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WORKING PAPER

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ASSEMBLY — 40TH SESSION

EXECUTIVE COMMITTEE

Agenda Item 26: Other high-level policy issues to be considered by the Executive Committee

ARTIFICIAL INTELLIGENCE AND DIGITALIZATION IN AVIATION

(Presented by the International Coordinating Council of Aerospace Industries Associations (ICCAIA) and Civil Air Navigation Services Organisation (CANSO))

EXECUTIVE SUMMARY

Artificial intelligence (AI) and digitalization are game changers in aviation, as in every other sector. The use of AI and digitalization technologies allows for more safety, adaptability, optimization, efficiency, capacity and more support to all aviation stakeholders. AI and digitalization will deeply impact the competencies of aviation professionals, and there is a need for the whole aviation sector to prepare for this significant change. New or updated standards and regulations will be necessary to allow for the application of AI technologies. In particular, new concepts for certification, qualification and data sharing are needed.

Action: The Assembly is invited to:

a) acknowledge the significant impact of digital technologies on the competencies of aviation professionals, as part of the Next Generation of Aviation Professionals (NGAP) initiative;
b) request that ICAO further liaise with industry in order to establish an inclusive dialogue at strategic level that will encourage further collaboration in this area;
c) request ICAO to explore the options for allowing industry, and other stakeholders, to initiate a review of the existing Standards and Recommended Practices (SARPs) and to initiate updates and amendments of the SARPs to allow for the use of new Artificial Intelligence technologies in aviation; and
d) acknowledge the importance to apply existing rules for aircraft modifications over its lifecycle when it matters to adding new connected devices or sensors on aircraft that can impact aircraft systems or systems integrity.

Strategic Objectives:	This working paper relates to Strategic Objectives Safety, Air Navigation Capacity and Efficiency and Economic, Environmental Protection and Development of Air transport.
Financial implications:	The activities referred to in this paper will be subject to the resources available in the 2020-2022 Regular Programme Budget and/or from extra budgetary contributions.
References:	Doc 10115, *Report of the Thirteenth Air Navigation Conference* (AN-Conf/13), Corrigenda Nos. 1 and 2, and Supplement No. 1. Doc 10075, *Assembly Resolutions in Force (as of 6 October 2016)*

[1] Arabic, Chinese, English, French, Russian and Spanish versions provided by ICCAIA and CANSO.

1. INTRODUCTION

1.1 While there is no single accepted definition, artificial intelligence (AI) are technologies that combine the raw computing power of machines with the cognitive power to think, learn and make decisions. In the context of this paper, the term AI can be used to describe a wide variety of technologies and functionalities (e.g. machine learning, deep learning, artificial neural networks, knowledge based reasoning…), which enable a machine's ability to perform simple tasks extremely well, possibly even better than humans.

1.2 In the civil aviation sector, as in other industrial sectors, paper-based processes have been progressively replaced by digital processes. Manuals are now available on computers and electronic flight bags, control towers are becoming strip-less, and most of the aeronautical information is exchanged through digital databases. These evolutions are all part of the general digitalization of aviation.

1.3 More and more data are generated and exchanged by the systems in aircrafts, by the surveillance systems, air traffic control systems, but also between these ones and the airport operation systems and other stakeholders. These data are the basis for creating new services, and their aggregation and interoperability can bring even more value to the whole ecosystem of aviation.

1.4 Digitalization and AI technologies are technical enablers for the development of new functions and services, to improve the level of safety, the environmental and economic efficiency, and the capacity in Aviation. Yet, for these innovations to become operational, collaboration between ICAO, States and Industry is needed, in order to setup the adequate frameworks for training, certification, qualification, operations and data sharing.

2. DISCUSSION

Impact on competencies of aviation professionals

2.1 The applications of digitalization and AI are numerous, and frequently disruptive. The most striking example is the advent of autonomous aircraft that is still at a conceptual stage but often included in industry innovation roadmaps. It is likely that flight crew will remain in the cockpit of passenger aircraft for years to come. However, in the short term some evolution is expected. Supported by smarter avionics, flight crew will more and more focus on mission management, and less and less on aircraft systems. The same will apply for air traffic controllers, who will be assisted by new tools for decision making and flow management. For States, AI and digitalization may also impact the rulemaking and oversight processes, by allowing a better use of available data. All support functions may be redefined too, and already are, by digital technologies.

2.2 Considering these evolutions, the Assembly is invited to acknowledge the significant impact of digital technologies on the future competencies of aviation professionals. The set of skills, knowledge and abilities needed for the future pilots, air traffic controllers, engineers, technicians, rulemaking officers, inspectors – to cite a few – is expected to be greatly modified by digitalization and AI. These impacts should be analyzed and acted upon as part of the Next Generation of Aviation Professionals (NGAP) initiative.

AI Classification

2.3 AI should be categorized into the number of stages depending on the application and level of autonomy. The stages will indicate various methodologies for AI implementation into the Industry. Therefore, this will be the first step for certification and qualification procedures based on AI categories. According to different research agencies, there are four stages or so called “waves” of AI. The first wave of AI is a rule-based system that follow rules defined by a human. The second wave of AI includes system becoming intelligent by using statistical methods. The third wave of AI is a contextual adaptation. The fourth wave is fully autonomous AI. The fourth wave will integrate all data coming from different systems and provide systems the ability to sense and respond to the environment effectively, for example, swarms of unmanned aerial vehicles (UAV) or data exchange between air traffic control (ATC) operators.

Need for Certification and Qualification Standards

2.4 From a certification and qualification point of view, AI and particularly machine learning (ML) raises new challenges. The traditional “development assurance” approach (e.g. DO-178, DO-254) is not applicable to ML algorithms, because it has not been developed with AI technologies in mind. There is considerable work ongoing in industry and academia in the area of “provable AI” and “trustable AI” which is required to bring AI into the safety critical operational domains. Key enablers are to make data-based AI systems more robust (to outliers and cyberattacks) and make it more interpretable and explainable “to humans trained to understand”.

2.5 There is a strong need to move from regulatory requirements based today only on traditional “development assurance” to a hybrid approach mixing both “development assurance” and “learning assurance” combined with an enhanced operational monitoring capability. Therefore, States and industries should be encouraged to develop certification and qualification standards for AI, taking into account the challenges of AI trustworthiness, explainability and correctness.

2.6 As more and more on-board devices generate data for maintenance and health monitoring purpose, such devices are increasingly equipped with communication / connectivity capabilities that integrate into aircraft communication bus. It is therefore critical to respect exiting rules for any aircraft modifications to guarantee systems integrity.

Impact on Existing ICAO SARPs

2.7 Beyond certification and qualification standards, updates of other standards are also needed, to allow for novel ways of working. With the implementation of AI, the interaction between human and machine is evolving. Systems are now able to make accurate recommendations and decisions, even in complex situations, and to adapt to changes in the environment. These increased capabilities of systems should be accounted for in ICAO SARPs, to allow the use of AI at its full potential, for the benefit of safety, capacity and efficiency in operations. To this end, the ICAO Council should initiate a review of the existing SARPs and initiate updates and amendments of the SARPs to allow for the use of new AI technologies, where relevant.

Need for data sharing in a trustable environment

2.8 Digitalization and AI rely on data. Both the quantity and the quality of data are of critical importance to support successful implementation of these technologies. Collaboration and data sharing

between all stakeholders are therefore a key capacity and should be enabled by open standards to facilitate data compatibility, as well as a trustable environment to ensure data is authentic and unmodified.

2.9 The need for data is global, and each stakeholder in each geographic zone can participate by accelerating the emergence of open standards for data sharing. The objective should be to share data as openly as possible, in a collaborative manner. There is no need for additional regulation in this area, and efforts should rather be put on data sharing initiatives, based on open standards, to enable efficiency gains in terms of safety, , environment, and operations. Trust will be a mandatory enabler of data sharing, and should be ensured through an appropriate framework. Such framework should allow enough flexibility and scalability to avoid barriers and bottlenecks in the flow of data. It should also provide the necessary level of cybersecurity to ensure authenticity. It should also protect industry stakeholder intellectual property.

Flight Simulation Training Devices as Digital Twins

2.10 Digital twins play a vital role in all digitalization projects, including aerospace industry. Since the middle of the last century, flight simulation training devices (FSTD) are actively developing in the direction of pilot's training. However, the dynamic growth of computing power in conjunction with amount of generated data greatly expands the capabilities of FSTD in perspectives of new challenges, such as, AI's training or analysis and optimization of ATC for urban air mobility. Therefore, ICAO Doc 9625, *Manual of Criteria for the Qualification of Flight Simulation Training Devices* needs to be revised, based on new challenges in aerospace digitalization initiative.

3. CONCLUSION

3.1 AI and digitalization are great opportunities for aviation that allow for increased safety, efficiency and capacity. These new technologies will contribute to the future of aviation and will redefine the core competencies of the Next Generation of Aviation Professionals. To allow for the development of AI and digitalization and benefit from these technologies, ICAO, States and Industry must work together to update existing SARPs and create new standards when needed. Data sharing between all stakeholders in a trustable environment will be essential to the success of AI and should be supported by the development of open standards and a trustable environment.

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