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DIRITTO E POLITICA DEI TRASPORTI
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Articles and essays

Regulating Drones in a Digital World

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Abstract
Regulating Drones in a Digital World.

ICAO's third symposium on drones titled DRONE ENABLE/3 with the theme Facilitating Future Innovation was held from 2 to 14 November 2019 in Montréal, Canada. The symposium brought together key stakeholders from government, industry, academia, and international organizations active in the unmanned aviation sector to exchange research, best practices, lessons learned and respective challenges. Although the symposium offered much thought on technical issues such as aircraft registries and information management with some focus on cyber issues, there was a conspicuous absence of any discussion of legal and regulatory issues pertaining to pilotless aircraft that could be fully or partially automated in the future. Perhaps the legalities were not discussed at the symposium for the reason that elsewhere in ICAO, at the 39th Session of ICAO's Assembly in 2016, many States requested that ICAO develop a practical regulatory framework for national UAS activities, in addition to the standards it was already developing for international operations. Furthermore, the Agenda of items in the Work Programme of the Legal Committee of the Council of ICAO for its 37th session comprised inter alia the study of legal issues relating to remotely piloted aircraft.
The above notwithstanding, this legal lacuna brings to bear the compelling need to address the increasing issues emerging from rapidly proliferating drones in the skies and how to develop a global "rule book" for pilotless aircraft in the digital world of today. This article does some "scenario planning" as to what might be the issues that could form discussions in the Legal Committee, focusing on some already existing legal and regulatory provisions pertaining to the subject.

Key words: *Remotely piloted aircraft; Chicago Convention; ICAO; aeronautical telecommunications; operation of aircraft; digital law.*

Table of contents — 1. Introduction — 2. ICAO initiatives — 3. ICAO guidelines. The Manual — 4. Drones and Article 3 bis of the Chicago Convention — 5. Human v. Digital — 6. Conclusion

1. Introduction

There is no doubt that unregulated drones cause a serious threat to the safety of civilian aircraft. The Guardian has reported that "*the rate of near misses between civil aircraft and drones in the UK has tripled since 2015. The UK Airprox Board (UKAB), which*

monitors all near misses involving commercial aircraft, said there were 92 between aircraft and drones in 2017. That was more than three times the number in 2015: 29. In 2016, there were 71 and the data is clearly tracking the growth in drone use"[1].

The Federal Aviation Administration (FAA) of the United States has admonished drone operators against disrupting and threatening fire fighting aircraft, issuing a severe warning to drone operators to avoid unauthorized flights near wildfires or face civil penalties totaling more than $20,000[2]. The Flight Safety Foundation records the FAA as having warned drone operators: "*if you fly your drone anywhere near a wildfire, you could get someone killed*"[3], stating further that unauthorized drone flights not only constitute a collision hazard for fire fighting aircraft but also can distract pilots of firefighting aircraft.

Technically, a drone is a remotely piloted aircraft (RPA) and is just one type of unmanned aircraft. Drones include elements such as ground control stations, data links and other support equipment. A similar term is an unmanned-aircraft vehicle system (UAVS), remotely piloted aerial vehicle (RPAV), remotely piloted aircraft system (RPAS). Drones are intrinsically linked to air traffic management and air traffic growth which doubles once every 15 years. This growth can present a conundrum. On one hand, traffic growth is a sign of increased living standards, social mobility and generalized prosperity. On the other hand, air traffic growth can lead to increased safety risks if it is not properly supported by the regulatory framework and infrastructure needed.

From an international perspective, drones are subject to the discretion of the State flown over, as Article 8 of the Chicago Convention (the multilateral treaty addressing international civil aviation) says that no aircraft capable of being flown without a pilot can be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Furthermore, under the treaty, each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft will be so controlled as to obviate danger to civil aircraft. Here, the operative words are *"…aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft*". This part of the provision could be relevant to digital automation both in terms of machine learning and deep learning as they involve image detection and precision implementation. The process of Deep Learning exposes multilayered neural networks to enormous amounts of data. By feeding the computer a learning algorithm and exposing it to terabytes of data, the computer can be left to figure out how to precisely recognize objects and images. It must be noted that remotely controlled and uncontrolled (autonomous) aircraft were already in existence at the time of the First World War, operated by both civil and military entities. "Aircraft flown without a pilot" therefore seemingly refers to the situation where there is no pilot on board the aircraft.

Prior authorization and coordination are required where it can be reasonably expected in the planning phase that the RPA will enter into the airspace of another State. For example, situations where conditions would require the remote pilot to fly alternate

[1] How dangerous are drones to aircraft? *The Guardian*, 20 December 2018, https://www.theguardian.com/technology/2018/dec/20/how-dangerous-are-drones-to-aircraft.

[2] FAA Warns Against Drone Interference With Firefighting, Flight Safety Foundation, https://flightsafety.org/drone-interference/.

[3] https://www.facebook.com/FAA/posts/if-you-fly-your-drone-anywhere-near-a-wildfire-you-could-get-someone-killed-bitl/2133898069985137/.

routes, avoiding hazardous meteorological conditions, restricted areas or where the alternate aerodrome in case of emergency is situated in another State. On the other hand, an unforeseen emergency would not require prior planning and prior special authorization, since it could not have been reasonably expected.

The above brings to bear a fundamental question: at the present time, is there a clear demarcation between remote human control of an RPAS and an automated computer centre? It is quite obvious that the International Civil Aviation organization (ICAO)[4] in its *Manual on Remotely Piloted Aircraft (Doc 10019*), refers to human control when it says: "*remote pilots must be able to perform their duties at an adequate level of alertness. To ensure this, RPAS operators whose organizations include operation shifts and crew scheduling schemes should establish policies and procedures for flight and duty time, operation shift schedules and crew rest periods based on scientific principles*".

This point is further unfolded on the issue of remote pilot licences. The Manual goes on to say that a person should not act either as remote pilot in command (PIC) or as a remote co-pilot of an RPA unless that person is the holder of a remote pilot licence, containing the ratings suitable for the purpose of executing the operation. Also, a person should not act as an RPA observer unless that person has undergone a competency-based training on visual observer duties concerning RPA operations. The focus on a "person' is further elaborated in the provision that says that remote pilot licence requirements and the requirements for the RPA observer competencies should consider the integration of human performance issues within a competency-based training and assessment approach. Finally, all stakeholders (instructors, assessors, course developers, training providers, inspectors, etc.) involved in the training and assessment process should be provided with guidance on how to develop, implement and manage or oversee competency-based training and assessments that integrate human performance elements. Human performance training should not stand out as a separate subject.

Further provisions in the Manual leave no room for doubt that exclusive automation though digitalization is ruled out. For example the Manual states that remote pilots that are required to communicate with air traffic services (ATS) must demonstrate the ability to speak and understand the language used for ATS communications to the level specified in the language proficiency requirements in Annex 1 to the Chicago Convention (Personnel Licensing) and have proof of language proficiency and that proof of language proficiency in either English or the language used for communications involved in the remotely piloted flight should be endorsed on the remote pilot licence.

[4] The International Civil Aviation Organization (ICAO) is the specialized agency of the United Nations handling issues of international civil aviation. ICAO was established by the Convention on International Civil Aviation, signed at Chicago on 7 December 1944 (Chicago Convention). The overarching objectives of ICAO, as contained in Article 44 of the Convention is to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport to meet the needs of the peoples for safe, regular, efficient and economical air transport. ICAO has 193 member States, who become members of ICAO by ratifying or otherwise issuing notice of adherence to the Chicago Convention. ICAO's Strategic Objectives are Safety: Enhance global civil aviation safety; Air Navigation Capacity and Efficiency: Security and Facilitation: Enhance global civil aviation security and facilitation; Economic Development of Air Transport: and Environmental Protection. See ICAO Business Plan 2017-2019. https://www.icao.int/Meetings/a39/Documents/Business%20Plan%202017-2019.pdf.

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' Standards and Recommended Practices (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.

2. ICAO initiatives

At its Thirteenth Air Navigation Conference held in Montréal, from 9 to 19 October 2018, ICAO suggested that ICAO guidance will be needed for regulators on how to accommodate new aircraft within existing global Standards and policies. In addition, requests from States unfamiliar with these types of operations for ICAO and the community for aid can be expected. It was agreed that as higher airspace operations develop and evolve, all aspects within the scope of the Global Air Navigation and Global Aviation Safety Plans (GANP and GASP) will be implemented by ICAO through the well-established processes for assigning technical work to relevant expert groups.

Annex 10 to the Chicago Convention on aeronautical telecommunications plays an important role in ensuring that telecommunications and radio aids to air navigation are necessary for the safety, regularity and efficiency of international air navigation. The Annex aims at protecting all aeronautical telecommunication stations, including end systems and intermediate systems of the aeronautical telecommunication network (ATN), are protected from unauthorized direct or remote access. Annex 11 on air traffic services provides that States can designate other States to provide air traffic services on their behalf without giving away their sovereignty, stating further that when it has been determined that air traffic services will be provided in particular portions of the airspace or at particular aerodromes, then those portions of the airspace or those aerodromes are required to be designated in relation to the air traffic services that are to be provided. The designation of the particular portions of the airspace or the particular aerodromes are designated as flight information regions - those portions of the airspace where it is determined that flight information service and alerting service will be provided – and control areas and control zones, which are those portions of the airspace where it is determined that air traffic control services will be provided to IFR (flying by reference to instruments on the flight deck) flights are needed to be designated as control areas or control zones.

Aviation in the digital world extend to LOON - defined as "*a network of stratospheric balloons*" - deployed between altitudes of 18km and 25km and calculated to enable remote communities around the world to benefit from internet connectivity, would have distinct aeronautical features as the balloons would be High-Altitude Long-Endurance (HALE) aircraft operating in the stratosphere – which is the second level of the Earth's atmosphere – and therefore their operations would come within the basic premise of the Chicago Convention which addresses international civil aviation and provides the each contracting State (country) recognizes that every State has sovereignty over the airspace above its territory. Although the balloons would be flying at altitudes above flight level 600 (60,000-70,000 feet, well over altitudes traversed by commercial aircraft) they have

nonetheless to take off and land at low altitudes which would place them within the regime of a global air navigation system.

The inherent problem in this process is seemingly predicated upon the absence of a harmonized global "rule book" that standardizes the aeronautical aspects related thereto. Should a State, for instance, in view of its State sovereignty, regulate the LOON process? Diligently working on this dilemma is an industry group called the Upper Airspace Working Group (UAWG), which is "*developing positions on policies and strategies concerning national and international regulation, legislation, and standards unique to high-altitude unmanned and manned aircraft, spacecraft and other users*". Some of the principles that are being considered for harmonized regulation are: "*Uniform airspace organization and management principles will need to be applicable to all regions; Global principles will be applicable at all levels of density and will affect total traffic volume; Airspace management processes will need to accommodate diverse and dynamic flight trajectories and provide optimum system solutions; When conditions require that different types of traffic be segregated by airspace organization, the size, shape and time regulation of that airspace will be set to minimize the impact on all operations equitably; The complexity of operations may pose limitations on the degree of flexibility; Airspace use will be coordinated and monitored in order to accommodate the conflicting legitimate requirements of all users minimizing constraints on operations; For operations lasting longer than 24 hours, airspace reservations will be expected and planned in advance with changes made dynamically whenever possible. As occurs today, the system will also accommodate unplanned requirements; Structured route systems will be applied only where required to enhance capacity or to avoid areas where access has been limited or where hazardous conditions exist. Otherwise, airspace management principles will remain as flexible as practicable*".

This is an area where sustained work by ICAO is needed and it is hoped that the HALE issue is discussed with a sense of purpose and direction at ICAO's General Assembly which commences on 25th September 2019. Of particular note in this context would be the decision of the Conference of October 2018 referred to earlier, that States with relevant experience in higher airspace operations, share, through ICAO where appropriate, their experience and expertise with other States and provide assistance to other States on the regulatory aspects of these operations. It was also agreed that States expected to benefit from higher airspace operations, agree to consider risk-based operational trials in their airspace. In this regard ICAO was to support ongoing higher airspace operations by providing guidance and, as necessary, other provisions on the regulatory aspects of these operations as well as working with States and industry to share information on current and forecasted needs for higher airspace operations, to identify issues affecting the global air navigation system and to proactively address harmonization for these operations. ICAO was requested to consider establishing a multidisciplinary group of experts to consider needed criteria, operational issues, and operator and provider responsibilities for operations in higher airspace; and develop a performance-based global framework for higher airspace operations considering current and future work in emerging technologies, for example, in the areas of information management and sharing, strategic planning, separation and environmental Standards, situational awareness and security; and ensure that the framework includes flights transitioning through controlled airspace and to and through airspace above FL600, as necessary.

3. ICAO Guidelines. The Manual

ICAO has expressed the view, in its *Manual on Remotely Piloted Aircraft* that a RPAS is just one type of unmanned aircraft[5] and that all unmanned aircraft, whether remotely piloted, fully autonomous or combinations thereof, are subject to the provisions of Article 8 of the Chicago Convention[6]. Here, one sees an extension of the principle in the Chicago Convention that applies only to aircraft capable of being flown "*without a pilot*" to "*remotely piloted aircraft*" in Doc 10019. The Manual goes on to define a "*remotely piloted aircraft*" as "*an unmanned aircraft which is piloted from a remote pilot station*". There is no definition of a "*pilot*" in the Manual. Applying these principles top a RPAS which is purely operated by computers with no human involvement, one could only assume that Article 8 of the Chicago Convention would be applicable to digitally driven aircraft.

The next issue to be discussed would be what type of licenses are issued to digital equipment that operate RPAS. Article 32 of the Chicago Convention on personnel licensing provides that the pilot of every aircraft and the other members of the operating crew of every aircraft engaged in international navigation are required to be provided with certificates of competency and licenses issued or rendered valid by the State in which the aircraft is registered.

The Manual conveniently bypasses this issue by saying that remote pilots are not subject to Article 32 which was drafted specifically for those individuals who conduct their duties while on board aircraft, quoting Appendix 4 to Annex 2 (to the Chicago Convention) which contains a Standard requiring remote pilots to be licensed in a manner consistent with Annex 1 — Personnel Licensing. Here, the ambiguity arises in the term "*remote pilots*" with a presumption that we are still referring to "human" pilots. In the digital age of the future, this point may need to be clarified with legal specificity. Another point of contention could be, in the years to come, Article 33 of the Chicago Convention which provides that certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State in which the aircraft is registered[7], will be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licences were issued or rendered valid are equal to or above the minimum standards which may be established

[5] An aircraft is defined as any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface. An aircraft which is intended to be operated with no pilot on board is classified as unmanned. An unmanned aircraft which is piloted from a remote pilot station is an RPA. See Manual on Remotely Piloted Aircraft Doc 10019, at 2.2.1.

[6] The full text of Article 8 states that no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft. See Doc 10019 supra at 1.1.1. Included in this category are Remotely piloted Stations (RPS) which are components of the RPAS containing the equipment used to pilot the RPA. The RPS can range from a hand-held device up to a multi-console station. It may be located inside or outside; it may be stationary or mobile (installed in a vehicle/ship/aircraft). *Id*. 2.2.4.

[7] The manual does not apply to: State aircraft, without prejudice to the obligation for "*due regard*" in Article 3 (d) of the Chicago Convention; autonomous unmanned aircraft and their operations including unmanned free balloons or other types of aircraft which cannot be managed on a real-time basis during flight; operations in which more than one RPA is being managed by an RPS at the same time; and model aircraft, which many States identify as those used for recreational purposes only, and for which globally harmonized standards are not considered necessary.

from time to time pursuant to the Convention. The Manual in 1.3.11 states that Article 33 is the basis for mutual recognition of certificates and licences and that it does not apply to licences of remote pilots since remote pilot licences are not encompassed by Article 32. It goes on to say that proper oversight of remote pilot licences may dictate that they be issued or rendered valid by the licensing authority of the State in which the RPS is located, rather than the State of Registry of the RPA.

All this may be well and good for the time being where we are at the incipient stage of digital control of air transport in terms of piloting of aircraft. It is time however, that issues for the future are subject to study so that ICAO and the aviation community will be prepared for things to come.

Annex 6 to the Chicago Convention (Operation of Aircraft) defines different types of operation for manned aviation: commercial air transport operation; and general aviation operation which includes corporate aviation and aerial work. The Manual of RPAS goes on to say that for RPAS operations, the distinction is not considered relevant since regulatory distinctions will be based on the scale and complexity of the operation, rather than on the traditional types of operation or class of aircraft. This has implications on the responsibilities of RPAS operators. The Manual does not envision that carriage of persons on board an RPA will not be considered in the initial regulatory framework. In paragraph 2.3.6 the Manual states that RPA designed and built for other than recreational purposes may be regulated under the jurisdiction of the civil aviation authority even if used for recreational purposes. Conversely, model aircraft designed and built for recreational purposes, if used for any purpose other than recreation, may be regulated under the jurisdiction of the civil aviation authority.

One of the issues that need consideration is in paragraph 2.3.9 of the Manual which provides that RPA that are intended to be operated in any given airspace must comply with the requirements of that airspace, e.g. certifications, approvals and equipment. Irrespective of these certifications, approvals or equipment requirements, RPA may be prohibited from operating in certain areas, such as above heavily populated areas, if so determined by the civil aviation authority. Who would receive notice of prohibition? Would there be a central focal point that will be designated by States in each case? From an international perspective (to which ICAO is limited) would this come within the purview of Article 9 of the Chicago Convention which provides that each contracting State may, for reasons of military necessity or public safety, restrict or prohibit uniformly the aircraft of other States from flying over certain areas of its territory, provided that no distinction in this respect is made between the aircraft of the State whose territory is involved, engaged in international scheduled airline services, and the aircraft of the other contracting States likewise engaged. Such prohibited areas shall be of reasonable extent and location so as not to interfere unnecessarily with air navigation. Descriptions of such prohibited areas in the territory of a contracting State, as well as any subsequent alterations therein, shall be communicated as soon as possible to the other contracting States and to ICAO.

RPAS will be operated under the overarching provision in Article 8 of the Chicago Convention which requires authorization for the pilotless aircraft to be flown over the airspace of a State. Under this umbrella, the Manual of RPAS recommends that in order to facilitate the practical implementation and execution of the special authorization process, States may agree mutually upon simpler procedures through bilateral or multilateral agreements or arrangements for the operation of specific RPA or categories

of RPA. This will reduce the workload on RPAS operators and the State authorities. The same objective may be reached through regulatory measures at regional levels.

The Manual goes on to say, in paragraph 3.2.3 that coordination with the appropriate air traffic services (ATS) authority is mandatory prior to the operation of RPA over the high seas. In this context, the appropriate ATS authority is the authority designated by the State responsible for providing those services over the high seas. Usually, the ATS authority is the designated air navigation service provider (ANSP) for that volume of airspace. The Manual recommends that the request for authorization form be used for the required coordination with the appropriate ATS authority for the operation of an RPA over the high seas. The appropriate ATS authority may require additional information.

Prior authorization and coordination are required where it can be reasonably expected in the planning phase that the RPA will enter into the airspace of another State. For example, situations where conditions would require the remote pilot to fly alternate routes, avoiding hazardous meteorological conditions, restricted areas or where the alternate aerodrome in case of emergency is situated in another State. On the other hand, an unforeseen emergency would not require prior planning and prior special authorization, since it could not have been reasonably expected[8].

The above provisions bring to bear a fundamental question: at the present time, is there a clear demarcation between remote human control of an RPAS and an automated computer centre? It is quite obvious that the Manual refers to human control when it says: "*remote pilots must be able to perform their duties at an adequate level of alertness. To ensure this, RPAS operators whose organizations include operation shifts and crew scheduling schemes should establish policies and procedures for flight and duty time, operation shift schedules and crew rest periods based on scientific principles*"[9].

Further provisions in the Manual leave no room for doubt that exclusive automation though digitalization is ruled out. For example the Manual states that remote pilots that are required to communicate with air traffic services (ATS) must demonstrate the ability to speak and understand the language used for ATS communications to the level specified in the language proficiency requirements in Annex 1 to the Chicago Convention (personnel Licensing) and have proof of language proficiency and that proof of language proficiency in either English or the language used for communications involved in the remotely piloted flight should be endorsed on the remote pilot licence. Such proof of language proficiency should indicate the language, the proficiency level and the validity date. The applicant for a proof of language proficiency should demonstrate at least an operational level of language proficiency both in the use of phraseologies and plain language. To do so, the applicant should demonstrate, in a manner acceptable to the licensing authority, the ability to: communicate effectively in voice-only and in face-to-face situations; communicate on common and work-related topics with accuracy and clarity; use appropriate communicative strategies to exchange messages and to recognize and resolve

[8] Doc 10019, *supra* n. 215 at 3.2.5.

[9] *Id.* paragraph 6.9.10. The paragraph goes on to say that such policies and procedures should be documented in the operations manual and may include: training and education on personal and operational fatigue-related risks and countermeasures; implementation of mitigations where necessary and monitoring of their effectiveness; and continued review of fatigue-related risks through safety management processes.

misunderstandings in a general or work-related context; and handle successfully, and with relative ease, the linguistic challenges presented by a complication or unexpected turn of events that occurs within the context of a routine work situation or communicative task with which they are otherwise familiar; and use a dialect or accent which is intelligible to the aeronautical community. Except for remote pilots who have demonstrated language proficiency at an expert level, the language proficiency endorsement should be re-evaluated periodically, according to the level of language proficiency[10].

4. Drones and Article 3 bis of the Chicago Convention

In the context of AI in aeronautics and air navigation, the important issue of interception of civilian aircraft by unmanned automated drones is a plausible scenario, Article 3 bis of the Chicago Convention states that Article 3 bis of the Chicago Convention which provides that the contracting States to the Convention recognize that every State must a refrain from resorting to the use of weapons against aircraft in flight and that, in case of interception, the lives of persons on board and the safety of aircraft must not be endangered. This provision shall not be interpreted as modify- in any way the rights and obligations of States set forth in the Charter of the United Nations arguably in the context of foregoing discussion.

Secondly, Article 3 bis states that the contracting States recognize that every State, in the exercise of its sovereignty, is entitled to require the landing at some designated airport of a civil aircraft flying above its territory without authority or if there are reasonable grounds to conclude that it is being used for any purpose inconsistent with the aims of this Convention; it may also give such aircraft any other instructions to put an end to such violations. For this purpose, the contracting States may resort to any appropriate means consistent with relevant rules of international law, including the relevant provisions of this Convention, specifically the principle discussed in the preceding paragraph. Each contracting State agrees to publish its regulations in force regarding the interception of civil aircraft.

Finally, Article 3 bis provides that every civil aircraft shall comply with an order given in conformity with the preceding paragraph as discussed above. To this end each contracting State is required to establish all necessary provisions in its national laws or regulations to make such compliance mandatory for any civil aircraft registered in that State or operated by an operator who has his principal place of business or permanent residence in that State. Each contracting State is further required to make any violation of such applicable laws or regulations punishable by severe penalties and shall submit the case to its competent authorities in accordance with its laws or regulations.

It must be noted that Article 3 bis has three dimensions as reflected in the three paragraphs above. The fist pertains to the use of weapons against civil aircraft in flight. In the digital context, one could argue that the implantation of this provision incontrovertibly involves human activity in the ultimate decision-making process. Decisions taken exclusively by an automated process would not be adequate as the above discussion on drones in the previous chapter demonstrates. An important point in this context is that Article 3 bis is not a technical provision, nor is it strictly legal in

[10] *Id*. 8.4.6 to 8.4.10.

nature. It also involves moral principles and human dignity that is enforced through mutual respect between humans.

Of greater significance in Article 3 bis is the statement: "*…in case of interception, the lives of persons on board and the safety of aircraft must not be endangered*". The question is: should an automated process be given the discretion of deciding how not to endanger the safety of those on board an aircraft in flight? From a legal perspective, much thought should given to the issue of accountability and responsibility and the need for a clear legal and regulatory regime that would identify responsibility and accountability of those applying AI to grave decision making in air transport. As a follow-up to responsibility and accountability should be the sensitivity of AI to a clear retrospective understanding in the way AI worked when something went wrong with the AI application used. Until these various issued become clearer AI should be used as a mathematical and scientific tool that provides extended intelligence to humankind.

The second dimension in Article 3 bis is instructions issued to aircraft to land at specified airports in case the aircraft does not have authority to fly over a State or a State is suspicious that aircraft's intent (my emphasis) regarding the safety of the State flown over. Article 3 bis provides inter alia: "*the contracting States may resort to any appropriate means (my emphasis) consistent with relevant rules of international law, including the relevant provisions of this Convention, specifically the principle discussed in the preceding paragraph. Each contracting State agrees to publish its regulations in force regarding the interception of civil aircraft*". How would a machine know whether an aircraft overhead is suspicious?

It could argued that through machine learning – a process of supervised learning systems where the machine is provided with numerous examples of a correct answer and the machine arrives at the most desired solution – could deduce the suspicious nature of an overhead flight but there is always a danger of over-profiling through examples fed into a machine.

The third dimension is the requirement for States in which their aircraft are registered to have comprehensive laws and regulations that would impel aircraft to comply with a requirement by another State to land at a designated airport. The question arises as to how an automated aircraft would be fed with laws of a state that would enable a machine to comply with an order to land at a specific airport.

5. Human v. Digital

In a working paper submitted to the 40th Session of the ICAO Assembly in 2019, Presented by the International Coordinating Council of Aerospace Industries Associations (ICCAIA) and Civil Air Navigation Services Organisation (CANSO ICAO member States were advised: "*[A]ccording 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*"[11]. The paper went on to say

[11] Artificial Intelligence and Digitalization In Aviation, *A40-WP/2681 EX/111* 1/8/19, at p. 3.

that 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.

Regulation and certification of AI in aeronautics and air navigation was highly recommended in the paper: "*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*"[12].

6. Conclusion

In view of the foregoing discussion, the operative question would be whether in a scenario looking ahead over the next 30 years, drones would be used exclusively to perform human functions in international civil aviation. The answer would be in the negative for the foreseeable future. The application of AI to air transport should be based on the highest values of human rights and must not intrude on the contemporary aspirations of people living in the 21st century. The World Conference on Human Rights held in Vienna in 1993 recognized and affirmed that all human rights derive from the dignity and worth inherent in the human person, and that the human person is the central subject of human rights and fundamental freedoms, and consequently should be the principal beneficiary and should participate actively in the realization of these rights and freedoms. The Conference also reaffirmed the solemn commitment of all States to fulfil their obligations to promote universal respect for, and observance and protection of, all human rights and fundamental freedoms for all in accordance with the Charter of the United Nations, other instruments relating to human rights, and international law, stating that the universal nature of these rights and freedoms is beyond question. A future where drones would bring us into a world of human dignity and sensitivity as well as the balance of human judgment is yet to be foreseen.

[12] *Ibid.*