 737 MAX, and the LEAP-1C powers the COMAC C919. Safran is responsible for components such as the air inlet and low-pressure turbine, while GE handles the high-pressure compressor, turbine, and combustion systems.
The LEAP engine integrates advanced technologies including composite fan blades made with 3D woven RTM, blisk high-pressure compressors, TAPS II combustors reducing NOx by 50%, ceramic matrix composites (CMC) in turbine shrouds, and 3D-printed fuel nozzles.

LIST OF MAJOR AVIATION EVENTS WORLDWIDE IN 2025

ATI CONFERENCE
4-5 NOVEMBER 2025
ICC WALES, NEWPORT, UNITED KINGDOM

PREDICTIVE AIRCRAFT MAINTENANCE
6 NOVEMBER 2025
SINGAPORE

DUBAI AIRSHOW
17-21 NOVEMBER 2025
DUBAI



EUROPEAN ROTORS 2025
17-20 NOVEMBER 2025
COLOGNE, GERMANY

SPACE TECH EXPO EUROPE 2025
18-20 NOVEMBER 2025
BREMEN, GERMANY

AMERICAN AEROSPACE & DEFENSE SUMMIT 2025
4-5 DECEMBER 2025
GLENDALE (ARIZONA), ABD

AIRSPACE ASIA PACIFIC 2025
09-11 DECEMBER 2025
HONG KONG

15TH AVIATION FORUM HAMBURG 2025
10-11 DECEMBER 2025
HAMBURG, GERMANY

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