

New frontiers in flight safety

Flying is already the safest way to travel long distances. But as air traffic grows and new technologies emerge, the aviation community must come together to address new challenges, set rigorous standards and build on an extraordinary decades-long safety record.



Honeywell
Aerospace

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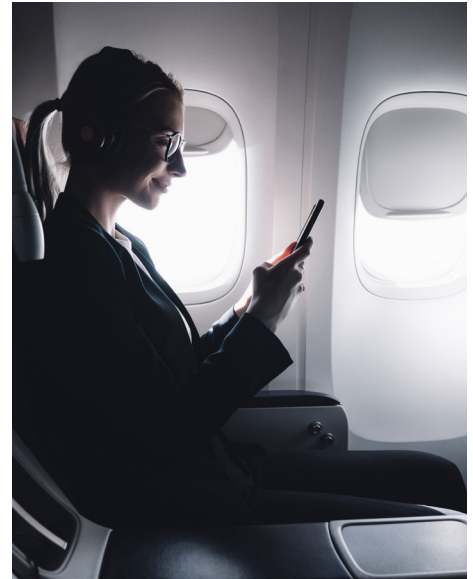
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Safety is fundamental

“ More than 10 million passengers buckle into an airplane seat every day, trusting the aviation industry to transport them safely to their final destinations. Aviation safety has improved almost 40-fold in recent decades¹ and the momentum must continue. This will require a shared sense of purpose, high levels of leadership and collaboration, a robust safety culture and groundbreaking innovations that will take flight safety to even higher levels and define the future of aviation.”

Jim Currier

President and CEO
Honeywell Aerospace



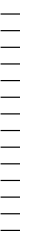
A troubling series of fatal aircraft accidents captured headlines in 2024 and early 2025. They included a runway incursion in Japan, an accident in Kazakhstan possibly caused by an errant surface-to-air missile, a runway overrun in South Korea following a probable bird strike and a midair collision between a regional airliner and a military helicopter over Washington, D.C.

These incidents may prove to be anomalies for the aviation industry, which recorded its safest year ever in 2023.² They also validate the need for continued diligence as regulators, aircraft manufacturers, airlines and business jet operators, and safety innovators join forces to create the safest possible future for air transportation.

Air travel is the world's safest mode of transportation, and it's getting safer according to MIT researchers who cite a sharp decline in fatal accidents over the last six decades. In fact, they found that the risk of a fatality from commercial air travel was one per

13.7 million passenger boardings between 2018 and 2022. This is a significant improvement from one per 7.9 million boardings in the 2008–2017 timeframe and a dramatic change from one per 350,000 boardings in 1968–1977.³

Rare as they are, most aviation accidents involve human error. “Human error is the cause or a contributing factor in up to 80% of aviation accidents and incidents,”⁴ according to Thea Feyereisen, Honeywell Aerospace distinguished fellow and safety systems human factors leader. “We need a relentless focus on safety to understand human limitations and provide aids to make people more aware and give them time to correct mistakes.”





Will positive safety trends continue?

The rarity of accidents is evidence of the effectiveness of aviation's rigorous approach to safety. Safety remains paramount as the industry ushers in the future of flight — with more crowded skies, busier airports and runways, new kinds of aircraft and advanced technologies that promise to improve situational awareness, aid decision-making and mitigate human error.

While there are no guarantees that these positive safety trends will continue, MIT researchers project that a combination of technology, training and regulatory compliance will extend aviation's long record of continual improvement — perhaps indefinitely.

Aviation safety improves year over year

According to MIT's Arnold Barnett, "You might think there is some irreducible risk level we can't get below. And yet, the chance of dying during an air journey keeps dropping by about 7% annually and continues to go down by a factor of two every decade."⁵

Aviation's outstanding safety record is a product of the industry's dissatisfaction with the status quo and shared belief that one accident is one too many. But continued progress will not happen of its own accord.

Stakeholders need to work together to identify emerging threats, learn from incidents and close calls, set universal safety standards, and embrace new technologies and operating procedures that enhance safety and safeguard lives on the ground and in the air.

About this Honeywell Aerospace whitepaper

This whitepaper covers the aviation industry's uncompromising commitment to safety from Honeywell Aerospace's perspective as a leading innovator of aviation safety technologies, services and software solutions. The paper focuses on key elements of aviation's safety culture, emerging safety challenges and opportunities, and technology's role in creating aviation's safer future.

To read more about aviation safety or engage with Honeywell Aerospace flight safety professionals, visit us online at honeywellaerospace.com.

< 1 in 11M

Less than one in 11 million

Accident rate reduction from one in three million, caused by controlled flight into terrain



Immeasurable

Number of lives saved by Honeywell Aerospace's ground proximity warning system (GPWS)

Exploring the new frontiers in flight safety

Aviation's earliest days were filled with the storied exploits of daredevils, barnstormers and stunt pilots who thrilled throngs of awestruck spectators and literally put their lives on the line every time they took flight. Flying was risky, and accidents were all too common due to a lack of regulations, pilot training and even the most basic safety precautions.

Flight safety took a great leap forward in 1914 when aviation pioneer Lawrence Sperry demonstrated a gyroscopic stabilizer (essentially the first autopilot) during an aviation exhibition over the Seine River in Paris. He and his mechanic showed off the stabilizer by climbing out of the open cockpit onto the wing and letting the aircraft fly itself to the amazement of the crowd below.⁷

Sperry created the concept of controlled flight with an innovation that made flying safer, reduced pilot workload and hinted at the more automated future of flight.⁸

Since Sperry's Curtiss C-2 biplane, automated flight has advanced markedly and more than a century of safety-first thinking has made it possible for millions of people to experience the wonders of safe, reliable air transportation.

“In a normal year, approximately 130,000 flights per day take off and land without incident. Furthermore, long-term accident trends confirm that aviation is getting safer. This presents a paradox. The safer aviation becomes, the more difficult [it is] to drive further improvements.”⁶

International Air Transport Association (IATA)





What makes aviation so safe?

Groundbreaking innovations and incremental improvements in safety technologies have led to significant safety advancements over the last century. But aviation safety is a complex, dynamic and multifaceted challenge that also involves other critical factors.

Regulatory oversight

Agencies such as the United States Federal Aviation Administration (FAA), European Union Aviation Safety Agency (EASA) and Civil Aviation Administration of China (CAAC) ensure that safety standards are maintained, enforced and continuously improved. The FAA is widely regarded as the standard-setter among aviation authorities, and other countries often follow the FAA's lead when it comes to setting new standards.

Under the guidance of the International Civil Aviation Organization (ICAO), nearly 200 countries share knowledge and best practices on aviation safety, risk management, cybersecurity and other priorities. ICAO and the regulatory agencies work together to ensure interoperability and harmonization of safety systems to create a safe and seamless global aviation system.

To prevent deviations from established standards that can compromise safety, ICAO conducts regular audits and inspections, implements corrective action plans if deficiencies are identified, helps regulatory agencies improve their capabilities and shares best safety practices among member states.

“ We are constantly talking with policymakers about safety innovations and the need for proactive mandates that address safety standards and priorities like runway safety, cockpit voice recorders and Advanced Air Mobility (AAM). Honeywell Aerospace innovations have contributed heavily to aviation safety over the last 100-plus years. We're proud of our record, but we are laser-focused on the future of aviation and on developing innovations that will define an even safer future for airlines and the flying public.”

International Air Transport Association (IATA)



Safety mandates

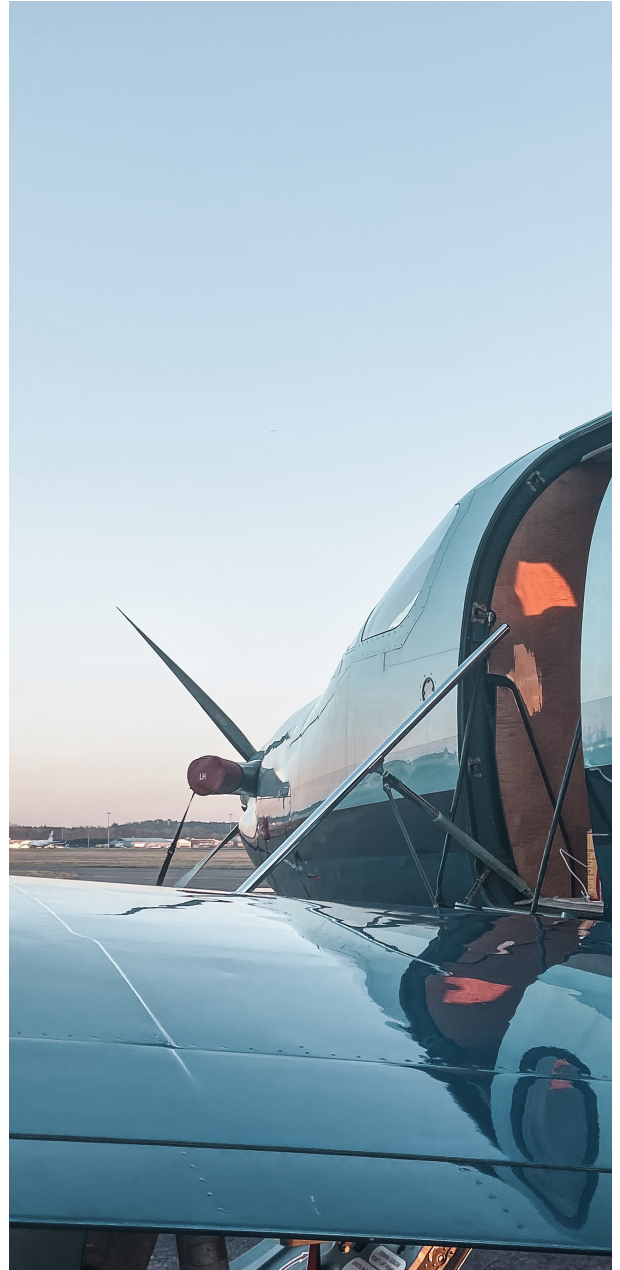
Regulatory agencies sometimes issue mandates that set minimum standards covering manufacturing, operating and maintaining aircraft. Mandates can require airlines, business jet operators, airports or aircraft manufacturers to follow new procedures or install the latest safety equipment.

For example, most of today's large passenger aircraft must have:

- Automatic dependent surveillance–broadcast (ADS–B) capabilities to let air traffic control and other aircraft in the vicinity know their exact location
- Terrain awareness and warning system (TAWS) technology to help pilots avoid controlled flight into terrain (CFIT)
- Cockpit voice recorders (CVRs) to continuously record cockpit conversations and sounds, and flight data recorders (FDRs) to record critical flight information

In an industry known for razor-thin profit margins, airlines need to keep an eye on the bottom line while also investing in new technologies and other safety improvements. Mandates help accelerate and prioritize airlines' substantial safety investments.

Airline financial performance is essential to safety. Profitable airlines have the money to invest in updating their fleets, implementing mandated and voluntary safety measures, maintaining equipment, and hiring and training pilots, cabin crews and maintenance teams.



Safety culture

Spurred by mandates in the U.S. and Europe, and supported by the IATA and ICAO, safety management systems (SMS) flourish within the aviation community. The FAA and other regulators require large airlines and some other aviation enterprises to establish proactive safety management systems to help build a stronger safety culture.¹⁰

An SMS uses a defined set of business processes and tools to examine data from everyday operations, isolate trends that may foreshadow incidents or accidents and identify ways to reduce risk.

The four key SMS components — safety policy, safety risk management, safety assurance and safety promotion — drive higher levels of operational performance. An SMS demands compliance with technical standards, which is critical for airlines and organizations manufacturing aircraft and flight-critical equipment.

“Accident investigations have identified that a positive safety culture is a critical factor in the prevention of accidents and incidents ... a positive safety culture supports open reporting and a learning culture; it facilitates the effective management of safety risks and creates employee engagement based on trust. It acts as an essential enabler for a successful business and a thriving aviation industry.”⁹

International Air Transport
Association (IATA)



Dedicated professionals

Aviation safety relies heavily on dedicated, well-trained professionals in cockpits, control towers and maintenance facilities. The aviation industry is addressing shortages in the pilot, controller and mechanic ranks by boosting pay rates, streamlining training requirements and encouraging young people to consider aviation careers.

The U.S. pilot shortage could reach 60,000 by 2030.¹¹ This has prompted organizations like the National Business Aviation Association (NBAA), Air Line Pilots Association (ALPA) and Aircraft Owners and Pilots Association (AOPA) to launch aggressive efforts to attract, train, retain and engage the best-available talent. Many airlines also have active recruitment programs aimed at both new and experienced pilots with civilian and military backgrounds.

Airlines and maintenance, repair and overhaul (MRO) providers are actively recruiting aircraft technicians by offering competitive salaries, advanced training and apprenticeship opportunities. They also are working with trade associations to address workforce challenges and promote the aviation maintenance profession.



To combat the problem, the agency authorized institutions in the Air Traffic-Collegiate Training Initiative (AT-CTI) to offer the same curriculum as the FAA Air Traffic Controller Academy to accelerate controller training. It also started hiring experienced controllers year-round and took various steps to reduce overtime requirements, relieve stress and improve working conditions for controllers.

New training and simulation techniques are being used across the board to help train pilots, controllers and mechanics faster and more effectively. Automation technologies are changing jobs for the better by improving situational awareness, aiding decision-making and reducing human error in these critical fields.





Studies show that airlines using AI for predictive maintenance reduced unscheduled maintenance events by 25% and reduced Mean Time Between Failures (MTBF) for critical aircraft components by 40%.¹³

Accident analysis

Understanding the details of accidents and close calls can drive significant safety improvements. In the U.S., the National Transportation Safety Board (NTSB) investigates accidents to understand the circumstances leading up to the event, determine probable causes and issue safety recommendations to prevent or mitigate the effects of similar accidents in the future.

The Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) — often called “black boxes” — are essential tools in accident investigations. The CVR continuously records cockpit conversations and sounds while the FDR records various flight parameters such as altitude, heading, airspeed and engine performance.

Maintenance and inspections

Regular and thorough maintenance and inspections of aircraft help identify and resolve potential issues before they can impact flight safety. As aircraft maintenance has evolved, today’s maintenance teams use advanced data analytics, artificial intelligence and machine learning to proactively identify and address potential issues before they become full-blown safety issues.

Aircraft inspections may involve anything from a preflight walk-around by the flight crew to regulator-required periodic inspections that cover the entire aircraft, including the airframe, engine and systems. An effective inspection routine is a fundamental aspect of aviation safety because it helps operators avoid mechanical failures that could contribute to an accident or incident.

“The safe integration of AAM into our airspace is a priority as the number of Unmanned Aerial Systems (UAS) expands exponentially and manufacturers get ready to launch next-generation aircraft including air taxis. Nothing will be allowed to fly unless it’s safe, which is an inflexible principle in aviation.”

Pulkit Agrawal

Regulatory Affairs Lead for AAM
Honeywell Aerospace

Technology's impact on aviation safety

“Innovations like next-generation cockpits, smart navigation systems and predictive maintenance software are using automation and AI to set new standards for aviation safety. Safety technology is advancing at the fastest rate in history, and it's exciting to see how each innovation moves us forward and enhances our ability to anticipate, prevent and respond to safety hazards.”

Vipul Gupta

VP and General Manager – Avionics
Honeywell Aerospace

Air transportation is already extraordinarily safe compared to other modes of transportation. But the aviation ecosystem is changing as new AAM aircraft are poised to begin operations, innovations like aircraft electrification and renewable fuels are starting to take hold, and air traffic is expected to double in the next 20 years.¹⁴

To progress further, the aviation community needs to act as one and prioritize global standards, cultivate a resilient safety culture and drive new levels of innovation. The future of aviation is rooted in the enormous potential of automation, advanced data analytics, AI and machine learning to transform safety, reduce human error and improve emergency response.

Spotlight: Future flight deck



Today's airliner and business jet cockpits are models of safety, integration and functionality. Pilots get most of the information they need to fly the airplane from easy-to-interpret symbology presented on a few liquid crystal displays.

They use a flight management system (FMS) for planning, navigation and performance management. Honeywell Aerospace's next generation fms (NGFMS) reduces pilot workload and improves safety.

Pilots rely on Honeywell Aerospace satellite communications systems to provide secure safety, voice and data services to the aircraft cockpit. Pilots can easily connect with air traffic control using SATVOICE or short text messages. Onboard systems can also automatically generate and transmit performance data to techs on the ground, and pilots can receive information such as weather updates over SATCOM.



Looking forward

Anthem is a ready-now cockpit that ushers in the flight deck of the future. It's a cutting-edge, cloud-connected and highly intuitive integrated cockpit designed to improve flight safety and enhance the flying experience for pilots and passengers alike. Anthem uses touch screens and intuitive symbology that reminds pilots of their smartphone or tablet, making the system familiar, easy to learn and easy to fly.

"Anthem sets new standards for pilot-cockpit synergy, and the result is a safer, more efficient flying experience," said Jeff Woithay, senior director of product management for Honeywell Aerospace. "For example, the system features a smart scratchpad that anticipates pilots' next action — like tuning to a certain frequency for landing — and queues it up for the pilot."



Its modular design makes Anthem extremely flexible and gives aircraft manufacturers and individual pilots enormous freedom to customize its look and feel. The new flight deck is ready to fly on several aircraft and AAM platforms, and Honeywell Aerospace is getting ready to introduce enhancements that will make Anthem the model for many future cockpits.

Tomorrow's business jet cockpits will likely feature an innovative 3D airport moving map display, based on Honeywell Aerospace's SmartView Synthetic Vision System (SVS), which will improve pilot situational awareness while taxiing and reduce the possibility of runway accidents.

The Honeywell Aerospace Aspire 350 satellite communications system will give pilots fast, reliable safety, voice and data service coverage anywhere they fly. "The new Aspire 350 also provides connectivity for business jet cabin passengers," said Jennifer Hounslow, director of product management for the Aspire product line. "In fact, the Aspire 350 is the first two-in-one SATCOM system to receive a Technical Standard Order (TSO) from the FAA."

Spotlight: Flight automation

Using automation to enhance safety dates back almost to the dawn of powered flight and the development of the first autopilot. Since then, constant advancements in technology have made modern aircraft safer, more efficient, more mission-effective and more automated than ever before.

Today, automated aircraft systems minimize the risk of human error by handling routine tasks and complex calculations, enabling pilots to focus on decision-making and monitoring their flight.

For example, FMS automatically integrates navigation and performance data to optimize flight routes and adherence to air traffic control systems. Other examples include autothrottle systems, which reduce pilot workload by maintaining the ideal airspeed, and auto-land technology, which automatically guides an aircraft to a safe landing.

Looking forward

Aviation will be mostly autonomous or highly automated by the 2040s, which will make flying even safer and more accessible than it is today. Greater autonomy will reduce costs, improve operations and aircraft utilization, and enable better use of the airspace. It also will ease the massive pilot shortage, which will become more severe as new AAM vehicles come online.

Higher levels of autonomy will make the task of piloting an aircraft simpler, safer and more user-friendly, according to Sharad Rathour, Honeywell Aerospace senior chief systems engineer for AAM. "True autonomy is hard to define and deliver," he said. "What we are really after is 'trusted autonomy,' which means developing aircraft systems that operate on their own with little or no pilot supervision."

Honeywell Aerospace is working on a range of technologies to drive higher levels of flight automation including advanced navigation, detection and avoidance, autonomous taxiing and predictive maintenance systems.

“Flight computers are getting smarter all the time. In the future, they will prevent pilots from making errors by knowing the state of the aircraft and helping ensure it operates within a safe envelope. This ‘layer of automation’ will provide a safety net for pilots and improve safety by reducing the possibility of human error.”

Sapan Shah

Senior Director of Product Management – AAM
Honeywell Aerospace



Spotlight: Hazard avoidance

Modern aircraft fly with sophisticated systems that help pilots recognize and avoid safety hazards. Mandated by the FAA and other aviation authorities, these technologies include innovations like the enhanced ground proximity warning system (EGPWS), which was the brainchild of legendary Honeywell Aerospace engineer Don Bateman.¹⁵

“EGPWS helps pilots avoid CFIT, which occurs when an airworthy aircraft under pilot control is unintentionally flown into the ground, a body of water or other obstacle,” according to Brad Miller, Honeywell Aerospace senior chief engineer for surveillance and data communications technologies. “Since the original ground proximity warning system mandate was issued 50 years ago, CFIT accidents involving commercial aircraft have become almost nonexistent.”

Other hazard avoidance and warning systems include the traffic collision avoidance system (TCAS), which helps prevent midair collisions; weather radar, which identifies severe weather conditions and helps pilots take evasive action; and runway awareness and advisory system (RAAS) technologies like SmartLanding and SmartRunway, which increase pilots' situational awareness during runway-related ground and air operations.





Looking forward

Honeywell Aerospace continues to enhance EGPWS capabilities. EGPWS will host the software behind the company's newest innovation in runway safety, Surface Alert (SURF-A). "SURF-A is the first system designed specifically to alert pilots to the imminent danger of a runway collision," said Priyamvada Poyil, director of aerospace offerings for Honeywell Aerospace safety systems. "That's important because pilots are the last line of defense against runway incursions."

The new software will provide pilots with real-time aural and visual alerts when an aircraft is on a trajectory to collide with another plane or ground vehicle within 30 seconds. SURF-A uses GPS data, ADS-B equipment and advanced analytics to pinpoint the exact location of traffic hazards on or near the runway.

Honeywell Aerospace was commissioned by the FAA to develop the first TCAS system in the late 1980s. Now, the company is working on the next-generation Airborne Collision Avoidance System X (ACAS X). ACAS X will use probabilistic algorithms to deliver more accurate warnings, fewer false alarms and better resolution advisories to help pilots avoid threats. ACAS X aims to create a system and architecture that will fit the future of aviation, ensuring safe integration of AAM vehicles into the airspace.

Climate change is altering weather patterns and increasing the frequency of thunderstorms, hail, turbulence and other severe weather conditions that can injure passengers, damage aircraft and cause extensive flight delays.

Severe weather avoidance innovations like Honeywell Aerospace's IntuVue 3D weather radar systems provide pilots with unprecedented levels of situational awareness so they can stay away from dangerous storms. Future IntuVue products will benefit from new capabilities embodied in a new Hazard 3.0 offering. Hazard 3.0 will include cell trending, which will tell pilots if a storm cell is getting bigger or smaller and what direction it is moving.



30 seconds
advance warning pilots
receive with SURF-A



300 million+
departures tracked by Honeywell
Aerospace TCAS since 1991

50+

50+ year history
GPWS has helped nearly
eliminate CFIT accidents
involving commercial aircraft

Spotlight: Navigation



Today, most large commercial aircraft rely on highly accurate navigation systems that blend signals from an inertial navigation system (INS) and a global navigation satellite system (GNSS). The GNSS signals are used to correct errors that cause inertial systems to drift and become less accurate over time.

This data and modern FMS technology — embodied in the Honeywell Aerospace next generation FMS (NGFMS) — helps pilots manage flight plan considerations like fuel, weather predictions and air traffic control requirements. The NGFMS also reduces pilot workload.



Honeywell Aerospace
FMS Guided visual approaches
require no hardware
or software changes



Looking forward

Navigation challenges can arise when GNSS signals are jammed, spoofed or are simply unavailable. “Disruptions to GNSS signals are becoming more common, even for commercial aircraft,” according to Phil Smith, Honeywell Aerospace vice president and general manager of aircraft navigation. “This can cause both operational and flight safety problems.”

Smith noted that spoofing involves someone intentionally providing incorrect inputs that can manipulate the navigation system, leading to potential off-course navigation. “This is concerning from a safety perspective as it can mislead the aircraft’s course without immediate detection,” he said. “Our goal is to make aircraft more resilient to jamming and spoofing to ensure safer navigation in conflict zones.”

To that end, Honeywell Aerospace also works closely with our military partners to implement new capabilities like the embedded GPS/inertial navigation system (EGI) with M-Code that offers improved security and anti-jamming capabilities for contested environments. Honeywell Aerospace’s EGI with M-Code is also the first to meet military standard order requirements for airworthiness and safety.

Performance-based navigation (PBN) enables pilots to use standards based on navigation performance accuracy instead of ground-based navigation radio aids. Honeywell Aerospace has developed procedures for terrain and traffic-challenged airports like Aspen and Chicago Executive.

Additionally, FMS guided visual (FGV) approaches are designed to help business jet pilots execute stable approaches at challenging airfields where area navigation (RNAV) and instrument landing system (ILS) procedures aren’t available.

On the military aviation side, we are leveraging alternative navigation technologies using cameras, LiDAR, radar, radios and star trackers that can augment INS data in a GNSS-denied situation.

Spotlight: Maintenance

Maintenance has evolved enormously over the decades. By leveraging data analytics and machine learning, predictive maintenance processes enable technicians to identify and address potential issues before they can cause a safety problem.

Aircraft operators and MRO providers have embraced approaches like condition-based maintenance to make their maintenance processes timelier and more accurate. Enabled by AI algorithms, advanced diagnostics provide detailed insights that lead to more efficient and effective maintenance practices — as well as improved aviation safety.

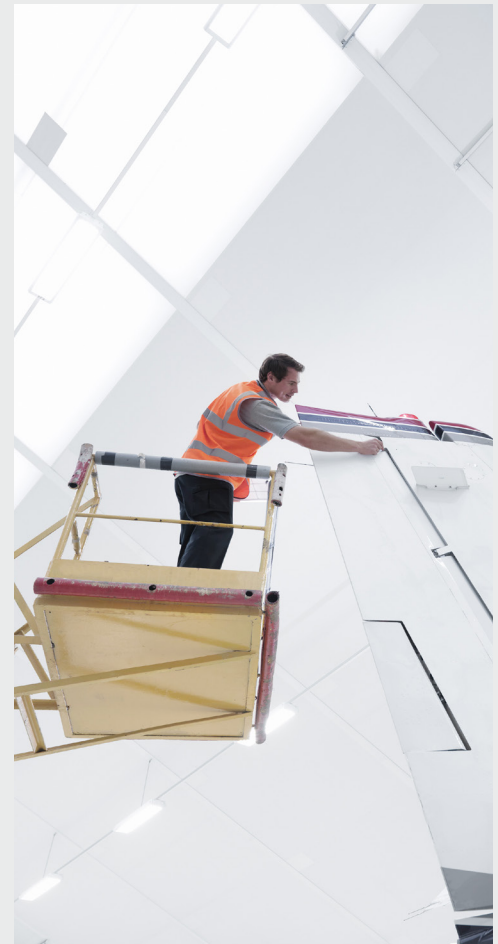


Honeywell Aerospace Ensemble service can detect, analyze and proactively address potential issues with engines before they disrupt flights

Looking forward

Digital maintenance solutions like Honeywell Aerospace Ensemble will automatically download and transmit engine information to track engine conditions after every flight in near-real time. The service can detect, analyze and proactively address potential issues with engines before they disrupt flights.

It will also facilitate digital connections between operational data, engine maintenance records and a digital engine logbook. As a result, airlines and business jet operators will see increased aircraft uptime, improved dispatch reliability and enhanced mission assurance.



Spotlight: Accident investigation

Aviation authorities require most commercial aircraft and business jets to be equipped with two “black boxes” that record flight information. The CVR records radio transmissions and other cockpit sounds, while the FDR monitors altitude, airspeed, heading and other flight parameters. These recordings are invaluable to aviation agencies like the NTSB in determining the probable cause of an aircraft accident or incident.

Following recommendations from ICAO and the NTSB, the FAA and EASA recently mandated the use of 25-hour voice recorders for new and existing aircraft. The need for 25-hour CVRs arose after several incidents where critical data was lost because recordings were limited to two hours in the past.

25-Hour

Voice recorders: The FAA and EASA recently mandated the use of 25-hour voice recorders for new and existing aircraft



Looking forward

Connectivity is poised to change the way voice and data recordings are handled, according to Borka Vlacic, Honeywell Aerospace director of marketing and product management for SATCOM products. “In the future, technology will allow real-time data transmission from the aircraft to the ground via satellite,” she said. “This technology, referred to as the ‘black box in the sky,’ will give investigators continuous access to flight data, which can be crucial in emergency situations.”

The future also holds the potential for virtual recorders, which would require minimal hardware on the aircraft. Instead, data would be securely transmitted and stored on the ground, reducing the need for physical recorders on the aircraft.

Honeywell Aerospace is continuously working on more sophisticated tools for analyzing flight data. These tools aim to provide quicker and more accurate analysis to help investigators and airlines better understand and learn from past experiences.



Future of aviation safety

Advancing the safety of flight to protect passengers, people on the ground and physical assets is a responsibility shared by regulatory authorities, manufacturers, airlines and business aviation operators, and safety innovators like Honeywell Aerospace.

Aviation is already incredibly safe, and continual improvement from this point will require a shared sense of purpose, high levels of leadership and collaboration, a robust safety culture and groundbreaking innovations.

But it will be worth the effort.

Honeywell Aerospace is passionate about aviation safety and dedicated to working across the industry to create a safer future for aviation. Learn more about our capabilities at honeywellaerospace.com.



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N61-3233-000-000 | 06/26
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