HERMES
AIR TRANSPORT ORGANISATION

2020_RECOMMENDATIONS

DIGITALIZATION, AI IN AVIATION AND THE HUMAN FACTOR

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DIGITALIZATION, AI IN AVIATION AND THE HUMAN FACTOR

Introduction

According to a White Paper prepared for the World Economic Forum, "There is widespread recognition among industry leaders that the role of digital technology is rapidly shifting, from being a driver of marginal efficiency to an enabler of fundamental innovation and disruption." The White Paper further notes that the aviation industry has been at the forefront of digital innovation, but that, "further digitalization will be vital if the expectations of tomorrow's consumers are to be met." Along the same lines, a working paper prepared by the Singapore delegation to ICAO's Thirteenth Air Navigation Conference notes, "The growing pace of digital technological advancement provides opportunity to advance the global aviation industry, but is also a challenge that can disrupt the aviation industry."

Digitalization promises to increase efficiency and safety in the aviation industry, as well as to improve the customer experience. Integration across physical and digital assets, "will result in a seamless customer journey by making information available continuously, reducing waiting and transfer times, hyper-personalizing services and optimizing rerouting." Increasing the digitalization of assets will further facilitate predictive maintenance, as information is communicated on a real-time basis to control centers outlining required safety checks and repairs.

Building on these digital advancements, artificial intelligence (AI) offers the opportunity to learn from experience: "The differentiating factor of an AI system from a standard software system is the characteristic ability to learn, improve, and predict." According to a recent report by McKinsey & Company, "Machines powered by AI can today perform many tasks—such as recognizing complex patterns, synthesizing information, drawing conclusions, and forecasting—that not long ago were assumed to require human cognition... After decades of false starts, artificial intelligence is on the verge of a breakthrough... Tech giants and digital natives are investing in and deploying the technology at scale, but widespread adoption among less digitally mature sectors and companies is lagging."

The pace of change in aviation from digitalization and AI is fast and accelerating, with almost every aspect being impacted – not just greater autonomy in the air in aircraft and other airspace vehicles and in air traffic management but also on the ground for operations, security and the passenger experience. Clearly, increased use of digitalization and AI in the aviation industry will disrupt the current workforce. Although, some jobs will be lost with workers replaced by technology, many more workers will need to be retrained to accommodate the new technologies: "Digital transformation demands a different skill set from workers in today's economy, and will create new types of jobs... Challenges such as managing the impact of automation on employment, reskilling the

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industry workforce for the digital economy, and creating a safety net for workers in a flexible workforce, will need to be tackled collaboratively by industry, regulators and policy-makers."

In this context, Hermes invites interested stakeholders to submit papers on the following topics:

- **What changes are needed to ensure that aviation proactively embraces digitalization and AI in a way that ensures continued safety, security and sustainability?** Are current arrangements with ICAO (regulations, standards, etc) and industry associations (industry standards, benchmarking, sharing of best practices, etc) adequate or is there a need for more explicit leadership in aviation and, if so, by whom?
- **What policies and regulations need to be instituted, altered or removed to ensure successful implementation of digitalization and AI in aviation?** Is a performance-based approach to human involvement and to regulation sufficient or is there a need to be more prescriptive on when human involvement and management is essential?

- **Digitalization and AI will reduce the cognitive load on humans but will also have a significant impact on the need for human time and resources. How can aviation best anticipate and manage that impact?** What changes are needed to recruitment, management, retention and retraining practices to ensure adequate and appropriate human resources that thrive in the aviation workplace?

1 World Economic Forum, Digital Transformation Initiative Aviation, Travel and Tourism Industry, White Paper, January 2017.

2 Ibid.

3 ICAO, Thirteenth Air Navigation Conference, Working Paper, AN-Conf/13-WP/232.

4 World Economic Forum, op. cit.

5 ICAO, Thirteenth Air Navigation Conference, op. cit.

6 McKinsey & Company, Artificial Intelligence: The Next Digital Frontier? Discussion Paper, June 2017.

7 World Economic Forum, op cit.

R20-I
01/04/2020

HERMES
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INTERVIEW

AI in civil aviation

Salvatore Sciacchitano, President of the ICAO Council

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INTERVIEW

R20-I
01/04/2020

What is ICAO view on the potential for Artificial Intelligence (AI) in civil aviation?

New technological innovations such as AI hold significant potential for civil and commercial aviation worldwide. The differentiating factor of an AI system from a standard software system is the characteristic ability to learn, improve, and predict. Through training, an AI system can generate knowledge and apply it to novel situations not encountered before.

In ICAO today it is foreseen that these AI capabilities and other emerging areas of innovation hold the potential to drive very positive benefits in terms of aviation safety, security, efficiency, and sustainability performance.

And what about for ICAO itself and its community of national regulators?

AI innovations can also be leveraged toward more efficient and streamlined aviation regulatory processes, making it vital that the international civil aviation sector take timely action to monitor and evaluate these developments.

ICAO is doing just that today through a series of partnerships and arrangements with key innovators in this area. Our goal is to maximize the potential of these innovations as rapidly as possible, and such that no country is left behind as these capabilities mature.

Can you provide some examples of the types of partnerships being explored?

One involves ICAO partnering with the Interdisciplinary Center for Mathematical and Computational Modelling of the University of Warsaw and several ICAO member States. This is endeavouring to develop algorithms that can be used to optimize global air transport connectivity given various frequency, affordability, flight time, and fuel burn (emissions) constraints.

We also partnered on the UN AI for Good Annual Global summit, where we convened a working session on AI in aviation, collaborated with the XPrize Foundation by providing AI challenges and participating in the Global Initiative on AI and Data Commons, and we are currently exploring the creation of an *AI in Aviation* focus group under the International Telecommunication Union (ITU) to address issues relating to compliance and certification.

The above activities are in addition to our outreach with local AI innovators and universities in the Montreal, Canada, where our HQ is based, as it is currently seen as a leading global centre for AI research and development. We are also hosting internships and developing in-house deep-learning models showcasing natural language processing techniques for aeronautical information management and document summarization.

Does ICAO foresee a role for AI with respect to the fundamental air traffic management (ATM) needs of today's global network?

Absolutely. In fact during our most recent and 13th Air Navigation Conference, during its agenda item focused on Emerging Issues, a working paper was presented specifically on AI which explored the work now underway in Singapore to develop AI-based applications for ATM.

The ATM Research Institute (ATMRI), under the auspices of the Civil Aviation Authority of Singapore's Centre of Excellence for ATM, is researching the development of an Air Traffic Control Officer (ATCO) decision-making tool that leverages AI to learn and predict traffic management strategies for en-route operations. When mature, this tool will help controllers to better organise air traffic flows, reduce interventions needed from executive surveillance controllers, and allow the planning controller to focus much more on strategic-level planning.

Are there any other initiatives which ICAO is aware of?

There is much more going on as well, of course, and even to the point last Spring where we saw how a new AI tool had landed a small plane carrying passengers by sight alone at an Austrian airfield. This university-led initiative didn't need to rely on the radio signals provided by existing Instrument Landing Systems (ILS), which as you know many smaller airports cannot often afford.

In addition to developing solutions to support en-route operations, AI can be applied in speech recognition to detect read-back errors, the synchronisation of aircraft ground movements, or predicting optimal runway configurations to maximise throughput. It also permits a substantial increase in existing airspace capacity without significantly increasing the demand on the limited number of controllers available and their respective cognitive capabilities.

AI systems therefore have high potential in ATM, specifically in areas which involves decision making under uncertainty (e.g. conflict detection and resolution) and prediction with limited information (e.g. trajectory prediction). These approaches can provide human operators with timely and dynamic information on atmospheric hazards, traffic fluctuations, and airspace utilisation.

How urgently needed are these types of solutions for global civil aviation today?

Today's air traffic system is clearly reaching its operational limits.

Simply put, accommodating future air traffic growth will be a challenging task for air navigation service providers (ANSPs) unless new capabilities are brought to the fore which permit more aircraft to be safely managed in the world's finite airspace.

What are some of the main challenges ICAO foresees as this innovation continues?

Certainly the opportunities outnumber the challenges where AI is concerned, but a very basic challenge we're confronted with, from the onset, is to develop the competencies of the specialists who must assess and ultimately certify AI-based systems for operational applications.

Another very key challenge, with AI and all digitally oriented innovations today, are the cyber vulnerabilities they present from both an information and operational security standpoint.

There is also a clear need to coordinate the researchers, academia, industry, State regulators, and service providers involved in this process, and fortunately the Singapore example I mentioned above has taken this path and provides an important best practice for other States and regions considering similar initiatives.

This function can be replicated at the global level to keep pace with other industries that are leveraging technological advancements enabled through the fourth Industrial Revolution, and I've been encouraged by how proactive the ICAO Secretariat has been in this regard.

Ultimately the promise of intelligent automation for aviation can only be realised through a globally coordinated approach, and I am confident that ICAO is very well-placed to lead that coordination among such diverse public and private stakeholders, consistent with its mission and role.

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R20-PP/01
27/01/2020

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POSITION PAPER

Blockchain Technology Applications

Presented by ACAO's General Directorate

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POSITION PAPER

R20-PP/01
27/01/2020

Paper summary

This paper presents the importance of the uses of Block chain technology in the civil aviation system and the importance for the Arab Civil Aviation Organization to implement it.

Introduction

Today, the world has become more aware of the benefits and uses of the Block chain technology, which is no longer restricted to payments and digital currencies. Indeed, this technology can revolutionize the way we interact with intellectual property, capital markets, insurance, health care, and government in addition to smart contracts, which are the basic building block of decentralized applications, i.e. the transaction contractual management between any two or more parties that can be programmatically verified via block chain, instead of traditional methods such as the central controller or decision-maker such as the broker or the bank and others.

Global air traffic volumes are expected to double over the next fifteen years, which will result in increases in the number of aircraft and flights, ground activities, number of passengers, ticketing, cargo handling, and parallel expansion of tracking, documentation, approval, and certification requirements associated with them.

With the growth of air traffic, one of the new challenges and risks consists in the increasing number of logistical, administrative and control activities that can be addressed through "Block chain" technology applications whilst maintaining increased demand and quality levels. In addition, block chain applications can be used in all regions of the aviation system where important and complex safety records are managed and updated, such as personnel licensing, aircraft maintenance, operational processes or cargo lists.

In this context and to support this trend, the International Civil Aviation Organization organized important events, through which it aimed to shed light and support block chain technical applications in the aviation system starting with the aircraft and other assets that fund commercial operations including traveler's experience, contract management, record keeping and security.

The civil aviation system today relies in most cases on the human factor or intermediaries to carry out data and information validation activities, and therefore we can expect that the integration of block chain operations to support the countries aviation safety monitoring system may require substantive modifications to the relevant regulations, procedures and responsibilities. On the other hand, risks need to be taken into account as relying on a set of servers and smart contracts in order to validate documents and issue certificates presents clearly and specifically electronic risks. Therefore, it is necessary to consider security measures before adopting block chain applications for managing air safety operations and other civil aviation related issues.

The Arab Civil Aviation Organization support cooperation between the civil aviation authorities and the air transport industry in order to put in place procedures and measures to benefit from the use of related "block chain" applications in the civil aviation system.

—END—

R20-PP/02
28/01/2020

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POSITION PAPER

Digitalization, AI in Aviation and the Human Factor

Presented by A4A

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POSITION PAPER

R20-PP/02
28/01/2020

[Introduction]

Digitalization has drastically changed the way humans live and has affected every aspect of our life, our work, the way we travel and do business. Digitalization and AI is influencing almost every aspect of business as we transition to a smarter and more connected world.

Profound changes through digitalization in aviation present both opportunities for growth, cost reduction and greater productivity and at the same time difficulties since the industry needs to adapt quickly to these rapid and complex changes.

There are huge implications for the operating model of organizations working in aviation, with massive impact as consumer behaviours evolve to include digital and physical interactions and engage in greater sharing of personal data.

It is crucial that the aviation industry proactively embraces digitalization and AI in a way that ensures continued safety, security and sustainability with the right digital strategy.

1. **What changes are needed to ensure that aviation proactively embraces digitalization and AI in a way that ensures continued safety, security and sustainability? Are current arrangements with ICAO (regulations, standards, etc) adequate or is there a need for more explicit leadership in aviation and, if so, by whom?**

Digital disruption can drive change in the aviation industry overnight. Our companies must make digital investments wisely and cautiously build long term digital strategies.

Digitalization and advances in AI are reshaping the future of the aviation industry, developing new business models, innovative technologies, processes and practices for better customer experience, revenue management, predictive maintenance and flight scheduling.

Currently, there is no one definition for artificial intelligence. In the context of this paper, AI will be referred to as the wider variety of functionalities and technologies which help machines to simply and efficiently perform tasks. Depending on the level of autonomy of AI, this technology can generate data from different systems to enable them to respond proactively to their environment.

AI and digitalization should be regarded as a prerequisite to solving the problems posed by the increasingly growing demand for air travel, and the need to meet evolving consumer expectation. Many aspects of the airline industry will benefit from AI and digital technologies to realise greater efficiency. The desirable goal will be to simplify tasks, improve efficiency, develop new services and opportunity's and manage this transition without increasing resources

AI maintenance, if implemented properly, can result in cost savings and assist in the prediction of failures before they occur. Flight maintenance is another aspect to consider for safety and economic reasons, as unplanned aircraft maintenance is a direct cause for delays or cancelation.

AI can help airlines achieve greater profitability with their **ticketing systems**, calculating the most efficient prices for each flight and provide competitive pricing for customers.

Airlines continue to seek ways to offer better customer experience. Digitalization and AI open up opportunities to adopt new technologies in **passenger identification**, **self-service bag drop machines**, automated **customer service**, and simplified communication between a pilot and air traffic controller.

Changes are needed to realise these opportunities. Concrete actions are coming out from industry, regulators and policy makers. adapting legacy systems into agile and interoperable platforms. The current arrangements with International Civil Aviation Organization (ICAO) are an important initiative, but it takes around two years for an initial proposal for a new or improved Standard, Recommended Practice or procedure to be formally adopted or approved. With a growing demand for travel and the rise of the digital consumer, successful digital transformation requires strong leadership, investments from organisations, evolution of corporate culture and positive communication towards adoption and acceptance.

A key challenge remains the issue of privacy and the goal of working with the data of our customers in a way that is secure and respectful. Data is the essence that drives Digitalization and AI, and the trust of the consumer to provide their data is a critical element in any system. Multi-stakeholder approaches among private, public and civil society organizations to define regulatory frameworks for appropriate uses of data are therefore important.

2. What policies and regulations need to be instituted, altered or removed to ensure successful implementation of digitalization and AI in aviation? Is a performance-based approach to human involvement and to regulation sufficient or is there a need to be more prescriptive on when human involvement and management is essential?

AI drives efficiency improvements either by disrupting how certain tasks are performed or by doing it faster than pervious methods, resulting in lower resource required and increased efficiency.

AI and digitalization are great opportunities for the aviation sector to realise advances in increased safety, efficiency and capacity. 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 to benefit from these technologies, ICAO, States and Industry must work together to update existing and create new standards where necessary. Data sharing between all stakeholders in a trusted environment will be essential to the success of AI and should be supported by the development of open standards and a secure environment.

Nonetheless, additional regulations in this sector should be limited. Efforts should be rather centred on data sharing initiatives to allow efficiency gains in the industry. Trust is a key enabler for data sharing between stakeholders across borders. A flexible and scalable framework that ensures intellectual property and cybersecurity will need to be developed to prevent any potential obstacle in the flow of data.

Although innovation now plays a substantial role in discussions at the international level via ICAO, the latter will have to find a regulatory framework that can support innovation while regulating new entrants. A framework that enables this regulatory balance has already been initiated in the field of digitalization and aviation safety. The ICAO Global Aviation Security Plan (GASP) has outlined key priority areas to facilitate digitalization, such as flight tracking and unmanned aircraft systems.

3. Digitalization and AI will reduce the cognitive load on humans but will also have a significant impact on the need for human time and resources. How can aviation best anticipate and manage that impact? What changes are needed to recruitment, management, retention and retraining practices to ensure adequate and appropriate human resources that thrive in the aviation workplace?

By 2037, the air transport industry is forecasted to carry 8.2 billion passengers[1] (IATA, October 2018). To meet this growing demand for air travel, it is estimated that 94% of commercial aircraft will need to be equipped with advanced digital technologies. This digital revolution implies increased efforts in terms of R&D and innovation.

It's a new world that needs to meet the global demand for qualified and competent aviation personnel. In order to fly and maintain fleets, the airline industry will need to hire 804,000 pilots over the next twenty years, as well as 914,000 cabin crew and 769,000 new maintenance technicians (Boeing, 2019)[2]. However, by simplifying tasks through AI, labour resources can be reduced as well as associated costs, such as crew wages and pensions.

However, the development of unmanned drones and UAVs may represent an opportunity to alleviate the strain from the global shortage of pilots. Moreover, this solution could save associated costs, such as crew wages and accommodation costs.

This progress is also challenging businesses in fundamental ways. The workforce of the future will require a new set of skills and knowledge. Skills mismatch on a global scale will impact millions of jobs. People need to better understand technology, upskill, understand and manage artificial intelligence and merging autonomous vehicles that will be created in the digital age. Digitalization and AI will reduce the cognitive load on humans but will require learning how to think, act and thrive in a digital world.

Digitalization and AI will deeply impact the competencies, set of skills and the abilities needed for future operations and performance by aviation professionals. The best way to approach this trend is to anticipate the required actions for transitioning to new ways of working and thriving in a digital aviation workplace. These changes are going to be needed in recruitment, management, retention and retraining practices.

Beyond recruiting technology driven professionals, the aviation industry will have to reinvent its entire work organization/strategy to better incorporate AI technologies. In this context, employees will have to constantly improve their analytical skills.

A new division of work will have to be developed in order to optimally and ethically allocate tasks between technologies and human resources. The current organizational structure may be increased by communities of interest. Workers will need to develop both AI operational skills and interpersonal skills.

At the industry level, the acceleration of data usage will imply that the decision making-process will have to be accelerated. To support this technological transition, all levels of decision-making in the industry will have to accept the role of AI while giving some meaning to activities that will be renewed at the rate of tool updates.

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[1] IATA, "IATA Forecast Predicts 8.2 billion Air Travelers in 2037", 24 October 2018.

Ignorance of AI or of their evolution will limit business strategies in the industry. People need to be open to learn new skills as automation will significantly change or make their jobs obsolete. Companies need to approach training of employees as an investment strategy.

In the medium term, soft skills rather than technical skills will become critical to the industry. Team management, creativity and emotional intelligence will be the most desired qualities for aviation professionals in the next ten years.

At the political level, new functions and services induced by AI technologies combined to digitalization waves will only be possible if collaboration is fostered between industries and ICAO States. This cooperative effort will permit us to establish the adequate frameworks for operations, data sharing, training, certifications and qualifications.

Similarly to the ICAO TRAINAIR Plus programme, regional and international regulatory aviation agencies will be pressured to create some data-driven programmes to enhance the knowledge of aviation professionals in the field.

This is a very important step, since several reports forecast the transport sector to lag behind many other sectors in terms of adoption and exploitation of AI technologies.

In conclusion, digitalization and AI will undoubtedly have a significant impact on the entire aviation value chain over the next 10 years. How governments, organizations, businesses and individuals involved in the sector adapt to these changes will dictate their success or lack thereof. What is certain is that this profound change will reach into every aspect of how the airline industry operates, how travellers interact with the industry and how the industry is governed. This will require diligence, a willingness to adapt established processes to take advantage of more efficient possibilities and ensure that the workforce we depend upon today is trained in the requisite skills to overcome the challenges of tomorrow.

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R20-PP/03
29/01/2020

HERMES
AIR TRANSPORT ORGANISATION

POSITION PAPER

Digitalization, AI in Aviation and the Human Factor

Presented by AACO

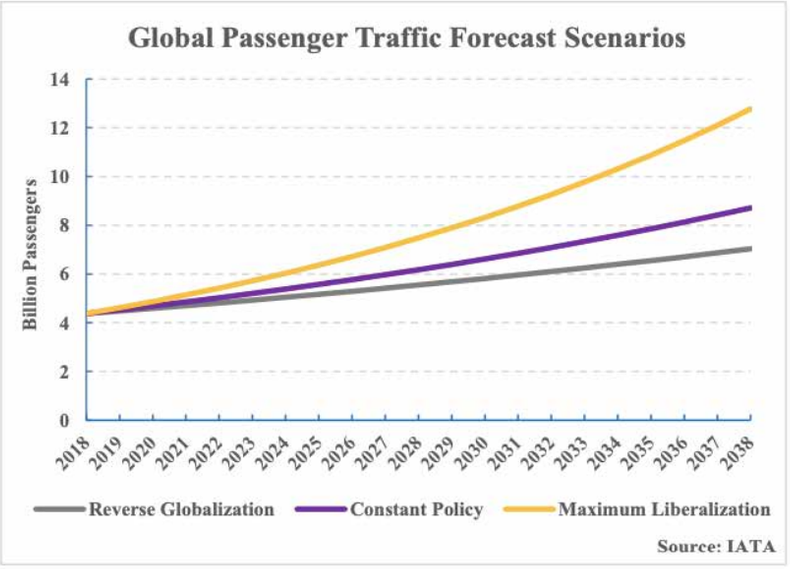
HERMES AIR TRANSPORT ORGANISATION

POSITION PAPER

R20-PP/03
29/01/2020

1. Introduction

In spite of the global challenges, demand for air travel is growing at a steady pace. According to the latest IATA 20-year forecast, the total number of passengers could double by 2038, reaching around 8.7 billion passengers (at constant policy scenario*), which could support 100 million jobs globally.



Travel demand is increasing amid the rise of the middle class in emerging and developing economies and the increase in their disposable income, a growing number of millennials willing to travel, and the decrease in airline fares over growing competition.

In order to cope with the growing number of passengers, operational complexities, and advanced fleet, airlines started adopting new technologies to ensure efficient and effective performance. One of those technologies is artificial intelligence (AI), which can be defined as giving computer machines the ability to think, learn, and recommend decisions.

Today, an enormous amount of data is generated by aircraft systems, ATCs, airport operation systems, and other stakeholders. These data sets represent new opportunities that may bring added value to the whole aviation ecosystem. AI technologies are key enablers for developing new services and practices to enhance customers' experiences, safety, security, and environmental efficiency. However, in order to achieve those targets, industry stakeholders must collaborate to set up the necessary framework in terms of training, certification, operational interoperability, and data exchange.

***Constant policy scenario: forecast based on the current trends in the market (economic and trade sensitivities, geopolitical tensions, and unchanged liberalization policies).**

2. Discussion

2.1.How Can Aviation Proactively Embrace AI

As technologies continue to advance, Artificial Intelligence (AI) will play more prominent roles in our future. At present, many industries have already started incorporating AI technology in their operations. The availability of meaningful data is critical to support the implementation of AI. Therefore, in order to facilitate the use of AI in the aviation industry, data sharing is needed between industry stakeholders. Moreover, regulations and standards defining how the data is processed, by whom, and how data security is ensured need to be set by the concerned governing bodies. On the technical side, changes must be made on the legacy infrastructure level. Implementing AI

technology while overcoming legacy systems requires an established plan that needs to be set by all concerned stakeholders for what can be achieved with pre-existing systems.

There are many challenges to overcome in implementing AI. Accordingly, the shift from current procedures and systems should be done gradually. It is recommended that concerned stakeholders conduct an impact assessment after each implementation phase to assess the results and take necessary actions, as we still do not quite fully understand what AI is capable of and how it will impact the aviation industry.

2.2.Impact on Existing Regulations

The use of AI in the aviation industry would require certification and qualification by regulating bodies. National authorities and governing bodies should ensure that the use of AI is safe and secure, considering the operational complexity of the aviation industry. In terms of data security, adequate cybersecurity measures should be implemented that such sensitive data is not leaked, which may cause operational disruptions.

Also, operating procedures and other related standards might require revision upon the use of AI. As AI continues to be adopted by industry stakeholders, the interaction between humans and machines is progressing, making systems able to recommend appropriate decisions during complex situations. Accordingly, the enhanced capabilities of AI should be recognized in standard and recommended practices issued by the aviation regulating bodies, which include ICAO, IATA, and National Authorities. This will allow industry stakeholders to fully utilize AI systems in various fields, including safety, security, and operations.

2.3. Impact on the Aviation Current Workforce

Automation is expected to disrupt the aviation's workforce current scheme. Several projects have been tested by different stakeholders moving from the autonomous aircraft concept, 3-D printing for aircraft parts, drone technology in aircraft inspection, and Augmented Reality devices in maintenance. Accordingly, it is expected that automated technologies will partly or entirely replace some repetitive jobs. However, such technologies will not replace critical positions involving immediate decision making that requires human logic, experience, and common sense.

Therefore, the trend of the Next-generation workforce requires human and machine interaction. The flight crew will be assisted by smarter avionics and will focus more on flying rather than aircraft systems. Similarly, advanced air traffic control systems may fill in gaps in the current scheme. Looking at the National level, AI may assist states in the certification and oversight practices through the effective use of the available data.

Considering the upcoming leap in the use of technology, the New-generation workforce, including flight crew, engineers, technicians, air traffic controllers, and inspectors need to possess an updated skill set. Accordingly, concerned stakeholders are recommended to identify the necessary training required to ensure that the current workforce is equipped with an adequate skill set to cope with technological improvements.

3. Conclusion

There is no doubt that the use of Artificial Intelligence in the Aviation Industry can make tasks and operations easier, faster, and more efficient. However, unlike other industries, the aviation industry remains the one with the greatest risk as the real-life harms are exponentially higher. Therefore, the adoption of AI should be thoroughly studied, well calculated, and gradually implemented. That being said, the industry needs to evaluate every level of implementation further, assess the results, and take necessary actions to ensure the required benefits are achieved.

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POSITION PAPER

Digitalization, AI in Aviation and the Human Factor

Presented by I FATSEA

HERMES
AIR TRANSPORT ORGANISATION

POSITION PAPER

R20-PP/04
31/01/2020

31/01/2020

To: Hermes - Air Transport Organization

Subject: **Position paper by IFATSEA for Hermes - Air Transport Organization on Digitalization, AI in Aviation and the Human Factor**.

Introduction

IFATSEA's response to the three questions posed by HERMES within the above subject is listed below.

Q1: What changes are needed to ensure that aviation proactively embraces digitalization and AI in a way that ensures continued safety, security and sustainability? Are current arrangements with ICAO (regulations, standards, etc) and industry associations (industry standards, bench-marking, sharing of best practices, etc) adequate or is there a need for more explicit leadership in aviation and, if so, by whom?

Q1:(keywords: changes, proactively embrace digitalization and AI , current regulations/standards and explicit leadership)

The forthcoming implementation of Digitalization in aviation and especially in the domain of ATM/ANS, has not been clearly defined yet as a concept, nor it has reached maturity in terms what it really is, so it is difficult to answer. A quick reply would be closer to speculation rather than sound judgement on solid technical and operational grounds. Moreover, the areas to be impacted within ATM/ANS have not been identified yet.

A clear and unambiguous definition of the term ''digitalization'' that is commonly adopted by all stakeholders in aviation as *a concept of the way of operating , is missing.*
Nowadays various things are met with the term digitalization, like, Surveillance data processing (includes ADS-B and MLAT), Medium-Term Conflict Detection (MTCD), 4D Profiles for separation and MTCD, Electronic flight strips, Auxiliary Aeronautical Information Display (including weather information) etc.

All the above are based on modernization of CNS/ATM infrastructure but what else could embrace the term ''digitalization'' in full breadth of the ATM industry, is not yet clear.

What about the digitalization of AIS service? To which extent that digitalization will be extended? What about the METEO data and in particular those that will be directly uploaded to aircraft? etc. However, some indications have risen through the work in the SESAR exploratory research and even through dedicated industrial applications.

On this basis and taking into consideration the ATS, CNS, AIS, MET constituting the services of ATM/ANS in

Europe, there are two domains which are both of Operational nature. The Technical systems and procedures on the operation of CNS/ATM systems (dealt by ATSEP) and the associated procedures and the operations of ATS (linked to ATCO).

While the discussion on the introduction and implementation of the Automation and AI notions into the safety critical area of Air Navigation Services is ongoing, some CNS services are already provided from space based infrastructure and in some cases combined with terrestrial elements.

While we are moving towards distributed and interoperable ANS systems , we rely on defined interoperability European standards aiming at achievement of interoperability. However, we are overlooking means and tools like System Monitoring and Control (SMC) to assist the ATSEP aiming at ensuring the highest Resilience of ATM/ANS system as a whole that will be able to pace and sustain the ground ATM/ANS community into the Automation and AI era. It is like designing procedures how to fly the space shuttle without ensuring its Technical systems interoperability, CNS systems health monitoring, and control.

In addition, discussions focus only on the Operations side taking for granted that they are based upon robust, stable and resilient electronic infrastructure, that never fails. Evenmore, until recently ,not fully realizing the operational role of Cybersecurity, which inevitably will be another parameter of potential instability within the digitalized environment. It must be noted that IFATSEA has alerted the CNS/ATM community on the cyber risks of the proposed distributed architecture but without managing to be heard as the focus was only on Operations and their cost reduction. Recent failures on current, state of the art, ATM flight data processing or CNS systems (e.g Irish FDP or NATS Voice Communication configuration) rendered large parts of controlled airspace to be highly affected with hundreds of millions of Euros cost.

Moreover, over focusing on reducing the cost of services while asking for more capacity and generally better performance, is the wrong way to go about it. Furthermore, Cybersecurity will probably entail additional cost, due to new systems and procedures involved aiming at protection of the operational CNS/ATM systems. This additional cost was probably not anticipated when designing a distributed system over SWIM. The ICAO Total System approach is not evident in the ongoing discussions while Performance/cost prevail. There have been presentations from ICAO where, CNS on which all services are based upon, is not mentioned at all.

ICAO is the implicit and appropriate leader to drive this out of the box endeavour of the introduction of extent Automation and AI that will bring us into the new Automation and AI era. Including in the loop all stakeholders from the States, the industry and Professional Staff Associations such as IFATSEA , while not overlooking the Academic and research community, will be beneficial for reaching a meaningful approach and road map forward.

*This cooperation and endeavour must come in **two** steps.*

Step 1: *First ICAO collects input on the envisaged Automation and AI introductions in aviation, providing clear definitions and objectives and potentially a road-map of implementation.*

Step 2: The second step is the definition and development of the Concept of Automation and AI in technical systems and operations , not only for operational issues, without disregarding the interoperable technical solutions.

A collective approach of all the above will be actually beneficial for the future ATM/ANS system. It must be noted that after moving aviation into the AI ecosystem there may be a 'no turning back' road after a few years .

A lot of newly appearing questions appearing, due to the new aviation ecosystem based on AI, besides Responsibilities and Liabilities, have also to be addressed. The impact to Procedures e.g incident or accident reconstruction and analysis with ever changing AI self learning algorithms is really a challenge.

IFATSEA believes that only after these two steps described above are taken , we will be able to talk about ICAO NGAP updated training content (delta from today) and development of regulations.
Similarly , current arrangements either in ICAO and world regions will be incomplete since the above building elements, described in Steps 1 & 2, will not be available since it will be difficult to implement them while there will soon be a need to revisit them. We need to know what kind of systems/equipment will eventually be needed, what kind of procedures and then extrapolate the needs on HR.

In summarizing :

1.We have to Think out of the Box as the forthcoming situation has never existed before. The shift of Human tasks to a machine has to be thought of very carefully and be able to safely recover from degraded or failure modes of AUTOMATION. This includes AI applications, at least during the first years of maturity until we come to trust the machine and the process, the process and the machine.
2.Currently the attention only on OPS separately for the ground element with a culmination of focus on the ATS provision disregarding the ultimate consumer/user of the ANS product (being Safety and Efficiency/Performance) with Over-focus on COST reduction, distorts the viewing and decision making angle.
3.New challenges, unique, must be proactively addressed e.g Incident reproduction on ANS/ATM applications based on AI ever-changing algorithms have to be considered from start
4.According to ICAO Chicago convention the responsibility for the provision of ATM/ANS services relies on Member States. In light of adoption of AI, to which extent the States have been involved? And what conclusions (if) has this consultation delivered?
5.New tools to aid ATCO & ATSEP into their areas of expertise are needed for the new environment. Their development must be gradual, with buy-in and learning from other safety critical domains (such as Space or Nuclear domains).
6.There is a clear lack of standards and/or Technical specification for the ground ATM Systems since they exist only for CNS systems (ICAO Annex 10 Vol I-IV)

Cybersecurity: some questions as food for thought

a) *Producing Regulations is desirable but have we understood the problem? Especially in a real time, safety critical environment like the ANS/ATM services provision?*
b) *Are there any tools available for a CNS/ATM digitalized environment to help ATSEP identify (preferably proactively) whether a degradation is due to Cyber attack, technical failure or both? If not, how can we contain and mitigate a cyber-attack during live operations?*
c) *SESAR was and is successful because it incorporates input from airspace and ground users including Professional staff organizations (PSOs) so it has a pretty good idea of the applicability and acceptance of the researched concepts and systems before they become products for deployment. Let's harvest it!*

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Q2: What policies and regulations need to be instituted, altered or removed to ensure successful implementation of digitalization and AI in aviation? Is a performance-based approach to human involvement and to regulation sufficient or is there a need to be more prescriptive on when human involvement and management is essential?

Q2: (Keywords : policies and regulations needed, performance based approach to human involvement)

-New regulations must not be focused only towards Performance-wise on Cost reduction but also on Technical and Operational Resilience of the Total System.

While the complex structure integrating ground, air and space which is extremely demanding, is progressing, equal attention must be exhibited for all areas. For example while intense care is taken for the airborne systems software e.g FMS with extreme care placed in the coding in terms of Software safety assurance, the regulations referred to ground ATM systems globally, do not include Technical Specifications and Software safety assurance requirements for the Ground systems (in Europe regulation EU 482/2008 on software safety assurance has been repealed). Neither, do we have Technical specifications or Minimum Performance Requirements defined for the ground ATM systems yet.

The latter seems to be contradictory as the requirements for increasing performance figures in terms of capacity, safety etc., are sought from ATS without having ensured the optimum performance (in terms of availability, accuracy, response time, continuity of service etc.) of ATM/ANS systems and tools being used. However, having said that, we must not forget the notions like the new proposed End to End assurance approach that the TSG has done on behalf of the European Commission or the older Total System Approach by ICAO .

With regard to the Human factor, for the ground part, we have to focus on ATSEP and ATCOs which are the professionals that will mainly be in charge for ensuring availability and efficient operation of the ATM/ANS system and systems. What has to be understood right from the beginning is that these personnel will continue to do their current routine tasks while the paradigm change of Automation and AI introduction is taking pace. This means that the same people of today, (in many cases aged) will be needed to maintain-operate the existing systems as well as to monitor and through trials to evaluate/validate the new solutions.

Speaking specifically for ATSEP, they will be needed to be retrained to new technologies new notions like understanding AI algorithms behavior (in ATM applications) and their troubleshooting in trying to identify the root cause of a potential unexpected behavior of ATM/ANS applications. Although the new automated systems to be used by ATCO will be needed to continue to deliver ANS while in degraded modes of operation or failures, the identification of strange behavior of AI and their resolution will be a quite demanding and hard task which is obviously directly linked to ***safety of services*** *and* ***resilience*** *of the system. These two parameters Safety of services and system's Resilience are also related to Performance which has to be ensured as well.*

To achieve the aforementioned goals the appropriate training for ATSEP is a basic presupposition. That training must not only be focused on the academic approach of ''principles of operation'' but also on monitoring and addressing proactively an imminent malfunction, the restoration to nominal service, maintenance, predictive monitoring and health management , mitigation of Cyber attacks while maintaining the ANS service to users unaffected and non degraded.

In addition the smooth transition to fall back scenarios in cases of serious malfunctions or cyber-attacks has also to be part of training program. All the above will incur ANSPs with additional cost which seems to be inevitable in light of the new systems and new concepts of operation but they must not be disregarded.

Human resources must be prepared to intervene when automation fails, or when it encounters conditions it hasn't been programmed to deal with.

It must be noted that currently there is no reference on the need to Hire more ATM/ANS personnel (ATCO&ATSEP) at least to cover needs for the interim period before Automation expands in terms of implementation & deployment. Are there any indicators envisaged we have thought for the Human pillar?

Q3: Digitalization and AI will reduce the cognitive load on humans but will also have a significant impact on the need for human time and resources. How can aviation best anticipate and manage that impact? What changes are needed to recruitment, management, retention and retraining practices to ensure adequate and appropriate human resources that thrive in the aviation workplace?

Q3: (keywords: impact of Automation and AI on Human roles, changes are needed to recruitment, management, retention and retraining) .

We have to be extremely cautious when we are going to introduce AI in the domain of Aviation and it will be needed to follow a stepped approach. There is a lot of knowledge and experience to be learned and is much better to acquired them without causing fatal incidents.

Digitalization in ATM/ANS or aviation in total is understood in different ways by different actors. How can we reach a Common understanding when we have such diverse understanding of Digitalization ? When we are referring to the Cognitive load we mostly refer to operators like Pilots or ATCO.

In the case of ATSEP responsible for the safe and efficient operation of the CNS/ATM ground systems is a totally different question. There, the needs which will be a lot more demanding and in a way that has not been studied yet (!). How can the ATSEP of the future achieve a Total (distributed) System Awareness and address its malfunctions or cascade failures?

Especially for ATSEP, there will be a need for a Human machine formalized interface for the interoperable over SWIM systems as well as specialized instances for Automation related degradations which have not been studied in CNS/ATM yet! It is noted that the EGHD body advising the European Commission in Europe has started work on the ATSEP working Position (ATSEP WP) with innovative and useful output.

In Europe there are options like Remote Towers and Virtual ATC centers notions, potentially fed with data from ADSPs (ATM data service providers) that are on the pipeline. However, without having addressed how the full system wide awareness and resilience will be achieved by ATSEP for these Geographically separated system elements. Seen it in a Total system approach this is not recorded yet.

Some questions that naturally arising when defining the problem.

Digitalization in ATM/ANS from the Human side :

d) *What exactly do we mean by Digitalization in ATM/ANS? We must have a common understanding*
e) *Which are the domains? We have to identify the domains that we have an anticipation on the mapping of the impact?An accepted Digitalization Impact assessment?*
f) *Where in the different areas of ATM/ANS do we expect an impact and what should be the global approach?*

The employee profile for the new Automated Aviation environment and especially for ATM/ANS, and especially for ATSEP, will evolve to a more demanding need for scientific background along side the usual technical background ones . Today's ATSEP are working on legacy and up to state of the art CNS/ATM

systems with a large portion of their work on software related work, such as operational systems management configuration and maintenance as well as monitoring and control. During the last 15 years there has been a major shift in the inclusion of computer controlled systems , local and remote operations , while maintaining the older systems like SSR or ILS in operation to be retained at least in the mid term future (10years). So there is an existing software culture in the profession of ATSEP where in the past ATSEPs were doing a lot of replacing of modules in systems.

Nowadays the scope of the work is maintaining the continuity of service, therefore a lot of resilience is needed in the architecture of systems. The main aim is to offer the ATCO continuously the same interrupted image of the Functional system. This requires a lot more programming and a lot more understanding of the architecture of systems. So on the one hand more specialists will be needed and also on the other hand more general / overall knowledge for ATSEPs will be needed.

ATSEP will have an advanced role in the global scene, been among the critical enablers of succeeding the required growth in aviation. Moreover, they will play a vital role in advancing all needed technological steps towards a new era in aviation. An era in which the human pillar will still be in control of all the new beyond state-of-the-art technologies implemented.

ATSEP will have to be retrained in new principles and domains while this must be taken care for newcomers for which new a lot more elevated scientifically qualifications will be needed:

Impact on ATSEP:.

- ✓ ***Disruption** on the ATSEP Entry Qualifications and ongoing training must be thought off very carefully, as they will be required to identify the root causes and restore applications and systems, that will be distributed over different geographical areas implementing Automation and AI. They will need to be retrained to accommodate the new technologies as "Digital transformation" demands a broader skill set…*
- ✓ ***Retention**: ATSEP Licensing introduction will lead to commitment and retention of ATSEP on the Job and justify the investment. We cannot afford to hire, train and then loose technical experts (ATSEP) especially with accumulated experience in CNS/ATM systems that cannot be found in the market.*
- ✓ ***Lack of ATSEP**: ATSEP in the near future are going to be scarce since the other industries are and will be antagonistic and offer better business opportunities at less Responsibility and Safety requirements*
- ✓ *ATSEP **English language proficiency** requirements will constitute an enabling factor for interoperability, mutual understanding and coordination between ATSEP and ATCOs for problem understanding and resolution as by 2030, it is expected that Sensors, Radar Data Processing, ADSPs and Virtual Centers will be geographically separated. This anticipated Fragmentation of services delivery will introduce a strong need for coordination between the providers that does not exist today!*
- ✓ ***Resilience** enabling decision making for ATSEP with special tools for addressing system wide awareness and cybersecurity (with Prediction capability). They can be based on AI for ATM/ANS system failures or degradations due to Cyber or Technical incidents. This has not been addressed yet at ICAO (Again, only recently EGHD in Europe has produced some basic documents e.g on the ATSEP Working Position).*
- ✓ ***Crisis management** over large geographical areas for inter-ANS providers for cases of Cybersecurity or failure of common elements and Cascade failures, will introduce new needs for cross border cooperation on top of those for ATC related activities, involving ATSEP and ATCO. This context has not been addressed or studied yet and will impact their Training.*
- ✓ ***New actors**: UAV induced degradations or interference in Surveillance for example will require special training and tools for ATSEP. Signal in space interference in combination with space navigation interference at a busy airport will be a very realistic scenario for the near future and has also to be dealt with in the ATSEP tasks.*

The ATSEP(-s) will need to have different training and cooperation with entities outside their remit e.g police, Space navigation providers, National Security teams e.t.c. What will be the new procedures?

All the above arguments make it clear that a paradigm shift like the introduction on Digitalization and AI in the aviation can drive towards the identification of a need for a lot more specialized scientific background for technical staff like the ATSEP but also for the other front line operators like Pilots and ATCO.
Regulations must follow after the problem has been understood and defined.Cost will be an issue but the product will be more capacity efficiency and comfort of the passenger with an increase of safety.

Links*:

- ✓ https://www.aviation24.be/air-traffic-control/breaking-air-traffic-stopped-in-ireland-due-to-radar-issue/
- ✓ https://www.irishtimes.com/news/ireland/irish-news/irish-air-traffic-system-failure-caused-by-irregular-software-fault-1.3651638
- ✓ https://www.theguardian.com/uk-news/2014/dec/13/london-airport-chaos-computer-failure-nats-heathrow-gatwick-airspace
- ✓ https://www.caa.co.uk/WorkArea/DownloadAsset.aspx?id=4294974241
- ✓ https://www.nats.aero/wp-content/uploads/2014/08/ATC%20Disruption%207%20Dec%2013%20-%20Report.pdf

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Digitalization, AI in Aviation and the Human Factor

Presented by ACI

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Digitalization, Artificial Intelligence in Aviation and the Human Factor

Nina Brooks, Director, Security, Facilitation and IT, ACI World

The Need for Change

Global passenger traffic reached 8.8 billion in 2018 and is expected to double by 2037[1]. Aviation provides the only rapid worldwide transportation network, which makes it essential for global business and tourism. It plays a vital role in facilitating economic growth, particularly in developing countries.

This anticipated scale of growth necessitates systems and processes that are up to the task of tomorrow's facilitation and security challenges. The challenge for aviation is to manage performance and growth, contain costs, make better use of resources and find efficiencies, all while increasing sustainability, improving passenger experience, and maintaining safety and security.
Airports are complex ecosystems, with multiple stakeholders performing time-critical functions in a highly regulated environment. Responsibilities are shared or split between stakeholders, requiring a high degree of communication and coordination. Airports, therefore, lend themselves perfectly to the digitization of complex processes and the leveraging of technologies such as artificial intelligence to become more flexible, responsive and proactive in managing activities across multiple stakeholders.

Digitization versus Digital Transformation

Airport leaders acknowledge that business success is not just about the deployment of new technologies. Instead, success will come from transforming the business of airports, adapting to customers, staff, community and cultures while leveraging existing and new technologies to meet strategic objectives and goals.[2]

Digitization implies the transformation of an analogue or manual process into an equivalent digital process. Rather than focusing solely on digitization, we should think rather about digital transformation – business transformation in a digital world.

Digital transformation involves both the implementation of new technologies and the integration of existing technologies, processes and services to deliver a better experience to all stakeholders. It embraces the integration of systems and services, including those provided by partners in the airport ecosystem such as airlines, security, border control authorities, concessions and ground handlers.
Digital transformation leverages the use of technologies such as indoor geolocation, identity management, flow management, data mining and the Internet of Things (IoT). It requires making these digital technologies secure in the cyber world to ensure that every system works as intended.
Major business drivers for airports are customer experience, enhanced services, improved collaboration and increased revenue. Furthermore, digital channels and distribution will also create completely new business models such as the commercialization of data.

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[1] *World Airport Traffic Forecasts (WATF) 2019–2040*

[2] https://aci.aero/about-aci/priorities/airport-it/digital-transformation/

Customer Experience

Similar to other industries, airports are experiencing a digital evolution to help maximize business and operational objectives. Today's technologies can allow airports to do something that was unimaginable just a few years ago: deliver personalized and individual services to millions of passengers. Today's digital devices bring this personalized information in real time directly to the customer, such as real time flight information, wayfinding in the airport terminal, levels of road congestion for the journey to the airport, and electronic payment for goods and services.

Artificial intelligence (AI) and the use of algorithms now make it possible to give the right information to every passenger at the right moment, based on location, time before flight, profile and preference.

In addition, over fifty airports and their partners globally are already leveraging biometrics to provide a seamless, document-free passenger journey (in addition to the government authorities already using biometrics for immigration purposes.) As standards emerge and multilateral agreements are made, we expect to see the end-to-end journey revolutionized by touch-free walk through identity checks that enhance both security and customer experience.

Operational Efficiency and the Power of Data

In terms of internal gains, digitization, data and in particular AI, offer opportunities to improve productivity and efficiency. Airports are collecting and monitoring vast amounts of data every hour of every day. Harnessing this data can provide an airport with invaluable data to optimize performance.

Predictive modeling and artificial intelligence will enable swifter real-time decisions using a wider array of data than could be performed by any human. Awareness of the changes to a passenger's journey, the status of aircraft, cargo or baggage will enable the airport to optimize the decision-making across their whole operation, and airlines to coordinate their activities across their entire network:

- Real-time metrics can provide immediate feedback on usage or occupancy of a given passenger touchpoint, to correct inefficiencies as they occur
- Short-term metrics are collected periodically with the aim to track performance over a limited period of the time. This may be for management and executive reporting, or to monitor service level agreements against actual performance
- Long-term metrics are collected periodically with the aim to track long-term performance and trends to identify projected infrastructure development triggers or as a means to assess the impact of systemic changes on operational and financial performance.

Predictive analysis enables the creation of forward-looking information based on historical data. Because it has yet to occur, it is still a projection. However, the availability of historical performance monitoring information combined with parameters specific to the period ahead (e.g., rostering and flight schedules) can provide more reliable and sophisticated predictive analytics.[3]

The output from this analysis can be used to reduce operational costs and increase revenues. Examples include developing models to optimize resourcing allocation, whether at a passenger touchpoint or an aircraft at a gate.

[3] ACI World Passenger Facilitation Performance Metrics Handbook, 2020

Metrics can also be used to optimize area occupancy and measure throughput or processing rates. This data enables business intelligence solutions to optimize future performance and improve terminal design.

The exchange of accurate, real time data between airlines, airports and air navigation service providers offers opportunities to improve performance of the whole aviation ecosystem. Airport collaborative decision making (A-CDM), for example, aims to improve the efficiency and resilience of airport operations by optimising the use of resources and improving the predictability of air traffic. It achieves this by encouraging the stakeholders to work more transparently and collaboratively, exchanging relevant accurate and timely information.
In order to achieve this level of collaboration, a common vocabulary for data exchange is needed. ACI's ACRIS data model aims to provide exactly that – through ACRIS, all stakeholders can exchange data with the confidence that they are speaking the same language. This also enables standard APIs (application programming interfaces) to be provided by airports who wish to provide their data to third parties.[4]

Safety

Over and above the improvement of the passenger journey, automation brings the opportunity to improve operational safety. The deployment of autonomous or semi-autonomous equipment and systems has the potential to save millions of dollars that are lost by damage done to aircraft and other assets on the airside. Modifications to the ground service equipment (GSE) is being explored by many manufacturers, airports and airlines.

Working with airline partners, airports are looking at how to make the aircraft gates safer by scanning the aircraft environment with cameras using AI and machine learning. This way, it ensures that all the equipment around the aircraft is located at the right place and that the area is clear and exempt of foreign object debris.[5]

Still, challenges need to be overcome around recreating real life conditions. These challenges include the impact of external variables (weather related, lighting and visibility) and the interactions of different AI systems of the various stakeholders involved in the traveller process, such as ground handlers, airlines and airports.

Furthermore, human factors that pose a threat to operational safety can be mitigated by autonomous vehicles. For example, some airports have deployed autonomous snow clearing equipment to ensure fatigue, hypothermia or frostbite do not impact the frequency of required snow control.
Self-driving vehicles and systems must guarantee the safety of human drivers, passengers and pedestrians, however. To ensure safety, numerous sensors will monitor the external environment, geolocation and advanced analytics will predict road conditions.

Security

There are many examples where digital transformation can assist in security activities. Deploying artificial intelligence in combination with video infrastructure can enable enhancements such as

[4] https://aci.aero/about-aci/priorities/airport-it/acris/

[5] ACI World Autonomous Vehicles and Systems at Airports Report, 2019

biometric recognition, unusual behavior detection, unattended-baggage management and monitoring and control of building and fencing access.

Artificial intelligence can also be used for automated threat detection, providing an aid to human image analysis, by enabling x-ray machines to automatically detect potential threats, or clear trays that clearly do not contain potential threats to aviation security.

ACI's Smart Security programme[6] aims to provide airports with options for optimizing the security checkpoint in the short term by leveraging technologies such as advanced cabin baggage screening, while striving for future solutions that offer a truly walkthrough security gateway, where passengers are screened according to risk. This vision relies on a combination of advancements in screening equipment, such as stand-off screening technologies, and fully leveraging data to optimize the screening experience.

Autonomous machines can also offer a useful layer of security to a security programme at an airport, such as automated perimeter monitoring and robotic surveillance.

However, the use of automation introduces an additional security risk, especially concerning cybersecurity. This will be a key consideration as more processes are digitized, IoT technologies are deployed and systems are linked. ACI is working with the International Civil Aviation Organization (ICAO) on an action plan for aviation cybersecurity, as well as providing guidance to airports in best practices, training and a tool to help airports assess their cybersecurity readiness.[7]

Sustainability

Digital transformation is also rapidly becoming an essential component of sustainable practices. A deep understanding and monitoring of passenger flows can help to optimize the capacity of airport infrastructure as well as offering predictive maintenance that will reduce costs and maximize airport-asset utilization. Intelligent building management can also significantly reduce electricity and gas usage.

The deployment of autonomous vehicles will also provide opportunities to reduce the use of traditionally powered vehicles in favour of electric passenger vehicles, baggage and cargo dollies and ground service equipment.

Barriers to Change

The aviation business landscape is changing in all regions of the world and the way airports do business needs to be adapted to accommodate these changes. Solutions are needed for airports both big and small, with different regulatory and operational realities.

To keep up to speed and to capitalize on all the benefits of frontier technology, the aviation industry needs a clear framework with government in which to operate, and regulatory permission to change. Innovation can not thrive in an over-regulated environment. There are many areas where there are significant opportunities within the purview of States and their national authorities to encourage innovation.

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[6] https://aci.aero/about-aci/priorities/security/smart-security/

[7] https://aci.aero/about-aci/priorities/airport-it/cybersecurity/

One key area is enabling faster clearance of the majority of passengers through security, customs and border control, promoting adoption of new technologies and simplifying inspection points throughout the passenger journey.

Examples include:

i. allowing for different, performance-based approaches to border and aviation security to adapt to operational realities, and
ii. promoting adoption of automated and electronic processing for all passengers for security, customs and border control processes.

These can be achieved through innovative approaches to funding, resources and the facilitation of regulatory amendment and encouraging the use of emerging technologies and innovation such as biometric entry and exit clearance, artificial intelligence, digital travel documents, electronic and mobile customs declaration and mobile boarding passes.

Endorsement of greater data sharing between all stakeholders in the aviation ecosystem, including between agencies such as customs and immigration services, law enforcement and security agencies, airports, airlines and service providers, will remove duplication, increase efficiency and strengthen security.

With technology rapidly changing, testing and certification of new equipment need to be accelerated, along with regulatory support for new technology trials.

Capital investment will also, of course be a challenge, with solid business cases developed for the adoption of new technologies. Airports will need to consider future digital infrastructure requirements alongside building design as they prepare for digitalization. This includes secure high-speed networks to support systems such as biometric verification, as well as technology to enable indoor geolocation and support for autonomous electric vehicles.

As more trials and pilots emerge, ACI plans to collect further case studies to be able to share lessons learnt amongst its airport members and start to develop best practices.

Human Factors

When innovative solutions and processes are implemented, it is easy to forget the needs of the user. Bradley Rubenstein, Manager, Industry and Regulatory Relations at the Port Authority of New York and New Jersey, recently cited the perfect example in the non-digital word: the propensity of architects and designers to conceal paper towels in bathrooms. This may be aesthetically pleasing, but is incredibly frustrating to passengers in a hurry. This equally applies to digitization.

Paul Chavez from Arup endorsed this view at a recent ACI facilitation meeting. He says that "Designers must consider that this technology is ultimately at the service of people - attempting to get themselves or their cargo from one place to another. The user's goals and their capabilities should always be at the root of any technology project. This is the practice of User-Centered Design (UCD), the discipline that has evolved from software and product design into systems, services and immersive experience design.

Solutions might range from changes in the physical layout of a space to digital solutions such as mobile apps, biometric sensors or video displays. User-centered designers consider the user's cognitive and physical limitations as well as their mental models (how they believe a system to

work). Any technology that is deployed to help the user achieve their goal is driven by focusing on the user's needs – and not by the feature set of a pre-built product. Through middleware or custom integrations, off-the-shelf technologies can be integrated to reduce complexity and achieve user's goals more simply. When spaces and services are designed with user-centered design methods, people make fewer errors, feel less stress and become more autonomous ultimately benefitting their wellbeing."

The industry also needs to give attention to workforce capacity, both in terms of attracting tomorrow`s workforce as well as the capacity of the current workforce. We must keep track of larger trends in the labour market that have the potential to influence future skills. We will need to forecast how such changes will interact with those in our industry as we fight to get our fair share of talent. This includes how technology is going to change the workforce. A greater number of staff will be needed for more complex, skilled tasks that require a human touch or use of judgement, rather than repetitive tasks that may be easily automated.

Growth will also require recruitment, support and promotion of careers for women in aviation. ACI, along with others in our aviation industry, understand that we cannot ignore half of the world`s population and expect to fill our workforce demand. All businesses will need to start planning for training and retention of staff with these new sets of skills.

Enabling and Encouraging Innovation

Innovation is about the practical implementation of something new to have a meaningful impact. It needs vision, partnership and a clear path to adoption. Embracing the new is important, but not for its own sake. Organisations need to experiment, implement and learn from new technologies but also make sure that they use them to create value.

If implemented correctly, innovation can produce great returns and competitive advantage, but energy also needs to be directed towards integrating technology within the wider organisation and addressing the challenges presented by legacy technologies.

Development and adoption of consumer technology has vastly outpaced corporate technology. Organisations need to understand that mobile technologies are no longer treated as a tool – for many, it's part of the way they operate.

Some of the conditions needed to achieve innovation are better regulation, with an adaptable, flexible framework within which innovation can thrive; partnerships between industry, manufacturers, entrepreneurs and government and providing support and regulatory space to foster pilots and trials.

Time and time again, these key ingredients have proven successful in moving the air transport system forward, proving concepts and technologies that have now become the new normal.

Alignment and cooperation between public and private stakeholders, between States and between agencies within States is a critical factor to realize the benefits of bringing innovation to the heart of aviation.

The Role of Industry Associations

ACI, its members, and airport stakeholders are already leading many initiatives that can address capacity issues, improve customer experience and optimize resources.

In this context, ACI and the International Air Transport Association (IATA) launched in 2017 a joint initiative known as NEXTT - New Experience Travel Technologies - to look at the future of travel, thus creating a common vision that encompasses all individual projects and concepts.

NEXTT provides a vision and, while it will not create a single product to be deployed to the travelling public, it is an initiative that allows the industry to challenge the ways in which it operates and aim for a common goal.[8]

Through NEXTT and with our airport members and World Business Partners, ACI is aiming to foster innovation and bring together a community that can benefit from each other's experiences.

An Imperative for Change

Airports are set to welcome over 20 billion passengers by 2040. This will only be possible if the industry makes the necessary preparations, not just in the long-term, but in the now and in the short-term.

Many airports are facing congestion without having a way to increase capacity. Airport leaders are faced with pressure to manage performance and growth, without constantly adding infrastructure and cost, while striving for environmental sustainability and robust security.

All players in the value chain, in every area of airport operation, will have to become more responsive and efficient. There is no doubt that there are already crowded skies and crowded airports, industry and government need to work together to make sure that we can sustain this growth.

Consumer demands for great experiences enabled by digitalization are forcing businesses in all sectors to re-evaluate their strategies and approach digital transformation in a new way. Aviation is no different.

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[8] www.aci.aero/nextt

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HERMES
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POSITION PAPER

Digitalization, AI in Aviation and the Human Factor

Presented by JAA TO

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POSITION PAPER

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A submission by the Joint Aviation Authorities Training Organisation (JAA TO) upon invitation of Hermes - Air Transport Organisation's call for position papers on Digitalisation, AI in Aviation and the Human Factor.

By Norman MacLeod

Introduction

The Joint Aviation Authorities Training Organisation (JAA TO) is a non-profit organisation and the Associated Body of the European Civil Aviation Conference (ECAC). The JAA TO provides aviation regulatory training in the field of safety and security and helps aviation professionals and organisations to better understand and implement these domains in practice. JAA TO is the only ICAO Regional Training Center of Excellence (RTCE) in Europe and a leading member of the EASA Virtual Academy (EVA).

The JAA TO also delivers specialist training courses to allow organisations to fulfil obligations under aviation safety and security regulations. These are primarily aimed at skilling managers in areas such as audit, inspection, certification and security. More specialized courses cover specialist areas such as cyber-security, carbon emission monitoring and event investigation. Finally, we offer dedicated courses on topics such as Human Factors and Electronic Flight Bags (EFBs).

We would differentiate between 'digitalisation' – understood as the translation of paper systems into digital systems – and 'data-driven management' – the use of all available data to render systems safer, more efficient and secure. The comments below focus primarily on maintenance and flight operations.

Digitalisation

Digitalisation addresses the need to sustain the integrity of the aviation system. A primary goal in this domain would be 'credentialing' – using digital technology to guarantee the traceability and validity of an item. The item might be a spare part or replacement assembly in the maintenance system or it might be a license to operate in a recruitment process – an electronic, transferrable, universal pilot licensing scheme, for example. Blockchain technology is increasingly being used to support product traceability.

A second key area, and possibly more complex to deal with, is the delivery of legal information to the point of service delivery. For example, in flight operations, pilots deliver a performance (operate the aircraft) within a framework of regulation, advice and guidance. Different types of information have different legal weights. Information is drawn from a variety of sources (such as manufacturers, supra-regulators such as EASA (European Aviation Safety Agency), national aviation authorities, air navigation service providers, third party database providers), aggregated into operators control documents (manuals) and distributed to the flight deck through systems such as EFBs and personalised tools (such as tablet devices). A future 'smart' NOTAM system exemplifies this approach. Organisations can develop in-house solutions, commission from a third party and also draw on free-standing applications available in the market (such as weather information services). The development of an operational environment with assured integrity requires an understanding of the complexity of the task and limitations of each part of the system.

Finally, digitalisation offers enormous opportunities to change the way training is delivered. The aviation industry was in the forefront of the use of computers to deliver training, initially to pilots as part of aircraft type training. Using technology to distribute training is now commonplace. Developments in networked virtual reality (VR) devices now allow for collaborative (i.e. teams and crews) training to be remotely delivered. It is not too much of a stretch of the imagination to see that two pilots could complete their periodic 'simulator' training while both sat in their own homes, in different parts of the world, using VR technology. Training can be both on-line and off-line, synchronous and asynchronous. The flexibility this offers, together with the implications for credentialing discussed above, represents a challenge.

Digitalisation builds, in the main, on existing technologies but places a greater emphasis on systems integration.

Data-driven Management

Data-driven management comprises of two distinct application domains: Artificial Intelligence (AI) and Machine Learning (ML). The former integrates input devices (vision systems, audio, text inputting and other sensing systems) with algorithms to allow a machine to take an 'intelligent' action or make a differentiation (e.g. illegal v legal passenger). The latter links data sets and algorithms to make decisions and predictions. Both fields will see rapid growth in the near future.

We will increasingly see AI being used in areas such as autonomous ground maneuvering (all Ramp traffic, aircraft taxiing), cargo handling, data communication between agencies via voice recognition, passenger checking and reconciliation and other security applications. Robots will assist in routine replenishments during aircraft turnaround. We have seen the first trials using AI to control the aircraft take-off and the individual components of reduced-crew and, ultimately, pilotless commercial aircraft will make great use of AI. Such systems will need to be coordinated with data sources discussed under digitalisation. For example, aircraft vision systems will need current navigation data on runway size and shape. NOTAM relating to runway surface conditions will initiate algorithms that could detect debris, FOD, contamination and other performance degrading factors. Aircraft modification state and current maintenance condition (e.g. brake wear) will be factored into the responses available to the autonomous system.

Whereas AI will have a significant impact on the conduct of operations, ML has the potential to make step change improvements in safety and efficiency. Looking to safety first, in an already safe system, the challenge is to prevent any degradation of safety in the face of traffic growth, technological change, societal expectation and adverse effects of climate change. Aircraft and their systems already generate significant amounts of data. Engine health monitoring is already well-developed but the broader use of data for safety monitoring lags. There is a need to shift the focus of flight data monitoring away from threshold excursions and anomalies towards fully exploiting all available data. Smart algorithms exist that can be routinely applied to flight data that can detect trends in normal operations and potential hazardous behaviours. By associating data with leading indicators, trends in pilot proficiency can be fed into training systems to build continuously updating adaptive training regimes. Similarly, given the existential threat posed by climate change, efforts to reduce carbon emissions have now a paramount importance. Aircraft flight data can monitor pilot performance, provide insights into aircraft handling, the adoption of fuel efficiency measures and aspects of aircraft configuration through automation management that reduce fuel efficiency thereby aggravating emissions.

Implementing AI into the aviation system will happen at the level of the aircraft manufacturer, the airport operator and the ANS provider. However, ML applications will more probably be implemented at the level of the individual operator. We can anticipate two core issues that will need to be addressed.

The first is scalability. At the moment, most of the benefits that flow from significant changes to regulation and oversight accrue to major operators. A true systemic approach to safety and efficiency will require ML systems to be available to all operators (although there will be generational issues as older aircraft types will lack adequate data capture provision).

The second core issue is that the current emphasis on de-identification and secrecy in the use of data is probably no longer tenable. The whole industry culture around the use of data for performance monitoring will have to change .

Implications for Regulation and Oversight

The next wave of the 'Digital Revolution' will present considerable challenges for regulators, industry bodies and operators. What should be apparent from the discussion so far is that there will need to be a broader understanding of the technologies, their strengths and limitations.

Industry lead bodies will need to act on behalf of the industry to identify appropriate technologies and advocate for development and adoption. This will probably require greater collaboration between sectors to ensure scalable solutions.

Regulators themselves are under pressure to maintain standards given diminishing resources. Such pressure should lead to an emphasis on developing the most valid and reliable system performance measures. Operators should be allowed to innovate the development of training regimes that exploit technology to deliver more efficient and effective training but tracked through reliable use of data. Regulators have moved away from compliance to performance-based oversight. The next stage is outcome- based regulation.

Conclusion

There are three key areas of flight operations, aircraft maintenance and engineering that will be affected in a significant way by emerging technologies. It is our view that the differences between, and implications of, these technologies require further inquiry and better understanding. Some elements are already well established (e.g. digital charting and EFBs) but future developments will involve more extensive integration of data with radically new modes of presentation (e.g. navigation information viewed via head up displays). Other uses of data and algorithms are still in prototype or yet to be discovered.

Their potential remains to be seen. The implications of such technologies for the selection and training of pilots and engineers, for the oversight of operations and the management processes required (and, thus, skills required of managers) have yet to be considered. The 'human factor' that flows from digitalisation and the application of AI/ML is two-fold; to what extent will these new technologies introduce new modes of failure and what skills are required of future aviation managers to understand, exploit and maintain control of these technologies.

—END—

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31/01/2020

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Digitalization, AI in Aviation and the Human Factor

Presented by ALTA

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ALTA

ALTA's Position Paper on Digitalization, AI in Aviation and the Human Factor

Is Latin American & the Caribbean aviation prepared to implement AI?

Latin American and Caribbean air transport today represents 8% of global passenger traffic with over 316 million passengers, more than 3 million aircraft departures and over 1,900 aircraft in service.

Despite political, economic and social unrest that frequently challenges industry performance, the Latin American and Caribbean region is gaining relevance within the global market and yet has important growth potential with expectations to double passenger traffic within the next 10 years (reaching more than 600 million passengers) and growth rates surpassing global average within the next 20 years according to different projections (5.9% growth in the region vs. 4.6% global average growth).

Those are quiet relevant figures that makes our region an important focal point for global aviation. So, what do we need to do to reach our full potential?

Latin American and Caribbean passenger traffic reached in 2019 its sixteenth consecutive year of growth; however, we still travel very little (0.4 air travels per capita per year) compared to mature markets as Europe (with 1.1 air trips per capita per year) and United States (with 2.2 air trips per capita per year).

Our geography has given us the privilege of beautiful landscapes, wonderful fauna and flora, and a very vast variety of natural and cultural resources. We have a major opportunity to attract more tourists as today just the Eiffel Tower receives more tourist per year than Brazil.

Due to geographical characteristics, our region needs air transport and we have in front of us a spectacular opportunity to develop capillarity to communicate our countries and bring the benefits of aviation to every corner of the region. Infrastructure, competitiveness and connectivity – not only in major cities – are key to achieve it.

Connectivity is crucial to bring the benefits of aviation to more places and more people, generating employment, services, tourism, and business opportunities. For every job created in aviation other additional 4 jobs are created in other industries.

Aviation and tourism are key for the sustainable economic and social development of the region and an increasing joint work between industry and government is vital to take the actions needed for the industry to reach its full potential.

Open skies agreements, passenger fees and taxes reduction, air space redesign, harmonization, fuel cost reductions, and monopolies elimination are some of the good practices that will enhance aviation to grow. But one of the most important ones is to continue making aviation the most efficient and environmentally responsible means of transportation.

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Technology plays here a key role and fortunately aviation is well recognized as an always evolving industry. Innovation is part of its nature, despite of intrinsic and external aspects. However, due to the financial nature of the airline industry - characterized by very low profit margins and major focus on operational and safety issues - airlines in most cases have not had the resources to heavily invest in digital transformation, so its maturity on the industry lags behind other industries such as retail or banking.

Just as an example, the distribution and flight shopping technologies the industry currently relies on, were developed decades ago when the Internet didn't even exist. This causes that in many cases the processes are not flexible nor efficient enough.

In regards of digitalization, other challenge so far has been the traditional education systems and even the traditional mindset within industry companies, where yet conventional skills are requested over new digital and technological skills. We need our universities to be ready to prepare the new workforce the industry needs.

In this sense, we need to reinvest in the industry and reinvest in education. Dedicate resources to create a culture of flexibility and adaptability to re-learn, to thing outside the box, to keep innovating. Industry cannot do it alone, need government and education stakeholders joint work.

Why?...

According to a study carried out by Accenture, digitalization has the potential to generate approximately US$1 trillion of value for the industry and wider society over the next decade.

The possibility to increase efficiency, generate savings and reduce risk can largely benefit the industry and furthermore enable more people to make use of air transport. The airline industry is well-known for transferring its efficiencies to the air transport user and this has allowed that, in real terms, the rates have decreased by 16% since 2011.

According to Oliver Wyman consulting firm, advance analytics can generate between 2% and 2.5% of savings in airlines global operating costs (between US$ 5 billion and US$ 6 billion annually). This represents an important cost reduction that would benefit the entire ecosystem.

Technology has been and is key to make it more affordable for more people to make use of air transport, which is so necessary in the region as previously saw.

From a technical point of view, digitalization can help the industry make a smarter use of assets, anticipate the needs of the equipment and operating conditions, optimize efficiency of all processes, develop a better understanding of the business, routes, costs and opportunities of improvement, and even increase safety with more efficient surveillance and real-time communication systems.

Digitalization has demonstrated it can help improve airport security, make control processes more agile, helping operations go out on time and decongest air and ground infrastructure already collapsed in the main markets of Latin America and the Caribbean.

From a commercial point of view, digitalization can help better understand travelers needs and improve passenger experience, from the desire to travel and throughout the entire journey.

We have seen lots of improvements in AI with more intelligent machines capable of processing impressively large amounts of data.

According to Oliver Wyman consulting firm, by 2026, the global fleet will annually generate 98 exabytes (or 98 billion gigabytes) of data; and the newest generation of aircraft will generate between 5 and 8 terabytes per flight (up to 80 times what older planes generate today).

AI systems can reliably process all this data generated by millions of people on thousands of flights and operations in hundreds of countries, all in real time, which wouldn't be possible to manage by humans. This data translates into better business decisions and into better experiences for passengers.

AI is already a reality in some ALTA airlines as they are using this technology to improve customer service. GOL, for example, with its virtual assistant Gal takes care of customer needs in real time, no matter the day or hour. Other airlines have opted for more interactive and intuitive apps, self-service kiosks at airport with facial recognition capabilities and programs to anticipate customer preferences, to name a few.

Maintenance, materials and repairs currently represent 6% of Latin American and Caribbean carriers total operating costs. Digitalizing MRO can effectively reduce maintenance costs, delays and aircraft downtime. Several ALTA Affiliate Members are offering these solutions, and we consider key to continue bringing this topic to meetings to better understand how airline, suppliers and regulators can define the best way to take advantage of digital systems.

According to Infosys, digital services and consulting company, IIoT (Industrial Internet of Things) systems can help to make procurement more accurate and automated by helping take better decisions on price, quality and time; can help deliver between 10% to 30% higher efficiency in inventory management compared to current MRO software tools; and can help predict demand accurately and in advance.

The correct management and analysis of data will inevitably lead to a wider comprehension of the operation, making it possible to opportunely respond to expected and unexpected events. Digitalization furthermore helps all aviation ecosystem to be connected and in constant communication, making the entire value chain safer, more efficient and even more enjoyable.

When adopting AI strategies, companies have to review their corporate culture, have a leadership committed to embrace disruption and budget to develop training to guarantee the correct understanding of new systems.

The implementation of digitalization will require human time and resources. A change of mindset and lot of training is required to have a successful migration to a digital industry. As a result, AI and digital systems will lead to a reduction in process driven, low-skilled physical and administrative jobs (for example check-in staff). However, new types of jobs will emerge empowered by technology to perform more complex tasks. Reviewing corporate culture and developing programs to train employees on new digital skills will be fundamental to prepare the industry's workforce for the changes ahead.

In the first place, embrace a corporate culture that recognizes the value of innovation, education and people. Having a dedicated team to manage transformation is key to review current talent, the talent needed to perform the new tasks and what to do to train, attract and retain those talents.

How?...

In ALTA's perspective, there are 3 enabling factors that can incentive the industry to adopt digital transformation ensuring continued safety, security and sustainability:

Regulation: regulations and regulatory frameworks will have a strong influence on digital transformation and the speed of digitization. Regulations can face major complications for cross-border integration, as in diverse countries they can be very different and may have different interpretations.

Technology and innovation are generally several steps ahead of regulation and policymaking, so institutions and governments need to work faster on new regulations in order to catch up with emerging technologies as they are developed.

Regulatory fragmentation also poses a threat; this is especially true for airlines in the Latin America region where major carriers have a holding structure, having multiple carriers in different states with multi-national operating certificates. The low level of harmonization in terms of regulation among countries in the region can affect the profitability and possible efficiencies of adopting digital technologies.

Investments in infrastructure: digital transformation is complicated and expensive by legacy technology investments and many times airlines need to make two ends meet. One end is the very traditional legacy systems, and the other is the very fast-moving digital technology.

A single digital initiative may sound easy to implement by an airline but doing so involves changes to multiple older legacy systems, with those changes demanding a lot of human and financial resources. Airlines in their vast majority currently rely on old IT infrastructure that makes it difficult to pull out all the data together into an environment that enables them to get all the value possible from it.

Workforce readiness: Digital transformation demands different skills compared to the skills needed for legacy systems. Airlines have to adapt to this transition, with change being led by people within the organization. The main challenge will be training current and new workforce to adapt to a more digitized environment: digital transformation will lead to a reduction in process driven, low-skilled physical and administrative jobs (for example check-in staff). On the other hand, new types of jobs will emerge empowered by technology to perform more complex tasks. Reviewing corporate culture and developing programs to train employees on new digital skills will be very important to prepare the industry's workforce for the changes ahead.

In conclusion, every effort from ICAO on regulations and standards, need to involve a task-force leadership team from governments and the airline industry in order to effectively launch together several custom-made and creative solutions across regions for the 3 enabling factors mentioned above. Solutions should make air transportation safer, more efficient and more accessible, by leading to:

- Support the design of national and subnational digital plans and agendas for the expansion of the digital ecosystem.
- Strengthen institutional development of the digital ecosystem.

- Advocate for the definition of public policies to create conditions for the development of the digital economy such as data protection, privacy etc.
- Review and implement new procedures to drive technological change.
- Reduce barriers related to implementing new technologies.
- Develop a cyber-security legislative framework.
- Establish fast-paced prescription cycles (based on sufficient performance evidence, technology evolution and safety standards) on when and where human involvement and management is essential, according to each phase of technology implementation.
- Create, adapt and promote educational programs based on the prior prescription cycles and technology development.

Aviation is a highly regulated industry; therefore, regulatory entities play a key role towards a successful digital implementation. Furthermore, aviation is a highly specialized industry that requires training and certifications, which make it necessary to have industry organizations, regulators and companies on board and aligned.

Once again joint and aligned work throughout the entire value chain is key. Digital implementation starts by understanding the new market needs and tools available, review corporate structures and dialogue to take the actions needed granting training, safety and correct execution.

This year ALTA will add two focus to its activities: digitalization and environment.

The first one, as just explained will help aviation to reach its full potential to widely benefit the region and its people, have a more connected world with more and better options for all.

The second one is key to ensure the sustainability of air transport. Environmental responsibility is not a trend, but a long-term commitment to make innovation sustainability viable and respectful to our mother earth.

In 2010, the aviation industry set three goals to mitigate the environmental impact of its operations: increase 1.5% per year the efficiency in fuel consumption between 2010 and 2020; achieve carbon neutral growth as of 2020; and reduce by 50% net CO2 emissions by 2050, compared to 2005 levels. These ambitious goals will be achieved through four pillars: technological innovation; operational improvements; infrastructure improvements and economic and market measures.

ALTA member airlines are a global example, since they have achieved an annual fuel efficiency of 3.5% (higher than the goal of 1.5% set in 2010) and have avoided the emission of one million tons of CO2 in the last 7 years, thanks to the fact that they have renewed more than 50% of their fleet over the last decade, thereby reducing 35% the average age of the fleet which is estimated today is 8.5 years on average. Airlines in the region have not only renewed their fleet but have also implemented several operational measures to reduce fuel consumption and therefore emissions, such as single engine taxiing, reduce flap configuration takeoff, reduced APU usage and many others.

In terms of fuel, there is an important potential to reduce emissions up to 80% for the aircraft of the current generation and we hope that soon this type of fuels gets more affordable and accessible. Currently, some concepts of hybrid aircraft and electric battery are being studied. Development of electric aircraft is expected to begin in the mid-2020s with prototypes with a capacity of 15 to 20 passengers and with the aim of climbing to larger capacity aircraft (regional or single aisle) in 2035.

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Aviation is the greater engine for economic and social development and now, with a strengthening on the commitment with the environment, the industry will drive a sustainable growth in Latin American and Caribbean countries. From ALTA, we will continue accompanying and advocating to consolidate the best conditions for air transport to continue growing.

—END—

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Digitalization, AI in Aviation and the Human Factor

Presented by the EUROPEAN COMMISSION

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Introduction

Artificial intelligence (AI) is already starting to transform how the world lives and works, and the pace of AI deployment is currently rapidly accelerating. In a world increasingly driven by big data, and with massive developments in recent years in computing power and advanced algorithm use, AI will play a major role in all industrial sectors, driving competitiveness and productivity, and offering, if correctly deployed, huge economic and societal advantages.

AI in the EU

The European Commission is committed to enable scientific breakthrough, preserve the EU's technological leadership and ensure that new technologies are at the service of Europeans – improving their lives while respecting their rights. Commission President Ursula von der Leyen announced in her Political Guidelines a coordinated European approach on the human and ethical implications of artificial intelligence as well as a reflection on the better use of big data for innovations. Thus, the Commission supports a regulatory and investment approach that promotes the uptake of AI while addressing the risks associated with this new technology.

AI and aviation

As a sector, aviation is well placed to take full advantage of AI, in particular machine learning. Indeed, AI and machine learning are already contributing to a wide spectrum of value opportunities in the aviation industry, from non-safety critical to safety critical applications. AI has huge potential for use in areas where it can reduce human workload or increase human capabilities in complex scenarios. As aviation actors increasingly embark on digital transformation journeys, AI represents a potential breakthrough technology, capable of transforming the aviation industry value chain. In particular, AI will enable better use of aviation data leading to more accurate predictions and more sophisticated tools, increased productivity and enhanced use of scarce resources, helping both tackle capacity and environmental impact, the twin major challenges facing aviation today.

To modernise air transport and deliver a digital European sky as defined in the European ATM Master Plan, the next SESAR research and innovation programme will aim to deliver an AI powered ATM environment, more digital cockpit and ground assistants and exploit IA for better airborne operations.

Key AI challenges for aviation

The European Aviation AI HLG has identified a number of challenges, which need to be addressed if aviation wants to make best use of AI technology:

1. *Lack of a data foundation framework;*

2. *Evolution of the role of humans in AI:* One of the most common misconceptions of AI is that AI, as a new form of intelligence, will ultimately replacing the human, and that this is undesirable in a human-centric and safety-critical business environment.

3. *Certification/approval:* Since there can be nondeterministic aspects to certain adaptive algorithms whilst the learning component of adaptive control is permanent, hence verification, validation and safety demonstration is seen as a key challenge for AI-based safety-critical solutions. Moving forward, safety demonstrations need to include considerations for "learning assurance", and provide confidence that the result of the end-to-end chain of software development is safe. Reproducibility will be a major topic, particularly in the context of incident and accident investigation.

4. *Cyber-resilience:* A key challenge is how best to exploit AI to increase the cyber resilience of aviation systems, as well as how to identify and address the new vulnerabilities of aviation in an AI environment.

5. *Partnerships:* Aviation has for decades formed a highly specialised world attracting highly skilled experts. However, the advent of transformative technologies such as AI poses its own risk in terms of skills: there is a significant risk that AI talents could be attracted to other sectors.

AI and safety

Aviation safety has historically developed primarily on the basis of lessons learned from previous incidents. To date, safety cases and demonstration requirements rely heavily on expert judgement. Digitalisation and AI, however, open up new possibilities for aviation safety, as huge amounts of data can now be processed in order to identify unknown risks, including previously hard-to-analyse data such as informal written reports. So while today we are still struggling to put in place an efficient safety occurrence reporting system across all aviation actors, digital solutions have the potential to process and detect unsafe situations that today could go unreported or unanalysed. In addition, digitalisation enables us to virtually recreate such events, and so improve the definition of preventative actions such as retraining, improved supervision, etc.

In order to provide a relevant database for developing IA in aviation, the European Union Aviation safety agency (EASA) is currently initiating the Data4Safety program, which principal objective is to ensure that all aviation safety, security and environmental components benefit from the digital transformation. This program will seek to gather all the data generated by the aviation system on a daily basis and organise a global partnership with the different actors that will deliver intelligence for aviation safety and environment.

Conclusion and next steps

Artificial intelligence is a strategic technology that offers many benefits for citizens and the economy, provided it is human-centric, ethical and respects fundamental values. Artificial intelligence offers important efficiency and productivity gains that can strengthen the competitiveness and improve the wellbeing of citizens. It can also contribute to finding solutions to some of the most pressing societal challenges, including the fight against climate change, the challenges linked to sustainability and demographic changes, and the protection of our democracies.

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The Commission will put forward a White Paper on Artificial Intelligence to support its development and uptake and ensure full respect of European values and fundamental rights. Making the most of artificial intelligence will help us find new solutions to old problems and reduce the time required to perform a broad range of tasks. However, we need to establish an ecosystem of trust to ensure it develops within clearly defined ethical boundaries.

—END—

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AFRICAN AIRLINES ASSOCIATION ®
ASSOCIATION DES COMPAGNIES AERIENNES AFRICAINES
AFRAA

Introduction

The African continent is a very interesting environment for the development and implementation of industry specific technology, no matter what industry one is interested in. On the one end Africa has been labeled as the least developed continent and the infrastructure and technology across almost every sector lags behind the global trends. And yet, when one considers that Africa leads the world in terms of adoption and utilisation of mobile payment platforms, one then sees a completely different perspective of this vast continent. Telephony and technology have been embraced so much that, in MPesa, Africa has the making of a world beating mobile payment platform.

Africa's technology, and by extension its digitilisation focus is bound to provide the required support structure, indeed the foundation for the infrastructure development for the continent. This attention has led to the increasing policy pronouncements at different tiers of government across the continent.

AFRAA believes that the opportunities for the aviation industry in Africa to be part of the policy development is in line with the requirements for the industry at large. This will enable the entire aviation industry to benefit from the ever developing and dynamic digitalisation platform.
The dichotomy of the African continent is more pronounced with the contradiction in that while telephony penetration is at a very high level, access to the internet per capita is at the lowest level. This is due to the fact that the traditional telephone operators mostly owned and managed by the national governments have not been able to keep abreast with the developments in the ICT sector. That lack of investment in this field led to the burgeoning mobile telephony industry in Africa becoming more than a force to reckon with.

AFRAA therefore encourages its member airlines to embrace the use of Artificial Intelligence as part of their digitalisation strategies in order for the airlines to keep up with the demands of their customers. In reality, digitalization has become inseparable from the Sustainable Development Goals of the United Nations in that for nations to be able to provide the basic human rights they need to develop at the required pace and levels in digitalization.

According to Ann Therese Ndong-Jatta, the Director of the UNESCO Regional Office for Eastern Africa, "More Africans need digital skills to enable them to use Artificial Intelligence. To really benefit, Africa cannot only be user of Artificial Intelligence created elsewhere, but must be a producer of Artificial Intelligence created locally. They need the skills and capabilities within Africa to do this themselves"

Sustainable growth

The aviation industry has been at the forefront of innovation and technology and this continues to be one of the hallmarks of the industry. In Africa there is a need to ensure that the industry keeps

pace with the developments worldwide and remains focused on the sustainability of the environment. Cost is a major factor and must be factored in all the decisions made with respect to the growth of the industry. The digital landscape offers the opportunity for the industry to adopt policies that are geared towards maintaining sustainability. This implies that the human capital development aspects must be at the forefront in order to ensure that there is a correlation between the growth in the industry and the development in the human capital. The sustainability will be ensured by strict adherence to the United Nations sustainable development goals, particularly the following:

Goal 4 – Quality education
Goal 8 – Decent work and economic growth Goal 9 – Industry, Innovation and Infrastructure

These goals are interdependent to the extent that any action or inaction on the one has a direct impact on the other goals. As an airline association, AFRAA chooses to focus on these three goals which can be referred to as fundamental to the growth and development of the aviation industry in Africa.

Digital innovation

There has been a sustained focus on innovation as a prerequisite for organization and communities to grow, and this has been accepted as a must in most environments. In the aviation industry in Africa, there is a noticeable need for the focus to go beyond mere innovation and to become specific to digital innovation. The digital space is where AFRAA believes its member airlines will be able to establish themselves a sustainable competitive advantage. The fact that Africa is not far behind the rest of the world makes it affordable for the airlines to adopt the digital evolution and embrace the 4^{th} Industrial Revolution for its own benefit at affordable costs. The biggest advantage being that with the leading role being played by AFRAA where it seeks cooperation and collaboration with other organisations, the learning and adoption costs are minimized and the implementation time-frames are substantially shortened.

The main areas of need for African digitalization are driven by the understanding that the automation of processes and business models requires investment in the appropriate technology and access to information in order to enable appropriately trained people at all levels of the business. In view of the requirements for digitalization, it goes without saying that the transformation of organisations to achieve any level of digitalization is a transformation that requires investment in time, people and financial resources. This transformation requires courage on the part of the investors, the management of the company, the people in the company and the end users or customers of the business. Not only is there a requirement for investment, but there is a real danger that the business can end up losing its customers due to dysfunctional processes and disgruntled employees.

It is therefore important that a systematic process is established and adhered to for the successful implementation of digitalization in airlines.

Cost and Complexity challenges

Airlines do not have to contend with the potential challenges of dysfunctional systems and processes, given the fact that an airline seat is inarguably one of the most perishable commodities which renders airlines susceptible to the slightest shifts in market demand.

AFRAA believes that airlines can start by ensuring that their organizational objectives of digitalization are based on specific outcomes so that their investments are channeled to the appropriate desired outcomes. This begins with the airlines modernising their existing products and services using digital processes. This would entail revision and re-alignment of corporate strategies to ensure that the resources are channeled to the specific areas of the business processes that need to be transformed. Quite a number of airline functions already incorporate digital functions even if it is at different levels, and these functions include flight operations, aircraft maintenance, flight planning, scheduling, revenue management and pricing to name a few. Airlines are served by a plethora of service providers most of whom are very advanced in their digitalization strategies. This makes for a compelling case for airlines to enter into strategic relationships with these service providers who will be able to customize solutions for airlines. Airlines should be able to secure professional assistance and collaboration from these innovative and creative partners so that they can actualise their digital transformation aspirations cost effectively.

Dynamics of uncertainty

The much spoken about concept of disruption is very much a reality in the aviation industry and it continues to be a major cause of uncertainty for many airlines. Technology and digitalization are at the forefront of disruption in the aviation industry because they provide uncertainty on the one end and yet they provide opportunities on the other end. It is therefore very important that the airlines in Africa embrace these disruptions and make it a mission critical requirement to know and understand the extent of the opportunities and benefits of technology at their disposal. This knowledge will enable the airlines to make informed decisions on the investments required in order for them to leverage on the technology and digitalization. Equally important is for the airlines to have a very good understanding of the possible impact of the digitalization and technology that they seek to bring into their business. This approach enables the airlines to manage the uncertainty of digitalization by being able to craft appropriate communication strategies for their various audiences at appropriate times and to utilize the most effective channels of communication.

Impact of digitalization – main areas

Airlines are subjected to the impact of digitalization in every area of their businesses due to the multiplicity of technologies being used and being developed. It is correct to say that there is a pipe of continuous production and roll out of technologies. Every business activity of an airline continues to be under threat of evolving technologies, be it Human Resources, ICT, Procurement, flight operations, MRO, Sales and Marketing, Finance, and Customer Experience are already being managed in a digitalization process in one way or the other.

i) Customer Experience:

Robotics is the tool that readily lends itself to be deployed mostly in the customer facing environments because of the ease of integration and non-intrusive nature of the interactions with customers. It is important to emphasise that the legal aspects have been taken care of very quickly with the implementation of legislation such as the General Data Protection Regulation (GDPR) in Europe. Where customer information or data is stored, the customer's consent has to be obtained if the business intends to use the said information. Artificial Intelligence applications have multiplied over a very short period of time to the extent that few interactions between an airline and its customer are not effected through Artificial Intelligence.

ii) Flight Performance

Airlines have been investigating the opportunities for applying technology with the objective of efficiently and effectively performing their operations. Digitalization has enabled the implementation of processes that have taken out substantial costs from airlines without compromising the safety of their operations. Digitalization is gaining importance by enabling the airlines to implement and monitor effective cost containment initiatives in their businesses. At the same time the airlines have been able to reduce their impact on the environment by virtue of the technology enabled planning and operations efficiencies. The sustainable environment has meant reduced costs for the airlines, resulting in a win-win situation.

iii) Maintenance, Repair & Overhaul

This area of the airline business has witnessed the bulk of the silent revolution of digitalization in that the amount of new technology rolled out has been phenomenal and yet has almost gone unnoticed. Artificial Intelligence applications enable airlines through predictive maintenance schedules as well as real time aircraft operation observation to schedule their maintenance schedules appropriately. This enables the airlines to minimize the downtime and schedule interruptions are minimized. The AFRAA team supports the adoption of these technologies and encourages the digitalization of the MRO through knowledge sharing.

iv) Sales, Marketing, Pricing

Airlines in Africa face a daunting task of fighting for a fair share of the market and the Sales environment is considered the make and break arena. Artificial Intelligence and digitalization are enabling the early adopters to plan their strategies and implement their tactics as efficiently and effectively as possible. Digitalization has enabled airlines on the continent to embrace the concept of ancillary revenue generation and subsidiary gateways. New payment platforms have been incorporated into the airline offering for the benefit of customers who are now able to effect payment from their handheld mobile devices as well as in retail outlets in shopping malls. By far the biggest positive development has been the mobile money payment platform which enables customers to perform various functions on their mobile phones as they interact with the airlines.

Challenges

In as much as there is optimism and confidence in the digitalization of business processes amongst African airlines, there is the reality of challenges that need to be addressed effectively in order for the gains of digitalization to be maintained.

Costs

First and foremost are the crippling costs of financing operations. It is not a secret that most African airlines are struggling financially due to various reasons. The cost of operations is very high on the continent and fuel alone contributes up to 35% of these costs. AFRAA is tirelessly working in conjunction with other stakeholders to address the fuel costs. AFRAA's fuel project contributes a significant amount of bottom line savings to the AFRAA member airlines that participate in the project. Digitalisatiion in the operations environment complements these efforts and AFRAA encourages its member airlines to evaluate the available technologies and deploy the suitable ones for their own benefit.

AFRAA encourages its members to embrace the concept of digitalization even as the costs in Africa are still much higher than those applicable in other areas of the world. The initial costs of digitalization should be considered as a necessary investment because at the end of the day the improvement in the overall business performance will be amortized in due course. The approach taken by most airlines of going it alone can be quite prohibitive given that they are cash strapped at most times, hence the encouragement from various AFRAA initiatives where collaboration and cooperation are required so as to bring the costs down to manageable levels.

Infrastructure

Technology is readily available due to the number of vendors that have successfully established their operations on the continent. However, the not so up to date infrastructure poses a major concern to the airlines and results in delayed deployment of the technology. Digitalisation efforts are held back until such time as adequate and appropriate infrastructure is in place. This delay in the implementation of the much needed digitalization across the entire aviation landscape leads to the unavailability of technology that would in effect make the operations of airlines minimally optimal at the best and unprofitable at the worst. It is important to reiterate that digitalization is in most cases inseparable from technology, the bedrock on which most of the digitalization processes are based.

Operations and Customer Experience

Digitalisation brings with it an exciting array of opportunities for airlines to meet and exceed the expectations of their customers. Airlines and airports are already embracing Radio Frequency Identification (RFID) for baggage handling in order to enhance the baggage delivery for their customers. The airlines are demanding more technology based navigation services through integrated product innovation amongst the original equipment manufacturers, airlines, and airspace management authorities so as to achieve the desired cost and operational efficiencies. Energy costs are a major focus area for airlines and performance based navigation enabled by digitalization is gaining momentum.

The aircraft manufacturers are embracing the feedback and requirements provided by the airlines resulting in increased use of flight data management and analysis to enhance safety and operational efficiency.

Human element

People are a critical success factor of the digitalization journey and this is more so because of the disruption that is required to happen internally first. There is no doubting that in fact there is an expectation that digitalization and transformation must happen simultaneously. The technology goes through stringent phases from formulation to roll out and in that respect there is not much concern. The people are the biggest aspect of the digitalization process and the people make or break the initiative. The airline business is vulnerable at most times due to the various challenges and competition faced by the airlines. To add the chances of the people in the business posing a threat raises the stakes very high to the extent that it becomes the top priority of any digitalization process. It is therefore imperative that training and development of the people in the airline industry takes center stage and is initiated ahead of any other process. This will enable the airlines through their people to deliver through the deployment of technology and digitalization to meet and hopefully to exceed the expectations of their customers. It is the human capital and the change through digitalization that make for a successful digitalization initiative.

Process

It is important that the airline business starts to comprehensively address the need for digitalization and budget for the entire process. The business must ensure that there is clear communication across the business informing the team members of the commitment made by the business to go ahead with the digitalization initiative. The budget for the digitalization must be cast in stone and used exclusively for this initiative This will enable all parts of the business to start the process by either learning the new processes and implementing the required technology driven processes. The parts of the business that are already at an advanced stage of digitalization must be encouraged to complete their processes as quickly as possible and then they must be motivated through other means to assist other parts of the business that might be lagging behind. There is no one proven way of digitalization because airlines differ from one to the other. As such it is recommended that benchmarking becomes department based and should not be forced on any unit simply to conform to the stipulated time frames. Small projects with minimal impact in the event that things do not work out as planned are recommended as a safe way to start the process.

Data and digitalization

It is almost inconceivable that a digitalization initiative can be implemented without putting in place a solid big data management policy in place. The insights drawn from the data are critical for the success of the digitalization effort so much that every effort must be made to ensure that the data is managed efficiently. As the digitalization process picks up pace there is a need to ensure that the data collected and analysed provides the answers and or solutions required for the business. The answers could lead to decisions regarding the acquisition of new technologies at a significant investment. The new technology will create impetus for the people and the organization as a whole will need to embrace the changes.

Conclusion

There is no doubt that digitalization has been embraced by the majority of African airlines and AFRAA urges its members to continue with their strategies of finding efficient and effective ways of managing their businesses. The airline business environment demands agility on the part of every operator for them to remain competitive. That is why the way of doing business requires companies to reduce physical assets which cost money in maintenance. Instead the businesses are focusing on data acquisition and mining for effective decision making. This approach is gaining momentum in Africa and the results are very encouraging. The airlines that have embraced digitalization are making headway and improving their performance across the spectrum.
Our focus remains on the need for digitalization as a business improvement strategy based on the ever dynamic and challenging airline business environment. Through digitalization airlines will be able to reengineer themselves in anticipation for the long term benefits of the process.

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HERMES
AIR TRANSPORT ORGANISATION

POSITION PAPER

Digitalisation, AI and the human factor in aviation security and ATM domains in particular

Presented by ERA

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POSITION PAPER

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european regions airline association

Historically, aviation security referred to unlawful acts including destruction of an aircraft, hostage-taking on board an aircraft or at airports and the carriage of weapons or other hazardous materials for criminal purposes. However, looking at the present (and future) most modern aircraft and airport systems are dependent on the reliable functioning of critical computer systems infrastructures (e.g. flight management systems, electronic flight bag, e-enablement of aircraft and extending to air traffic management). As a consequence, the aviation industry's vulnerability to cyber-attack has been significantly widened.

In the past terrorists or lone perpetrators with malicious intent may have attempted to smuggle a bomb into an airport or on board an aircraft, whereas computer system hacking now provides such individuals with an alternative means of causing disruption or even threat to life. Although there may be no loss of life during such events, they nonetheless demonstrate how vulnerable computer systems are to cyber- attack and aviation is a prime target. An important tool for the industry to combat the threat of cyber is to firstly recognise and understand the threats. Such threats are defined into two specific categories; either an attack that is designed to facilitate an event with the aim of causing risk to or loss of life, or an attack designed to cause disruption to airport or airline operations, principally around passenger facilitation.

The facilitation of an attack via cyber can be aimed at numerous aircraft and airport systems that are vulnerable due to them employing either computer software or digital communication devices. At an airport, this can include security checkpoints such as baggage and passenger scanning equipment or ID/entry-controlled gates to restricted areas (e.g. airside). Infecting such systems with malware will prevent the devices from functioning properly and thus afford the perpetrator(s) the opportunity to smuggle through a concealed weapon or explosive device. A cyber-attack aimed at disruption may not have the intent on causing physical harm to individuals but can still result in an enormous financial impact on airlines and/or airports. Malware in check-in, baggage handling and passport control systems can result in severe disruption to the flow of passengers, creating both a backlog in the terminal and potential delay of flights. For smaller, regional airlines that operate multi-sector days the impact would be enormous.

From an aircraft perspective, cyber-attack can have far more serious consequences. Pilots become more reliant on advanced digital glass cockpit displays powered by sophisticated computer systems. Consequently, such aircraft digital advancements accelerate, so does the vulnerability and attack surface from cyber widen. An Aircraft whilst on the ground or in flight is constantly transmitting various data across networks via both ground antennas and satellites. The more complex/modern the aircraft the greater number of antennas, with the Airbus A380 aircraft being a good example where in excess of 1000 applications are running when the aircraft is airborne.

To elaborate further, aircraft computerised control systems are classed into three specific categories, namely Flight Controls, Cabin Controls and Passenger Controls. Flight Controls operate such safety critical systems required to fly the aircraft including the elevators, flaps, rudder and outside temperature sensors. The systems used to operate/maintain the aircraft cabin will lighting, air conditioning and most importantly the fire suppression systems in the cargo compartment due to the

on-going concerns regarding lithium batteries. Finally, there are the passenger control systems governing in-flight entertainment, seat displays and the cabin crew control panel.

With the aviation industry gaining operational efficiency via the use of digitalisation and computer systems and their integration to optimise the management of their networks, the number of software systems, connectivity and entry points is thus constantly increasing. It is therefore critical that all industry stakeholders, particularly aircraft operators and airports are aware that although their systems and processes may be more convenient and efficient, they are also consequently increasingly vulnerable to a cyber-attack.

The Air Traffic Management domain has been slow to react to an ever faster evolving digital world. Fortunately a number of initiatives are now either in place, or will be in place over the next few years in order to modernise the ATM system which will, in turn, provide better granularity, predictability and hopefully deliver additional capacity and better Network performance in the airspace through automation. Indeed, delivery of SESAR initiatives are predicated on the timely realisation of digital services.

The cornerstone of a digitised environment is through the provision of harmonised information exchange. System wide information management (SWIM) provides infrastructure and related governance though several interoperable services as defined in ICAO Doc 10039. Through these open standard services, information access and exchange between all ATM stakeholder will reduce costs and increase competition, allowing all components of the ATM value chain to become more efficient.

We are already seeing the shift from Aeronautical Information Services (AIS) to Aeronautical Information Management (AIM), which will deliver dynamic, integrated and harmonised AIS to airspace users. Meteorological and flight information management services through SWIM must be delivered in order to address the demand vs airspace capacity gap that is starting to become critical.

On the ground, Airport Collaborative Decision Making (A-CDM) is a relatively mature concept - the first airport – Munich - going live in 2007 - improving efficiency and throughput by the optimisation of airport assets and resources whilst improving the quality of information provided to air traffic services at local and Network level. Full A-CDM is not for every airport, and to address this the advanced ATC tower concept was introduced which allows smaller airports to send a small subset of the A-CDM data to relevant stakeholders without having the financial or operational burden of full implementation. The evolution of the digital remote tower can provide huge savings for the airport ATM infrastructure as control towers can now be situated hundreds of miles away and centralised (a benefit for smaller regional airports with limited movements per day).

For the airspace users, digitisation can’t come soon enough in certain areas, as the airlines have embraced new technologies for some time both in the commercial and operational arenas. However, care needs to be taken particularly with regards to data services where we need to see positive cost benefit analysis, understand fully the controls and accessibility of data as well as safety oversight. There is also some nervousness around local and continental implementations in a global operating environment. It should be noted that users share a significant amount of information today whether it schedule information, flight planning information and enhanced equipage data however it is not fully clear how much of this is used to deliver maximum benefits.

One of the potential disruptive technologies that might radically influence or transform the aviation industry value chain (including ATM) is the Artificial Intelligence (AI). The business of all

incumbent and traditional industry players will be impacted by the products and services made possible by the use of AI, which will also open the market up to new entrants. A new ecosystem of players is already emerging and those new players will be important partners for traditional aviation companies. New players' technology expertise can be used by aviation/ATM actors to unlock value potential from AI, and the industry has to be also prepared for them claiming their share of the aviation and mobility markets (as Google, Tesla or Uber did in the automotive industry). The industry should take action to fully capture the AI-enabled value opportunities in both the short and long term whilst protecting / further enhancing the overarching value of the aviation safety.

Application of AI, introduced with the desirable performance outcome that the joint human-AI system performs better than human plus AI separately, will inevitably affect the human performance across the entire aviation industry. It will help airline/ANSP/airport management to take strategic decisions e.g. in terms of fleet management or infrastructure monitoring, in ATC it might substantially alleviate controller's workload, propose the best possible options to the human and solve complex trajectory situations using machine-to-machine communication with air vehicles.

However, if not appropriately managed, introduction of new technology might include the risk of adding new type of complexity, especially in ATM where the human operates in an already complex system. In a new human-machine partnership between the human and the AI, automation and people do not compete but have to coordinate as a joint system (Joint Human Machine System (JHMS) philosophy). Further, the human operator needs to develop trust in the AI assistant and also retain certain core skills to take back control safely in case the AI's analysis is judged erroneous or inadvisable, or in case of temporary AI unavailability or failure. In order to achieve this, the involvement of operational staff in early stages of systems development will be critical as it will provide a guarantee that the system complies with all user requirements. Hence this will increase its usability and acceptability as being seen as a useful tool instead of a competitor.

Overall, digital transformation of the industry, including ATM is a necessary and vital step in delivering improved performance and opening up new possibilities. However, with ATM already lagging someway behind other industries in adoption of new technologies, we must ensure that whatever is deployed in the next decade or so is future proofed so we don't find ourselves in out of date shortly after these new methods of operating are deployed.

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POSITION PAPER

Digitalisation

Presented by IATA

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What is / is not digital transformation

Digital Transformation is a broad topic and there is no lack of definitions to describe it. From the airline industry perspective, IATA likes to define it as value creation through deconstruction of legacy processes based on physical assets, and reconstruction of processes leveraging digital assets. The interesting part of this definition is that it stresses what digital transformation is not: Digital Transformation is not about adding a layer of technology or electronic messaging on top of a legacy process. A well-known illustration is the electronic ticket: moving from paper tickets to electronic added benefits, evaluated at $3bn savings per year, however it was not Digital Transformation as it maintained the attributes of a physical ticket, whereas moving for tickets to orders will completely remove the need for tickets.

Why Digital Transformation for the airline industry?

The world began its digital transformation in the twenty-first century. For example, in the world of payment, after moving the credit card to the electronic world by using the card number in online forms, new digital players proposed payment solutions that did not rely on any legacy card processes anymore. The reason for extending a physical process to an electronic one is continuity: the payment ecosystem comprising banks and card schemes can rely on the same card numbers and associated processes. However, the reason for disrupting the legacy processes and moving to a digital process is cost saving and agility: using card numbers online is a source of fraud, using a central number-based system precludes new solutions like instant payment or electronic wallets.

In the world of aviation, the digital transformation is still at its beginning. For flight or ground operations, the introduction of technology mostly supports legacy processes. For commercial operations and customer experience, there are some examples of digital transformation, with an attempt to redefine processes, but it is still limited. In the cargo world for example, the priority is still to move the transport documents (known as air waybill) to an electronic version. The sense of urgency comes from the customer expectations and the competitive pressure, with airlines at risk of losing the contact with their customers. This explains why travellers have access to airline apps comparable to digital players, but most areas in air transport have not been transformed yet.

Recognition of multiple tracks – Leaders and Followers

On a positive note, the digital transformation of air transport has started in a few tracks. A few leading airline groups have transformed a part of their business to compete with digital players. For example, an airline has implemented offers and orders which can be sold and fulfilled by travel partners that have no footprint in legacy air travel processes. In another example, an airline has evolved its business model to become a travel app, and soon a “super app”, offering services like food delivery or instant payment.

Whereas the air travel industry is known for its global standards and the consistency of its services, digital transformation recognizes that a few leading organizations will drive the change in selected tracks where the benefits are more visible and more achievable. It does not mean that the air travel industry will lose its globally consistent services, which make it easy for a traveller to buy a service and travel anywhere. It means that the change will come where it makes more business sense, where customer and competitive pressure is more intense.

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IATA's Digital Transformation agenda and priorities

Recognizing the value of Digital Transformation and the need for a coordinated approach at industry level, the IATA Board of Governors endorsed a digitalization strategy for the industry, sponsored by a newly formed Digital Transformation Advisory Council (DTAC), comprising 15 senior digital airline leaders. DTAC identified six priorities to lead the air travel industry through its digital transformation. (1) Digital Maturity Index: DTAC recognized the need to define a vision of a digital airline by 2035 and to measure the progress on an annual basis. (2) Digital enablers: a digital infrastructure relies on key elements, such as an Aviation Industry Data Model, an API ecosystem, an Identity Management framework, and an Aviation Data Exchange protocol. (3) Architecture: all digital initiatives must be connected and complementary. (4) Data: the most valuable asset of a digital airline is its data, not its aircraft; data must be properly governed and protected. (5) Innovation: DTAC recognized that innovation in a digital world is critical and does not operate like in the past, e.g. working with developers. (6) Security: Cybersecurity aims at protecting digital assets from external threats.

Having defined its priorities DTAC can now provide direction for each topic, in terms of advocacy, standards and development of services. DTAC will monitor the progress for each topic and provide support when needed. For more information about DTAC, visit the IATA website.

Practical business application (rather than hype)

The approach of digital transformation consists in challenging all existing legacy processes. The approach starts with the customer expectations and the value creation. Unlike what media usually report, digital transformation is not about a technology, like AI or blockchain, looking for a problem to solve.

A practical example of business application is the distribution of airline products. In the 1970s, accountable documents were in paper, airline products were regulated and defined by their schedule and fares. Due to limitation in technology, airlines delegated the creation of offers to third party technology providers, which embedded the regulated products into their technology. Four decades later, technology is ubiquitous, airlines don't need to delegate the creation of offers to third parties anymore. They have the capability to create the offers that customers expect. The business driver is to give transparency and choice to customers who buy travel, and to enable airlines to differentiate their products. Whether the new solution is based on AI and Blockchain, is a consequence, not the driver.

Link to skilling the industry

While the air travel industry recognizes the need and timing for digitalization, and identifies priorities for its transformation, it acknowledges that skills are a key success factor. The skills that made the air travel industry successful at connecting and enriching the world until 2020, are not the same that will take it through 2030. During the next decade of changes, many tasks will be much better handled by machines. Indeed, machines are learning to see, to make decisions, to anticipate, and to support or replace human judgement and errors. While more tasks can be delegated to machines, new skills are required to build and manage software and machines. New skills are needed to manage data and related policies. New skills are needed to manage business across modes of transport, enabled by seamless integrated technology. New skills are needed to manage data-enabled safety and security.

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Moving to a digital world is bigger than revisiting processes and implementing technology. In a digital world, employees will work for multiple companies over their career, maybe at the same time. They will do different jobs and will continue to learn new skills throughout their careers. The role of a trade association, like IATA, will evolve accordingly. Advocacy is probably the area that will be the last to be automated and handled by machines. The development of standards has already completely changed, from documenting processes to enabling developers to build interoperable software. The provision of products and services is already evolving from a transactional business to a platform, where the value is in the efficient collaboration between members and partners, more than in the individual transaction itself.

While airlines began as transactional companies, carrying one passenger at a time, identified as one transaction record, they are now becoming retailers, knowing their customers and being able to sell any product at any time. Digital transformation will enable airlines to become integrated, multi-modal, mobility service providers.

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POSITION PAPER

Digitalisation, AI and the Human Factor - Looking Forward for Africa with a Focus on Souther Africa

Presented by AASA

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AIRLINES ASSOCIATION OF SOUTHERN AFRICA

Digitalisation, Artificial Intelligence (AI) and the Fourth Industrial Revolution (4IR) are the current buzzwords of business and the focus of most industries to develop better products and services, improve productivity, safety levels as well as implement more efficient environmental and economic capacities. This is very much the case for the aviation sector at this time. But some of these concepts are not that new. As far back as the mid 1940's, American Airlines began experimenting with an automated reservation system culminating in the first Central Reservation System (CRS) introduced by SABRE for American Airlines in 1963. This is probably one of the first examples of AI to be implemented in the aviation industry.

In terms of passenger services, a significant development was IATA's 2004 launch of Simplifying the Business initiative which led to the introduction of digital e-tickets to replace paper tickets, bar coded boarding passes, self-service products (including the introduction of common use self-service kiosks), RFID, automation of cargo and additional Fast Travel products to facilitate a seamless journey for the passenger. Since then, the development of new technologies such as biometrics has accelerated as each organization tries to differentiate their product offering to their customers and create that all important competitive advantage. In addition, these technologies have been adopted by Government Agencies to improve their safety and security controls on the passengers moving through their borders.

As noted above, digitalisation technology and its automation systems have been in the aviation industry since the middle of the 20th Century. This is now helping to drive AI development. AI has many definitions, but for the purposes of this discussion Accenture Research provides a relevant interpretation as follows : "AI is the collection of multiple technologies that allow machines to detect, understand, act and learn either on their own or to augment human activities". It is effectively a machine driven by an algorithm to solve specific problems that have traditionally been dealt with by humans, and possibly perform better than humans. Its relevance is that commercial aviation is a service delivery business with multiple customers with multiple needs and requirements that need to be satisfied. The big challenge is to find even better ways to achieve improvements in efficiencies and productivity, and satisfy growing customer expectations. Being able to predict customer behaviour could provide a distinct advantage to airlines, airports and service providers.

In the aviation industry, applications incorporating AI and digitalisation include revenue management, on line or mobile check-in, identification of passengers, with the use of biometrics to enhance innovation at several phases of the passenger's journey, assistance to passengers to deal with resolution of their travel problems at airports with real time provision of information on flight updates, changes, delays and baggage management. AI technology is also being introduced in the maintenance field to predict possible failure of parts, and incorporating this into the maintenance planning schedule. In the flight operations and air traffic control fields, 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 digitalisation of aviation.

With continuous technological advancement beyond current applications, AI and digitalisation have through disruptive innovation, the potential to play an even more critical role in the airline industry, revolutionize its future, impacting both airport and airline business models throughout the value chain, including how they deal with and process big data, improve and personalize the entire passenger experience, and use predictive analysis to optimize efficiencies within their operations. However, with the increased use of technology and automation, the impact on the workforce with potential threats to employment has been raised as a concern. This is particularly an issue in countries with active Labour Unions such as South Africa, and needs to be dealt with.

How do these developments impact aviation in Africa and in particular Southern Africa. Firstly IATA predicts that the over the next 20 years the global average passenger growth rate will be 4.6% per annum, with Africa's average growth rate expected to be 5.7% per annum, thereby doubling the market by 2035. Southern Africa continues to be a stable, growing and competitive market expected to match average African aviation growth. South Africa needs to urgently overcome political and economic headwinds, ensuring its GDP growth (currently at just under 1% per annum) matches the global and region's 3.5% GDP growth rate.

Africa's aviation industry is underachieving (only 3% of the current global passenger market) with much unrealized tourism potential, and has potential to reach close to or even exceed double digit growth over the next few years if strategies dealing with challenges confronting African aviation and ensuring sustainable growth into the future are put in place. More passengers bring higher expectations and technology can help to meet those demands. The growth enablers would include improved airspace and airport infrastructure and advanced technologies to meet the demand of increased passengers for access to new technology and facilities, and ensure safe and secure operations.

These must include AI and digitalisation. Throughout Africa, the development of ICT must be prioritized to keep pace with developed countries to improve business performance in all fields including aviation and tourism. Incorporating digitalisation would have the impact of increasing productivity, growing per capital income and raising GDP growth.

As the African and Southern African market grows, passengers who travel internationally, want and expect to enjoy experiences similar to those in other developed countries. This includes all the airline and airport digitalized fast travel / self-service / automated offerings to ensure a smooth incident free path from the time of making a flight reservation to boarding the flight. Most Southern African airlines have introduced on line and mobile applications, and common use self-service options including kiosks, bag drop and self-boarding have been introduced at many airports across Africa.

However, further work is required to fully benefit from current new technology available, including the use of biometrics, particularly to facilitate a secure path through security and immigration processes. The ability to provide access to such facilities is impacted largely by cost constraints. There is limited Government funding available, access to finance is difficult, and user charges are in general currently high and a burden to the passengers. Unfortunately, in addition, challenges being experienced by airlines have largely kept airlines away from investing in new technologies. Notwithstanding, it is important to do the necessary research and benchmark with developed airports to capitalize on new opportunities and compete effectively with global airlines. The more technology that passengers use, the higher the satisfaction rate will be.

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Digitalisation 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 required, in order to setup the adequate frameworks for training, certification, qualification, operations and data sharing. This must be done through the amendment of ICAO Standards and Recommended Practices (SARPS) or the formulation of new SARPS required to regulate new technologies and systems.

The aviation industry is very effectively regulated through the ICAO SARPS as incorporated into State legislation and regulations. However, as was evident at the 39th ICAO Assembly held in Montreal in September and October 2019, the development of new SARPS is a lengthy process due to the need for comprehensive consultation across all ICAO member States through the various ICAO panels and working committees. The lack of regulation could hinder the ability to implement new initiatives and systems in the interest of the industry.

From the many papers considered at the Assembly, it is also evident that much work needs to be undertaken by specialist groups to understand what is behind the implementation of new technology and the development of SARPS (and thereafter regulations) to be able to effectively regulate these new systems. However, this must be done without burdening the operators and users, to the extent that such systems become economically unviable. Examples of this impacting the advancement of AI and digitalisation technologies would include RPAS (including drones), resolving airspace utilization by both commercial aviation and RPAS, cyber security and risk based assessment of security concerns.

IATA is responsible for translating many of these SARPS into processes, procedures and best practice for implementation by the airlines. The time taken to formulate and reach agreement on these systems can also be extremely lengthy. An example of this is the implementation of NDC which went through an extremely lengthy consultation phase before full acceptance by aviation and related industries.

From a leadership perspective, it is important to identify experts in the field to lead the processes, even if it means bringing in external consultants to assist ICAO and IATA where they may not have the expertise. Sometimes, one gets the impression that leaders on new initiatives do not carry sufficient background or knowledge on the new projects and they require time to research the new technology and gain an understanding of the requirements to effectively regulate. I believe this could be true for regulation of RPAS and the new and challenging area of cyber security, where developers of the new technology could be requested to assist in drafting regulation. This would continue under the supervision of ICAO and IATA as appropriate.

Policies and regulations which need to be instituted, altered or removed to ensure successful implementation of digitalisation and AI in aviation, are probably self-evident. However, as noted above, it requires experts to lead and drive the process. From a human involvement and development process, it is considered that as the technology evolves and is introduced, and as the business determines targets and goals it wishes to achieve, it will incorporate additional performance based targets and goals.

In respect of the human resource impact from AI and digitalisation, a lot has been said about the negative impact of new technological development and automation on job sustainability. There is no doubt that job descriptions will evolve and new jobs will be created as new technology and systems are developed incorporating AI and digitalisation. This situation is probably true in most

industries, not only aviation. While digitalisation and AI development will certainly disrupt the work environment, with the right strategies in place, it should create more jobs than it removes.

These new developments provide a huge opportunity for upskilling employees and preparing them potentially for new roles and challenges, in particular in the technological field. Without job growth in this area, the increasing demand will not be satisfied and this in turn could lead to a shortage of skills. If there is growth of aviation, more jobs will become available. Customer service is the differentiator in the airline business and many positions could evolve into attending to the needs of customers as they get used to new technology and systems. There will be new opportunities and staff who are prepared to adapt and be part of an exciting innovative time in the airline industry, should easily be accommodated.

AI and digitalisation is a game changer in the world and very importantly in the aviation industry. In an IATA 2018 report, it was said that "The airline industry appears to react to new technology rather than lead the way. Disruption to existing airline models may come from energy breakthroughs, alternative modes of transport, big data and data transparency, new manufacturing tools, and quantum computing." This is changing but the airline industry needs to ensure that it leads with new technology and adapts to new initiatives. If not, other disruptive innovators will no doubt develop alternatives that will meet specific customer needs and potentially replace certain traditional airline products. Aviation needs to still remain a functional but also pleasurable experience. It remains the most efficient means to travel large distances in a relatively short space of time. The industry, both globally and throughout Africa, must embrace the new technology wholeheartedly to ensure it remains competitive and continues to meet and surpass the expectations of its customers.

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R20-PP/13
05/03/2020

HERMES
AIR TRANSPORT ORGANISATION

POSITION PAPER

A European Perspective on Artificial Intelligence in Aviation/ATM

Presented by EUROCONTROL

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EXECUTIVE SUMMARY

On the 5th of March 2020,EUROCONTROL together with 13 partners published the FLY AI report, a comprehensive study of the current use and future potential of Artificial Intelligence in aviation. The report sets a number of recommendations to proactively embrace digitalization and AI in a way that ensures continued safety, security and sustainability.
This position paper presents its main outcomes and further develops impact on the human and the change management requirement that our sector will require to accelerate the uptake of AI.

1. AI is already in the sky, but requires further urgent actions

Artificial intelligence (AI) is already starting to transform how the world lives and works, and the pace of AI deployment is currently rapidly accelerating. As a sector, aviation and air traffic management (ATM) is ideally placed to take full advantage of AI, in particular machine learning. AI and machine learning are already contributing to a wide spectrum of value opportunities in the aviation/ATM industry, from efficiency-focused to safety critical applications. AI has huge potential for use in areas where it can reduce human workload or increase human capabilities in complex scenarios, e.g. to support air traffic controllers (ATCOs), pilots, airport operators, flow controllers or cybersecurity officers. AI will also increase safety through the provision of new conflict detection, traffic advisory and resolution tools as well as cyber resilience.

However, the full potential of AI is far from being harnessed across Europe or in aviation/ATM. While there are many AI success stories, they remain limited in scope. Understanding of how AI can generate business and societal value remains in its infancy, and expertise is scarce.

In recognition of these challenges, EUROCONTROL together with the European Commission and a wide range of partner organisations took the decision to set up a European Aviation High Level Group on AI (the EAAI HLG) with the goals of advancing understanding among aviation/ATM actors of AI and its potential, demystifying the topic, and helping accelerate the uptake of AI in our sector.

To help drive AI forward, we conclude with a practical "FLY AI Action Plan" with a series of recommendations, notably to create a federated AI infrastructure containing historical data for training purposes and to develop AI applications, together with an appropriate governance structure; to accelerate the deployment of AI notably in the areas of cyber and non-safety-critical applications, to conduct more AI research and development in particular to help respond to the safety-criticality of aviation/ATM operations, to foster the emergence of an AI Culture through training and re/upskilling of staff across enterprises; to foster partnerships with other Digital Innovation Hubs, AI specialists and other industrial sectors; and to facilitate and increase experience/knowledge sharing, communication and dissemination.

Although the report aims at the development of AI in European aviation/ATM, a broader adoption is encouraged.

2. New standards for AI

The FLY AI report foresees standardisation activities as a main area of activities to accelerate the uptake of AI in aviation/ATM. Such standardisation activities should address the need to adapt the current certification/approval frameworks to AI-based applications

both in the context of on-board certified systems, and ATM/ANS AI-based applications/ services. The future process for certification/approval of AI-based products, as currently discussed at EUROCAE WG 114/SAE G34 group could include features like learning assurance, formal methods, testing, explanation, licensing, in-service experience and on-line learning assurance. Explainable AI remains in the area of research and must be accelerated.

RECOMMENDED ACTIONS

Data and AI-infrastructure framework	■ A federated data foundation and AI-infrastructure should be established
Research and Innovation	■ Further exploration of the potential of AI in aviation/ATM should be strengthened in areas of: ■ high impact on aviation/ATM performance and environment ■ human-machine collaboration ■ safety-critical operations ■ safety intelligence tools and cyber threat intelligence services
Validation and Standards	■ Appropriate AI validation methods and tools should be developed as well as standards and guidelines
Deployment	■ The rapid uptake of AI-based solution in operations should be encouraged in the cybersecurity domain and non-safety critical operations ■ European aviation/ATM actors should aim to reduce AI-developments time to market.
Communication and Dissemination	■ Communication on AI should be enhanced ■ Dissemination of AI benefits and lessons learned should be strengthened ■ AI aviation/ATM applications developments and deployments should be regularly scouted
Training and Change Management	■ An AI culture through training/re/upskilling and change management should be developed
Partnership	■ The aviation/ATM community should build-up an inclusive AI aviation/ATM partnership

Moreover, defining and implementing standards for data handling, data structure, data elements, metadata and data quality will facilitate integration and utilisation in multiple applications and analytics. Such standards should support data integrity and quality checks. A figure of merit of the data quality should be introduced to clarify who is responsible for what during the data production, dissemination and storage and who is controlling whom and who is liable for what along the entire data cycle. Open data emergence can favour competition and allow an easy use for future applications that cannot yet be imagined.

Some standardisation initiatives from the industry or industrial working groups should be considered and be complemented to fully address data standards for AI.

3. A joint Human Machine System for AI evolution

A performance-based approach is needed with or without AI to ensure a system does not affect the overall performance of air operations. Currently, systems developed in aviation for safety critical operations are producing an understandable, explainable and reproducible

response, which allows the establishment of clear repeatable human operating procedures. So for example, at any stage until touchdown, a pilot can abort a landing by initiating a go-around; he remains the one making the decision.

In the current AI/machine learning applications, the role of the human does not change significantly, but the operator needs to develop trust in AI to assist. Hence, he/she needs some degree of 'explainability' over AI behaviour and outcome. In particular, the operator needs to understand how AI works and 'reasons', what exactly it is doing, what it can do right – but also what it could do wrong. Care also has to be taken that the AI system is not misinterpreted as having the capacity to understand and feel in a human sense, as this could potentially affect team work.

However, when AI is capable of supporting higher levels of automation/autonomy or more advanced decision-making/reasoning tasks, it will be essential to assess and redefine the tasks of the human within the Joint Human Machine System (JHMS)[1] to ensure meaningful interactions and appropriate oversight and control. Such advanced AI capabilities have not yet been deployed in aviation/ATM, but would create a new interaction model with new reasoning/decision making processes, which differ from human intelligence. This naturally would necessitate new models of interaction as all existing models are based on human-related ones.

Additionally, the degree of delegation could vary depending notably on the type of AI used and the level of customisation to the user's performance. Hence, while the AI system should enhance the performance of the human, they could if customised to the operator lead to a variable, non-systematic and non-deterministic involvement of the human in decision-making. Therefore, a prescriptive involvement of the human may not be appropriate in all circumstances.

Hence, in the context of AI supporting advance decision-making/reasoning tasks, the performance-based approach should take into account the Joint Human Machine System and should consider the notion of trust and how trust can be established, characterised and safely demonstrated to deliver the expected performance.

When considering full autonomous systems, we may reach a paradigm shift where the human may no longer be able to safely recover AI failures. Therefore, these advanced AI-based solutions would require increased system robustness or adapted contingency procedures, as is the case for any safety-critical system today.
The report recommends to adapt ATM/ANS safety cases to AI-based solution specificities.

4. An AI culture through training/re/upskilling and change management

Most sectors transitioning to a digitalised workplace and in particular developing AI-based solutions are faced with the same issue – a shortage of the required AI skills among existing staff, and the high costs of recruiting staff with AI expertise. Aviation/ATM is no different in this regard. Furthermore, AI has not formed part of the training of aviation engineers so far. Hence, aviation/ATM expertise in AI is still limited, and few connections have been built with the academic world of AI.

To tackle this gap, a workforce that includes aviation data scientists and analysts should emerge together with expertise in data modeling, data engineering and related competencies. These profiles will be supplied by a limited number of experienced hires coupled with an extensive effort to train existing staff with precursor skills in the business: existing staff in our industry are often highly numerate as well as having a strong business understanding, both of which are good departing points for developing an understanding of data science.

[1] The Joint Human Machine System (JHMS) philosophy leads to human and machine being considered as components of a system that has been designed to ensure that AI enhances, not supersedes, human capabilities.

Online training courses on AI do exist, but they tend to be diverse and cover too many topics, with a clear lack of guidance on where to start. In any case, AI technology is developing rapidly, requiring constant adaptation and making many general courses swiftly redundant. Finally, to be successful in AI development, business knowledge is fundamental.

The FLY AI report highlights that upskilling and on-the-job aviation/ATM AI-related training is necessary as well as change management.

However, such training courses will very much depend on the function of the staff. In-depth training will apply primarily to industries developing AI applications. Regulators, who will play an essential role in defining the “still to be defined” certification/approval criteria, should also follow specific training addressing both the technical and operational specificities of AI.

It will be essential to train end users like ATCOs/supervisors, airport operators and ATM flow managers on such matters as AI awareness, trust in AI and to understand its expected behaviors under normal and rare abnormal conditions. However, in a highly automated environment and/or future AI-based environment in which controllers could lose their current skills, maintaining human abilities to guarantee safe and secure management of extremely rare but safety critical events will require new type of operational training and reskilling programmes.

Deployment of AI will require significant efforts in change management and training to address the full range of needs from users to developers across the aviation/ATM sector.

Altogether, to embrace fully AI, we need to nurture an “AI culture” in aviation/ATM through training, (re/up) skilling programmes and change management. The purpose of creating an AI culture is to ensure that developers can master data exploitation, appropriate cross-functional collaboration is established, and learning from realistic use cases is encouraged, as this will facilitate agile, safe and secure AI development. Moreover, an AI culture should aim at demystifying the whole topic of AI, while establishing the required level of trust needed to facilitate acceptance of AI by human operators.

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Digitalization, AI in Aviation and the Human Factor

Introduction

Prior to the recent downturn in the aviation business, global air traffic, which reached 8.8 billion passengers in 2018, was, according to IATA, expected to double by 2037. The challenge for aviation was viewed as managing this growth, while containing costs. The key was making better use of resources through efficiencies, while at the same time increasing sustainability, improving passenger experience, and maintaining safety and security. The digital transformation of the industry was seen as a key to achieving these goals. With the downturn in the industry, digitalization has become even more important, as reducing costs and achieving efficiencies is critical to industry participants as they seek to remain financially viable.

Today's technologies allow airlines, airports and other industry participants to operate in ways that were not possible up to just a few years ago, including the delivery of personalized and individualized services to millions of users. This can be accomplished because of the enormous amount of data that are available; data that are generated by aircraft systems, air traffic control, airport operating systems and stakeholders. These data, combined with algorithms that convert the data into usable information, represent enormous opportunities to the industry. Digitalization allows industry participants to improve the customer experience, while at the same time, increasing efficiencies and generating revenues. However, there are considerable challenges to realizing the benefits from digitalization.

Definition of AI and Digitalization

IATA defines digital transformation as *value creation through deconstruction of legacy processes and the reconstruction of these processes leveraging digital assets*. The goal of digitalization is to simplify tasks, improve efficiency and develop new services. A distinction is sometimes made between digitalization and digital transformation. Digitization implies the conversion of an analogue or manual process into an equivalent digital process, whereas digital transformation involves both the implementation of new technologies and the transformation of business operations. Whereas digitalization, by itself, may preserve existing forms and procedures, digital transformation can completely change the way business is conducted.

One way to achieve digital transformation is through artificial intelligence (AI). AI is the collection of technologies that allow machines to detect, understand, act and learn either on their own or by augmenting human learning. AI involves the development of algorithms that can be used to solve problems that have traditionally been dealt with by humans. AI integrates input devices (vision systems, audio, text inputting and other sensing systems) with algorithms to allow a machine to take 'intelligent' actions.

Uses of AI and Digitalization

The industry trade associations that contributed their briefs to Hermes outlined many uses for AI and digital technologies. Some of the most important uses of digitalization and AI in aviation are outlined below:

- Maintenance, Repair and Overhaul (MRO). AI technology can be used in the maintenance field to predict possible failure of parts. Moreover, digital technology can be used to guarantee the traceability and validity of a part (called "credentialing); often in conjunction with blockchain systems.
- Training. Digital technologies can change the way training is delivered; for example, through the development of virtual reality (VR) devices that allow for realistic-based collaborative learning.
- Cargo Movement with Autonomous vehicles. AI can be used to improve the functioning of autonomous vehicles, such as ground handling equipment and drones, improving their operations while maintaining safety.
- Air Traffic Management. AI can be used to better control aircraft movements to increase efficiency and improve safety. For example, AI can be applied in speech recognition to detect read-back errors, the synchronization of aircraft ground movements, and in predicting optimal runway configurations to maximize operating capacity. The use of AI can lead to a substantial increase in airspace capacity without significantly increasing the demands on air traffic controllers and their respective cognitive capabilities.
- Flight Safety. Using the data generated by aircraft and their systems, smart algorithms exist that can detect trends in normal operations, as well as potential hazardous behaviors.
- Aviation Operations. Digitalization can help the industry make smarter use of assets, optimize efficiency of all processes and develop a better understanding of the businesses, routes, costs and opportunities for improvement. Applications include on-line or mobile check-in, identification of passengers with the use of biometrics, assistance to passengers to resolve travel problems and the real-time provision of information on flight updates, changes, delays and baggage management.
- Revenue Management. AI can help airlines achieve greater profitability, by allowing enhanced inventory availability and price optimization, based on intelligent demand analysis. AI can assist in the analysis of product configuration decisions (seat or cargo payload) at specific points in time, thereby providing highly competitive, customized (product) pricing for all customers. Airlines can thus attain higher flight/aircraft/fleet utilization, creating operating efficiencies and producing additional revenues that can be directed to customer service enhancement.
- Enhance the Customer Experience. Digitalization can help the aviation industry better understand traveler needs and to improve the passenger experience. AI can be used to meet the needs of individual passengers; for example, in terms of inflight-entertainment options and meal requests. AI can also assist in resolving customer breakdowns; such as helping passengers to arrive at their destination after missed connections.

Challenges to Meet

For digitalization and AI to achieve the greatest benefits for the aviation industry, key challenges must be overcome. As outlined by industry trade associations in their briefs to Hermes, key challenges include the following:

- Developing and Implementing Standard Practices. Regulatory frameworks will have a strong influence on digital transformation and the speed of digitalization. However, regulations can face major complications for cross-border integration, as they may have different interpretations across countries. For digitalization and AI technologies to become operational, collaboration among ICAO, States and industry is required. Both States and industry must agree to frameworks for training, certification, qualification, operations and data sharing. New industry procedures may be accomplished through amendments to ICAO Standards and Recommended Practices (SARPS). However, the development of new SARPS is a lengthy process, requiring comprehensive consultation. Then, even after there is agreement to the new SARPS, implementation, perhaps through trade associations, could take considerable time and effort.
- Data Privacy. Modern aircraft and airport systems are dependent on the reliable functioning of critical computer systems infrastructures. Consequently, the aviation industry's vulnerability to cyber-attacks is considerable. Sharing data among stakeholders in a trusted environment is a requirement for the successful implementation of digital technology. Regulations and standards defining how the data are processed, by whom, and how data security is ensured need to be set by governing bodies. Data drives digitalization and AI, and the trust of the consumer to provide their data is a critical element in any system.
- Cost of Implementation. The aviation industry, especially in developing areas such as Africa, is often characterized by very low profit margins. Airlines and other industry participants do not have the resources to heavily invest in digital transformation, so developing regions could lag wealthier regions. Unless funding is made available to the industry, it is likely that the implementation of digital technologies will be slow and uneven.

Specific Human Factor Challenges

In addition to general challenges faced by the aviation industry in the implementation of digital technologies and AI, there are specific challenges related to human factors. While digitalization and AI will certainly disrupt the work environment, with the right strategies in place, these new technologies can provide opportunities for upskilling employees and preparing them for new roles and challenges.

Digital transformation demands a new set of skills compared to the skills needed for legacy systems. Automated technologies will partly or entirely replace some repetitive jobs. Digital transformation will lead to a reduction in process driven, low-skilled physical and administrative jobs (for example check-in staff). On the other hand, new types of jobs will emerge empowered by technology to perform more complex tasks. However, such technologies will not replace critical positions involving immediate decision making that requires human logic, experience, and common sense.

Human actions currently contribute to the lion's share of aviation accidents and incidents. Therefore, ensuring that aviation workers are well-trained can be a cornerstone to the pursuit of aviation safety. For example, with the implementation of AI and the dynamic push toward digitalization, a disruptive environment has emerged that will push the industry towards the refinement of Aviation Management Systems. As the history of safety systems development in aviation has shown, it is important to be proactive in the training of personnel in the operation of the new systems.

In order to implement the new technologies, organizations must bring together teams of employees and all other involved stakeholders to explore synergies and jointly address areas of concern. Soft skills will be critical to guiding implementation. Team management, creativity and emotional intelligence will be desired qualities for team members. Hiring and developing personnel with these qualities will be essential to the successful implementation of AI and digitalization.

Outsourcing some tasks will also be possible. Airlines are served by many providers, some of which are very advanced in their digitalization strategies. This makes for a compelling case for airlines to enter strategic relationships with service providers to help transform the industry. Again, teamwork and other soft skills, such as negotiations, will be necessary to work successfully with suppliers in a team environment.

Recommendations

As noted in the brief from ICAO, the promise of intelligent automation for aviation can only be realized through a globally coordinated approach. Moreover, the implementation of digital technology and AI requires a clear set of standard operating practices. Both industry and State buy-in to the regulations is essential, so that a common set of standards emerge. In addition, regulations must both allow for the sharing of digital information and the protection of individuals' privacy. Finally, given the recent severe downturn in the industry as a result of the COVID-19 crisis, there must be funding available to industry participants to implement the new technologies and (re-)train staff accordingly. With this in mind, we propose the following:

- ICAO needs to take the lead in providing clear definitions and objectives and potentially a roadmap for the implementation of AI and digital technologies in the industry. Standards must be universal. They also must be accepted by States. As a worldwide intergovernmental organization, ICAO is the only forum for these standards to be developed and implemented.
- The development of standards, however, is not sufficient. States must enact regulations that allow industry participants to implement the technology. Unless enabling regulations are enacted, the risks and costs to industry participants in enacting new procedures could be deemed too high.
- The implementation of industry standards can be best accomplished through industry associations, such as IATA. However, given the lead times required for developing and implementing new operating procedures, these industry associations should proceed concurrently with ICAO standards development. Concurrent development will help ensure that the standards are workable and will allow industry to better participate in the development of the standards.

- Funding sources for technology implementation must be identified. Unless funding is available for industry participants around the world, implementation will be slow and uneven.
- Training and development focusing on digital skills and practices should be implemented immediately. The recent downturn of the industry has idled thousands of industry employees. Now is an ideal time to engage in training and re-training for the future needs of the industry.

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