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4.3: Leveraging air transport data and the digital ecosystem for seamless, secure and resilient operations

A HARMONIZED RISK-BASED APPROACH TO ARTIFICIAL INTELLIGENCE

(Presented by the International Coordinating Council of Aerospace Industries Associations (ICCAIA) and International Business Aviation Council (IBAC))

EXECUTIVE SUMMARY

This paper presents a view from the international manufacturers on the economic benefits and risks from Artificial Intelligence and Machine Learning (AI/ML) and the need for a harmonized risk-based approach to standardization. AI/ML is a groundbreaking suite of technologies that can revolutionize aviation by unlocking new products and associated markets as well as improving efficiency and reducing costs across operations in legacy and emerging sectors. However, AI/ML may introduce new risks that need an adequate and proportionate response. Both under-regulation and overregulation need to be considered as economically harmful. Under-regulation could lead to safety impacts affecting the whole sector whereas overregulation slows or even prevents the sector from capitalizing from its benefits.

1. INTRODUCTION

1.1 Artificial intelligence and machine learning (AI/ML) have the potential to significantly transform aviation, not merely improve it. AI/ML is not a single technology, but instead a broad set of techniques and methods, some of which have existed for decades. Their increased relevance today reflects greater digitalization, increased computing capability, and the growing availability of operational and engineering data across aviation.

1.2 AI/ML can deliver real operational benefits across the aviation lifecycle, which in turn can yield significant positive economic impacts, including through enhancement in safety, reliability, maintenance, manufacturing, air traffic management, and operational decision-making processes. Optimizing current systems and unlocking technical capabilities and facilitating break-through innovations can also contribute to enhancing safety and streamlining operations, next to enabling new products and service concepts.

1.3 AI/ML is particularly valuable where large amounts of dataset must be analysed to identify patterns, trends, anomalies or correlations that may be difficult for human experts to detect consistently or at scale. This can support earlier root cause detection, better analysis and more effective troubleshooting and decision support, while also providing the ability to develop intelligent models with capabilities that are currently not deployed in safety critical systems today.

1.4 AI/ML may enable new and more efficient forms of automation ranging from optimization of more complex, physics-based calculations, introduction of perception-based machine capabilities, to more natural interaction in the human machine interfaces. Potential applications range from inspection and monitoring to support for pilots, controllers, maintainers and future advanced air mobility operations. For example, optimization of physics-based calculations to maximize functional capabilities in hardware limited solutions.

1.5 At the same time introducing perception-based technologies, such as machine/computer vision, can enable lower-cost sensors for sense-and-avoid functions necessary for Unmanned Aerial Systems (UAS) or for runway obstacle detection, reducing reliance on more traditional and expensive systems such as lidar or radar. More natural and "human-like" interaction capabilities also improve international integration through automatic translation, monitoring of pilot compliance with air traffic controller (ATC) instructions, and supporting both pilots and air traffic controllers during high workload situations.

2. DISCUSSION

2.1 AI/ML can enable new aviation products and therefore expand markets – including for Unmanned Aerial Systems (UAS) and Vertical Take-Off and Landing (VTOL) "air taxis". AI/ML can also improve existing aviation activities by enabling new safety-enhancing functions on current aircraft, increasing engineering productivity, providing health monitoring and predictive maintenance, as well as finding and reducing defects or damage both during manufacturing and in service.

2.2 AI/ML also introduces risks if it is not properly understood, implemented, or overseen and if adequate guardrails are not introduced. Such risks may stem from human factors and include design or implementation errors, inappropriate human reliance on AI, degraded operator performance through over-trust or complacency, and diminished crew ability to recover control over an aircraft safely if an autonomous or intelligent system fails.

2.3 Some AI/ML-related risks are extensions of risks already managed in aviation or observed in other industries. The transition to AI/ML presents a profound opportunity to augment human expertise, driving significant productivity gains across design, manufacturing, and operations. While shifting skill requirements are a natural outcome of any technological evolution, the focus should be on upskilling the workforce to leverage AI as a decision-support tool, rather than viewing it as a source of "deskilling."

2.4 Other risks related to human factors are less evidence-based and reflect broader concern about unfamiliar technologies. To protect the economic value of these advancements, regulatory oversight must be strictly grounded in empirical safety data and operational context. Basing regulation on speculative concerns rather than demonstrable risk would create unnecessary compliance burdens, stifling the very innovation that drives cost efficiency and market expansion.

2.5 In response to such risks, AI/ML regulatory philosophies currently differ significantly across jurisdictions. Some regions are pursuing highly precautionary approaches that restrict most AI/ML uses unless proven safe, while others are considering a case-by-case approval approach. With direct effect

on aviation, AI/ML regulatory scope also varies – from restrictions applied only to AI/ML onboard aircraft to any AI/ML application with a potential safety impact. Definitions of AI/ML are likewise ranging from broad formulations that include expert systems to narrow focus on specific techniques such as Generative AI, recently increasingly popular with the general public. Currently, the lack of global regulatory alignment on AI/ML acts as a direct friction point for international trade and economic growth. Divergent approaches - ranging from overly precautionary prohibitions to fragmented definitions - create significant market-entry barriers. This fragmentation multiplies certification costs, lengthens time-to-market, and creates uncertainty that discourages long-term capital investment.

2.6 Aviation is a safety critical industry and accidents involving AI/ML-enabled systems risk affecting public confidence across the sector. Industry and regulators therefore share an interest in establishing a minimum baseline safety standard for AI/ML implementation and deployment. At the same time, excessive, unclear, or disproportionate regulation can inhibit development and implementation of AI/ML and delay beneficial innovation and the realization of economic gains. AI/ML frameworks should therefore be proportionate to the intended function and operational risk, avoiding a one-size-fits-all approach that could unnecessarily constrain innovation, including in smaller or emerging aviation sectors. Furthermore, inconsistent and unharmonized regulation creates safety risks and may inadvertently lead to unfair competition by creating incentives for some actors to exploit regulatory differences.

2.7 The regulatory response to AI/ML should be proportionate and differentiated according to the safety criticality of the specific application, rather than applying a uniform standard across all uses of the technology. A progressive, risk-based approach of this kind would give practical effect to the principle that regulation should avoid being excessive or disproportionate. Absent such differentiation, there is a risk that AI/ML oversight defaults toward the most stringent standard, typically anchored on flight-critical use cases, resulting in a single undifferentiated regulatory response that could burden lower-risk applications where much of the near-term economic and operational benefit is expected to be realized.

3. CONCLUSION

3.1 AI/ML can deliver real operational benefits across the aviation lifecycle, which in turn can yield significant positive economic impacts, including through enhancement in safety, reliability, maintenance, manufacturing, air traffic management (ATM), and operational decision-making processes. Some examples where AI can help to address some of the supply chain issues identified in ATConf/7-WP/144 include streamlining the design and certification process, optimizing production planning and increasing effectivity of maintenance lifecycle management.

3.2 AI/ML presents both significant opportunities and a real safety risk if not managed adequately. A minimum safety threshold is necessary to protect the public and maintain confidence in the aviation sector at large.

3.3 Globally inconsistent regulation, scope and definitions increase certification, validation and deployment costs for internationally operated products safety risks. They also create uncertainty about whether existing or future technologies will be accepted across markets.

3.4 Excessive, unclear or disproportionate regulation can unnecessarily delay or prevent adoption of AI/ML-enabled applications and products, limiting safety, operational and economic benefits.

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