



## BEING A ROLE MODEL AND IMPLICIT LEARNING

▶ **NEXT-GENERATION AVIONICS MAINTENANCE**  
ADVANCES IN AVIONICS TESTING AND REPAIR  
WITH NEW TOOLS AND TECHNOLOGIES

▶ **BASIC ELECTRICAL SYSTEMS IN  
MODERN AIRCRAFT**

▶ **ONE BOLT, ONE LIFE:  
THE POWER OF HUMAN FACTORS**

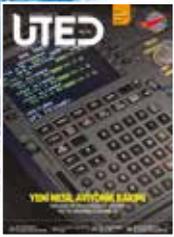


# UTED

# UTED 1968 INTERNATIONAL

# UTED MEETS THE WORLD

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**Dear Industry Stakeholders and Valued Readers,**

As we move from the operational intensity of December into the strategic clarity of January, we step into 2026 at a defining moment for our aviation technical community. Winter, for our industry, is never just seasonal; it is a demanding test of safety discipline, planning precision, and organizational resilience. The dedication demonstrated in our hangars, combined with the strategic foresight of our leadership teams, continues to shape a stronger and more future-oriented maintenance ecosystem.

The MRO sector has evolved far beyond its traditional boundaries. It now stands at the heart of the aviation economy, driving reliability, digital transformation, and sustainable growth. Aircraft availability and operational success are no longer measured solely in flight hours, but also in maintenance agility, data driven decision making, and the expertise of our technicians. In this environment, technical excellence is not optional it is strategic.

In 2026, international representation remains one of our central priorities. Technical capability gains its true influence when it is present and visible on the global stage. Through active participation in international aerospace exhibitions, global MRO summits, and technical forums, we will continue to position our aviation maintenance community as a respected and forward thinking force. Our responsibility is not only to maintain aircraft safely, but also to contribute meaningfully to the conversations that shape global maintenance standards and industry direction.

Innovation, particularly in areas such as AI driven predictive maintenance and sustainable operational practices, requires close alignment between craftsmanship on the hangar floor and vision in the boardroom. In aviation, success is born from this harmony. When operational expertise and strategic leadership move together, we build not only efficiency, but also trust and credibility.

As we begin this new year, we reaffirm our commitment to safety, operational excellence, and global engagement. I wish all our stakeholders, managers, engineers, and technicians a year defined by high standards, strong collaboration, and continued international success.

**With sincere regards,**



**Ömür CANİNSAN**  
UTED President

# Contents



## MRO DUBAI: STRENGTHENING THE MIDDLE EAST'S ROLE IN GLOBAL AVIATION MAINTENANCE

NEWS .....	6	ONE BOLT, ONE LIFE: THE POWER OF HUMAN FACTORS .....	40
MRO DUBAI: STRENGTHENING THE MIDDLE EAST'S ROLE IN GLOBAL AVIATION MAINTENANCE.....	14	DIGITAL COCKPIT, DIGITAL ORGANIZATION HOW ARTIFICIAL INTELLIGENCE IS TRANSFORMING AIRLINES .....	44
A NEW COMPETITIVE FRONTIER IN AVIATION: PEOPLE THE INDUSTRY'S REAL BOTTLENECK THROUGH THE LENS OF 2025 GLOBAL REPORTS THERE IS MONEY, THERE ARE AIRCRAFT... BUT WHO WILL MAINTAIN THEM? .....	16	SEIZING TÜRKIYE'S FUTURE: UAM AND ITS GROWTH PERSPECTIVE .....	46
NEXT-GENERATION AVIONICS MAINTENANCE ADVANCES IN AVIONICS TESTING AND REPAIR WITH NEW TOOLS AND TECHNOLOGIES.....	20	THE HUMAN FACTORS BEING A ROLE MODEL AND IMPLICIT LEARNING .....	52
BASIC ELECTRICAL SYSTEMS IN MODERN AIRCRAFT .....	24	BALANCING PRODUCTIVITY AND SAFETY IN MRO'S: STRATEGIC APPROACHES FOR SUSTAINABLE SUCCESS.....	56
SOJT TRAINING AND ITS CONTRIBUTION TO AVIATION .....	30	FUNDAMENTAL PRINCIPLES OF AIRCRAFT HANGAR FLOOR COATING DESIGN.....	58
THE LORD OF THE AIRCRAFT KURT WALDEMAR TANK .....	32	FATIGUE RISK MANAGEMENT IN AIRCRAFT MAINTENANCE: A SYSTEMATIC REVIEW OF PSYCHOLOGICAL RESILIENCE AND OPERATIONAL SAFETY .....	62
POWERFUL AND EFFICIENT COMMERCIAL JET ENGINE GE9X .....	34	AIRCRAFT COMMUNICATION SYSTEMS .....	66
TEAM EMOTIONAL INTELLIGENCE: THE INVISIBLE SAFETY NET FOR AIRCRAFT MAINTENANCE TEAMS .....	38	LIST OF MAJOR AVIATION EVENTS WORLDWIDE IN 2026.....	67



20

## NEXT-GENERATION AVIONICS MAINTENANCE

ADVANCES IN AVIONICS TESTING AND REPAIR WITH NEW TOOLS AND TECHNOLOGIES



34

## POWERFUL AND EFFICIENT COMMERCIAL JET ENGINE GE9X



52

## THE HUMAN FACTORS BEING A ROLE MODEL AND IMPLICIT LEARNING

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## Turkish Technic Extends AirSial Partnership

Turkish Technic, a leading MRO provider, has significantly expanded its collaboration with Pakistan's AirSial by signing a new component pool services agreement for the airline's Airbus A320neo fleet. This renewed partnership extends their existing 2020 cooperation for an additional five years while broadening the service scope. Under the agreement, Turkish Technic will provide comprehensive component support and pooling solutions, utilizing its vast global inventory and specialized workshops. This expansion aims to boost AirSial's operational reliability and fleet availability. Mikail Akbulut, CEO of Turkish Technic, stated that the agreement reflects a shared ambition and highlights their commitment to delivering world-class engineering services globally. The collaboration reinforces the strong operational bond between the two companies as they explore future growth opportunities together.



## Aims Community College Launches FAA-Certified AMT Program with Frontier Partnership

Aims Community College in Loveland, Colorado, has achieved a significant milestone with FAA Part 147 certification for its new Aircraft Maintenance Technician (AMT) Program. This accreditation enables Aims to offer a fully approved curriculum that meets federal standards for aviation maintenance education, preparing students with the technical expertise needed to enter today's high-demand workforce. In conjunction with the certification, Aims has entered a strategic hiring pathway partnership with Frontier Airlines, designed to create direct employment opportunities for qualified graduates. Under the agreement, eligible students who complete the AMT Program will have access to potential job offers with Frontier Airlines, including a \$25,000 signing bonus as part of the airline's recruitment initiatives.



## Artemis Aerospace Enhances European Operations with New Hamburg Hub and UK Warehouse

Artemis Aerospace has announced the opening of two new European facilities as part of its response to rising customer demand and its strategy to strengthen global service capabilities. The company's new hub in Hamburg will streamline supply and delivery operations for customers across Europe and enhance connectivity with its existing global network, which includes hubs in Miami, Los Angeles and Singapore. At the same time, Artemis has launched a principal UK logistics warehouse in Ashington, West Sussex, significantly expanding storage and handling capacity to better support inventory management and 24/7 AOG services across its international customer base.



## Baykar to Boost Piaggio P.180 Production and Launch

Turkish aerospace firm Baykar is planning a major expansion of production for Piaggio P.180 Avanti light twin-turboprop aircraft after 4–5 aircraft, Baykar intends to increase output to 25–30 aircraft annually, leveraging existing facilities and supply chains to meet growing market demand.

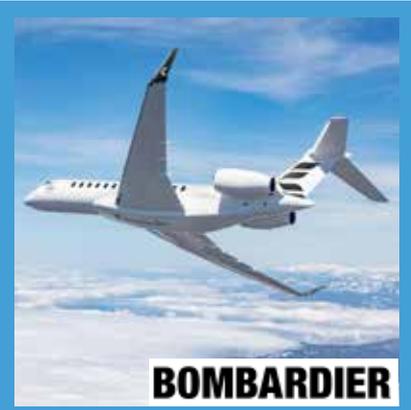
### “Avanti Next” Upgrade and Modernization

Alongside ramping up production, Baykar has announced plans to introduce an upgraded version of the aircraft called Avanti Next. This updated model will feature modern avionics, refreshed interiors. The expansion effort builds on Piaggio’s long legacy and aims to revitalize the unique P.180 platform—known for its distinctive design and.



## Turkish Technic and Pegasus Airlines sign agreements for Airbus A320neo fleet

Turkish Technic, a global leader in the aircraft maintenance, repair, and overhaul (MRO) industry and Pegasus Airlines have expanded their long-standing collaboration through two new contracts signed for the airline’s Airbus A320neo fleet. The agreements cover landing gear overhaul and base maintenance services, further reinforcing the cooperation between the two Turkish aviation companies. Under these renewed agreements, Turkish Technic will deliver comprehensive landing gear overhaul services for Pegasus Airlines’ Airbus A320neo fleet over the next six years. In addition, Turkish Technic’s expert maintenance teams will provide continuous base maintenance support on two dedicated maintenance lines between the Fall 2025 – Winter 2026 period, ensuring the fleet’s operational efficiency and reliability. As one of Turkish Technic’s valued and long-term partners, Pegasus Airlines continues to benefit from the company’s integrated maintenance solutions, extensive technical expertise and globally recognized quality standards. These new agreements reaffirm both companies’ mutual trust and commitment to advancing Turkish aviation on the global stage, while further strengthening their enduring partnership.



## Bombardier Reports Strong Q3 Revenue Growth

Bombardier has reported solid financial results for the third quarter of 2025, posting an 11 % year-over-year increase in revenue to US\$ 2.3 billion, driven by strong performance across its business segments. Services revenue rose by 12 %, while aircraft deliveries reached 34 units, four more than the same period last year. Adjusted EBITDA climbed 16 % to US\$ 356 million, with the margin improving to 15.4 %. Net income also saw substantial gains, with adjusted net income up 59 % to US\$ 129 million. Free cash flow generation was especially robust, reaching US\$ 152 million — a significant improvement compared with the prior year. Bombardier’s backlog remained strong at US\$ 16.6 billion, supported by a healthy unit book-to-bill ratio of 1.3, and the company continued to reduce debt, reinforcing its solid financial footing. These results underline Bombardier’s continued resilience and operational strength in a challenging aerospace market, highlighting improvements in both profitability and cash flow execution.



## Emergency Software Update for A320 Family

In late November 2025, Airbus issued an urgent precautionary software update for the A320 family of aircraft after identifying a flight-control vulnerability affecting thousands of jets worldwide. The manufacturer found that under certain conditions, including exposure to intense solar radiation, critical flight-control data could become corrupted, potentially leading to unintended control inputs. This discovery followed an incident on October 30 involving a JetBlue A320 flight that experienced an unexpected pitch-down event, prompting a safety investigation by aviation authorities. Airbus, in coordination with the European Union Aviation Safety Agency (EASA), issued an Alert Operators Transmission (AOT) requiring operators to install updated software or revert to a prior stable version before the next flight. The action triggered a massive fleet response, affecting roughly 6,000 A320 family aircraft globally and representing one of the largest precautionary directives in Airbus history. Most airlines completed the software modifications quickly, allowing the majority of grounded aircraft to return to service within days. Some older versions, however, required both software and hardware modifications, resulting in longer maintenance periods. Airlines emphasized that although the update caused operational delays and some flight rescheduling, there was no direct passenger safety threat, and all actions were taken with safety as the top priority.



## Emirates Places US\$38 Billion Order for 65 Boeing 777-9 Aircraft

Emirates has announced an order for 65 additional Boeing 777-9 aircraft, powered by GE9X engines, valued at US\$38 billion at list prices. The deal was unveiled on the opening day of Dubai Airshow 2025 and stands as one of the event's largest commitments. With this order, Emirates' total Boeing backlog increases to 315 wide-body aircraft, including 270 Boeing 777X, 10 Boeing 777 freighters and 35 Boeing 787s. The airline has also expanded its agreement with GE Aerospace to a total of 540 GE9X engines, reflecting a long-term commitment to the US aerospace industry and supporting thousands of high-value manufacturing jobs. The agreement also signals strong support for Boeing's proposed 777-10, with Emirates securing options to convert part of its 777-9 order to either the 777-10 or 777-8, depending on future needs. HH Sheikh Ahmed bin Saeed Al Maktoum stated that the order reinforces Emirates' confidence in the Boeing 777X programme and underlines the airline's strategy to invest in a modern, high-capacity and fuel-efficient fleet to support its global growth.



## Chromalloy Wins FAA Approval for CFM56 HPT Blade

Chromalloy has received Federal Aviation Administration (FAA) Parts Manufacturer Approval (PMA) for its CFM56-5B/7B high pressure turbine (HPT) blade. The company is a global specialist in the aerospace engine aftermarket, and this approval marks a major achievement. The CFM56-5B/7B engine family powers more than 20,000 aircraft worldwide. The CFM56-5B is used on the Airbus A320 series, while the CFM56-7B powers Boeing 737NG aircraft. Together, they form a large share of the global commercial engine fleet. Chromalloy's new HPT Blade is now the only aftermarket alternative to the original manufacturer's part. It is fully FAA approved and ready for production. The new design joins three existing PMA components for the same platform: the HPT Nozzle Guide Vane, LPT Stage 1 Nozzle Guide Vane, and HPT Shroud. Chromalloy also offers more than 50 designated engineering representative (DER) repairs for the CFM56 engine family. Of these, 25 are advanced repairs that provide extra value for airlines, leasing companies, and MRO (maintenance, repair, and overhaul) providers.



## Rolls-Royce and Turkish Technic Break ground On New MRO Hub

Rolls-Royce and Turkish Technic have officially broken ground on a state-of-the-art engine maintenance facility at Istanbul Airport. First announced in May 2025, this site will become a key part of Rolls-Royce's global MRO network, specifically designed to meet the rising demand for large civil aero engines. Scheduled to be operational by the end of 2027, the center will provide comprehensive services for Trent XWB-84, Trent XWB-97, and Trent 7000 engines. With a planned capacity of 200 shop visits annually, it will be one of the largest facilities in the region, supporting Turkish Airlines—the world's largest Trent XWB operator—as well as other global TotalCare customers. Rob Watson, President of Civil Aerospace at Rolls-Royce, noted that the facility marks a significant step in increasing global MRO capacity by 2030 and reinforces the strong partnership between the two companies.



## Pratt & Whitney Boosts Turbofan Tech for Future Combat Aircraft

Pratt & Whitney has completed a major round of testing on its small turbofan engine family, confirming that existing commercial-derived designs can generate up to 20% more thrust when adapted for next-generation military use, particularly Collaborative Combat Aircraft (CCA) programs. These CCAs are unmanned or optionally piloted platforms that require compact, responsive engines capable of providing enhanced maneuverability and range. The company's testing also includes evaluations of how airflow and pressure changes affect performance when engines are embedded within an aircraft's structure, helping reduce integration risks and improve predictive models. Engineers are combining digital twin simulations with physical tests to refine performance and stability under real-world conditions. By unlocking additional thrust from reliable, efficient turbofan designs, Pratt & Whitney aims to support future combat aircraft propulsion needs while keeping weight, cost, and development timelines under control—an approach that could accelerate adoption across multiple unmanned platforms.



## Korean Air and Archer Partner to Introduce Midnight eVTOL Aircraft in Korea

Korean Air and Archer Aviation have signed an agreement to bring Archer's Midnight eVTOL aircraft to Korea, positioning the country at the forefront of advanced air mobility. Under the partnership, Korean Air plans to purchase up to 100 Midnight aircraft, with initial operations focused on government use before expanding to commercial sectors. The collaboration combines Archer's electric flight technology with Korean Air's expertise in aircraft operations and maintenance, aiming to accelerate the adoption of next-generation aircraft across urban transport, logistics and emergency services. Archer's Midnight is a piloted eVTOL designed to carry four passengers, offering short recharge times and the ability to significantly reduce 60–90-minute road journeys to 10–20 minutes by air. The aircraft has recently completed successful flight tests, including its longest and highest piloted flights, and made a public appearance at the California International Airshow. The agreement marks a significant step toward the wider deployment of quiet, sustainable and cost-efficient electric air taxis in Korea.



## FL Technics Reports High Interest from Applicants for New Dominican Republic

FL Technics has reported strong interest in its new aircraft maintenance hangar in Punta Cana, Dominican Republic, receiving more than 3,500 job applications from both local and international candidates. The company plans to hire around 300 employees during the initial phase of operations, with the workforce expected to grow to up to 2,000 positions over the coming years. According to the company's HR Director, FL Technics aims to build a team composed of approximately 80% local professionals, supported by 20% international experts until full knowledge transfer is achieved. Through this approach, FL Technics expects to strengthen the local aviation workforce and contribute to the sustainable growth of the Dominican Republic's aerospace sector.



## flydubai Signs MoU with Airbus for 150 A321neo Aircraft

flydubai has signed a memorandum of understanding with Airbus for 150 A321neo aircraft, marking the airline's first-ever order with the European manufacturer. The agreement was signed on the second day of Dubai Airshow 2025 by His Highness Sheikh Ahmed bin Saeed Al Maktoum, Chairman of flydubai, and Christian Scherer, CEO Commercial Aircraft at Airbus. Sheikh Ahmed described the deal as a milestone for flydubai, highlighting that it supports Dubai's long-term aviation strategy and aligns with the Dubai Economic Agenda D33. He emphasised that the order goes beyond fleet expansion and plays a key role in strengthening Dubai's position as a global aviation hub. The A321neo aircraft will expand and diversify flydubai's narrow-body fleet, offering greater capacity and extended range to support network growth across established and emerging markets. The order is also expected to contribute to the development of Dubai World Central (DWC), envisioned as the world's largest airport. The agreement marks the beginning of a new long-term partnership between flydubai and Airbus, supporting the airline's next phase of growth.



## Rolls-Royce Opens First Trent Engine MRO Facility in Mainland China

Rolls-Royce has officially reopened Beijing Aero Engine Services Limited (BAESL), a new joint-venture MRO facility with Air China, strengthening its global maintenance, repair and overhaul network. Located in Beijing, BAESL is the first dedicated Trent engine overhaul facility in mainland China, supporting the long-term growth of wide-body fleets across Asia and beyond. At the opening ceremony, the Civil Aviation Administration of China (CAAC) granted BAESL its Maintenance Organisation Certificate (MOC), confirming the facility's readiness to carry out high-quality Trent engine overhauls in line with regulatory and technical standards. Equipped with advanced tooling, digital systems and a highly trained workforce, BAESL will enhance operational efficiency, reduce turnaround times and provide more localised support to airlines in China and the wider Asia-Pacific region. The facility reflects Rolls-Royce's commitment to long-term partnership, localisation and continued investment in one of the world's fastest-growing aviation markets.



## Ethiopian Airlines Introduces Full Strip-and-Paint for A350-900s Aircraft Maintenance in Africa

Ethiopian Airlines has set a new benchmark in African aviation by completing the continent's first full strip-and-paint process on its Airbus A350-900 fleet. The milestone highlights the airline's advanced Maintenance, Repair and Overhaul (MRO) capabilities and reinforces its leadership in improving aircraft efficiency, durability, and long-term performance. The highly specialized process involves removing existing paint layers and fully repainting the aircraft, enhancing surface protection, structural integrity, and fuel efficiency through reduced aerodynamic drag. Completing this procedure in-house marks a significant step forward for Ethiopian Airlines, reducing reliance on external providers and meeting international maintenance standards. Building on earlier strip-and-paint capabilities established for its Boeing 787 fleet, the achievement positions Ethiopian Airlines among a limited group of global carriers able to perform complex widebody maintenance internally. The expansion supports the airline's strategy to become a regional MRO hub, lowering downtime, improving turnaround times, and enabling third-party maintenance services. Ethiopian Airlines Group CEO Mesfin Tasew said the project strengthens operational resilience, self-reliance, and revenue generation, while reinforcing the airline's position as a leading MRO provider in Africa. With nearly six decades of experience, Ethiopian MRO continues to deliver advanced maintenance and aircraft painting services using modern techniques such as HVLP and electrostatic spraying. Overall, the completion of the A350-900 strip-and-paint program represents a major step in Ethiopian Airlines' technical excellence, sustainability goals, and leadership in African aircraft maintenance.



## SkyWest Chooses Salina for Major Maintenance Expansion

SkyWest Airlines has confirmed plans to establish a new aircraft maintenance facility at Salina Regional Airport in Kansas, marking a significant investment in the state's aviation sector. The facility is expected to be operational by early spring 2026 and will support maintenance for SkyWest's fleet of over 500 regional jets, including United Express services. This expansion will create several high-paying technical roles, with recruitment for technicians already underway to ensure a long-term regional presence. By localizing maintenance, SkyWest aims to enhance the reliability of flights to major hubs like Denver and Chicago. Supported by local stakeholders and Governor Laura Kelly's MRO expansion strategy, this project reinforces Salina's role as a critical aviation hub while providing high-quality employment and vital national connectivity.



## Emirates Takes Control of Trent 900 MRO, Extends Rolls-Royce TotalCare into the 2040s

Emirates has signed a new MoU enabling the airline to perform full in-house maintenance, repair and overhaul on its Trent 900 engines, which power its Airbus A380 fleet. Alongside this, Emirates and Rolls-Royce have extended the TotalCare support program for the Trent 900 fleet into the 2040s, reinforcing a long-term strategic partnership. To support this transition, Emirates will build a dedicated engine maintenance facility, with first engine induction planned for 2027. Emirates will handle fan case repairs internally, while Rolls-Royce will continue module-level maintenance through its global network. This hybrid model increases Emirates' operational autonomy while retaining OEM expertise. The agreement supports the long-term sustainability of the A380 fleet, strengthens Emirates Engineering's capabilities, and contributes to the continued growth of Dubai's aerospace ecosystem.



## India's aircraft maintenance, repair & overhaul market to be worth \$4 bn by 2031: Govt

India's aircraft maintenance, repair and overhaul (MRO) market is expected to reach a value of USD 4 billion by 2031, creating significant new opportunities for the aviation sector, Civil Aviation Minister K. Rammohan Naidu said on Wednesday. He noted that India is steadily positioning itself as a preferred global destination for aircraft maintenance services. Addressing the inauguration of Safran's new MRO facility, Naidu highlighted that the Safran Aircraft Engine Services India (SAESI) site is scheduled to become operational in 2026 and will play a key role in strengthening the country's domestic capabilities in the rapidly expanding aviation industry. The minister also emphasized that undertaking MRO activities within India could help save up to USD 15 billion in foreign exchange over the coming years. With India ranking among the world's fastest-growing civil aviation markets and domestic airlines having more than 1,500 aircraft on order, demand for maintenance services is set to rise sharply.

## VSE Corporation Announces the Acquisition of Aero 3

VSE Corporation announced that it has entered into a definitive agreement to acquire GenNx/AeroRepair IntermediateCo Inc., the parent company of Aero 3, Inc., from GenNx360 Capital Partners. The transaction strengthens VSE Aviation's position in the global aircraft wheel and brake aftermarket. Aero 3 is a diversified global Maintenance, Repair and Overhaul (MRO) provider and distributor focused on the commercial wheel and brake segment. The acquisition significantly expands VSE's capabilities, adding nine MRO facilities and increasing its total wheel and brake repair locations to twelve across the United States, Canada, and the United Kingdom. These facilities support commercial, regional, and business and general aviation operators. VSE President and CEO John Cuomo said the acquisition aligns with the company's OEM-centric strategy and builds on the earlier purchase of Desser Aerospace. He noted that Aero 3 enhances VSE's MRO, distribution, and proprietary product offerings while extending its global footprint, creating one of the industry's most comprehensive platforms dedicated to aircraft wheels and brakes. Aero 3 CEO Daniel Bell stated that joining VSE represents a natural next step for the company, citing strong alignment in technical expertise, operational excellence, and customer focus. Aero 3's leadership team will remain in place to support continued growth within VSE's Aviation Wheel and Brake Group. Founded in 1994 and headquartered in Manchester, New Hampshire, Aero 3 employs around 280 people, serves more than 750 customers worldwide, and completes approximately 50,000 MRO events annually. The business operates across three core areas: wheel and brake MRO services, OEM-aligned component distribution, and proprietary engineered repair solutions. Strategically, the transaction deepens VSE's exposure to the high-growth wheel and brake aftermarket, expands its global MRO footprint, strengthens OEM relationships, and accelerates the development of higher-margin proprietary products. It also complements Desser Aerospace's tire distribution expertise, enabling more integrated aftermarket solutions for fleet operators. The deal values Aero 3 at \$350 million in cash, subject to working capital adjustments, and is expected to close in the fourth quarter of 2025, pending regulatory approvals. Aero 3 generated approximately \$120 million in revenue in the trailing twelve months ended August 2025, with adjusted EBITDA margins exceeding 20%. The acquisition is expected to be funded through a combination of equity financing and existing credit facilities.



## GMR Group to Develop World's Largest MRO Hub at Bhogapuram International Airport

**G**MR Group is developing the Bhogapuram International Airport, which is now expected to become operational by June 2026—around six months ahead of schedule. A flagship element of the project is the creation of what is planned to be the world's largest Maintenance, Repair and Overhaul (MRO) facility, forming part of a fully integrated aerospace ecosystem spread across 500 acres. Announcing the update, GMR Group founder and chairman G M Rao said the greenfield airport, being developed by GMR Visakhapatnam International Airport Limited (GVIAL), will feature a large-scale aerospace hub designed to attract global aerospace and defence manufacturers. The ecosystem is expected to host OEMs, research and development centres, and aviation training providers, positioning the site as a comprehensive aviation and aerospace cluster. Developed under a Public-Private Partnership (PPP) model, the airport will initially handle six million passengers annually, with scope for future expansion. The project is expected to deliver a major boost to India's aviation and aerospace sectors by drawing foreign investment, supporting technological growth, and generating thousands of skilled and semi-skilled jobs. Establishing a large domestic MRO capability will reduce dependence on overseas maintenance facilities, help conserve foreign exchange, and strengthen India's ambition to become a global aviation services hub.



## Safran Taps 3D Printing to Boost Turbine Blade Production

**F**rench engine maker Safran Aircraft Engines has installed three Lithoz CeraFab System S65 ceramic 3D printers at its Gennevilliers facility near Paris to begin serial production of complex ceramic casting cores — critical components for turbine blades in next-generation aircraft engines. These advanced printers use Lithography-based Ceramic Manufacturing (LCM) technology, a process developed with Lithoz that enables highly intricate cooling channel designs previously unattainable with traditional methods. The result is ceramic cores that support higher turbine inlet temperatures, helping future engines achieve improved performance and efficiency. Safran chose the CeraFab S65 systems for their precision, speed and compliance with strict aerospace traceability standards, with the collaboration underscoring additive manufacturing's growing strategic role in aerospace propulsion innovation. This move highlights Safran's commitment to leveraging advanced manufacturing technologies as it prepares for the demands of future engine designs.



## Airbus turns to humanoid robots in early-stage manufacturing trials

**A**irbus has entered an agreement with Chinese robotics specialist UBTech to explore the use of humanoid robots in aircraft manufacturing, marking a potential new step in the airframer's drive to automate and digitise its production systems. The agreement covers the supply of UBTech's latest industrial humanoid robot and a joint effort to examine how the machines could be deployed in aerospace manufacturing. Airbus said the cooperation is currently limited to early-stage concept testing, with no indication yet of wider industrial deployment. UBTech said Airbus has already purchased its Walker S2 humanoid robot, which is designed to replicate human movement and perform complex physical tasks in industrial settings. Airbus has invested heavily in robotics and automation over the past decade. Still, humanoid robots represent a new frontier compared with established fixed and mobile robotic systems already used for drilling, fastening, inspection and material handling. According to Airbus, such initiatives aim to improve industrial efficiency and quality while enhancing flexibility on increasingly complex final assembly lines.



## MRO DUBAI: STRENGTHENING THE MIDDLE EAST'S ROLE IN GLOBAL AVIATION MAINTENANCE

MRO Middle East highlights Dubai's growing role as a global aviation hub and a strategic center for maintenance, repair, and overhaul (MRO) operations. The event brings together airlines, MRO providers, OEMs, and technology companies to address key industry challenges and opportunities. Major themes include digital transformation through predictive maintenance and AI, sustainability initiatives supporting net-zero goals, workforce development amid technician shortages, and strengthening supply chain resilience. More than an exhibition, the event serves as a vital networking platform shaping the future of aircraft maintenance in a rapidly evolving aviation ecosystem.

**D**ubai continues to solidify its position as one of the world's leading aviation hubs, and MRO Dubai has become a key event reflecting the rapid transformation of maintenance, repair, and overhaul (MRO) operations across the Middle East and beyond.

Bringing together airlines, MRO providers, OEMs, technology firms, and aviation professionals, the event highlights both the challenges and opportunities shaping the future of aircraft maintenance. As global air traffic continues its steady recovery and fleet expansion accelerates,

demand for reliable, efficient, and technologically advanced maintenance services is rising. Airlines operating in the Middle East, Africa, Asia, and Europe increasingly rely on regional MRO capabilities, making Dubai a strategic meeting point for stakeholders seeking partnerships and innovation. One of the main themes discussed during MRO Dubai is the modernization of maintenance operations through digital transformation. Predictive maintenance tools, artificial intelligence applications, and data-driven fleet monitoring are enabling operators to reduce unscheduled downtime while improving safety and operational reliability. The adoption of digital records and integrated maintenance management systems is also accelerating, supporting faster turnaround times and improved regulatory compliance.

Sustainability has also become a prominent topic. As the aviation industry pursues net-zero carbon goals, maintenance operations are adapting through greener workshop



practices, optimized component repair cycles, and sustainable material usage. Efficient maintenance directly contributes to fuel savings and lower emissions by ensuring aircraft operate at peak performance. Workforce development remains another central discussion point. The industry faces a global shortage of qualified maintenance technicians, making training and human factors programs increasingly critical. Events such as MRO Dubai provide a platform for organizations to exchange best practices in technician training, fatigue risk management, and safety culture enhancement—essential elements in maintaining high safety standards. Supply chain resilience has also emerged as a major concern. Parts availability challenges and logistics disruptions have pushed operators and MRO providers to develop more robust supply strategies, including localized component repair capabilities and strategic partnerships with suppliers and OEMs. For many participants, MRO Dubai is more than an exhibition—it is a networking and knowledge-sharing platform where future collaborations are born. Airlines explore outsourcing solutions,



maintenance providers showcase new capabilities, and technology companies present innovations aimed at reducing operational costs while maintaining the highest safety standards. As fleets continue to modernize and passenger demand grows, the Middle East's importance

in global aviation maintenance is expected to expand further. MRO Dubai stands as a reflection of this momentum, offering a glimpse into the future of aircraft maintenance in an increasingly connected and technologically advanced aviation ecosystem.





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Part -147 Type Training Instructor

# A NEW COMPETITIVE FRONTIER IN AVIATION: **PEOPLE** THE INDUSTRY'S REAL BOTTLENECK THROUGH THE LENS OF 2025 GLOBAL REPORTS **THERE IS MONEY, THERE ARE AIRCRAFT... BUT WHO WILL MAINTAIN THEM?**

Despite record revenues, growing fleets, and massive MRO investments, global aviation is facing its most critical constraint: people. Drawing on major 2025 global aviation reports, this article reveals how the deepening shortage of aircraft maintenance technicians has become the industry's true bottleneck — and why investing in technicians is no longer optional, but a strategic imperative for safety, continuity, and competitiveness.

**D**ear readers, in this article, drawing on the major global aviation reports published in 2025, I will examine where the aircraft maintenance technician profession stands today, how the shortage of qualified technicians is deepening across the industry, and why investing in this workforce has become not a choice, but a strategic necessity. As of 2025, the global

aviation sector appears stronger on paper than ever before. According to the International Air Transport Association (IATA), industry revenues have exceeded one trillion US dollars, and the number of passengers carried worldwide is approaching five billion. Airlines are placing new aircraft orders, MRO companies are expanding hangar capacity, and governments are declaring aviation a strategic industry.



Yet behind this impressive picture lies an undeniable reality that is now impossible to hide: There is money, there are aircraft, there is demand... but there are not enough technicians to maintain them. For many airlines and maintenance organizations today, the real challenge is no longer acquiring new aircraft. The true challenge is finding qualified maintenance technicians who can keep those aircraft airworthy, prevent costly ground time, and sustain operations safely. Hangars may be full. Work orders may be ready. But if shift rosters have no names on them, the system simply cannot function.

This is not a perception, it is a numbers driven crisis. According to Boeing's Pilot and Technician Outlook 2025–2044, the global aviation industry will require at least 710,000 new aircraft maintenance technicians over the next twenty years. This figure exceeds the total technical workforce of many countries. Moreover, this demand is driven not only by new aircraft deliveries, but also by more intensive utilization and aging of existing fleets.

During the same period, Airbus forecasts that the global maintenance and repair market will reach 311 billion US dollars in size. This clearly shows that maintenance is no longer a supporting operation, but one of aviation's primary economic pillars. However, Airbus and Satair reports converge on the same point: the greatest obstacle in front of this enormous market is not capital or infrastructure it is human resources. An aircraft sitting on the ground can generate losses exceeding \$100,000 per day. Increasingly, technician shortages are cited as the main cause of maintenance delays. In other words, aircraft remain grounded not because demand is missing, but because skilled people are missing.

Oliver Wyman's Global Fleet and MRO Market Forecast 2025–2035 makes the situation even clearer. The sector is entering an "MRO supercycle," with maintenance demand expected to remain high for at least the next decade. Yet the same report warns that a significant share of the current technician workforce will retire within ten years — while it takes four to six years for a new technician to become fully competent. The gap is widening faster than the industry can train people to close it.

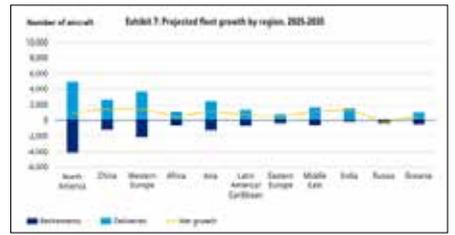
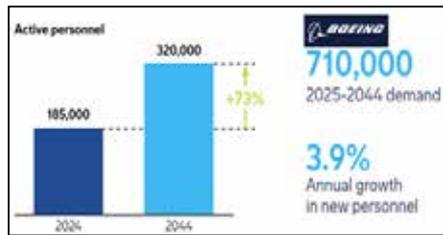
At this point, the aircraft maintenance technician profession has entered an entirely new position within aviation. Technicians are no longer a workforce that can be easily replaced, treated as a cost item, or assumed to be readily available.

They have become rare, strategic talent — and the industry must invest accordingly.



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**Global reports published in 2025 reveal that the real bottleneck in the aviation industry is not aircraft or capital, but qualified maintenance technicians. Despite growing fleet sizes, the deepening technician shortage is now reshaping competition in aviation around investment in human capital.**



CAE's Aviation Talent Forecast 2025–2034 supports this reality, highlighting that among the 1.5 million new aviation professionals needed over the next decade, maintenance technicians represent the most critical and hardest-to-fill segment.

**A Silent Transformation: Technicians Now Choose Employers**

However, the crisis is not only about numbers. A deeper transformation is taking place: Maintenance technicians are no longer simply looking for jobs they are choosing organizations.

Shift structures, fatigue management practices (FRMS), physical and mental working conditions, organizational culture, and the way human error is addressed have all become defining factors in technician retention and attraction.

Organizations that view people not as production tools but as strategic

assets prioritizing technician wellbeing, safety, and professional value are gaining a competitive advantage.

Thus, competition in aviation today is no longer shaped only by fleet size, route networks, or ticket prices.

**It is shaped by one question: Who invests in their technicians?**

So What Is the Solution? The True Meaning of Investing in Technicians

In an environment where the technician shortage has become so severe, solutions cannot rely solely on salary increases or short-term hiring campaigns. The aviation sector now needs a holistic approach — one that trains, protects, and retains technicians over the long term.

At the center of this approach must be a mindset that recognizes people not as labor inputs, but as strategic value.

### Education as the First Foundation

The first and most essential step is training — but not in the traditional sense of license-focused instruction alone. ICAO’s Competency-Based Training and Assessment (CBTA) framework emphasizes preparing technicians through real operational scenarios, strengthening decision-making and risk management skills.

CBTA helps balance the quantitative shortage through qualitative development, enabling safer and more competent technicians to enter the system faster.

### The Overlooked Crisis: The Shortage of Qualified Technical Instructors

At this stage, another critical reality emerges — often ignored, yet just as serious as the technician shortage itself: The number of qualified technical instructors is rapidly declining.

Experienced technicians are retained in operations due to immediate workforce needs, leaving training departments understaffed. In some cases, individuals with limited field exposure are forced into instructor roles.

But aircraft maintenance training is not merely transferring knowledge — it is transferring experience.

An instructor who has never faced real-time troubleshooting pressure in a hangar may teach correct procedures on paper, but the field value of that education remains weak.

Therefore, instructor development must become an inseparable part of workforce strategy. Instructor roles should be positioned not as alternative assignments, but as prestigious and specialized career paths.

### Working Conditions and Fatigue Risk Management

Equally critical are sustainable working environments. Many technicians cannot remain in the profession long-term due to exhausting shift patterns and chronic fatigue exposure. Flexible, human-centered workforce planning must be supported by Fatigue Risk Management Systems (FRMS),



The solution to the deepening technician shortage in aviation cannot be achieved solely through salary increases or short-term employment measures. The industry requires a holistic human capital approach that views technicians not as production tools, but as strategic assets. At the core of this approach lies Competency-Based Training and Assessment (CBTA), as emphasized by ICAO, aiming to develop technicians through real operational scenarios while strengthening their decision-making and risk management skills.

integrating technician capacity into operational decision-making. Organizations implementing FRMS strengthen not only safety, but also employee loyalty.

### Retaining Experience Through Mentorship

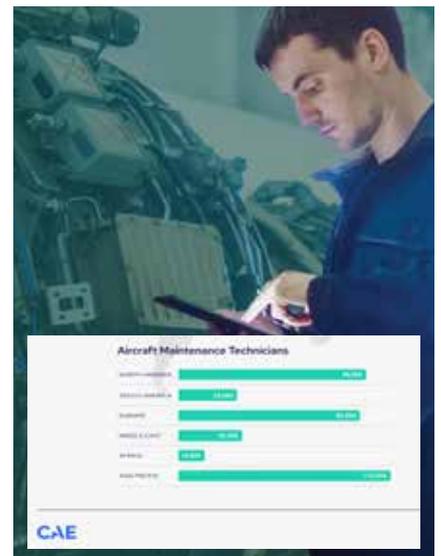
Another major priority is systematic knowledge transfer. The expertise of retiring technicians is leaving the system unplanned. To prevent this loss, organizations must establish structured mentoring programs that modernize the master-apprentice relationship. Young technicians’ learning must not be left to chance — it must be guided.

### Strengthening Industry-Education Partnerships

Finally, collaboration between universities, DGCA-approved training organizations, MRO providers, and professional associations is vital. Curricula disconnected from operational reality must be replaced with models directly aligned with hangar needs.

### Investing in Technicians Secures the Future

Investing in technicians does not only solve today’s workforce problem — it protects tomorrow’s aviation

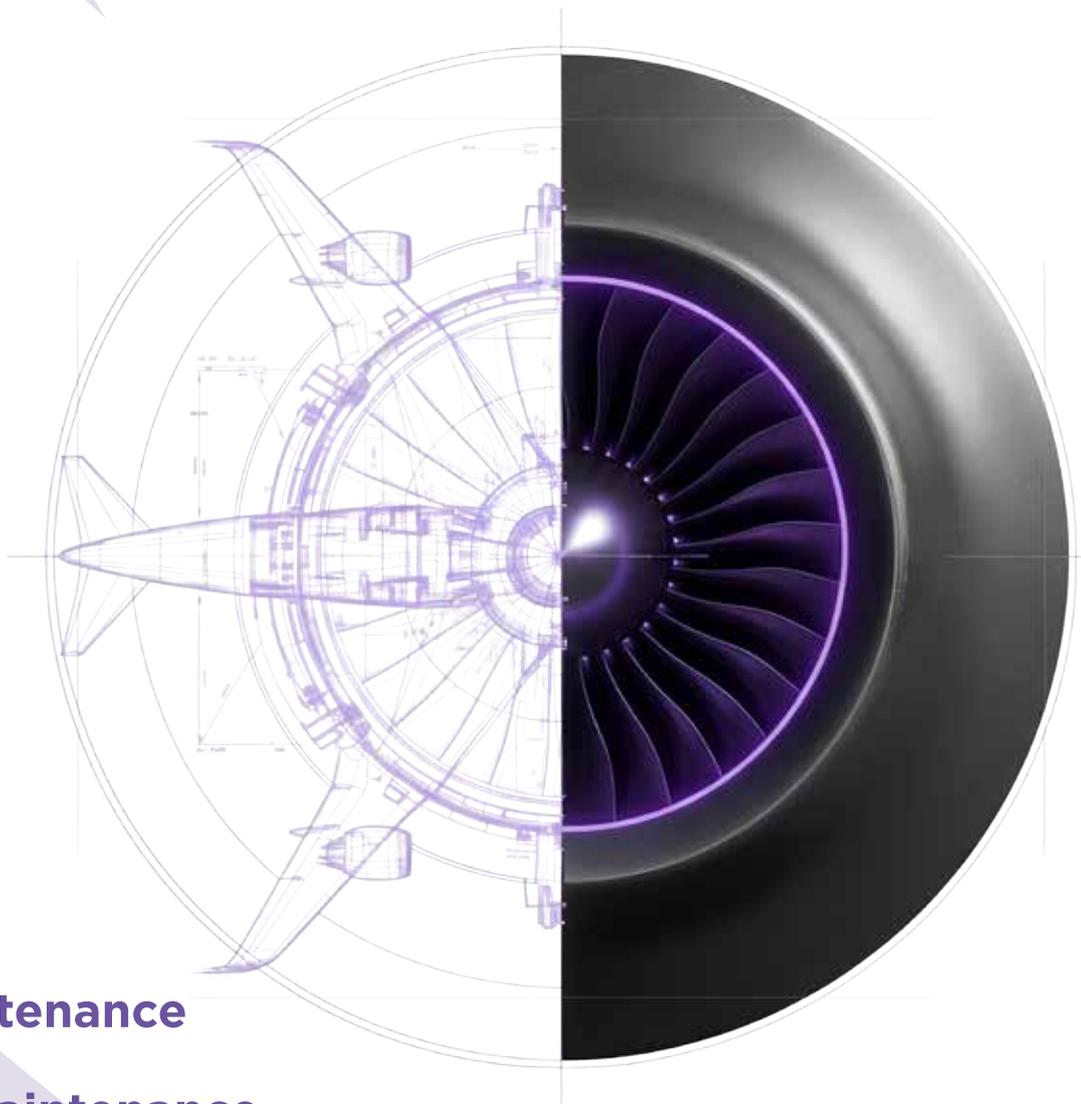


system. A technician who is trained, supported, valued, and retained becomes more committed, reduces error risk, and increases operational efficiency.

The conclusion is clear: Those who invest in technicians will be the ones who succeed.

Boeing PTO 2025-2044 (Yayın: 22 Temmuz 2025) - boeing.com/2025-pto  
Airbus GSF 2025 (Yayın: 9 Ekim 2025) - airbus.com/gsf-2025  
CAE Talent Forecast (Yayın: 16 Haziran 2025) - cae.com/talent-2034  
IATA Global Outlook (Yayın: 9 Aralık 2025) - iata.org/outlook-2026  
Oliver Wyman MRO Forecast (Yayın: 25 Şubat 2025) - oliverwyman.com/mro-2025

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# NEXT-GENERATION AVIONICS MAINTENANCE

## ADVANCES IN AVIONICS TESTING AND REPAIR WITH NEW TOOLS AND TECHNOLOGIES

Next-generation avionics maintenance is rapidly digitalizing through artificial intelligence, automated testing, and software-based solutions. While traditional troubleshooting approaches are giving way to predictive maintenance, maintenance centers are transforming into technology hubs supported by data analytics.

One of the most critical areas of the modern aviation industry—avionics systems maintenance—is currently undergoing a true revolution. Today, maintenance teams are no longer limited to troubleshooting failures; they are also developing methods that

make systems more durable, reliable, and intelligent.

AI-powered diagnostic platforms, portable test systems, and augmented reality (AR) applications have become the key drivers of this transformation. As aircraft increasingly evolve into software-

defined platforms, maintenance hangars are being reshaped into high-tech laboratories. This shift has transformed maintenance operations from a purely technical task into a multidisciplinary field that integrates engineering, data analytics, and digital technologies.

### Digitalized Repair Processes

Hardware-based methods are gradually giving way to software-centered solutions. Analog test equipment has become obsolete, while bus readers and laptop interfaces are now standard.

Despite this digital evolution, one tool remains indispensable: the multimeter. Bridging both analog and digital worlds, it continues to play a critical role in power, ground, and continuity checks on wiring and components.

The greatest advantage of digitalization is speed and precision. Technicians can now diagnose faults faster and more accurately, reducing aircraft ground time, lowering maintenance costs, and increasing operational efficiency.

### **Predictive Maintenance with Artificial Intelligence**

Artificial intelligence is transforming avionics maintenance by enabling predictive rather than reactive strategies. Instead of responding only after failures occur, AI analyzes trends and detects potential problems in advance.

Beyond fault diagnosis, AI processes large volumes of operational data from aircraft systems to identify patterns and anomalies. Maintenance schedules become smarter, inventory management is optimized, and costs are significantly reduced.

Equally important, field data is continuously fed back into AI models, improving both current systems and the design of next-generation avionics.

### **Automated Testing and Advanced Software**

Modern avionics testing has grown dramatically in complexity. Typical test procedures now include 10 to 100 times more checkpoints than those used two decades ago. Thanks to advanced automated test software, this increase in coverage does not extend overall testing time.

When a fault is isolated to a circuit board, technicians still rely on manual tools such as oscilloscopes for verification. In addition, boards undergo environmental stress testing—exposure to heat, cold, and vibration—to uncover hidden faults that may only appear under real flight conditions.

### **Continuous Modernization Through Incremental Improvements**

While core maintenance principles remain largely unchanged, equipment



**The testing of avionics components has become significantly more intensive, driven by new test standards established by aircraft manufacturers and equipment OEMs to enhance reliability and improve safety on modern platforms.**

and procedures are constantly being modernized. The discontinuation of legacy test equipment is forcing maintenance organizations to adopt next-generation solutions.

Unlike mechanical systems, avionics components typically have much

longer service lives and are removed only when faults occur. With proper power management and cooling, electronic systems can operate reliably for years.

However, processor boards present a unique challenge. In most cases, they cannot be repaired due to proprietary manufacturer data. As a result, replacement is the primary solution—accounting for approximately 98% of board-level fault resolutions.

### **A Data-Driven Maintenance Ecosystem**

Automated, software-based testing has reduced inspection and repair times by up to 80%. As a result, avionics maintenance centers are now



longer just repair facilities; they have become data-driven technology hubs.

The data collected during testing is now used not only for repairs but also for system design and future product development. Maintenance centers have evolved into strategic contributors shaping the next generation of avionics technology.

### Looking Ahead: The Next Phase of Digital Transformation

Three major trends will define the future of avionics maintenance:

#### Long-Term Partnerships:

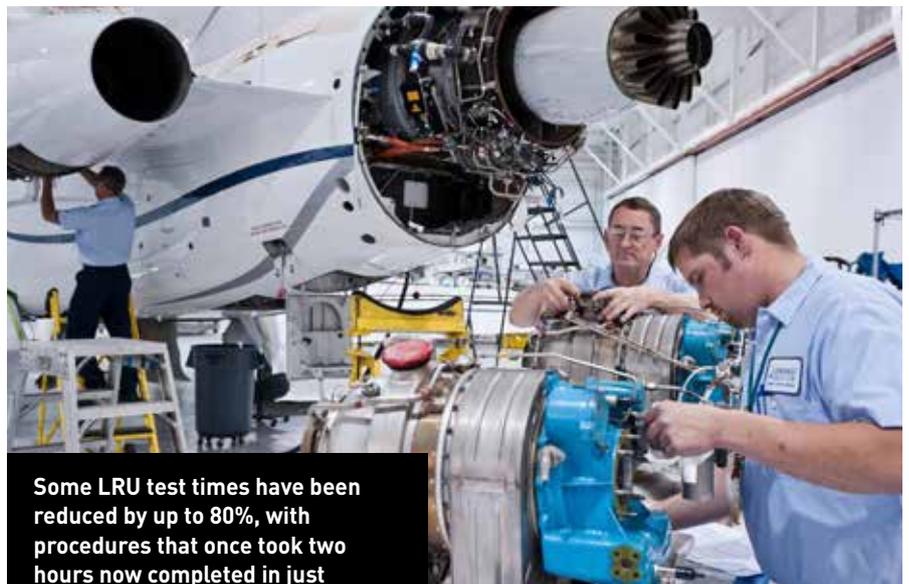
Closer collaboration between manufacturers and maintenance organizations will streamline development and support continuous system improvement.

#### New Regulations:

Regulatory requirements—such as the 25-hour cockpit voice recorder (CVR) recording mandate—will accelerate the adoption of new technologies and modern testing standards.

#### AI Integration:

The future of predictive maintenance depends on deeper AI integration.



**Some LRU test times have been reduced by up to 80%, with procedures that once took two hours now completed in just minutes. Thanks to advanced automated test systems and software-based solutions, maintenance processes are becoming faster, more reliable, and increasingly efficient each year.**

As these technologies mature, the industry moves closer to a near-zero-failure operating environment.

#### From Hangar to Technology Center

Avionics testing and repair are no longer merely technical support

functions for flight safety and continuity. Powered by artificial intelligence, automated testing systems, data analytics, and software-driven solutions, maintenance facilities have become far more than traditional hangars—they are now the technological backbone of the digital aviation era.

The steps taken today will not only safeguard current operations but also shape the future of aviation.



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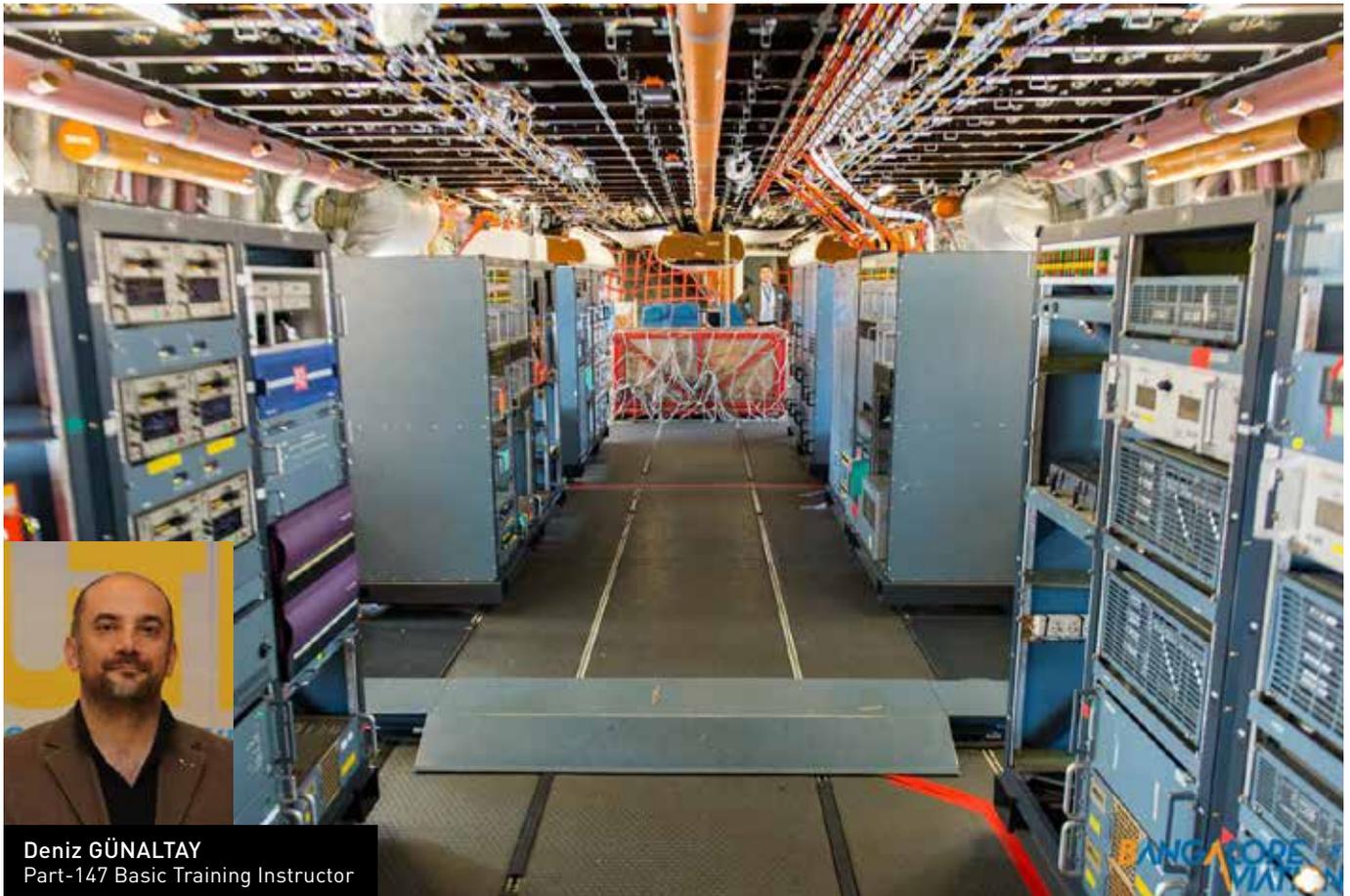
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## BASIC ELECTRICAL SYSTEMS IN MODERN AIRCRAFT

This article introduces the fundamental electrical power systems of modern aircraft, explaining basic AC/DC principles, 400 Hz usage, and main power sources such as batteries, IDGs, APUs, RATs, and ground power. By linking theory with real operational examples, it aims to make aircraft electrical systems more accessible for maintenance professionals.

In this article, we will examine the basic electrical systems in modern aircraft. We will attempt to explain the electrical systems in aircraft using general and fundamental information. At times, we will elaborate on our topics with intermediate transitions from basic training level to type level. Our colleagues working in the aircraft maintenance and repair sector, most of whom have a background in mechanics, structural engineering, or cabin operations, tend to approach electrical topics with a certain distance and hesitation, whether they are new to the job or experienced.

We hope this article will break the ice and pave the way. After this lengthy introduction, let us begin.

Fundamentally, there are two types of current in electrical theory. These are known as Direct Current and Alternating Current. Direct current is referred to as DC. Alternating current is referred to as AC.

Direct Current (DC) is defined as a current whose direction and intensity do not change over time, or as an electric current that remains at a constant voltage level. Batteries, accumulators and cells always produce Direct Current.

Alternating current (AC), unlike direct current whose direction remains constant, is an electric current whose magnitude and direction change periodically. The usual waveform of an AC power circuit is a sine wave, as this allows the most efficient transmission of energy. However, different waveforms such as triangular or square waves are also used in some applications. An AC generator is the simplest producer of electrical power.

Direct Current can be converted to Alternating Current using a component called an Inverter (SI Static Inverter). Alternating Current (AC) can be converted to DC using a component called a Transformer Rectifier Unit (TRU Transformer Rectifier Unit).

In aircraft, the voltage and current parameters are generally known as 115V (phase-to-neutral value) / 200V (phase-to-phase value) AC 400Hz 3-phase, 28V DC. I can hear you asking why aeroplanes use 400Hz

when mains power uses 50Hz. Let me try to explain this a little:

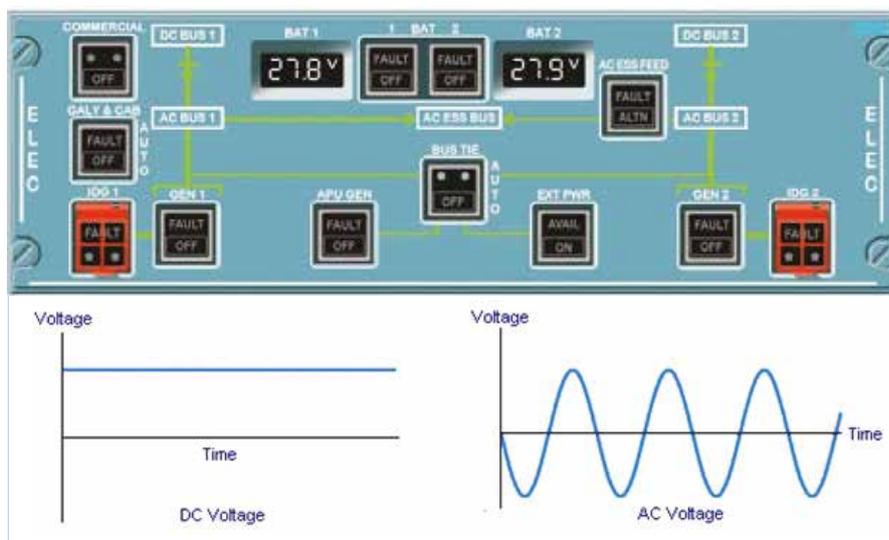
Scientific research has shown that higher frequencies mean smaller and lighter electrical components. Transformers, motors and generators can be much smaller and lighter at 400Hz compared to 50/60Hz. In aviation, weight savings translate to fuel savings, making this a significant advantage. At higher frequencies, electrical machinery (generators, transformers, motors) can handle more power in a smaller size. 400Hz systems provide the same power output as 50/60Hz systems but with lower weight and size. Many avionics and flight control systems require high-speed processing. 400Hz benefits navigation, communication, and radar systems by enabling faster response times in electrical circuits. Therefore, the reason for using 400Hz instead of 50/60Hz in aircraft is to reduce weight, increase efficiency, and improve avionics response times.

### Electrical Power Sources Used in Aircraft

#### Batteries

Aircraft batteries are fundamental components that provide power for various functions both on the ground and in the air. They produce 28V DC (direct current). Aircraft batteries are nominally classified as 24V, meaning their designed operating voltage is around 24 volts. However, when fully charged, their voltage is actually higher – typically around 28V. There are three types of batteries that have been used from the past to the present: Lead-Acid, Nickel-Cadmium (Ni-Cd) and Lithium-Ion. They are calculated in ampere-hours (Ah) and indicate how much charge a battery can store.

The basic structural unit of batteries is the cell. Connecting cells in series results in the battery output voltage (usually 24V). A typical aircraft (lead acid) lead-acid battery consists of 12 cells to provide a nominal voltage of 24V. In addition, a Ni-Cad battery has 20 cells that provide a nominal



**If we ask why 400 Hz is used in aircraft, scientific research shows that higher frequencies enable smaller and lighter electrical components. Compared to 50/60 Hz, 400 Hz systems allow the use of smaller and lighter generators, transformers, and motors, which provides a significant advantage in aviation. In aircraft, weight reduction directly translates into fuel savings.**

voltage of 24V. In modern aircraft, there are at least two batteries, which are connected in parallel to increase capacity. When power is supplied to the aircraft (Engine, APU or Ground Power), the battery charging units automatically start charging the battery.

The capacity of a battery is measured in ampere-hours (Ah = number of amperes multiplied by the operating time during discharge) and is the amount of electricity the battery can supply from its fully charged state to its discharged state at normal temperature. For example, the capacity of a typical Ni-Cad battery in commercial aircraft is approximately 40-65 Ah, while in wide-body aircraft it can be as high as 65-100 Ah.

#### The main uses of batteries in aircraft systems are as follows:

- To provide emergency power for the Inertial Navigation System (INS) or Inertial Reference System (IRS).
- To provide a limited amount of power to operate essential flight instruments and radio communication in emergencies; to provide power to start the engine or APU.
- To provide power for emergency lighting; to power avionics and other systems while on the ground and when ground power is unavailable.

#### IDG (Integrated Drive Generator)

It is known as the main electrical power source during flight. Previously, the constant speed drive and generator were separate components, but in modern aircraft, both have been combined into a single component called the Integrated Drive Generator. Therefore, the IDG is known as a generator that produces electricity from the torque it receives from the aircraft engine, with the gear group and generator section in a single component. The IDG is located on the gearbox (AGB – Accessory Gear Box) in the engine.

It is essential that the generator output has a nominal frequency of

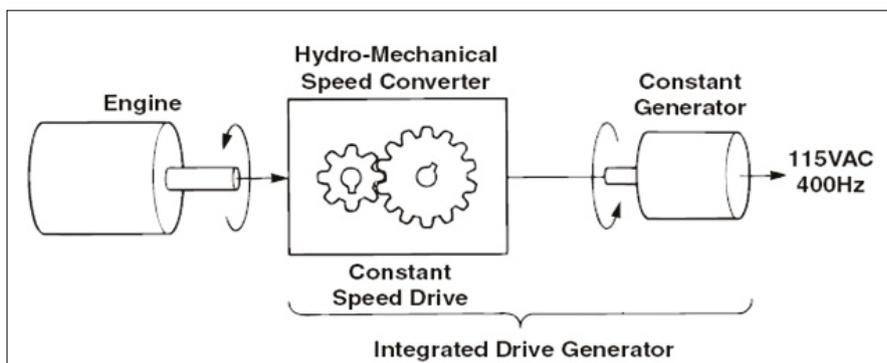
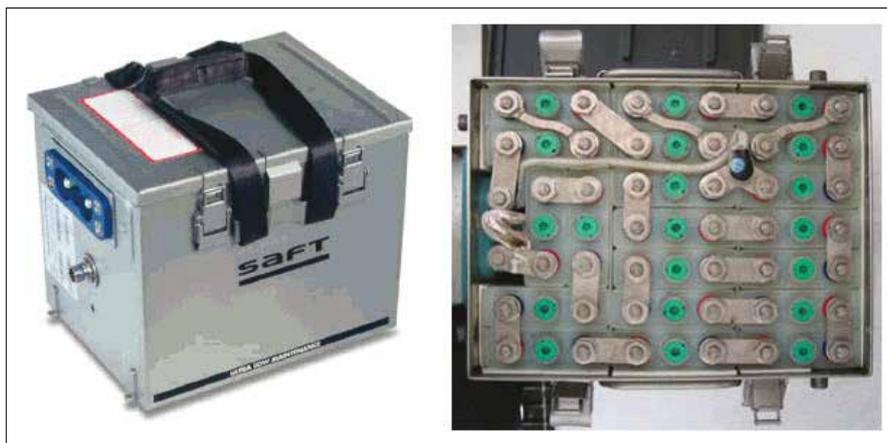
400Hz with a tolerance of typically 380 to 420Hz ( $\pm 5\%$ ). This is achieved throughout the engine operating speed range by using a hydraulically operated constant speed drive unit between the engine and generator.

A CSD consists of a variable hydraulic pump and motor connected so that the CSD (Constant Speed Drive) output remains constant, independent of the engine speed. A constant speed is required for the generator to have a 400 Hz output. Many modern aircraft use an integrated drive generator (IDG), which incorporates both the generator and the CSD in a single compact unit. In the event of a generator or CSD failure, the pilot can disconnect the input shaft from the drive to prevent any damage. Modern commercial aircraft have one generator per engine.

The main tasks of generators in aircraft can be defined as supplying the aircraft electrical systems, providing power to the main systems in emergencies, and charging the batteries. Its primary function is to convert the rotational motion, i.e. mechanical energy (engine rotation), into electrical energy. It thus supplies power to avionics systems, lighting, flight instruments and displays, fuel pumps, flight control systems, and cabin systems. It provides the system with a constant 115V/200V AC, 400Hz 3-phase power. It keeps the aircraft batteries (24V Ni-Cd) fully charged. The batteries serve as a backup power source in the event of generator failure.

If one generator fails, the remaining generator or generators continue to supply power to the systems. If both fail, for example in the A320, the RAT (Ram Air Turbine) drops down and continues to supply power to the system in an emergency.

To summarize briefly, the IDG (Integrated Drive Generator) is an electric generator that supplies electricity to the aircraft. The IDG supplies electrical power to all aircraft systems. It consists of a




**IDG example – (A320)**

**IDG characteristics summary**

- Voltage 115/200 V AC
- Power 90 kVA
- Frequency 400 Hz  $\pm 5$  Hz
- Input speed 4,500 – 9,120 RPM
- Generator speed 12,000 RPM
- Oil temperature  $< 127^\circ\text{C}$
- Oil pressure 220 – 280 psi
- Weight 56 kg

generator and a constant speed drive (CSD). The generator uses the kinetic energy of the aircraft engines and converts it into electrical energy. The CSD converts the variable speed of the engine into a constant rotational speed for the generator. This allows the generator to provide a constant frequency to the aircraft electrical system.

Oil, a hydraulic fluid, is one of the vital components of the IDG. Oil is used for cooling and lubrication and is also used by the CSD to mechanically regulate the generator's rotational speed. The IDG is driven by the AGB in the engine. The engine is accessible through the fan cowl. The reliability and efficiency of the IDG depend on the cleanliness and correct quantity of oil used. The oil level is checked using the sight glass

that indicates the oil level. As with all maintenance and repair activities, our Aircraft Maintenance Manuals (AMMs) are our sole reference source for IDG servicing, disassembly kits and testing procedures.

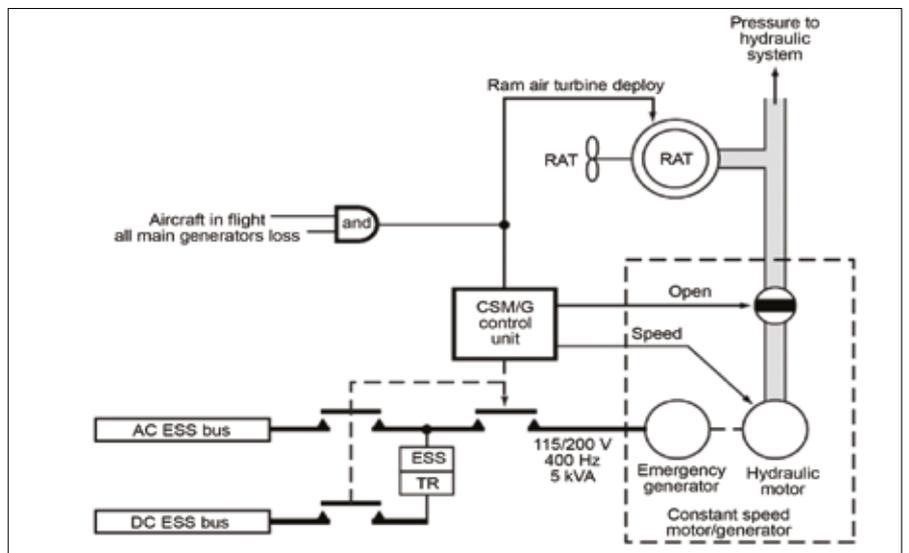
Contamination of the oil with water or dust can cause premature clogging of the filter and overheating. Oil containers and tools should be kept in a clean, dry environment. It is preferable to use a new container of oil when servicing the IDG.

In the event of oil overheating (means high oil temperature) or a drop in oil pressure (means low oil pressure), the amber IDG FAULT light illuminates and the ECAM/EICAS (Electronic Centralized Aircraft Monitor / Engine Indicating and Crew Alerting System) system is triggered. The IDG button must be pressed to



Batteries in aircraft are generally made up of individual cells, and the required voltage is obtained by connecting these cells in series. A typical aircraft lead-acid battery consists of 12 cells to provide 24 V, while a Ni-Cad battery has 20 cells. In modern aircraft, batteries may also be connected in parallel to increase overall capacity. Batteries are charged by the engine, APU, or an external ground power source. Battery capacity is measured in ampere-hours (Ah); for example, a Ni-Cad battery may have a capacity ranging from 40 to 100 Ah.

disconnect the IDG from the gearbox (AGB Accessory Gear Box). The switch on the cockpit electrical panel used to disconnect the IDG from the system is connected to a red protected switch and safety wire. This is because the IDG connection cannot be restored during flight once it has been disconnected. To prevent damage to the drive shaft coupling mechanism, the system can only be reconnected on the ground with the engines shut down. A mechanical



reset lever (ring) attached to the IDG allows the system to be reconnected while the engine is stationary on the ground.

### APU (Auxiliary Power Unit)

The APU generator (90 kVA) supplies power to the systems in flight if both IDGs fail while the APU is operational. The Auxiliary Power Unit (APU) is a small gas turbine engine located in the tail of commercial aircraft such as the Boeing 737NG and Airbus A320. It provides electrical power and pneumatic (air) supply when the main engines are shut down or unavailable. Like the IDG example, it has power and electrical parameters of 90 kVA, 115 V/200 V AC 400 Hz.

The APU's usage functions may vary depending on the flight phase. It supplies power for avionics, lighting

and systems before the engines are started. On the ground, it provides bleed air for engine start-up and air conditioning air for the cabin. On the ground (when not connected to ground power), it supplies electrical power to the aircraft. In flight (in an emergency), it acts as a backup power source if both engine generators fail. The APU is normally shut down after engine start-up to save fuel.

The Auxiliary Power Unit (APU) has an emergency shutdown system to protect the aircraft in the event of high EGT (Exhaust Gas Temperature), fire or other hazardous conditions. If a critical problem is detected, the APU either shuts down automatically or is shut down manually by the flight crew from the cockpit, or by aircraft maintenance technicians



The Ram Air Turbine (RAT) is an emergency power source used on aircraft such as the Airbus A320, providing essential electrical and hydraulic power during a total power loss. It deploys automatically and generates about 5–10 kVA, allowing critical flight controls to remain operational and enabling a safe landing. The Boeing 737 (CL, NG, MAX) does not have a RAT and instead relies on batteries and the APU for emergency power.

during maintenance by pulling the APU emergency handle. During flight, the APU does not shut down automatically if there is a fire; pilots must shut it down manually.

#### **RAT (Ram Air Turbine)**

The Ram Air Turbine (RAT) is an emergency power source found on commercial aircraft such as the Airbus A320. It is a small ram air turbine that provides backup electrical and hydraulic power in the event of a complete power failure (loss of both engine generators and the APU). It automatically activates in the event of failure of both the IDGs and the APU generator.

It generates electrical power in emergencies, supplying AC or DC power to essential systems. If hydraulic pressure is lost, it provides the hydraulic power required by the system, thereby keeping the essential flight control surfaces operational. It enables aircraft to land safely in emergency situations.

It is typically located under the wing or fuselage of the aircraft and is deployed by a spring-loaded mechanism. It generates power between 5kVA and 10kVA. The Boeing 737 series of narrow-body aircraft (CL&NG&MAX) do not have RAT; they

rely on batteries and the APU as backup power to keep essential flight systems functional in the event of failure of both engines.

#### **External Power / Ground Power**

External power (or ground power) is an electrical power source provided by the airport to operate an aircraft's systems while on the ground. This prevents unnecessary fuel consumption by the APU (Auxiliary Power Unit) or engines. On the Boeing 737 series, the external power connection is made from the external power panel located on the right side of the forward fuselage. On the A320 series aircraft, the external power connection is made from underneath the nose fuselage.

It is a 115V AC, 400Hz 3-phase power source from an airport Ground Power Unit (GPU) or Fixed Electrical Ground Power (FEGP). It performs the function of the generators in the engine or APU and supplies power to the aircraft's electrical system. It is used when the aircraft is parked at the gate or undergoing maintenance. It reduces fuel consumption, emissions and noise by eliminating the need for APU use.

A Ground Power Unit (GPU) connector has six pins to safely supply 115V AC,

400Hz power to an aircraft. These pins are required for electrical power transmission, grounding, and control:

**Three-Phase Power (Pins A, B, C)**  
It efficiently provides balanced 115V AC, 400Hz power.

**Neutral Cable (Pin N)** It provides a return path for the electrical circuit.  
**Grounding (Pin E)** Prevents electric shocks and short circuits.

**Interlock Control (Pin F)** It prevents accidental disconnection or arcing. This pin also checks whether the ground power cable is properly connected. If it is not connected, the system will not supply the required electrical power.

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## SOJT TRAINING AND ITS CONTRIBUTION TO AVIATION

**Structured On-the-Job Training (SOJT) significantly improves training efficiency in aircraft maintenance by integrating theoretical knowledge with hands-on practice. Participants learn aircraft systems directly on the aircraft, gain real operational experience, and perform maintenance tasks in a safer, higher-quality, and more effective manner.**

**A**viation authorities support the SOJT approach as a model for sustainable and effective learning. This not only increases the impact of current training programs but also strengthens the skills and motivation of the next generation of technicians.

### Dear Readers,

This month, I would like to introduce you to SOJT (Structured On-the-Job Training). This training model is not limited to the aviation sector; it is widely used across many industries. Developed countries adopted this approach years ago under the concept

of school–industry cooperation, abandoning the traditional school–internship model long ago.

Let us now focus on the aircraft maintenance sector. A brief look at the history of training in this field will help us understand how the system evolved. The training discussed here applies to Part-145 maintenance organizations. (Part-147 training will be covered in future articles.)

### Historical Background

Initially, aircraft-based training was introduced under the name “Field Trip.” At first, this was not mandatory, but it later became compulsory and

was integrated into theoretical type training programs. At that time, only a single training certificate was issued, and most organizations did not explicitly mention the field training on the certificate—it was simply included in the training syllabus.

The content was limited to aircraft systems and component locations. Some civil aviation authorities even requested aircraft registration details to verify that trainees had physical access to an aircraft.

Later, authorities concluded that this approach was insufficient and introduced On-the-Job Training (OJT). For Part-145 organizations, OJT certificates began to be issued separately from theoretical certificates.

It is important to note that this OJT is not the same as the OJT required to activate a first type rating on a blank license.

More recently, aviation authorities required that practical training be

provided by Part-147 organizations, and the program was officially renamed “Practical Training.”

### Transition to the SOJT System

One of the leading aviation authorities, EASA (European Union Aviation Safety Agency), has encouraged European states to adopt the SOJT model. Many countries have already begun preparations, and some have already implemented this system.

### Why SOJT?

After completing a theoretical type course, technicians must also receive practical training. However, theoretical certificates are valid for only three years for license endorsement.

In many cases, practical training cannot be provided immediately after theoretical courses. This time gap causes knowledge loss and reduces training effectiveness—ultimately affecting flight safety.

Because “flight safety comes first,” aviation authorities now support SOJT as a more efficient, integrated, and high-quality training model.

Although SOJT is not yet mandatory, many airlines and training organizations have started implementing it because of its proven success.

### How SOJT Works

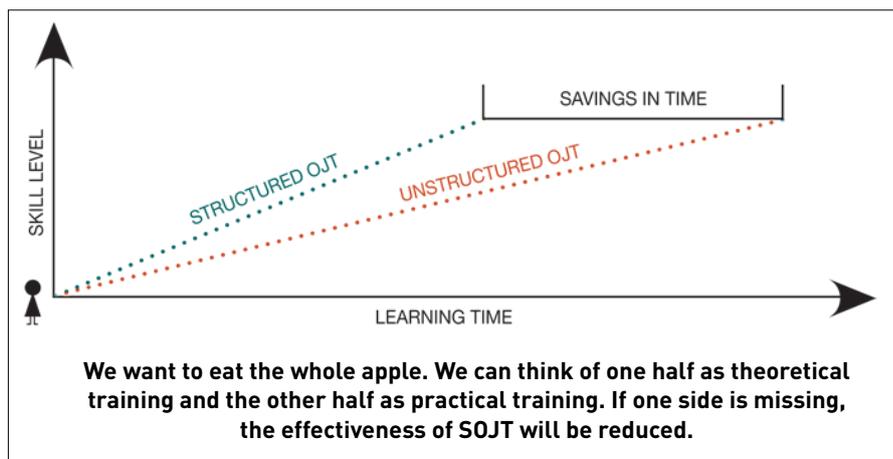
SOJT combines classroom-based theory with real operational practice. Up to 50% of the practical training may be delivered in a classroom environment using Synthetic Training Devices (STD), where available.

### Before performing any task on the aircraft, trainees are taught:

How the system works

- The safety procedures
- Possible failure modes and causes
- Relevant maintenance documentation
- Related systems and cockpit indications

How to use the Troubleshooting Manual (TSM) and Fault Isolation Manual (FIM)



### Where and how to perform system tests

Tasks are then analyzed, and trainees are shown how structured learning improves performance, motivation, and long-term quality.

### SOJT Implementation

Traditionally, OJT is delivered by Part-145 organizations.

For SOJT to succeed, Part-145 and Part-147 organizations must work together.

Whether a Part-145 organization can independently deliver SOJT depends on its internal structure, resources, and competencies.

In my professional opinion, an SOJT instructor must possess both strong theoretical knowledge and extensive hands-on experience. Having worked for many years both on aircraft and in training departments, I have seen the value of this balanced approach.

You can think of SOJT like an apple:

- one half theory, the other half practice.
- If one is missing, the training will never be fully effective.

### Final Note

If you would like to learn more, you are welcome to contact me with your questions or training requests.

As always, remember: “Knowledge becomes more valuable when it is shared.”

Due to my previous YouTube channel being compromised, I have created a new one. I invite those who are new to the profession or interested in these topics to subscribe and share.

Thank you for reading. I send you all my warm regards and best wishes.



**Ersan YÜKSEL**  
Senior Avionics Engineer  
Istinye University

## THE LORD OF THE AIRCRAFT KURT WALDEMAR TANK

If someone had asked Kurt Waldemar Tank, “What is your job?” he would have answered simply: “My job is to build airplanes.”

**F**rom 1932 to 1961, Kurt Tank designed aircraft without interruption. Among his most famous creations was the Fw 200 Condor, one of the most advanced passenger aircraft of its time. With two cabins and a total capacity of 26 passengers, the Condor featured an all-metal fuselage and wings and was powered by four Pratt & Whitney engines, each producing 875 horsepower. These were later replaced by BMW engines rated at 720 horsepower each.

Just one year after his meeting with Lufthansa executives, the Fw 200 Condor made its maiden flight on

27 July 1937, with Kurt Tank at the controls.

### The Aircraft of Records

The Fw 200 became known as the aircraft of records. On 10 August 1938, a specially modified Condor with auxiliary fuel tanks departed from Berlin-Staaken Airport and landed at New York’s Floyd Bennett Field 24 hours and 56 minutes later, becoming the first heavier-than-air aircraft to cross the Atlantic non-stop.

Only three days later, on 13 August 1938, the return flight from New York to Berlin took just 19 hours and 47 minutes.

Originally designed for commercial airlines, the aircraft was later adapted for military roles during the Second World War, including reconnaissance, bombing, and military transport.

### From Passenger Plane to Wartime Weapon

In 1939, German Foreign Minister Joachim von Ribbentrop used a specially prepared Fw 200 (registration D-ACVH) to fly twice between Berlin and Moscow for negotiations related to the German-Soviet Non-Aggression Pact.

Adolf Hitler’s personal aircraft was also an Fw 200, registered D-2600.

When used as a bomber, the Condor could carry 1,000 kg of bombs or naval mines. British Prime Minister Winston Churchill famously referred to the Fw 200 as “the Scourge of the Atlantic”, after Condors sank ships totaling 330,000 tons during the Battle of the Atlantic.

### The Philosophy Behind the Fw 190

Kurt Tank's goal in designing the Fw 190 was to surpass both the German Messerschmitt Bf 109 and the British Supermarine Spitfire.

He explained his design philosophy as follows:

"When we began work on the Fw 190, the Messerschmitt Bf 109 and the Supermarine Spitfire were the fastest fighters in the world. Both achieved this speed by fitting the most powerful engines into the smallest possible airframes. In both aircraft, weapons were secondary. I compare them to racehorses—if you feed them well and run them on a smooth track, they will beat all rivals. But once the terrain becomes rough, they stumble."

"During World War I, I served in both cavalry and artillery units. There I learned that weapons and ammunition must function under the harshest conditions. I was convinced that a different type of fighter—superior in combat—was needed. It had to operate from unpaved runways, be flown by inexperienced pilots, and maintained by minimally trained ground crews. In cavalry terms, it had to be a workhorse, not a racehorse."

In 1943, the Republic of Türkiye purchased 72 Fw 190s, known as "Würger" (Shrike), a name inspired by the cries of birds of prey.

### Exile and a New Legacy

After the war, Kurt Tank was left unemployed in the Allied-occupied zones. Although not imprisoned as a war criminal, he could not find work in Germany. He held discussions with representatives from the United Kingdom, Nationalist China, and the Soviet Union, but none resulted in employment.

It is said that the British government could not decide which position would suit a designer whose aircraft had been produced in over 20,500 units—a classic case of being "overqualified."

Tank later accepted an offer in India, becoming head of the Madras Institute of Technology. Among his students was Dr. A. P. J. Abdul Kalam, who would



The Fw 200 Condor (Vulture), as its name suggests, was an aircraft with wide wings and the ability to fly at higher altitudes than most aircraft of its era. In June 1936, Kurt Tank, Chief Designer of the Focke-Wulf Aircraft Company, proposed to Dr. Rudolf Stuessel, President of the German airline Lufthansa, the idea of building a land-based aircraft (\*) capable of carrying passengers across the Atlantic Ocean.

Kurt Tank knew that in order to operate economically over long distances, the aircraft would need to fly at higher altitudes. The Fw 200 Condor was therefore designed to cruise at the highest altitude that would not require cabin pressurization—approximately 3,000 m (9,800 ft). At that time, most passenger aircraft were limited to altitudes below 1,500 m (5,000 ft).

later become President of India in 2002 and lead the country's satellite launch and ballistic missile programs.

In 1969, Kurt Tank returned to Germany, settled in Munich, and worked as a consultant for Messerschmitt-Bölkow-Blohm—the successor to his former rival's company—until his death in 1983.

### Parallel Lives: Tank and Messerschmitt

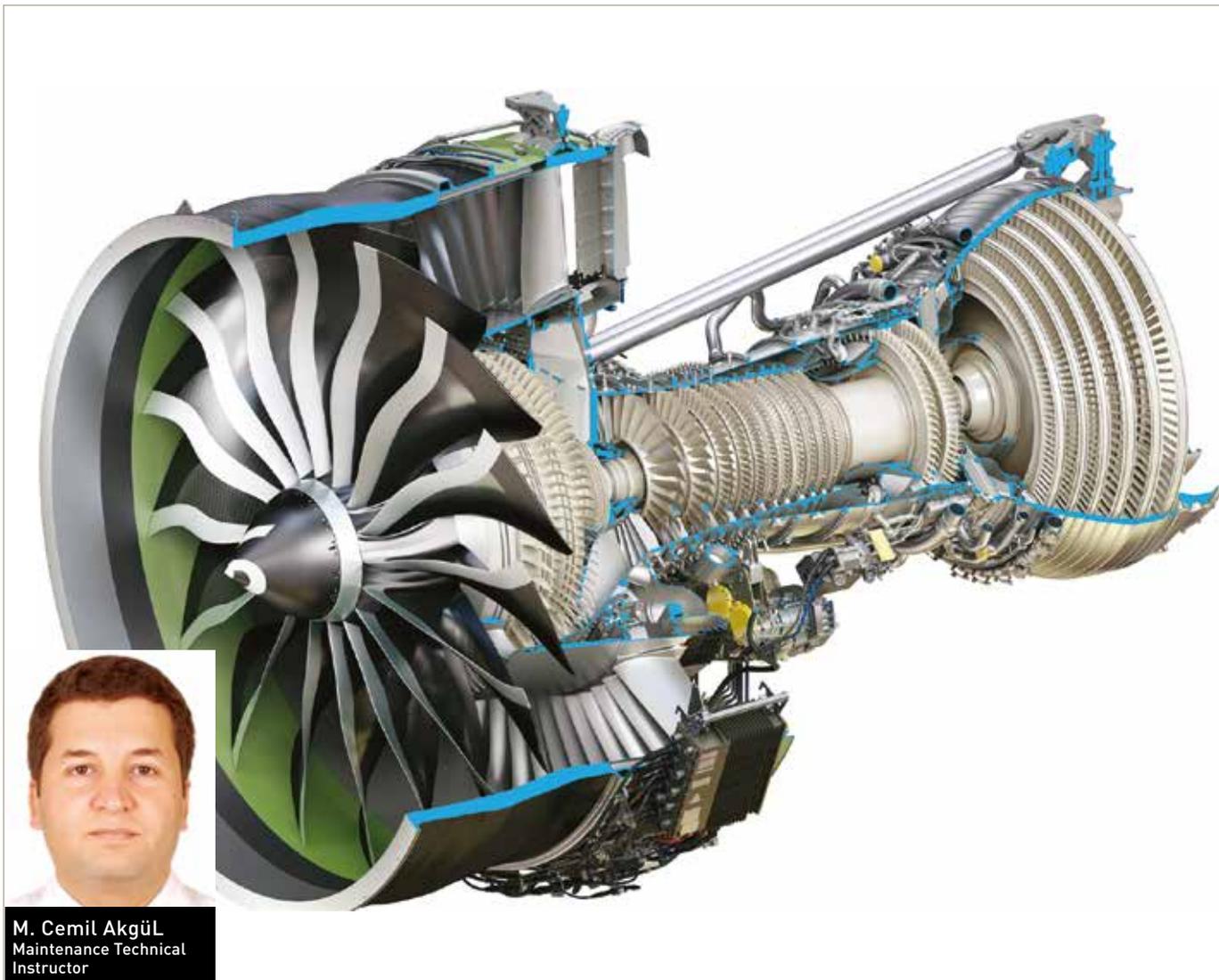
Willy Messerschmitt graduated from the Munich Technical University between 1918 and 1923. While still a student, he founded the Messerschmitt Aircraft Factory in Bamberg, designing gliders as well as the M17 light aircraft and M18 passenger aircraft.

That the aircraft designed by Messerschmitt and Tank became the

most widely used by the German Air Force—and ranked among the third and eighth most produced aircraft types in the world—and that both men were forced to work abroad after the war, became striking parallels in their lives. Both continued designing aircraft in Argentina, Egypt, and India.

Messerschmitt's decision to take Kurt Tank on as a consultant upon his return to Germany can be seen as an act of solidarity—an old rival helping a fellow craftsman in his later years.

Ironically, despite their extraordinary talents, the victorious Allied nations did not seek the services of either man. Both Tank and Messerschmitt asked to work for the occupying powers, yet both requests were declined.



**M. Cemil Akgül**  
Maintenance Technical  
Instructor

## POWERFUL AND EFFICIENT COMMERCIAL JET ENGINE

# GE9X

Developed for the Boeing 777X, the GE9X is the most fuel-efficient engine General Electric has ever produced. Compared to its predecessor, the GE90-115B, it delivers 10% better fuel efficiency. During ground testing, the engine generated 134,000 lb of thrust, setting a world record and earning a place in the Guinness World Records.

**T**he GE9X is expected to become GE's most economical jet engine to date, while maintaining the same world-class reliability standards as the GE90-115B. It also features significantly lower noise

and NOx emissions than regulatory limits, making it an environmentally responsible powerplant. The GE9X is part of GE's latest ecomaginationSM product line.

### **A Legacy Built on the GE90**

Since the GE9X is an advanced

evolution of the GE90, it is worth briefly reviewing its predecessor.

The GE90 first entered service in 1995, initially producing between 74,000 and 94,000 lb of thrust.

In 2002, a later version achieved 127,900 lb of thrust, breaking a world record. Its certified rating is 115,000 lb, and it still holds the title of the highest-thrust certified jet engine in commercial aviation.

The GE90 demonstrated its reliability by operating for 60 hours at triple red-line—maximum fan speed, maximum core speed, and maximum exhaust gas temperature.

It was also the first commercial engine to use composite fan blades. The engine's fan diameter is approximately the same as the fuselage diameter of a Boeing 737-800, and it has a 9:1 bypass ratio.

# GE9X

This Goliath engine is point-designed for the Boeing 777X. Scheduled to enter into service in 2020 with a backlog of about 700 engines. It will be the most fuel-efficient engine GE has ever produced on a per-pounds-of-thrust basis.

4<sup>th</sup> generation composite fan blades

ONLY 16 fan blades

The largest fan diameter in commercial aviation



8db margin to Stage 5 noise regulations

5% better specific fuel consumption (SFC) than any other twin-aisle engine in service in 2020

30% NOx margin to CAEP 8 regulations

10% lower fuel burn than the GE90-115B

27:1 compressor pressure ratio  
The highest ever in commercial aviation



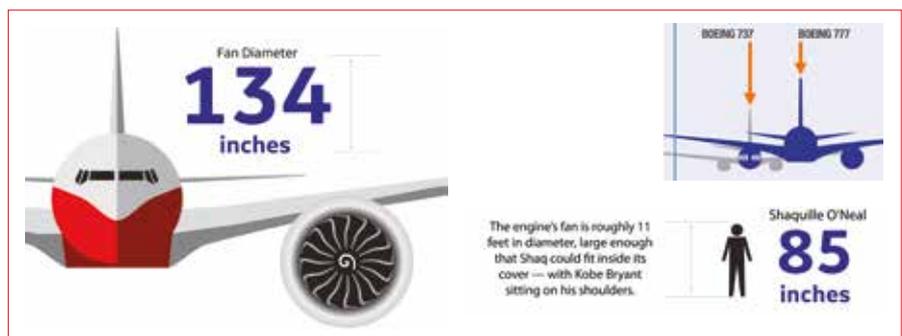
## The World's Largest Commercial Jet Engine

Although GE has not released an exact bypass ratio for the GE9X, it is expected to be around 10:1. The GE9X is officially recognized as the largest commercial aircraft engine in the world, with a fan diameter of 134.5 inches.

To illustrate its size: even if NBA star Shaquille O'Neal carried Kobe Bryant on his shoulders, they could still stand upright inside the fan case.

The fan case is made from composite materials, and the fan blades are fourth-generation composite blades. By the time the GE9X enters full service, these composite blades will have accumulated over 100 million flight hours.

GE remains the only manufacturer using composite fan blades, although the CFM LEAP engine—produced by CFM, a joint venture between GE and Safran—also uses composite technology.



The GE9X is recognized as the largest engine in commercial aviation. Its fan diameter is 134.5 inches. Even if NBA star Shaquille O'Neal carried Kobe Bryant on his shoulders, they could still stand comfortably inside the engine.

### Advanced Core and Compressor Design

GE's latest engines use a Variable Bleed Valve (VBV) system designed to expel debris entering the engine. GE calls this the "Debris Rejection System," and it is incorporated into the GE9X to protect the core.

- Low-Pressure Compressor (LPC): 3 stages
- High-Pressure Compressor (HPC): 11 stages
- The first five stages of the HPC use blisk (bladed disk) technology and advanced 3D aerodynamic design, delivering exceptionally high efficiency.
- HPC pressure ratio: 27:1
- Overall pressure ratio: 60:1
- This is the highest compression ratio ever achieved in aviation history.
- Lean-Burn Combustion and Emissions
- The GE9X combustor uses third-generation lean-burn technology (TAPS III).



The GE9X is the GE engine that makes the most extensive use of ceramic matrix composites (CMC). The combustor inner and outer liners, the first-stage HPT shrouds, and the first- and second-stage HPT nozzles are all manufactured from CMC. Compared to their metal counterparts, these materials provide twice the durability while significantly reducing weight.

Lean-burn means a higher air-to-fuel ratio than the stoichiometric mixture, improving fuel efficiency while significantly reducing emissions.

The GE9X achieves approximately 30% margin below CAEP/8 NOx limits.

CAEP (Committee on Aviation Environmental Protection) was established by ICAO in 1983 through the merger of:

the Committee on Aircraft Noise (CAN, founded in 1970), and the Committee on Aircraft Engine Emissions (CAEE, founded in 1977)

#### Global Partners

The GE9X program is supported by GE's international partners:

- IHI Corporation (Japan)
- Safran Aircraft Engines (France)
- Safran Aero Boosters (Belgium)
- MTU Aero Engines AG (Germany)

### Revolutionary Materials

The GE9X uses Ceramic Matrix Composites (CMC) extensively—more than any previous GE engine.

#### CMC components include:

- Combustor inner and outer liners
  - HPT stage-1 shrouds
  - HPT stage-1 and stage-2 nozzles
- CMC materials provide:
- 2x higher durability
  - 20% less cooling requirement
  - Up to one-third weight reduction

#### Next-Generation Manufacturing

Some compressor and turbine components are produced using powder metallurgy, where metal powders are shaped and sintered under heat and pressure. Many parts are also manufactured using 3D printing, allowing the production of complex geometries impossible with conventional methods.

#### Low-Pressure Turbine Innovations

The Low-Pressure Turbine (LPT) uses Titanium Aluminide (TiAl), which is stronger, more durable, and lighter than traditional nickel-based alloys. The GE9X LPT is the largest and most efficient ever built, produced through extensively tested, refined, and optimized manufacturing processes.

#### Record-Breaking Performance

Despite producing 134,000 lb of thrust, the GE9X is also the quietest engine GE has ever built, operating below Stage 5 noise limits. With 10% lower fuel burn than the GE90-115B, the GE9X stands as the most efficient engine in GE's history.



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**Eray BECEREN**  
Trainer -Anahtar Training

## TEAM EMOTIONAL INTELLIGENCE: THE INVISIBLE SAFETY NET FOR AIRCRAFT MAINTENANCE TEAMS

In aircraft maintenance, safety depends not only on technical skill but also on how well teams work together. Research by Vanessa Urch Druskat shows that even highly trained technicians can fail if their team lacks Emotional Intelligence (Team EI). Team EI is a shared culture of trust, respect, and open communication that prevents human-factor errors.

In the high-stakes world of commercial aviation, the safety of every flight begins in the hangar. Aircraft Maintenance Technicians (AMTs) are trained to be “virtuosos” technical experts who follow rigorous checklists and Standard Operating Procedures (SOPs) to ensure zero-defect performance. However,

decades of research by Vanessa Urch Druskat reveal a critical truth: even a group of highly skilled technicians can fail if they lack Team Emotional Intelligence (Team EI).

Team EI is not about how “nice” individual mechanics are; it is a group culture built on specific norms and habits that meet the core social needs

of the human brain. For maintenance teams, these norms act as the social operating system that prevents human factors errors and ensures that the team’s “collective brain” is fully engaged.

### **Why Team EI is Critical for Maintenance Safety**

Aircraft maintenance is a complex system where the quality of interactions between team members determines the outcome. In many maintenance environments, the focus is strictly individual rewarding the “lone genius” who can fix any turbine. However, research shows that a team of average performers with strong interaction norms will consistently outperform a group of disconnected “superstars”.

When technicians work in a culture lacking Team EI, they often fall into

“avoidance mode”. Because the human brain is evolved to scan for social threats, a technician who feels disrespected or ignored by their lead or peers will prioritize self-protection over the task. In aviation, this is dangerous: it leads to “knowledge hiding,” where a junior tech might notice a potential issue but remains silent to avoid being shot down or ostracized.

### The Three Pillars of a High-Performing Maintenance Culture

Druskat’s model organizes Team EI into three clusters of norms that transform a group of technicians into a high-functioning unit:

**1. Building a Supportive Community (Cluster 1)** Maintenance teams often work under extreme time pressure. High-performing teams don’t leave trust to chance; they intentionally build it by understanding team members’ unique skills and demonstrating care. This means knowing which technician is the expert on avionics vs. structures so that the right person is consulted at the right time. When technicians feel they genuinely belong, they are more motivated to share “novel insights” and admit mistakes early, which is the cornerstone of psychological safety.

**2. Learning and Advancing Together (Cluster 2)** Aircraft systems and regulations change constantly. Emotionally intelligent maintenance teams use a “Review the Team” norm pausing routinely to discuss what worked well and what didn’t during a heavy check or a quick turn. They also support expression, creating an environment where any team member can raise a “red flag” without fear of being shamed. This turns conflict into “creative abrasion,” where the clash of ideas leads to safer, more efficient repair strategies.

**3. Engaging Stakeholders (Cluster 3)** No maintenance team is an island. They must interact with flight crews, parts suppliers, and management. High-performing teams build external relationships to ensure they have the resources and information needed to anticipate delays or technical hurdles before they become crises.



### The “Maestro” in the Hangar: The Leader’s Role

Maintenance leads and supervisors act as “culture managers”. They set the “guardrails” for behavior. A lead who micromanages or creates fear effectively “shuts down” the brains of their technicians, reducing their cognitive capacity to solve complex mechanical problems. Conversely, an emotionally intelligent lead encourages participation from everyone, ensuring no talent goes to waste.

### Conclusion

For aircraft maintenance teams, Team Emotional Intelligence is not a “soft skill”—it is a hard requirement for system resilience. By intentionally designing norms that satisfy the human need for belonging, agency, and respect, maintenance

High-performing aircraft maintenance teams depend on Team Emotional Intelligence, built on trust, open learning, and strong collaboration with stakeholders. Leaders create a safe culture where everyone can speak up. Team EI is not a soft skill—it is a critical safety system that reduces human error and strengthens resilience.

organizations create a “social capital” that acts as a final safety net against human error. When technicians feel valued and heard, they don’t just fix airplanes; they collaborate to ensure they never fail in the first place.

### Source

Druskat, V. U. (2025). The Emotionally Intelligent Team: Building Collaborative Groups that Outperform the Rest. Harvard Business Review Press.



## ONE BOLT, ONE LIFE: THE POWER OF HUMAN FACTORS

Aviation is among the industries where safety must be maintained at the highest possible level. Modern aircraft are complex engineering systems composed of thousands of components, each of which must operate in full compliance with the highest safety standards. In addition, ensuring safe and uninterrupted operations requires highly complex maintenance processes. However, maintaining aircraft safety does not depend solely on technological systems, but also on the people responsible for the maintenance, repair, and inspection of these systems.

**H**uman factors play a critical role in aircraft maintenance. Maintenance technicians, engineers, and inspectors are essential to ensuring that aircraft meet operational requirements. Errors in aircraft maintenance not only create technical and operational risks, but also lead to serious economic losses. Engine failures, maintenance-related delays, and flight cancellations can cost airlines

millions of dollars. This raises an important question: How can human errors in maintenance processes be reduced and safety increased? In an era of rapid technological development, how can traditional maintenance practices be integrated with advanced technologies?

This article examines the role of human factors in aviation maintenance, the most common types of errors, methods used to

manage these errors, and how emerging technologies are being integrated into maintenance processes.

### **The Importance of Human Factors in Aircraft Maintenance**

Human factors in aircraft maintenance examine how technicians are affected by physical, psychological, and environmental conditions and how these factors influence job performance. Maintenance operations often require technicians to work under time pressure while performing highly detailed tasks on complex systems.

According to the Federal Aviation Administration (FAA), human error in aircraft maintenance directly contributes to approximately 15% of aviation accidents. Studies conducted by the International Civil Aviation Organization (ICAO) show that a significant proportion of maintenance errors are directly related to stress and time pressure in the working environment. The need to complete tasks within strict time constraints

can cause technicians to overlook procedures.

For example, in a Boeing study analyzing 122 maintenance errors, the following four main categories were identified:

**1. Omissions**

Failure to perform or complete a required maintenance step.

Example: Incomplete steps in a test card resulting in unreliable outcomes or leaving critical inspection areas unchecked.

**2. Improper Installations**

Incorrect or incomplete installation of components.

Example: Failure to install a washer during a modification, causing the remaining part to protrude and damage surrounding components.

**3. Wrong Parts**

Installation of incorrect or incompatible components.

Example: Installing a part not approved for a specific aircraft model.

**4. Other Factors**

Incorrect documentation, procedural errors, and communication failures.

Example: Inadequate information transfer during shift changes.

**Another study categorized maintenance errors based on technician knowledge and skill levels:**

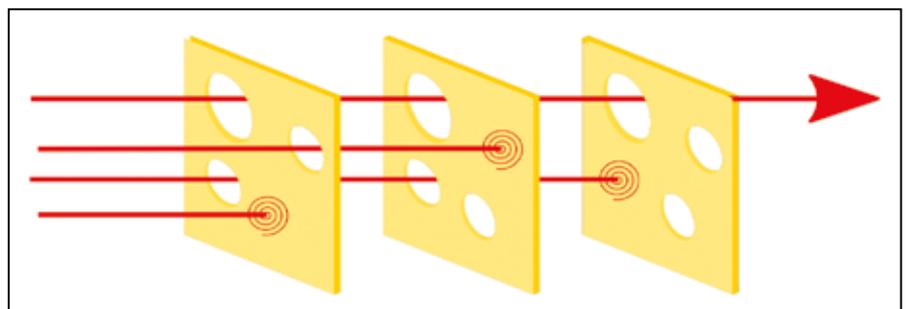
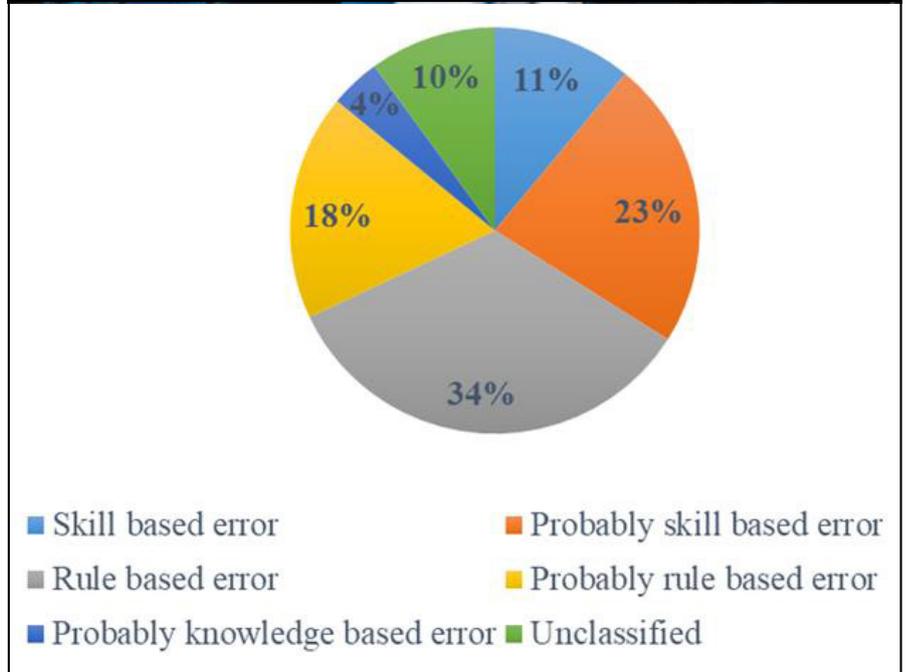
- **Skill-based errors (48%)**
- Routine tasks performed automatically leading to incorrect actions.

Example: A technician incorrectly assuming a different procedure is the same as a familiar one.

- **Rule-based errors (28%)**
- Incorrect application of procedures or rules.

Example: Using an inappropriate tool when replacing a component.

- **Knowledge-based errors (24%)**
- Errors caused by insufficient training or experience.



Example: A technician working on a new aircraft model without adequate training.

These classifications demonstrate that most maintenance errors stem from human factors and that the majority are preventable. Many of these errors result from poor

working conditions, shift changes, fatigue, and communication breakdowns. In addition, James Reason’s “Swiss Cheese Model” shows that accidents usually occur when multiple small failures align, passing through gaps in multiple layers of defense.

## Human-Factor-Related Accidents and Their Economic Impact

Some of the most catastrophic accidents in aviation history have been caused by human errors in maintenance:

### American Airlines DC-10 Crash (1979)

On May 25, 1979, a DC-10 lost its left engine and pylon during takeoff from Chicago O'Hare. Maintenance crews had removed the engine and pylon together instead of separately to save time, causing microcracks in the mounting points. The aircraft became uncontrollable, killing 273 people.

### Japan Airlines Flight 123 (1985)

A Boeing 747 crashed into a mountain after a structural failure caused by an improper repair seven years earlier. The incorrect repair led to metal fatigue and cabin pressure failure, killing 520 people.

### Southwest Airlines Flight 1380 (2018)

A Boeing 737 experienced engine failure due to metal fatigue. A shattered window caused a passenger fatality. The failure was linked to undetected fatigue cracks and delayed component replacement.

According to Boeing's cost analysis, maintenance-related engine failures cost airlines an average of \$500,000 per incident, while maintenance-related delays cost approximately \$10,000 per hour.

## Methods for Preventing and Managing Errors in Aviation Maintenance

### 1. Reactive Error Management

Focuses on analyzing accidents and incidents to prevent recurrence.

- Accident investigation boards
- Error reporting systems
- Internal audits and reviews

### 2. Proactive Error Management

Focuses on identifying risks before incidents occur.

- Risk assessment and management
- Training and awareness programs
- Communication and teamwork enhancement



Today, the aviation industry is undergoing a major transformation through digitalization. Traditional methods used in maintenance processes are being replaced by more efficient and reliable digital systems. This transformation reduces human errors, enhances flight safety, and maximizes operational efficiency. Digital maintenance technologies span a wide range, from electronic maintenance manuals to AI-powered analytics.

### 3. Maintenance Resource Management (MRM)

Improves communication, leadership, situational awareness, decision-making, and fatigue management.

### 4. Human Factors Analysis and Classification System (HFACS)

Analyzes errors at four levels:

- Organizational culture
- Supervision and management
- Environmental and situational factors
- Individual errors

### 5. Technological Support and Automation

- Digital maintenance manuals & checklists
- AR/VR-based training (Airbus, Boeing, HoloLens)
- AI-based predictive maintenance (Rolls-Royce, GE, Pratt & Whitney)
- Robotic inspection systems (Airbus drones, Invert Robotics)
- Blockchain-based maintenance records (Honeywell: 40% error reduction)

## Conclusion

Digitalization, artificial intelligence, augmented reality, and automation are among the most powerful tools for reducing human-factor-related errors. In the coming years, predictive maintenance, robotic inspections, and blockchain-based records will become standard, significantly improving safety and efficiency.

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# KAAN

The capabilities and equipment necessary for 5th generation plus fighter jets are designed using domestic and national resources, considering what such advanced aircraft should possess. They are designed to operate in a network-centric environment, allowing secure data sharing with friendly elements and employing smart munitions for strategic attacks against all types of air-to-air and air-to-ground targets.

National Combat Aircraft will dominate the skies with:

- High-performance radar, electronic warfare, electro-optical, communications, navigation, and identification capabilities.
- Precision and accurate firing from internal weapon bays at high/supersonic speeds.
- Automated target recognition and detection, multiple data fusion, and artificial intelligence capabilities enhancing combat power.

## **SYSTEM FEATURES:**

- High Situational Awareness
- Optimized Pilot Workload
- Combat Damage Assessment
- Next Generation Mission Systems
- Interoperability with Other Elements
- Low Visibility and Infrared Signature
- Sensor and Data Fusion Supported Precision Fire Control System
- Short Turnaround Time
- Easy Maintenance
- Sustainable Life Cycle Support
- Cost-Effective Life Cycle Support
- Internal Weapons Bay
- Supercruise Capability
- These advanced specifications and systems are crucial for maintaining an edge in modern aerial combat scenarios.



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## DIGITAL COCKPIT, DIGITAL ORGANIZATION HOW ARTIFICIAL INTELLIGENCE IS TRANSFORMING AIRLINES

Artificial intelligence is transforming airlines from the digital cockpit to the entire organization. In the cockpit, AI analyzes weather, fuel, and route data to support pilot decision-making. Across airline operations, similar AI-driven systems improve flight planning, fleet management, disruption handling, and crew scheduling, increasing efficiency and reducing human error. AI also reshapes human resources through data-driven performance analysis, training planning, and fatigue risk management, enhancing both safety and employee engagement.

**B**efore a flight, there is a quiet moment of preparation in the cockpit. While pilots review the flight plan, artificial intelligence-supported systems analyze weather conditions, fuel consumption, and route alternatives

within seconds. The digital cockpit is no longer limited to instruments and displays; it has evolved into an intelligent system that processes data, generates recommendations, and supports decision-making. However, this transformation is not confined

to the cockpit alone. The same wave of digitalization is fundamentally reshaping airline organizations as a whole. Today, artificial intelligence goes far beyond enhancing flight safety. It is redefining how airlines plan operations, manage resources, and position their human capital. In this context, the digital cockpit has become a small-scale prototype of the digital organization.

### **Artificial Intelligence from the Cockpit to the Organization**

Modern aircraft generate data from thousands of sensors during every flight. These data range from engine performance and fuel efficiency to flight profiles and system health. Artificial intelligence interprets this information and provides pilots with actionable recommendations. A similar process now operates behind the scenes of airline organizations.

In operations control centers, AI-supported systems assist with critical

decisions such as flight planning, fleet utilization, and disruption management. Sudden weather changes, technical constraints, or increases in operational intensity can be managed more quickly and accurately through algorithms. As a result, operational efficiency improves while the risk of human error is reduced.

### **A New Era in Planning and Crew Scheduling**

One of the most visible impacts of artificial intelligence is observed in crew planning and scheduling processes. Tasks that once required weeks of manual planning can now be completed in a much shorter time using big data and optimization algorithms. These systems simultaneously evaluate pilot and cabin crew licenses, rest requirements, fatigue risks, and operational needs to generate optimal assignments.

This approach does not merely deliver cost advantages; it directly enhances flight safety. Early detection of fatigue risk plays a critical role in preventing errors related to human factors.

### **HR Analytics: From Intuition to Data**

Another cornerstone of the digital organization is human resources analytics. Artificial intelligence enables airlines to analyze employee performance, training needs, and competency gaps based on data rather than intuition. As a result, managerial decisions rely on objective insights instead of personal judgment.

For airlines, this represents a significant strategic advantage. Assigning the right person to the right role not only improves operational performance but also strengthens employee engagement and motivation. Digitalization transforms HR from an administrative function into a strategic decision-support mechanism.

### **The Importance of an Agile and Digital Culture**

Technology alone, however, is not sufficient. Extracting maximum value from artificial intelligence requires an agile and digitally mature



organizational culture. Employees must perceive technology not as a threat but as a supportive tool. Otherwise, even the most advanced digital systems will fail to deliver their intended benefits.

At this point, leadership becomes critical. Digital transformation is not merely an investment in systems; it is a transformation of mindset. Training, transparent communication, and a culture of trust form the foundation of effective human-machine collaboration.

### **Conclusion: Technology Flies, Management Sets the Direction**

Digital cockpits represent the most visible and striking face of artificial intelligence in aviation. Yet the real transformation occurs not during flight, but before and after it—across the entire organization. From planning and human resources to maintenance management and operational culture, success in this comprehensive transformation depends not on the existence of technology, but on how it is managed.

Consider two airlines operating the same aircraft type with similar AI-supported planning systems. In the first airline, algorithms are used solely as cost-reduction tools. In the second, the same systems are integrated to account for crew fatigue,

training needs, and operational risks. As a result, the second airline achieves not only higher efficiency, but also a safer, more predictable operation with stronger employee commitment. The difference is not technology—it is management approach.

Artificial intelligence can collect data, analyze patterns, and generate alternatives. However, deciding which data to prioritize, how to interpret recommendations, and how to make the final decision remains the responsibility of human management. Therefore, digital transformation should not be viewed as a process that replaces humans, but as one that enables more informed, faster, and more consistent human decision-making.

The future of airlines will be shaped by organizations that successfully integrate artificial intelligence with human experience, support digital systems with a culture of trust, and foster shared digital awareness across the organization. While digital cockpits make flight operations easier, digital organizations ensure the safety, sustainability, and competitiveness of aviation. For this reason, investment in human capital and managerial vision is just as critical as investment in technology for the future of the industry.



## SEIZING TÜRKİYE'S FUTURE: UAM AND ITS GROWTH PERSPECTIVE

Urban Air Mobility (UAM), electric vertical take-off and landing aircraft (eVTOLs) to reduce traffic, emissions, and travel time in megacities like Istanbul. Türkiye is emerging as a key player in this field through domestic projects such as Baykar Cezeri and AirCar, supported by government R&D, local production policies, and vertiport development. With strong aerospace capabilities and sustainability goals, Türkiye is positioned to become a regional leader in next-generation urban air transport.

### Executive Summary

As the mega cities of Türkiye, especially Istanbul continues to grow, the Urban Air Mobility (UAM) along with domestically produced Electric Vertical Takeoff and Landing (eVTOL) will enable cities

to reimagine commutes by reducing cross-Bosphorus travel by 70% and significantly decrease air pollution. Türkiye continues to build on its aerospace capabilities as the UAM develops from 4.21 billion US dollars in 2024 to 14.64 billion dollars by

2032. The United States, Chinese EHang EH216-S certification and FAA empowered lift operations has had a tendency to motivate new innovations as does the Archer Aviation deals in the UAE, and Joby and Delta Airlines partnerships. The UAM sector has projected Indonesia to develop regulatory frameworks and infrastructure for integrating eVTOL aircraft into the country's urban mobility ecosystem, aiming to alleviate congestion in cities like Jakarta.

Strategically located, Türkiye combines its rich aerospace heritage with astonishingly agile innovation—traits domestically attributed to Baykar and TUSAŞ—to secure the majority of the high-altitude economy. During the month of October in the year of 2025, as the world's appetite for eVTOLs skyrocketed, Turkish startup AirCar astonishingly received

100 pre-orders within a week at the competitive rate of \$99,000, with 2026 stocks already sold out and advance payments of \$250 received showing impressive market demand. Türkiye is focusing on policies specific to the integration of Urban Air Mobility (UAM), including in Istanbul and Ankara where vertiports and UATM systems are being developed. This is supported by the Ministry of Industry and Technology's Mobility Roadmap, contract with TÜBİTAK for R&D, and 80% Turkish aerospace manufacturing content policies. Expectedly, such policies would provide a significant boost to the Turkish economy by 2030, adding billions of exports while aiming to comply with the EU's sustainability initiatives. Türkiye stands to become a beneficiary of innovative agile investments, and with such policies, is poised to become a global leader in sustainable aerial mobility.

In Türkiye, Urban Air Mobility (UAM) goes far beyond integrating a new technology. It is a vision where citizens unclog the traffic of Istanbul, access healthcare in remote parts of Anatolia, and breathe cleaner air in the burgeoning urban centers. It is worth noting that the center of UAM technology is the seamless integration of eVTOL vehicles together with UAVs into the Turkish air space. The promise, in this case, is tailored, eco-friendly, and efficient transit options that respond to the geography and requirements of the country. This article focuses on the evolving ecosystem of UAM in Türkiye. It evaluates the presents of opportunities, threats, and the strategic outlooks of the regulatory systems of the country. It also focuses on the science and technology policies of the country. The purpose is to show the potential of UAM, and that is to protect and serve the development of the nation first.

**Key Definitions: Advanced Air Mobility in Türkiye**

A first step in incorporating UAM 's evolution in Türkiye, is to explain the following definitions with regulatory and operational perspective.

- **VTOL (Vertical Take-Off and Landing):** Types of aircraft that



rise and descend vertically. This aircraft combines the effectiveness of a fixed-wing with the versatility of a helicopter. In Türkiye, a disaster response VTOL, a prototype of the Baykar Cezeri, is useful in rough terrains.

- **Electric VTOL (eVTOL):** Vehicles emitting no carbon during vertical takeoff and landing, noiseless due to distributed propulsion; models tailored for cost efficiency and urban integration, for example: Turkish AirCar, accommodates 2-5 passengers or cargo and offers a two-seater configuration.
- **Unmanned Aerial Vehicles (UAVs):** Defined in Turkish DGCA regulations and EU Regulation 2018/1139, remotely controlled or fully autonomous flying machines. In Türkiye, military UAVs and their civilian counterparts, such as wildfire monitoring (for over 2,000 incidents in 2023), demonstrate the country's novel dual-use innovation.
- **Advanced Air Mobility (AAM):** AAM in Türkiye integrates unserved regions with the broader seamless cross-multiply network and regional radiating pairs described in the 2030 Sanayi ve Teknoloji Stratejisi.
- **Urban Air Mobility (UAM):** Vertical circuits in electric aircraft, aimed specifically at urban centers; designed for Türkiye's cities to facilitate quick Bosphorus crossings.

**Advanced and Urban Air Mobility in Türkiye is built around new vertical flight technologies such as VTOL, eVTOL and UAV systems. These aircraft enable disaster response, urban transport, surveillance and logistics, while supporting sustainable, low-noise and zero-emission operations. National projects such as Baykar Cezeri, AirCar and dual-use UAV systems show Türkiye's strong innovation capacity. This ecosystem is supported by Unmanned Traffic Management (UTM) and Urban Air Traffic Management (UATM), which ensure safe integration of aerial vehicles into Istanbul's dense urban airspace and Türkiye's future smart transportation network.**

- **Innovative Aerial Services (IAS) & Innovative Air Mobility (IAM):** As in the case of Turkish IAS, which undertakes the agricultural mapping and the monitoring of the land and infrastructural development, the services pertain to the surveillance and the multimodal transport of goods and services.
- **Unmanned Traffic Management (UTM):** The overarching drone surveillance and monitoring



system. The DGCA has developed systems which manage and control the safe drone operations within the air territory of Türkiye.

- **Urban Air Traffic Management (UATM):** Primary control of air traffic in defined urban areas which is crucial for the horizontal integration of eVTOLs in the urbanized regions, like the city of Istanbul.

#### **Opportunities in UAM: Accelerating Sustainable Development of Türkiye**

The socio-economic development of UAM in Türkiye as highlighted above focuses on the people like in the case of Istanbul where an individual spends an annual traffic time of 50 hours on the road, and in the rapidly developing regions of Türkiye which are prone to earthquakes. According to the latest AAM reports published by NASA, the projected regional air mobility (RAM) market has the potential to serve between 300 and 700 million passengers. For the U.S. market, Deloitte projects the AAM market could reach about US\$115 billion annually by 2035 and could create around 280,000 jobs in that timeframe. According to Deloitte's latest reports, Türkiye also has the potential to generate significant employment in the UAM sector, contributing to broader economic development.

#### **The Integration of UAM into the Transport System of Türkiye**

The eVTOLs are designed to offer a cleaner and quieter alternative to the helicopters. This offer is in line with the European Green Deal, which

targets greenhouse gas neutrality by 2050. These vehicles will help in the decarbonizing of urban centers such as Ankara and Izmir, thereby meeting the emission targets set by the Türkiye government as well as the EU. And as the case with eVTOLs developed by Turkish corporations, they are easily integrated into the national transport system, which enhances the operational efficiency by lowering the carbon emissions in the crowded regions.

#### **The Economic benefits that come from UAM**

The main purpose of innovation, is to leverage the new opportunities that UAM makes, creates new jobs, and new structures, along with building new infrastructure. The Turkish UAV exports reached approximately \$1.8 billion, positioning the country as one of the world's leading UAV providers, with an estimated 65% share of the global UAV export market. Walsh (2025) estimates that the market for Regional Air Mobility (RAM), a segment within Advanced Air Mobility (AAM), could reach \$75 billion to \$115 billion by 2035. Globally, the emerging concept of a 'low-altitude economy' — encompassing UAVs, eVTOLs and other low-altitude airspace activities — is being developed through infrastructure, regulation and industry investment. In Türkiye, the regulatory and industry groundwork for Urban Air Mobility (UAM) is being built, reflecting the country's engagement with low-altitude air-mobility systems and supporting technologies.

#### **Increasing The Mean UAM's opportunities in Türkiye**

There are specific steps that should be taken that will boost the UAM in Türkiye to the next level.

- **Enhancing Demonstration of Societal Benefits to Gain Acceptance:** The promotion of public awareness that emphasizes the reduction of congestion in the Turkish city of Istanbul.
- **Environmental Responsibility of the Effects of Noise Pollution:** To ensure smooth operational landscapes in Türkiye wildlife, and operational city areas.
- **Investing in Training for the New Generation of Professionals:** Turkish research and innovation institutions, such as TÜBİTAK, support aerospace research and development and provide training programs for students and professionals in the aviation and aerospace sectors.
- **Reduction of the Cost of the Services:** To enhance the adoption of Urban Air Mobility (UAM) in Türkiye, policymakers could consider integrating UAM with existing multimodal transport systems. Such integration may improve efficiency and accessibility while potentially reducing costs for the public.
- **Risk Allocable Insurance:** Tailoring policies for Turkish operations covering risks like cyber-attacks to gain the trust of investors.

These approaches guarantee that UAM's diverse deployments will continue to assist with the equitable development of the Republic of Türkiye.

### Addressing the Specific Problems of Türkiye

Policy solutions are required within the specific context of Türkiye with regard to urban density, the high number of urban heritage sites, and the lagging legal and regulatory framework.

### Easier Problems to Solve: Physical Infrastructure

The development of vertiports and air corridors should take into account and protect Türkiye's cultural heritage, particularly the historic silhouette of Istanbul. It is also suggested to explore above-building integrations, where delivery or service points could be placed on rooftops or elevated platforms without interfering with the operations of the buildings below.

### Easier Problems to Solve: Digital Infrastructure

The UATM System is a prerequisite to guarantee safe UAM operations within the Republic of Türkiye, more so with the level of air traffic. Aligned with the European Union, there are active investments in Artificial Intelligence to mitigate cyber challenges and enhance flight operations capability.

### Legal and Policy Framework Challenges for UAM

Sound liability frameworks need to be in place, especially with the technology and the pace of change that the industry is experiencing. As scope and requirements increase, the need for more interactive collaborations including DGCA on certification and the intersection of privacy and technology, along with insurance, are needed.

### The Absence of Cohesive International Standards

The lack of global uniformity creates difficulties for Türkiye's efforts to go cross border. Though much influenced by EASA, national changes are more prominent.

### Türkiye's Strategic Vision for UAVs and VTOLs (2023-2030)

Company	Segment	Highlights
Baykar	UAV / eVTOL	Cezeri: MTOW ~241 kg; cruise speed ~100 km/h; range ~70-80 km; max altitude ~2,000 m; prototype completed test flights.
TUSAŞ	UAVs	Design, development, modernization, manufacturing, and life-cycle support of fixed-wing aircraft, helicopters, UAV systems, and space systems.
Havelsan	Software	R&D in aerospace technologies, avionics, software, unmanned systems.  Support UAV and aerospace development; contribute to civilian and commercial innovation.
AirCar	eVTOL	Two-seater eVTOL prototypes for urban air mobility. 100+ pre-orders; manned test flights.

Table 1: Türkiye's Industry Projections for VTOL UAV Development (2021-2030)

Year Range	Key Milestones	Contributions of Türkiye
2021-2025	Prototyping & Testing (Baykar Cezeri, AirCar flights)	Laying groundwork for domestic R&D and regulatory compliance
2026-2028	Regulatory Alignment & Pilot Programs	Expansion of pilot programs and urban mobility initiatives
2029-2030	Commercial Scale-Up	Enabling broader domestic deployment and supporting global competitiveness

Table 2: Türkiye's Strategic Vision for UAVs and VTOLs (2023-2030)

Phase	Strategic Goals
2023-2025	Become a top 5 global producer of civil UAVs; develop commercial UAV applications; launch 3 passenger eVTOL companies; achieve 60% local production of UAV components.
2026-2028	Reach top 3 in global civil UAV production; operate 10 commercial UAV and 10 passenger eVTOL companies; launch 1 UAV "unicorn"; achieve 70% local production.
2029-2030	Establish as a competitive global player in commercial and passenger eVTOL platforms using domestic subsystems; achieve 80% local production; advance toward an autonomous; aerial ecosystem.

Table 3: Türkiye's Major Aerospace Firms Alongside Active UAV and eVTOL Projects

### Global, Regional, and National Level Regulations

The baseline is set by ICAO, with EASA providing regional controls and DGCA in Türkiye responsible for the incorporation of drones and eVTOLs into the national airspace system with registration, ensuring alignment with international standards.

### Exemplary Case Studies in UAM Development

- **Uber Elevate - United States:** Uber Elevate was Uber's urban air mobility division, focused on eVTOL concepts and

infrastructure planning. It helped develop early UAM strategies and tools for on-demand aerial mobility before being acquired by Joby Aviation in 2020. While it did not reach full commercial operations, its research and planning influenced the global UAM sector.

- **UAE - Archer Aviation Infrastructure:** First hybrid heliport; similar to Türkiye's Vertiport and Urban Air Mobility Development projects.

- **Türkiye: AirCar's Rapid Success:** AirCar has reportedly received over 100 pre-orders by October 2025, with mass production anticipated around 2027. The project has garnered significant local investment, including support from platforms like Fonbulucu, reflecting growing interest in Türkiye's UAM sector.

### Recommended Plan for UAM

#### Challenges and Issues

- **eVTOL system and vertiport infrastructure:** Develop eVTOL vertiports in strategic locations in Türkiye.
- **Urban UAV logistics:** Allocate airspace for seamless urban logistics and efficient cargo transfer.
- **UATM with reasonable AI assistance:** UATM with situational awareness in dense airspace.
- **Demand surveys:** Feasibility Assess urban and emergency contexts in Türkiye.
- **Innovation and R&D:** Innovation Platforms to encourage investment via Turkish Technology and Scientific Research Institution (TÜBİTAK).
- **Regulatory Framework:** Align the policies of the General Directorate of Civil Aviation of Türkiye (DGCA) with international policies.
- **Cooperative Framework:** Develop comprehensive Public-Private Partnerships (PPP) to facilitate trust.
- **Geo-fence Integration and Assignment of Responsibility:** Clear rules of the airspace to be integrated for safe operations and defined liability.

### UAM and UAV Legal Operational Framework in Türkiye

Bolt is evolving to enable domestic UAM in Türkiye while complying to the Chicago Convention in international border safety. 'Article 1' is planning for airspace governance and border control; uncontrolled interface with neighboring countries could be strategically dangerous.



#### In eVTOLs, most relevant features...

- **Airspace Sovereignty:** Aircraft with Domestic Civil Aviation Authority (DGCA) approval.
- **Registration of Aircraft:** Vehicle registration is a prerequisite for all of them

#### Air Traffic Control: UATM system incorporation

As of November 2025, Türkiye's Urban Air Mobility (UAM) regulations are still under development. However, existing aviation laws such as Law No. 2920 and SHT-İHA require the registration of UAVs exceeding 500 grams. The DGCA (General Directorate of Civil Aviation) has introduced simplifications to the regulatory framework in 2025, facilitating smoother entry into the UAM sector. These changes support the country's broader Mobility Roadmap, which fosters collaboration across stakeholders to fill regulatory gaps and promote sustainable aerial mobility. Projects like Cezeri, developed by Baykar, and AirCar are pivotal in Türkiye's push towards establishing UAM infrastructure, including vertiports and regulatory frameworks for licensing. The Turkish government recognizes the social benefits of UAM development, focusing on improving urban mobility and reducing congestion. While social justice is not a clearly defined aspect of current UAM policy, there is an emphasis on workforce development and training programs in aerospace technologies to equip the next generation of professionals for future challenges in aviation and automation.

#### Turkish Air Mobility Ecosystem: Strategy and Forecasts

With 80% domestically produced and governed backed, Türkiye aims to UAM 'leadership'. AirCar's November 2025 crowdfunding success alongside

partnership of EU's Green Deal aims 30% urban emission reduction target.

#### Industry Projections for the Development of VTOL UAVs (2021-2030)

Current projections illustrate staged progression, and the primary focus at the moment is on testing.

#### The Aerospace Industry: Cornerstones of Industry within Turkish Aerospace

Türkiye is a UAV center and is researching eVTOLs for logistics and mobility. Particularly, used to optimise several processes, UAVs provided helpful information monitoring with the use of optical and IR, radar, photogrammetry (3D), and visual cameras. Predefined flight plans enabled real-time response using kinematic and static programmed UAVs. Economic development relies on actively used policies and the positive results of scientific investments by organizations and private enterprises. Looking economically, used technologically advanced solutions support policies of expenditure effective control.

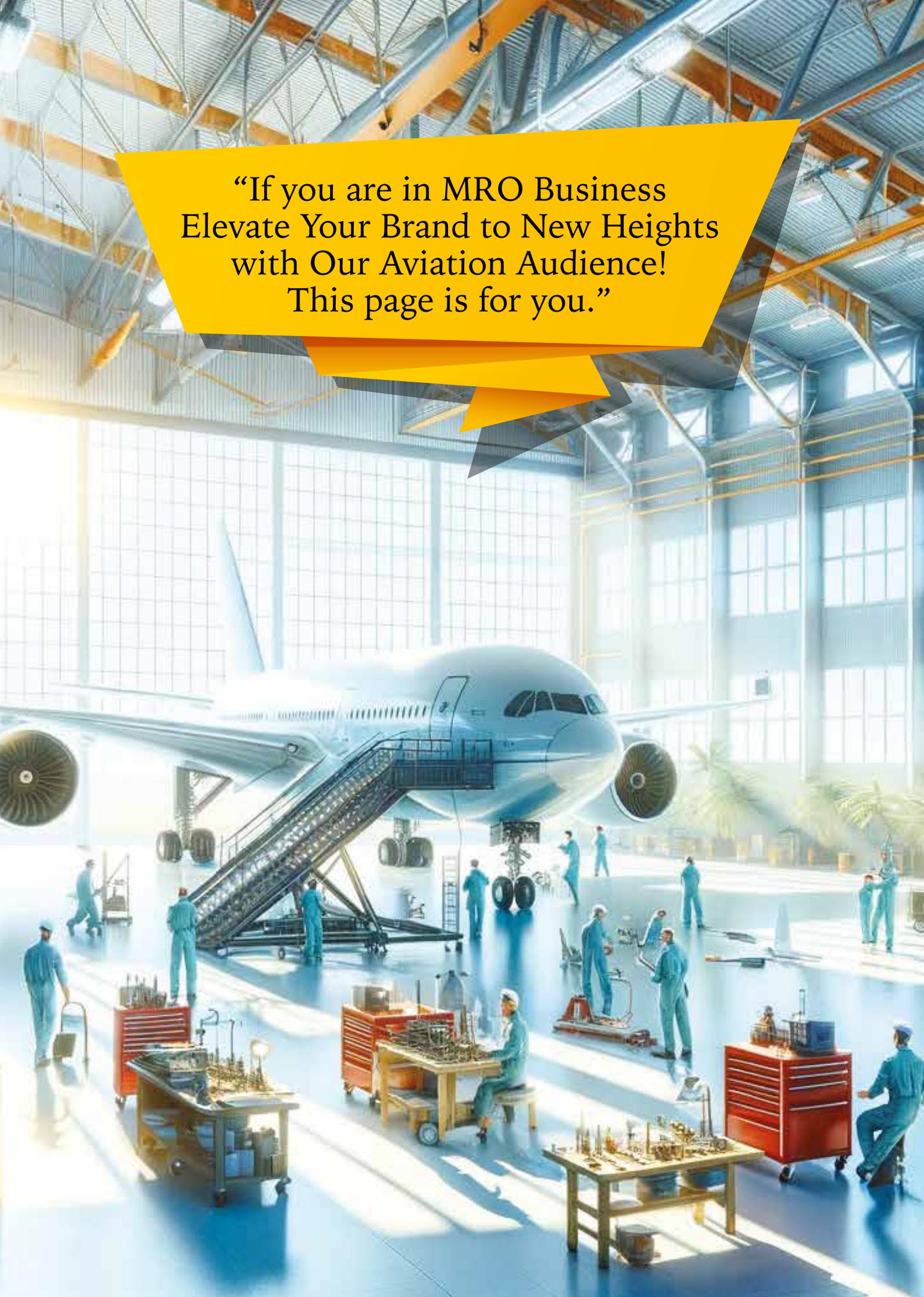
#### Conclusion: Türkiye's Strategic Plan

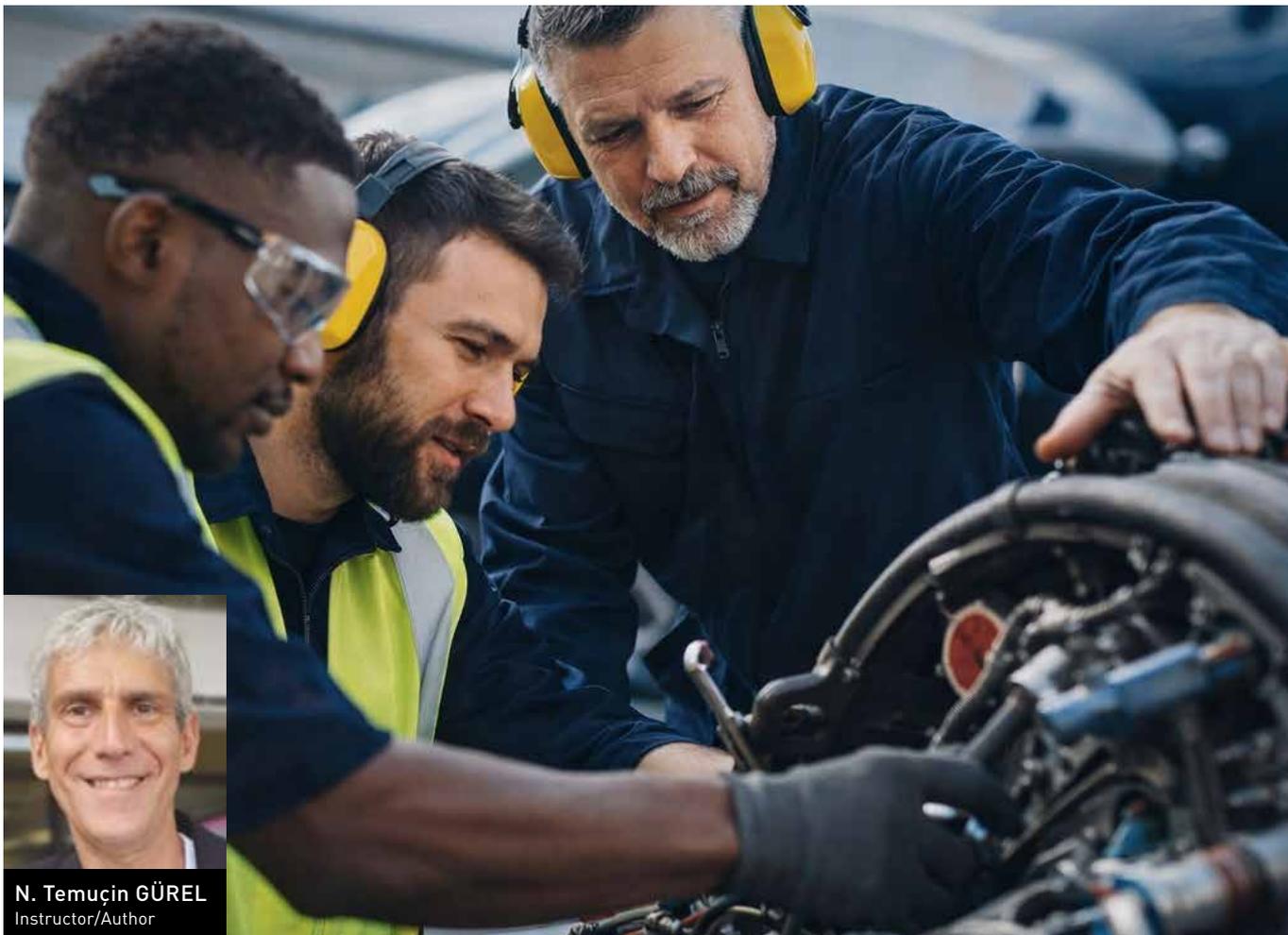
Türkiye's UAM's policy blueprint is the first of its kind to focus on people: fostering innovation and balancing it with policy. Addressing challenges with regulation, investment, and involvement: Türkiye's can be the leader in sustainable aerial mobility. Policy makers need to accelerate collaborations, training, and missions to help the people, and elevate the nation.

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**“If you are in MRO Business  
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N. Temuçin GÜREL  
Instructor/Author

## THE HUMAN FACTORS BEING A ROLE MODEL AND IMPLICIT LEARNING

In technical teams, real learning happens through people, not procedures. While training provides knowledge, behavior is shaped on the job through implicit learning and role models. Senior technicians and leaders influence safety culture not only by what they say, but by what they consistently do. Their daily actions silently teach younger staff how to work, decide, and behave. Strong role models turn training into practice, protect safety, and build real teams.

**W**e know that one of the most important social competencies for technicians is teamwork. One of the fundamental requirements for a group to become a real team is leadership. In technical teams, leadership appears as a key responsibility of highly experienced and senior technicians. It can

also be stated that leadership is a responsibility for technicians holding managerial titles such as Chief, Lead Technician, or similar positions.

A senior technician who possesses the qualities required for leadership may, perhaps without even realizing it, perform a critically important function for young technicians who are new to the system or already part

of it: being a role model. In other words, setting an example.

When we examine the sub-dimensions of teamwork competence, we can see that all of them are oriented toward developing correct and appropriate attitudes. An experienced technician who demonstrates the right behaviors in line with these attitudes not only performs their job safely and correctly, but also creates a positive influence on all team members.

Today, maintenance organizations, airlines, and ground handling companies that are aware of how human development contributes to organizational development—and how this directly affects safety—provide additional training for their managers and senior employees on being role models. In this way, they both create new learning opportunities and reduce training costs. How? Let us examine this together.

## THE LEARNING PROCESS

Learning can generally be defined as a permanent change in behavior that occurs as a result of repetition or experience. Accordingly, learning has three basic components:

- Behavioral change (observable or measurable),
- Emerging through repetition or experience,
- Showing continuity over time.

On the other hand, learning occurs in two main ways: conditioning and cognitive learning. Because of its relevance to role modeling, this article will focus on cognitive learning.

Cognitive learning processes are complex due to their structural characteristics. This type of learning occurs in the human brain. We constantly learn by reading, watching, and listening. Cognitive learning refers to the evaluation of information through mental abilities such as understanding, perception, memory, and thinking. The main focus of this type of learning is the accumulation and processing of knowledge. In other words, experiences are stored and given meaning.

Cognitive learning can take different forms. Let us briefly examine them.

### Implicit Learning

This can also be described as learning without awareness. In this type of learning, a person learns without the intention to learn, without realizing that learning is taking place. For example, while reading a book, we may unintentionally memorize the lyrics of a song that plays repeatedly in the background. Our goal is not to learn the lyrics, yet they become embedded in our memory.

### Learning by Role Modeling

Learning by role modeling occurs when a person observes, admires, and imitates someone they like for certain qualities and learns to behave in a similar way. For example, an individual may take one of their teachers as a role model because of one or more of their qualities and



strive to resemble them. This type of learning involves a degree of imitation. People learn by observing those they regard as references and who appeal to them with their characteristics.

### Learning Through Insight

Learning through insight occurs when the relationships among the components of a problem situation are discovered through evaluation and reasoning. In this type of learning, the solution seems to appear suddenly as a result of reasoning. For example, while working on a difficult problem, one may suddenly see the connection and reach the solution. This type of learning usually occurs more frequently in formal educational environments.

### The Impact of Learning Pathways

All of the methods mentioned above are effective in cognitive learning processes. However, it should be emphasized that implicit learning and learning through role models are the

**In aviation, safety is learned from people, not just from procedures. While training provides knowledge, behavior is shaped through implicit learning and role models. Senior technicians silently teach the next generation how to act, decide, and work safely—every day on the job.**

### BEING A ROLE MODEL IN THE WORKPLACE

Technical teams receive regular training in all required subjects. Among these are human factors trainings, which also include behavioral components. Both theoretical and practical knowledge are shared. In addition, in on-the-job training, great effort is made to transform knowledge into skills. Furthermore, technical personnel are

kept up to date through mandatory documentation they must follow in their daily work.

**However, we must not forget:**  
“People do not look at your words; they look at your feet.”

As this anonymous saying clearly expresses, real-life situations encountered in maintenance operations are far more decisive than any formal training or documentation.

For example, a newly hired technician is taught to perform tasks strictly according to documentation and not from memory. The importance of this is emphasized in training. However, when they enter the field and see that work is done from memory, outdated revisions are used, and this occurs repeatedly, the knowledge gained in training will gradually fade. Instead, what they unconsciously absorb from the environment and from their role models will take its place.

They may begin to think: “This is taught in training, but in real life things are done differently.” If they try to resist or criticize what they see, they may fear exclusion and eventually adapt.

Now let us look at the positive side of the same example. If the technician sees experienced colleagues strictly following documentation—and even witnesses a Chief Technician intervening to replace an outdated revision and reporting it as a non-conformity—this technician will gain learning far beyond what was taught in training.

After experiencing such examples repeatedly, the technician will begin to demonstrate the same behaviors without conscious effort. Moreover, they may adopt other positive traits of these role models and develop additional skills.

### THE PSYCHOLOGICAL DIMENSION

Beyond learning, this subject also has a strong psychological dimension. Research shows that people tend to respond in a way that mirrors the behavior they encounter. If someone



communicates with us respectfully and honestly, we respond in the same way. If they are rude or insincere, we often mirror that as well.

In daily life, we can easily observe this: If we offer a colleague a ride home, we are likely to see them return the favor later, perhaps by bringing us a coffee. This reflects the natural tendency to reciprocate positive behavior. Unfortunately, the same is true for negative behavior.

Consider a young technician whose supervisor asks for their opinion, listens, and responds appropriately. Even if their suggestion is not used, this behavior will encourage the technician to be more supportive and engaged in future tasks. Over time, they may even adopt this behavior as a role model and strive to act in the same way.

### CONCLUSION

The examples above show that learning occurs largely through implicit processes and role modeling. Therefore, experienced staff and those in leadership positions carry a critical responsibility: to be the right role model.

Inexperienced technicians will unconsciously absorb many behaviors from senior staff—not only during tasks, but even during breaks or casual moments. They will observe, imitate, and adopt what they perceive as positive.

For this reason, the number of positive role models within an organization is of great importance. Some aviation organizations provide specific training on role modeling to managers and senior operational staff to reinforce formal training through real-life practice.

This approach increases the likelihood that desired behaviors will be learned naturally and correctly, even when time constraints limit formal training. It also lays the foundation for the development of safe and appropriate behavior.

Ultimately, this is not only the responsibility of aviation organizations, but also the personal responsibility of every experienced professional within them.

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**FOR TURKISH AVIATION**





## BALANCING PRODUCTIVITY AND SAFETY IN MRO'S: **STRATEGIC APPROACHES FOR SUSTAINABLE SUCCESS**

The aviation industry is under increasing pressure to perform maintenance, repair, and overhaul (MRO) services more efficiently and safely in the face of rapidly evolving technology and rising passenger demand. This article examines how productivity and safety are balanced in aviation maintenance processes, how this relationship affects company performance, and how current industry approaches are improving these systems.

**D**espite ongoing global economic uncertainty, rising operational costs, and supply chain pressures, the aircraft MRO sector continues its stable growth. By 2025, the global MRO market is expected to exceed USD 120 billion. In this competitive environment, companies are no longer evaluated solely on their technical capabilities, but also on their efficiency, productivity, and maintenance safety performance.

### **MROs in Changing Market Dynamics**

Despite global economic fluctuations and increasing cost pressures, the MRO industry continues to expand. By 2025, the market is projected to reach USD 120 billion. However, growth alone is not enough—MRO organizations are now measured by multi-dimensional performance indicators such as:

- Productivity
- On-time delivery
- Human-error rates
- Safety performance

In such a highly competitive environment, technical competence alone is insufficient. Organizations that place continuous improvement at the center of their strategy gain a significant competitive advantage.

### The Strategic Importance of Productivity and Efficiency

The success of MRO organizations is directly linked to how efficiently and productively they use their resources (workforce, equipment, time, and capital). Commonly adopted methodologies include:

1. Lean Maintenance
2. Six Sigma
3. Theory of Constraints (TOC)
4. Critical Chain Project Management (CCPM)
5. Creative thinking and continuous improvement techniques

All of these approaches aim to shorten maintenance turnaround times, reduce costs, and enhance safety.

### **The Role of Safety and Human Factors**

In aviation, safety is not merely a goal—it is a prerequisite for sustainability. Regulations such as EASA Part-



In a market expected to exceed USD 120 billion by 2025, success is driven by efficiency, productivity, and maintenance safety. Human factor-related errors are analyzed through systems such as MEDA and CBTA, enabling continuous improvement.

These analyses are not only reactive but also serve as a proactive guide for preventing future errors.

### Current Developments and Digital Transformation

Key technological trends in the MRO sector (2024–2025) include:

- AI-supported maintenance planning systems
- Autonomous drone-based visual inspections
- Data-driven predictive maintenance
- Sustainable MRO practices (emission monitoring and eco-friendly solutions)
- Digital twin systems for component tracking

These innovations not only enhance operational performance but also support the development of a safer and more environmentally responsible aviation ecosystem.

### Conclusion

In today's competitive environment, MRO success depends not only on cost reduction or time savings, but on a holistic productivity–safety management approach:

- Safety-focused productivity models must be adopted
- Human factors must be managed through systems such as MEDA
- Digital solutions should be integrated to support productivity
- Continuous improvement must be combined with a culture of learning from errors

Productivity, sustainability, and safety are the three indispensable pillars of MRO organizations.

Wishing the industry continued progress toward a safer, more efficient, and sustainable future.



145 and FAA Part-145 require the widespread adoption of safety culture within maintenance organizations.

While in the early years of aviation nearly 80% of accidents were technically related, today this ratio has reversed, and more than 80% of aviation accidents are attributed to human factors.

To analyze and manage human error in maintenance organizations, several structured systems are used:

**MEDA (Maintenance Error Decision Aid):** A Boeing-developed system for root cause analysis of maintenance errors.

**HFACS-ME:** A human factors classification framework for maintenance errors.

**CBTA (Competency-Based Training and Assessment):** A competency-based training model mandated by ICAO as of 2023.

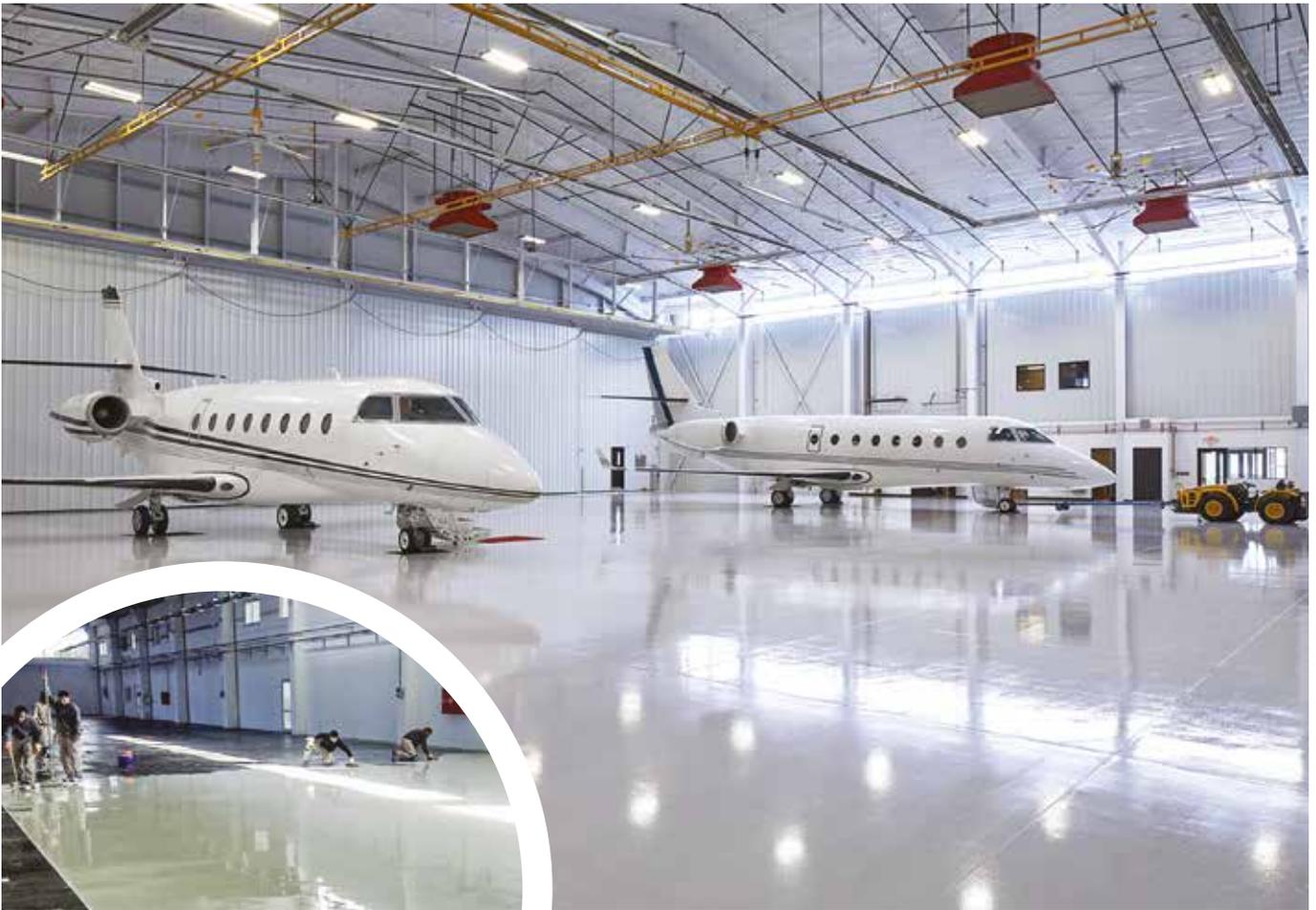
### Maintenance Errors: From Risk to Opportunity

Maintenance errors not only create financial loss but also damage organizational reputation. Recurrent errors lead to customer dissatisfaction, delays, and rework. To manage these risks, organizations typically follow a systematic process:

1. Error identification
2. MEDA investigation report
3. Error classification and contributing factor analysis
4. Definition of corrective and preventive actions

### Common contributing factors include:

1. Inadequate training
2. Fatigue and shift scheduling issues
3. Poor coordination
4. Equipment and environmental limitations
5. Documentation and procedural deficiencies



# FUNDAMENTAL PRINCIPLES OF AIRCRAFT HANGAR FLOOR COATING DESIGN

The aircraft hangar floor coating process begins with on-site concrete design. Before concrete placement, soil investigation, groundwater level, drainage conditions, and soil compaction must be evaluated. Concrete is poured in accordance with structural design, leveled using vibrating screeds, and finished with power trowels (helicopter trowel). Expansion and control joints are designed according to the project requirements.

**C**oncrete must cure for a minimum of 28 days, achieve sufficient strength, and have a low moisture content before any coating is applied. Moisture rising from the substrate must be checked, and suitable ambient and surface conditions must be ensured.

## Subgrade and Concrete Design

Hangar floor coating design starts with field concrete design. Before concrete pouring, geotechnical and foundation

reports are reviewed to determine the groundwater level and soil void ratio. A suitable drainage system is then designed and the soil is compacted. Depending on the site location and soil conditions, appropriate waterproofing systems are planned beneath the foundation in compliance with relevant standards.

According to the structural design, the concrete thickness and class are defined and the slab is cast in compliance with standards.

## Concrete Placement and Joint Design

During concrete placement, leveling must be carried out using vibrating screeds, followed by power trowel finishing. Expansion joints and control joints must be designed according to the structural layout. Otherwise, subsequent coatings may crack or fail as the concrete moves.

Control joints must be cut at least 1/3 of the slab thickness after a minimum of 24 hours following casting. In a properly designed system, floor coating should only begin after at least 28 days of curing.

Concrete must reach a minimum compressive strength of 25 N/mm (C20 class) and a minimum tensile strength of 1.5 N/mm. Moisture content at 2 cm depth must be below 4%.

**Test methods:** C-Aquamer, CM Device, Darr Method.

## Moisture Control

There must be no rising moisture from either new or existing concrete substrates. Groundwater may rise



through capillary action, causing floor coatings to blister and delaminate.

This condition can be detected with a simple polyethylene sheet test. A transparent polyethylene sheet is sealed to the concrete surface using polyurethane mastic. If moisture droplets form under the sheet, the floor must not be coated. If no moisture is observed after 24 hours, the surface is suitable for coating.

#### **Environmental Conditions**

The hangar roof, walls, doors, and windows must be completed. Ambient and surface temperatures must be between +10°C and +30°C.

In cold conditions, products should be stored at +20/+25°C before use. Rain, dust, wind, animals, and insects must be prevented from entering the building while the coating is fresh.

In resin-based systems, pot life and curing time are affected by ambient temperature, substrate temperature, and humidity.

- Low temperatures slow curing and extend working time.
- High temperatures accelerate curing and shorten working time.

The temperature must not fall below the minimum limits specified by the manufacturer until full curing is completed. After application, the coating must be protected from direct water contact for at least 24 hours.

If water contact occurs, softening and blistering may appear, and the coating must be completely removed and reapplied.

#### **Application Procedure**

When selecting coatings for aircraft

**When selecting a floor coating system for aircraft hangars, the most appropriate option should be chosen among epoxy-based, polyurethane-based, and polyurethane concrete coatings, taking into account the substrate structure, expected traffic loads, and exposure to temperature and pressure variations.**

hangars, the most suitable system should be chosen among epoxy, polyurethane, and polyurethane concrete coatings, considering substrate conditions, traffic loads, temperature and pressure variations.

In terms of performance, polyurethane



Layer	Product Name	Description	Consumption (kg/m <sup>2</sup> )
Primer	Polyurethane Concrete Primer	A three-component, solvent-free primer set obtained by modifying polyurethane-based resins with special additives and chemicals. It offers high chemical resistance.	0.30
Top Coat	Polyurethane Concrete Coating	A three-component industrial flooring system produced by modifying polyurethane-based resins with special additives and chemicals. Designed for use in wet and dry environments, it has a non-slip surface and excellent chemical, thermal shock, and solvent resistance. Applied at a thickness of 6–12 mm.	18.00

concrete coating systems are generally preferred because they provide greater thickness, higher resistance to heavy loads, superior thermal stability, and excellent chemical resistance. Therefore, this article focuses on polyurethane concrete coating design.

#### Surface Preparation

Concrete substrates must be prepared using abrasive equipment (shot blasting, milling, diamond grinding, etc.) to remove laitance and obtain an open-pore surface.

Weak concrete must be removed, voids and holes fully opened, and dust cleaned using an industrial vacuum.

Cracks, voids, and damaged areas must be repaired. For surface repairs and leveling, 60–70 AFS (0.1–0.3 mm) quartz sand should be mixed with special polyurethane concrete primer depending on site conditions.

Because polyurethane concrete may generate internal tensile stress, 8–10

**DüĖgün tasarlanmış bir uçak hangarı zemin kaplama sisteminde saha betonu döküldükten minimum 28 gün beklendikten sonra zemin kaplamaya geçilmelidir.**

mm wide joints must be created along columns and across the floor (every 4–5 meters). These joints must be cleaned and then filled with polyurethane concrete after primer application.

#### Primer Application

Polyurethane concrete primer is a solvent-free, three-component system, specially formulated for industrial flooring using modified polyurethane resins.

Because it is three-component, thorough mixing is essential. Use a mechanical mixer (e.g., Collomix CX 22).

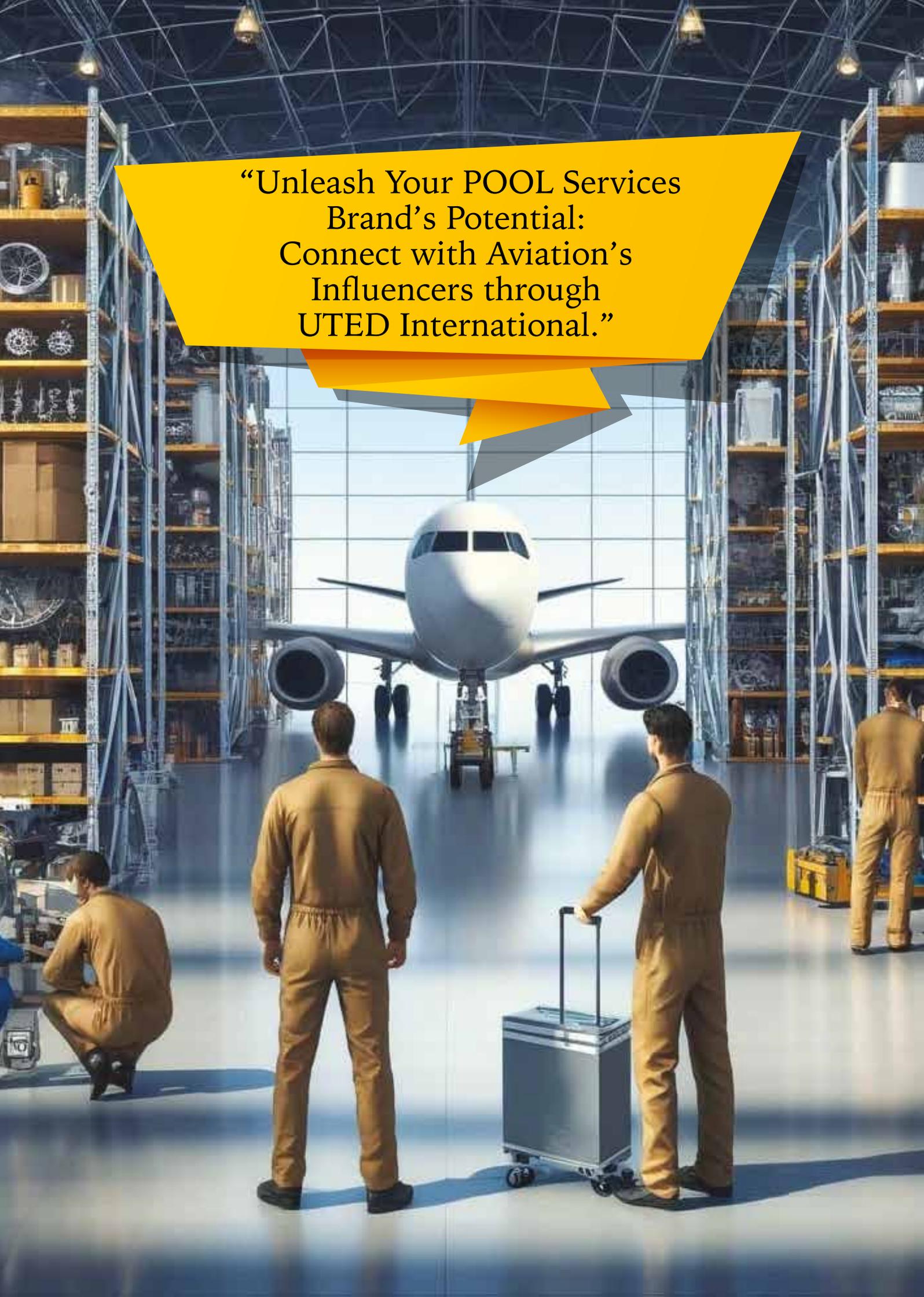


1. Pour Component A into a mixing container.
2. Add Component B completely and mix for 1 minute until homogeneous.
3. Add Component C and mix for 3 minutes until homogeneous.
4. Avoid excessive mixing to minimize air entrapment.

Apply the prepared primer at 300–500 g/m<sup>2</sup> using a roller, trowel, or notched trowel.

Ensure the surface is fully and uniformly coated without voids.

“Unleash Your POOL Services  
Brand’s Potential:  
Connect with Aviation’s  
Influencers through  
UTED International.”





**Seda ÇEKEN**  
Istanbul University, Institute of Aviation  
Psychology Researches,

## FATIGUE RISK MANAGEMENT IN AIRCRAFT MAINTENANCE:

# A SYSTEMATIC REVIEW OF PSYCHOLOGICAL RESILIENCE AND OPERATIONAL SAFETY

This study shows that fatigue is a major human factor risk for Aircraft Maintenance Technicians, reducing attention, decision-making, and safety performance. Fatigue is driven not only by long hours and shift work, but also by organizational, environmental, and psychological factors. The review emphasizes that Fatigue Risk Management Systems (FRMS) provide a proactive and effective solution, yet are still limited in maintenance operations. Integrating FRMS is essential to reduce errors, strengthen resilience, and improve overall aviation safety.

**T**his study presents a systematic review and document-based thematic analysis examining the impact of fatigue on psychological resilience

and operational safety performance among Aircraft Maintenance Technicians (AMTs). Aircraft maintenance is widely recognized as one of the most critical operational

pillars supporting aviation safety, as maintenance errors may directly compromise airworthiness and lead to severe safety consequences. Due to the continuous and safety-sensitive nature of maintenance operations, AMTs often work under demanding conditions characterized by shift-based schedules, high workload, time pressure, and exposure to environmental and organizational stressors. Within this context, fatigue emerges as one of the most significant human factors affecting technician performance and the overall reliability of aviation safety systems. Fatigue is not merely an individual physiological state but a multidimensional phenomenon involving cognitive, psychosocial, environmental, and organizational determinants. In the aviation maintenance domain, fatigue is commonly defined as a decline in mental and physical functioning associated with

reduced alertness, slower cognitive processing, shortened attention span, and impaired decision-making capacity. Long working hours, irregular rest opportunities, sleep deprivation, circadian rhythm disruption, and sustained workload intensity contribute to both acute and chronic fatigue conditions. Given the low error tolerance inherent to maintenance activities, even minor fatigue-induced lapses may initiate chains of human error with system-wide safety implications. The causes of fatigue among AMTs extend far beyond physical workload alone. Environmental conditions such as inadequate lighting, excessive noise, temperature extremes, and ergonomically challenging workspaces increase fatigue risk. Organizational pressures including overtime, shift density, insufficient staffing, and managerial constraints further amplify fatigue exposure. Individual-level factors, such as stress management capacity, sleep hygiene, and work-life balance, also play an important role in shaping fatigue vulnerability. From a human factors perspective, fatigue-related errors must therefore be interpreted not as isolated acts of negligence but as outcomes of systemic operational conditions.

Empirical evidence indicates that fatigue is highly prevalent among aircraft maintenance personnel. Recent studies report that more than half of AMTs experience significant fatigue levels, with measurable negative effects on cognitive performance, attentional control, situational awareness, reaction time, and decision-making accuracy. Field research consistently demonstrates higher error rates and slower performance among technicians working night shifts or extended duty periods. In addition, fatigue has been associated not only with reduced safety performance but also with diminished quality of life and psychological well-being, suggesting a direct relationship between fatigue exposure and resilience capacity in safety-critical work environments.



The safety implications of fatigue have been documented in multiple real-world maintenance-related incidents. Several cases compiled in aviation safety databases illustrate how prolonged shifts, excessive overtime, and unmonitored workload accumulation contributed to inspection failures, maintenance errors, and degraded human performance. These examples reinforce the understanding that fatigue is not an abstract physiological condition but a direct operational safety hazard produced by work organization and insufficient risk mitigation mechanisms.

Within this framework, the Fatigue Risk Management System (FRMS) is increasingly recognized as a comprehensive and science-based approach for managing fatigue-related safety risks. Unlike traditional

**Fatigue is a critical human factor risk for Aircraft Maintenance Technicians, impairing attention, decision-making, and safety performance. It is driven by long hours, shift work, and organizational pressures, and should be seen as a systemic operational hazard rather than an individual issue.**

prescriptive duty-time regulations that focus solely on limiting working hours, FRMS provides a proactive risk management structure designed to identify fatigue hazards, assess operational risk, implement mitigations, and continuously monitor safety performance. International aviation authorities such as ICAO,

EASA, FAA, and CASA have adopted FRMS principles to strengthen safety governance in fatigue-sensitive operational environments. However, the findings of this review indicate that FRMS has not yet been fully institutionalized within the aircraft maintenance sector to the same extent as in flight deck or air traffic control operations. This study employed a mixed qualitative design combining systematic literature review and institutional document analysis. Academic studies were collected from Web of Science, Scopus, and ScienceDirect, while fatigue-related guidance materials and regulatory frameworks were reviewed from authorities including ICAO, EASA, FAA, EUROCONTROL, and Turkey's Directorate General of Civil Aviation (DGCA). The review followed the PRISMA 2020 guideline to ensure methodological transparency and traceability. Publications between January 2000 and October 2025 were screened using inclusion and exclusion criteria focusing specifically on fatigue, FRMS, human factors, and safety outcomes in aircraft maintenance contexts.

The thematic analysis was conducted using Braun and Clarke's six-phase approach, resulting in the identification of four overarching themes that structure fatigue risk and FRMS integration in maintenance operations: (1) governance and regulatory framework, (2) human factors and organizational culture, (3) training and awareness, and (4) monitoring, measurement, and ergonomic improvement. Early research largely emphasized physiological fatigue indicators and environmental stressors, whereas more recent work increasingly conceptualizes fatigue as an organizational output requiring systemic governance and resilience-oriented intervention.

The review highlights that FRMS implementation in maintenance requires adaptation from models successfully applied in air traffic control and cockpit environments.



ICAO Doc 9966 provides a broad framework applicable across safety-critical personnel groups, supporting hybrid systems that combine prescriptive limitations with performance-based fatigue risk management. Furthermore, Turkey's GM-2025/3 circular demonstrates national-level legal recognition of fatigue risk governance for air navigation and AIM personnel, reinforcing the need for a comparable institutional structure targeting maintenance technicians.

In conclusion, this study argues that integrating FRMS into aircraft maintenance is essential not only for mitigating fatigue-related errors but also for sustaining long-term psychological resilience and organizational safety performance. Effective fatigue management must

**The study shows that fatigue in aircraft maintenance must be managed through a systemic FRMS approach focused on governance, culture, training, and monitoring. Using ICAO and national frameworks, it concludes that a tailored FRMS is essential to improve safety, resilience, and operational performance.**

be supported through regulatory enforcement, organizational culture development, continuous education, ergonomic improvement, and data-driven monitoring systems. Establishing a national and sustainable FRMS framework tailored to AMTs would strengthen aviation safety governance, enhance workforce well-being, and reduce systemic operational risk across the maintenance domain.

*A technician's labor and signature are involved in the production, maintenance and continuous airworthiness of an aircraft.*



*Ugur Ozkan*  
PHOTOGRAPHY



## AIRCRAFT COMMUNICATION SYSTEMS

Electromagnetic fields are low-energy waves emitted from both natural and artificial sources and form the foundation of all communication systems. As of 2025, communication has become far more intensive, secure, and low-latency through the integration of 5G–6G technologies and satellite frequencies. Transmitter systems deliver information using RF, optical, and satellite-based solutions, with low-power yet highly efficient technologies taking the lead. Receiver systems now go far beyond simple demodulation, offering advanced functions such as interference filtering, decryption, and AI-powered error correction.

### Fundamentals of Electromagnetic Fields

Radio frequency (RF) fields are a type of low-energy electromagnetic (EM) field. Electromagnetic energy propagates through space in the form of waves and is present everywhere at all times. These fields originate from both natural sources (such as lightning and cosmic radiation) and artificial sources (radio transmitters, cellular base stations, radar systems).

By 2025, the electromagnetic spectrum is being used far more intensively due

to growing communication demands. The deployment of 5G and emerging 6G technologies has introduced new frequency bands for ultra-low-latency communication, while the integration of satellite-based frequencies for aviation has accelerated rapidly.

### The Concept of Communication and Communication Systems

Communication is the process of transferring information from a source (transmitter) to another point within a defined time interval and receiving it at the destination (receiver). All

components involved in this process form a communication system.

Modern communication systems are no longer limited to data transmission; they also include security, authentication, encryption, and interference mitigation. In aviation, cybersecurity has become an integral part of communication.

### Transmitter Systems

Transmitters act as conversion units that transfer input signals (information) into the communication medium. Their structure varies according to operating frequency and transmission environment.

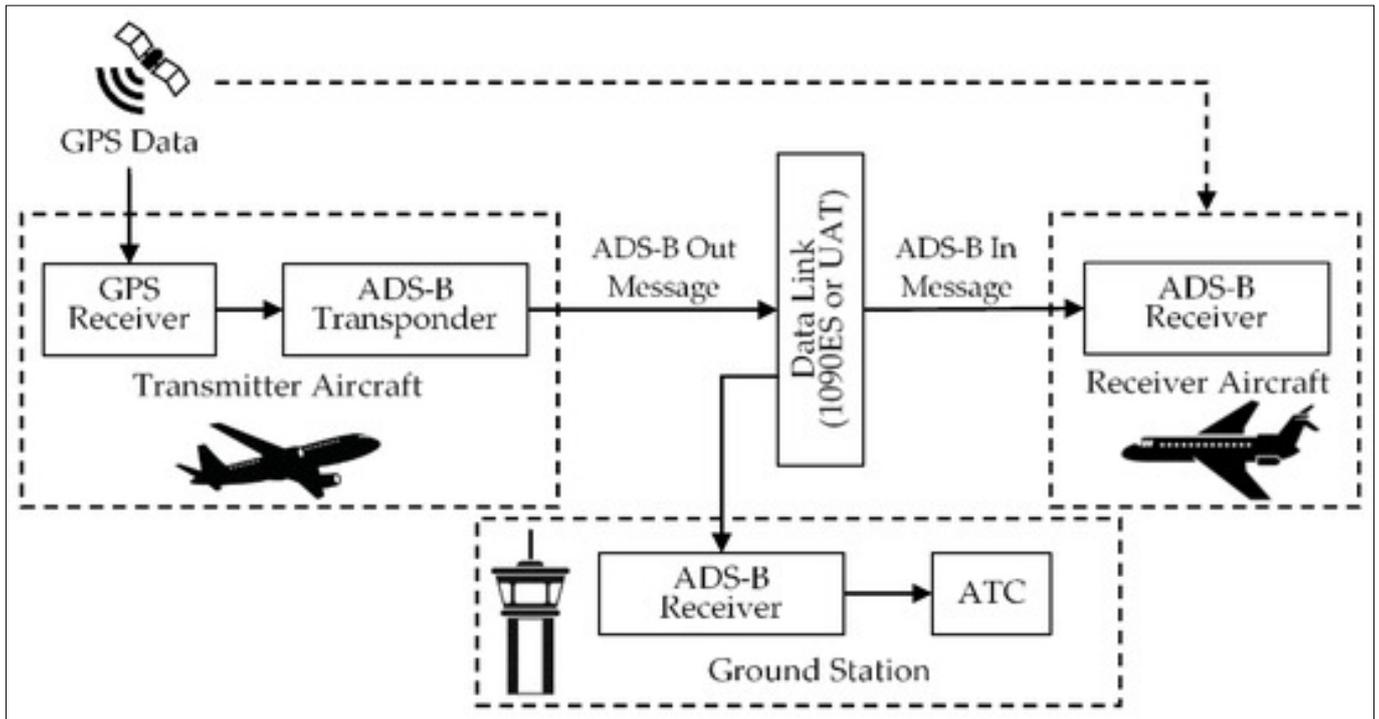
As of 2025, transmitter technologies can be grouped into three main categories:

#### Conventional RF Transmitters:

Used in radio and intercom systems, typically operating in the VHF (30–300 MHz) and HF (3–30 MHz) bands.

#### Optical Transmitters:

Laser-diode-based systems operating at milliwatt levels at the ends of fiber-optic cables. They provide extremely high data rates.



**Satellite and Digital Transmitters:**

Ku- and Ka-band systems used in modern aircraft, enabling high-bandwidth global connectivity.

Today’s transmitters are no longer just high-power radio antennas; low-power, high-efficiency optical and digital transmitters are now the backbone of communication.

**Receiver Systems**

The primary function of a receiver is to demodulate modulated signals and deliver the information to the user. However, by 2025, receivers have evolved to include:

**Interference filtering**

- Decryption
- AI-based error correction algorithms
- Simultaneous multi-frequency monitoring

As a result, modern receivers are far more advanced than traditional radio or television receivers.

**Aircraft Transmitter–Receiver Systems**

In aviation, transceiver systems are mission-critical. Communication between aircraft and ground stations, as well as between aircraft, is fundamental to flight safety.

As of 2025, the main communication systems used on aircraft include:



**VHF/UHF Communication:**

Still the primary method for aircraft-to-ground and aircraft-to-aircraft voice communication. The new VHF Data Link Mode 3 (VDL Mode 3) also enables faster and more secure data transmission.

**HF Systems:**

Used for long-range communication, especially on oceanic routes. New digital HF technologies provide lower noise and higher reliability.

**Satellite Communication (SATCOM):**

Ka-band SATCOM systems are now widespread, allowing aircraft to transmit real-time flight data to airline operations centers in addition to ATC.

**Integrated Transceiver Systems:**

Devices such as VHF transceivers combine transmitter and receiver in

a single unit, enabling continuous, two-way, ground-independent communication. In next-generation aircraft, AI-assisted frequency management systems automatically select the most suitable communication channel without pilot intervention.

**Conclusion**

Communication enabled by electromagnetic fields plays a critical role in the modern world and especially in aviation. As of 2025, transmitter and receiver systems not only transfer information but also ensure security, data integrity, and global coverage.

Advanced transceiver technologies enhance flight safety, while satellite-based communication systems provide uninterrupted connectivity on a global scale.

## LIST OF MAJOR AVIATION EVENTS WORLDWIDE IN 2026



**MRO LATIN AMERICA 2026**  
JANUARY 14-15, 2026  
SANTIAGO, CHILE



**MRO MIDDLE EAST 2026**  
FEBRUARY 4-5, 2026  
DUBAI, UAE



**AIRLINE & AEROSPACE MRO & FLIGHT OPERATIONS IT CONFERENCE - AMERICAS 2026**  
MARCH 10-11, 2026 MIAMI, USA



**MRO SOUTH ASIA SUMMIT & DEFENCE MRO XPO INDIA 2026**  
MARCH 11-12, 2026  
NEW DELHI, INDIA



**AIRCRAFT INTERIORS EXPO (AIX) 2026**  
APRIL 14-16, 2026  
HAMBURG, GERMANY



**MRO AMERICAS 2026**  
APRIL 21-23, 2026  
ORLANDO, FLORIDA, USA



**SAHA EXPO 2026**  
MAY 5-9, 2026  
İSTANBUL, TÜRKIYE



**EBACE 2026**  
MAY 27-29, 2026  
GENEVA, SWITZERLAND



**AVIATION FESTIVAL AMERICAS 2026**  
JUNE 3-4, 2026  
MIAMI, USA



**MRO ASIA-PACIFIC CONFERENCE & EXHIBITION 2026**  
SEPTEMBER 22-24, 2026  
SINGAPORE



**MRO EUROPE 2026**  
OCTOBER 27-29, 2026  
AMSTERDAM, NETHERLANDS

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## Central Asia Kazakhstan



mrokz.atocomm.eu

### The Next Milestone in Central Asia's Aviation Growth.

### October 7–8 Astana

## Executive Summary

**MRO Central Asia: Kazakhstan** has established itself as the region's premier platform for aviation maintenance, repair, and overhaul professionals. Following a successful 2025 debut that attracted over 200 participants and generated substantial business outcomes, the **2nd edition** returns to Astana on **October 7–8, 2026**, with expanded scale and deeper technical programming.

## The Opportunity

Central Asia represents the **world's fastest-growing aviation market**, and Kazakhstan commands **over 50% of regional capacity**. Recent developments underscore extraordinary growth momentum:

- **\$7+ billion** in new aircraft orders by Air Astana alone
- **100+ next-generation aircraft** ordered by regional carriers
- **Fleet doubling** in Kazakhstan by 2030 (from 109 to 221 aircraft)
- **26 million annual passengers** carried by Kazakhstan airlines is targeted by 2030
- **95.7% ICAO compliance** – ranking Kazakhstan among the world's top 20 for aviation safety
- **Billions invested** in airport infrastructure, new runways, and MRO hangars

This unprecedented expansion creates massive demand for MRO services, technologies, components, training, and financing—positioning **MRO Central Asia: Kazakhstan 2026** as the essential access point to this dynamic market.



Thank you very much to you and the entire ATO COMM team for the productive events and especially for launching MRO Central Asia: Kazakhstan.

We look forward to and will participate in ATO COMM events whenever possible. I fully agree that such events strengthen industry connections, facilitate experience sharing, promote best practices, and drive aviation development in the region.

Rustam Abdukadyrov, Technical Director, Maintenance & Engineering Complex, **Aircompany SCAT**

PARTNERSHIP SUPPORT



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### AMONG AIRLINES



market overviews



previous events' report

A STAR ALLIANCE MEMBER 

# CONNECT TO HOSPITALITY

with our caring cabin crew



**TURKISH AIRLINES**