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Committee on Aviation Safety – Topic 2

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[1] This paper reflects the author's personal views and cannot be considered as the views of ICAO.

Background Guide – Topic No. 2:

Artificial Intelligence and Automation

Artificial Intelligence (AI) and automation can transform civil aviation by enhancing efficiency and safety. AI is defined as a machine-based system capable of imitating human reasoning and operating with varying levels of autonomy and adaptability. These systems can generate outputs such as predictions, decisions, or recommendations, using more particularly Machine Learning (ML) and Deep Learning (DL). AI technologies can be employed in various areas, including aircraft design, flight operations, air traffic management, and maintenance. Automation, including autopilot systems and predictive maintenance tools, can prove central to modern aviation, enabling airlines to optimize performance and reduce human error.

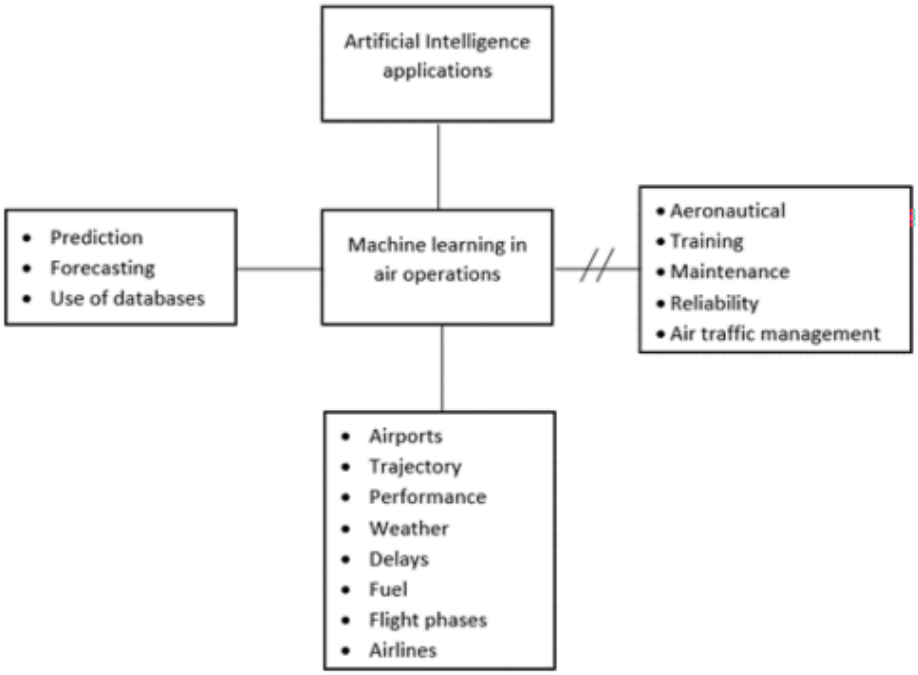
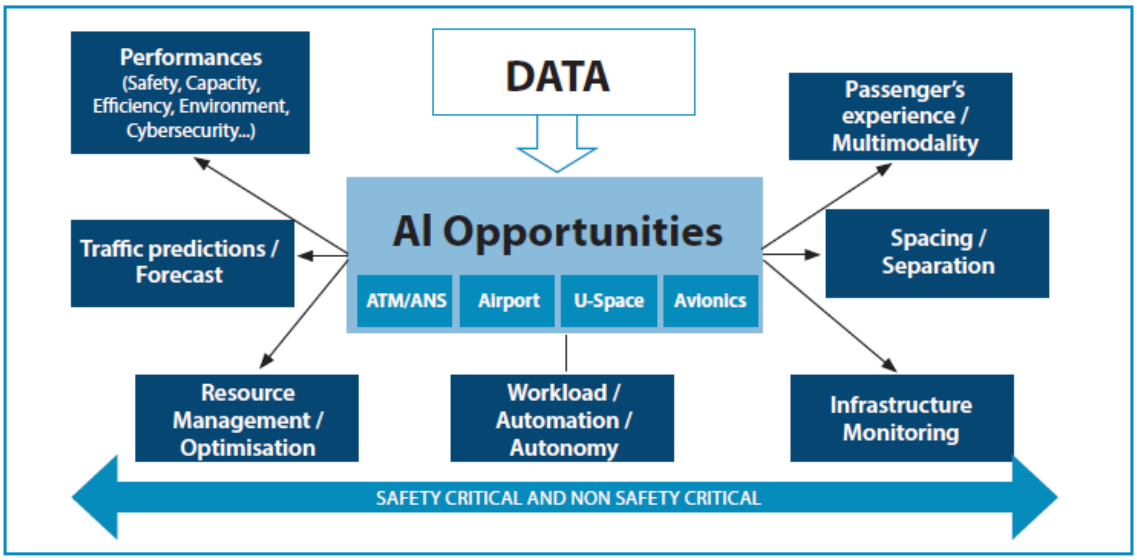


Fig. 1. Conceptual mind map.

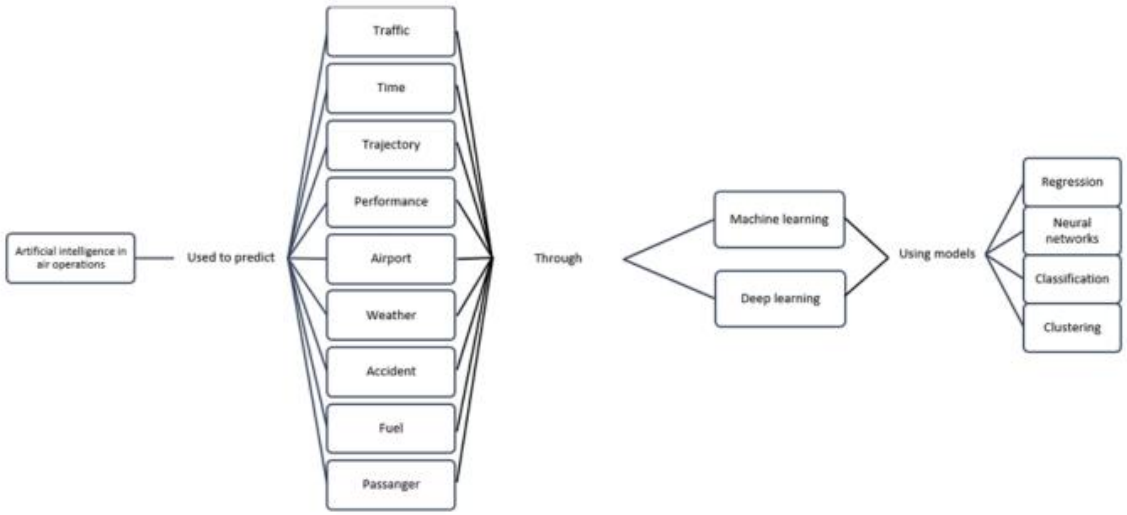
Source: Cristian Lozano Tafur, Rosa Gabriela Camero, Didier Aldana Rodríguez, Juan Carlos Daza Rincón, Edwin Rativa Saenz,"Applications of artificial intelligence in air operations: A systematic review" 25 Results in Engineering 103742 (2025)

The integration of AI and automation promises numerous benefits. AI-driven systems can enhance safety by providing predictive analytics that can foresee potential issues in the design or maintenance processes. They can also assist in making automated decisions to prevent accidents in the course of operations. Operational efficiency can also be significantly improved as AI and automation may be used to optimize flight paths and streamline various processes across the aviation sector.



Source: EUROCONTROL, " The FLY AI Report - Demystifying and Accelerating AI in Aviation/ATM", 2020

Currently, the integration of AI into drone operations has enabled significant advancements. Drones can perform complex tasks such as automated navigation.



Source: Cristian Lozano Tafur, Rosa Gabriela Camero, Didier Aldana Rodríguez, Juan Carlos Daza Rincón, Edwin Rativa Saenz,"Applications of artificial intelligence in air operations: A systematic review" 25 Results in Engineering 103742 (2025)

However, as there are prospects of including these new technologies in traditional aviation, these advancements raise significant legal and regulatory challenges, particularly at the international level, necessitating careful consideration at the International Civil Aviation Organization (ICAO) level.

I. Current Legal Frameworks and Challenges

The Chicago Convention (1944) and its Annexes form the backbone of international civil aviation law, supported by ICAO's Standards and Recommended Practices (SARPs). While these frameworks address traditional aviation systems, they often lack provisions explicitly designed for AI and automation.

One of the most pressing legal challenges is accountability and liability. Determining liability in cases of accidents involving AI-driven systems is complex, especially when errors arise from autonomous decisions made by these systems. Clarifying the responsibility of manufacturers and software developers while fostering trust in automated systems is crucial.

Another challenge is the certification of AI systems. These systems must meet rigorous safety and operational standards to ensure their reliability in critical aviation contexts. Harmonizing certification processes across jurisdictions is necessary to maintain consistency and facilitate international operations. Still, AI raises specific challenges: while algorithms can deliver predictable outputs, AI can give rise to unexpected behaviors, thus generating potential safety hazards. In this respect, Annexes 8 and 6 to the Chicago Convention would need to be adapted to provide safeguards and clear guidelines regarding the use of AI and increased automation. Additionally, human oversight and training are critical to integrating AI into aviation. Establishing clear protocols for human intervention in automated processes is necessary to maintain control and ensure safety in unexpected situations. Hence, updating training requirements for pilots and air traffic controllers to manage AI-driven systems would be the *conditio sine qua non* to integrating these technologies into existing procedures.

Cybersecurity represents an additional challenge. Addressing vulnerabilities to cyberattacks on automated systems is critical, as such incidents could jeopardize safety and security in aviation.

II. The different levels of automation

Regarding aircraft operations, the automation levels vary significantly, depending most notably on the aircraft type, ranging from uncrewed aircraft vehicles (UAVs) or 'drones', to traditional aircraft. Some UAVs are remotely piloted from a fixed or mobile ground station, while others are autonomous and can operate automatically after being preprogrammed, using GPS signals for navigation, with or without the possibility of human intervention in case of onboard system failure. The technology developed for UAVs could progressively be implemented in conventional aircraft.

Despite the multitude of technical solutions currently being developed, it is possible to distinguish several levels of autonomy:

- the remotely piloted level,
- the automatic piloting-guidance level,

- the autonomous navigation level,
- the autonomous decision-making level.

While most UAVs currently in service rely on an automatic piloting-guidance system, some are already capable of autonomous navigation, and manufacturers are working on solutions enabling autonomous decision-making. Automation is still considered with caution for conventional aircraft, although autopilot has been used for years, due to safety concerns and lack of public trust.

Level	Auto-pilot Engaged	Auto-throttle Engaged	Overview
Full Auto-flight	X	X	The aircraft's control is fully automated based on information preprogrammed by the pilots.
Tactical Auto-flight	X	X	The aircraft's autopilot is engaged, but pilots can direct changes to heading, speed, and altitude using a control panel.
Manual		X	The pilot is manually controlling the aircraft based on guidance assistance from the preprogrammed flight directors. This is primarily used for takeoff, initial departure and landings.
All Automation Off/Full Manual			The pilot is manually controlling the aircraft without the assistance of flight directors. This would be used to avoid collisions with other aircraft or to recover from an undesired aircraft state such as a stall.

Source: Moritz Hanusch, "Manual Flying Skills - Airline Procedures and their Effect on Pilot Proficiency" City, University of London Project 2017.

III. Key Questions for Delegates

Promoting global collaboration is necessary to develop unified regulations for the use of AI and automation in aviation. The balance between autonomy and human control also requires attention. Defining the acceptable limits of autonomy in aviation systems is critical to maintaining safety and operational integrity. Ensuring human operators retain ultimate control in critical scenarios is necessary to address public concerns.

From both legal and regulatory perspectives, several questions must be considered:

- **Regulatory frameworks must be examined to determine how ICAO can adapt existing Standards and Recommended Practices (SARPs) to address the integration of AI and automation in civil aviation.**
- **Liability and accountability are critical topics: what mechanisms can ensure a fair distribution of liability in incidents involving AI systems, particularly when autonomous decisions are involved?**

- **Safety and certification standards must be addressed to identify the international standards necessary to certify AI-driven aviation technologies, ensuring their safety and reliability.**

Suggested readings :

Jacques Hartmann; Eva Jueptner; Samuel White; Santiago Matalonga; James Riordan, “Artificial Intelligence, Autonomous Drones and Legal Uncertainties” 14 Eur. J. Risk Reg. 31 (2023)

Benjamyn I. Scott; Bart Custers, Henning Lahmann, “Drone Regulation and AI Law: Assessing the Intersection of the EU Legal Frameworks for Unmanned Aircraft and Artificial Intelligence” 49:6 Air and Space Law 565 (2024)

Brandon A. Bordenkircher, "The Unintended Consequences of Automation and Artificial Intelligence: Are Pilots Losing Their Edge?" 19:2 Issues Aviation L & Pol'y 205 (2020)

Sivadath Madhu Menon & T. Nayana, "Transmogrifying the Frontiers of Aviation with AI; the Imperative for Efficient Regulation in the Age of Machine Learning" 6 Int'l JL Mgmt & Human 961 (2023)