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ARTIFICIAL INTELLIGENCE
IN AVIATION: *the future is now*



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Intelligent aviation through artificial intelligence

Rannia Leontaridi

Director General for Civil Aviation, Department for Transport, United Kingdom, and ECAC Focal Point for Environmental matters



ECAC is pleased to present the first edition of ECAC News dedicated to artificial intelligence (AI) in aviation. Readers will be introduced to several key aspects, as well as to a series of accounts of successful implementation of AI by air traffic management operators, airports, airlines, and aircraft manufacturers.

The reason we chose to dedicate this edition to artificial intelligence was that more and more data are digital nowadays, and as information technology evolves continuously, the impacts on the aviation sector are potentially far-reaching.

At a broader level, the concept of artificial intelligence can be defined as human intelligence simulated by machines, especially computer systems, capable of learning and reasoning like a human being.

But why do we need artificial intelligence in aviation? Benefits of integrating artificial intelligence in the aviation industry include, for example: deciphering patterns from previous experience, intelligent decision-making processes, prescriptive and predictive analytics, forecasting, improving air passengers' experience, boosting productivity, etc.

We have already seen successful implementation of AI applications in air traffic management (ATM) and air traffic control (ATC) operations, in airports, U-space (including the use of intelligent drones) and avionics. Other examples of the integration of AI in aviation include dynamic ticket pricing, flight optimisation, real-time forecasts of flight delays or trajectories, crew scheduling, and predictive maintenance.

More importantly, artificial intelligence has the potential to tackle the two major challenges aviation faces today: reducing the environmental impact of air traffic, and improving the ability of the network to scale capacity up or down depending on the growth or decline of traffic.

Of course, the use of artificial intelligence in the aviation industry brings a series of opportunities and challenges that can be further discussed and addressed. It is an area where alignment between strategic leadership and practical implementation will be especially important. This, combined with constructive dialogue among stakeholders, can help us overcome the challenges, and identify and mitigate the associated risks.

Finally, I would like to thank all the contributors to this edition of ECAC News, and I invite you to read this magazine, hoping it will inspire ideas and fruitful discussions on the most appropriate ways to integrate artificial intelligence in the aviation sector.



EUROCONTROL has adopted AI to support aviation

Paul Bosman
Head of the Network Manager, EUROCONTROL

“If you read the newspapers, you might think that Europe has lost the race for artificial intelligence (AI) and it’s going to be China or the United States. They’re going to dominate us but we do not think it is necessarily the truth. Our destiny is in our own hands and we have many tools and ways to work together to really move AI forward. Maybe the only limitation is what we have in our own heads.” *FLY AI webinar on partnership*

► The FLY AI – a joint effort in AI for aviation

To move AI forward, EUROCONTROL – together with the European Commission and a wide range of partner organisations (airlines, airports, air navigation service providers, manufacturers, EU bodies, military and staff associations ⁽¹⁾) – jointly worked on finding ways to demystify AI with the goal of accelerating its uptake in the aviation sector, including air traffic management (ATM).

The FLY AI report ⁽²⁾ that came out of this cooperation provides an overview of the many ways that artificial intelligence is already applied and assesses its potential to transform aviation, notably in reducing human workload, driving the development of new ATM/U-space services, or increasing safety and cyber resilience and increasing its sustainability. Its action plan aims to accelerate the development of AI in European aviation and ATM. This year’s FLY AI webinars ⁽³⁾ explored each action area, covering partnering, research and innovation, ATM use cases, safety/certification, data sharing, cyber security and training/change management.

Each webinar reached more than 4000 people on average, mainly in Europe, testifying to AI’s growing importance to the avia-



tion community. The webinars highlighted that:

- AI is not science fiction. Aviation is currently using mainly data-driven AI and is beginning to exploit symbolic AI;
- in the foreseeable future, AI can complement and augment human capabilities but will not replace the human in ATM;
- partnering in AI can really help grow your business, accelerate your know-how, and help achieve successful certification of safety-critical systems in which AI is embedded;
- with the advent of common European data spaces focused on mobility, more data become available, while companies and individuals keep control;
- we must integrate AI-specific risk mitigations in aviation system design, and also use AI to help detect cyber threats. We need to work on new AI applications for cyber protection in aviation;
- EASA’s guidance for Level 1 machine learning applications structures the way AI systems in aviation should be designed; and
- EUROCAE WG-114 is preparing common standards for the development and certification of AI-based aeronautical safety-related products.

(1) EUROCONTROL, the European Commission, EASA, ACI EUROPE, Airbus, ASD, CANSO, Heathrow Airport, Honeywell, IATA, IFATCA, IFATSEA, the SESAR JU, Thales, as well as military partners EDA and NATO.
 (2) <https://www.eurocontrol.int/publication/fly-ai-report>
 (3) The FLY AI webinars webpage (<https://www.eurocontrol.int/fly-ai>) provides access to all webinar recordings and their presentations.

▶ EUROCONTROL supporting aviation by operating with AI

Responding to immediate operational needs, EUROCONTROL has developed a number of AI-based applications – and there are more in the pipeline. They will generate significant improvements to the European air traffic control network through offering new digital services that will be embedded in our future integrated Network Management programme (iNM) to the benefit of operational stakeholders.

In early 2019, the FLY AI group identified around 25 AI-based applications in European aviation and ATM, with some already operational (Heathrow Airport, Maastricht Upper Area Control Centre, Network Manager (NM)). Less than two years later, EUROCONTROL alone is developing over 30 applications. Some are already used operationally in decision-making tools for the NM operational team and their operational stakeholders (airports, airlines and ANSPs). These rapid developments were possible thanks to EUROCONTROL's innovation hub initiative and the availability of EASA's AI guidance material.

▶ Improving air traffic management efficiency

The Maastricht Upper Area Control Centre (MUAC) paved the way for the operational use of AI at EUROCONTROL with its Trajectory Prediction Improvement (TPI)⁽⁴⁾. TPI has been supporting Flow Management Position operators for over two years by trawling through the wealth of data that MUAC has collected, and applying AI algorithms to support several key integrated Flow Management Position (iFMP)⁽⁵⁾ functions to improve prediction of flight routes, 4D trajectories, take-off times, sector skips, and even hotspots of complex traffic.



Trajectory Prediction Improvement is in operation. What were the key steps to get there?

It took a lot of time and effort to get people to accept introducing AI, particularly our safety department, as AI introduces a new sort of unpredictability in the system. However, in the TPI case the worst thing that can happen is to end up with the wrong flight prediction, exactly as with conventional systems today. We are not introducing a new failure mode here. In MUAC, the system is augmented by AI with humans still at the centre of decision-making processes.

▶ Reducing flight delays and their cost to business

AI is also used to minimise flight delays, which impact airlines' punctuality and the passenger experience (the combination of which is covered in Regulation (EC) No 261/2004 on passengers' rights), and may generate night curfews imposed at many European airports. Curfews prohibit take-offs and landings during certain night-time hours; a single minute of curfew infringement can lead to a diversion of the flight. Diverting a long-haul flight can cost up to €68 000⁽⁶⁾, and results in significant disruption to the airline and its passengers. Developing effective methods to accurately identify flights at risk of curfew infringement is therefore of

paramount importance. EUROCONTROL's Curfew AI module⁽⁷⁾ can detect such flights well before the restricted period commences and provides improved predictions when compared to those of the enhanced tactical flow management system. Predictions are performed per aircraft (i.e. tail number), and can be queried at any time during the day, which is particularly useful when tracking curfew-affected aircraft.

The MIRROR operational decision support tool⁽⁸⁾ was used as a sandbox during the development of the Curfew AI module. It currently provides NM operational staff with a real-time view of each aircraft's flight legs, thus allowing identification of potential knock-on delays. The Curfew AI module will be made available in the coming months to MIRROR's several hundred industry users following an update of the MIRROR interface.

(4) <https://www.eurocontrol.int/publication/traffic-prediction-improvements-tpi-factsheet-and-technical-documentation>

(5) <https://www.eurocontrol.int/sites/default/files/2019-06/factsheet-ifmp-22022017.pdf>

(6) <https://www.eurocontrol.int/sites/default/files/2021-03/eurocontrol-standard-inputs-economic-analysis-ed-9.pdf>

(7) http://www.atmseminar.org/seminarContent/seminar14/papers/ATM_Seminar_2021_paper_15.pdf

(8) <https://www.eurocontrol.int/tool/mirror>

EUROCONTROL has adopted AI to support aviation



In addition, an application programming interface running on EUROCONTROL's cloud infrastructure will provide a broader access to the Curfew AI module, in particular to airlines for integration into their flight operational centres as a support tool.

► Reducing operational impact of ATFM delay uncertainty

To resolve imbalances between demand and capacity, the Network Manager imposes regulations, delaying flights on the ground. The length of the ground delay assigned to a regulated flight may change dynamically until departure. This variability in the delay stems from the mechanisms used by the computer-assisted slot allocation system (CASA) to manage the regulation slots.

The FADE AI module⁽⁹⁾ has been developed to reduce this uncertainty and therefore improves airlines' operations management throughout the day. Trained on historical data, it is fully integrated in CASA and can predict the trend of the delay with an accuracy of 75%. FADE reduces the prediction error by up to 63% when compared to the model without FADE.

► AI as cyber-protection assistant

As a first innovative action on Cyber for AI, EUROCONTROL's European Air Traffic Management Computer Emergency Response Team (EATM-CERT) has explored the way AI could increase the cyber resilience of the aviation system, notably for the rapid and reliable detection of aviation-related document leaks. In a hybrid approach based on symbolic and data-driven AI, they pre-trained an off-the-shelf "multilingual transformers model" to adapt it specifically to aviation's operational, technical and multilingual contexts⁽¹⁰⁾. Now integrated in EATM-CERT tools, the model can identify if a leaked document is relevant to aviation much more rapidly than data analysts could. Significant hours of scarce human resources are now being saved in addition to freeing staff from tedious and boring work. This delivers significant cost and operational benefits for the aviation community. Cyber risk has increased significantly during the pandemic and, as "AI for cyber" is still a new area for aviation security experts, increasing AI cyber collaboration and sharing lessons learned are paramount. This is a key objective for the Network Manager Cyber group (CY-

BERG), which is open to all network operational stakeholders.

► Going live soon...

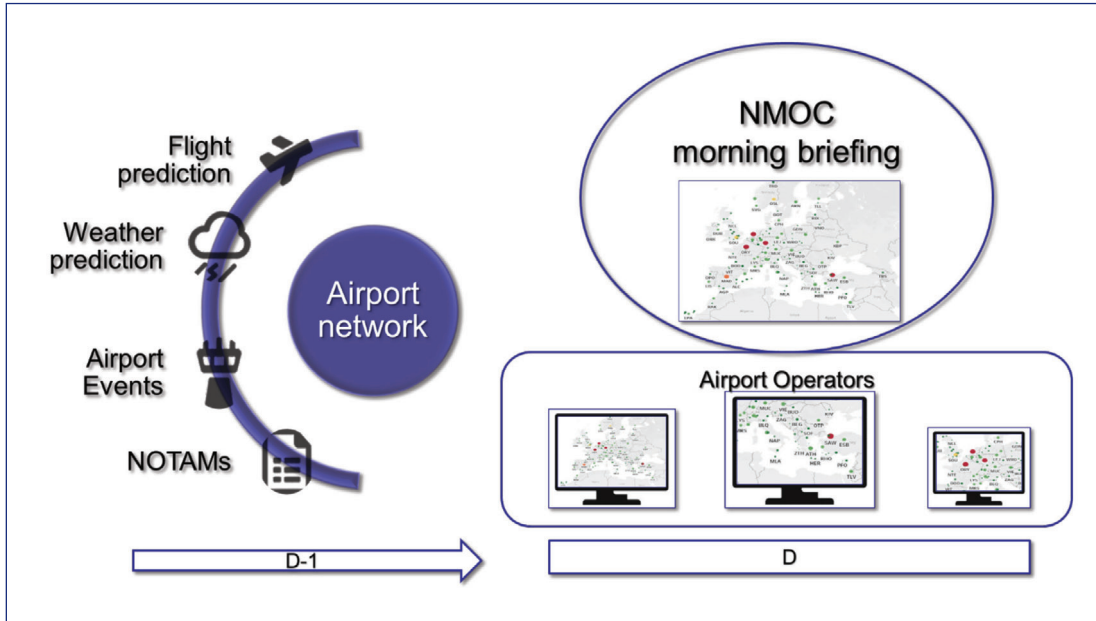
Early in the flight planning process, flights can be optimised to improve network efficiency. PREDICT AI improves optimisation and prediction by offering multiple alternative routes tailored both to aviation stakeholders' business needs and the Network Manager's traffic flow management criteria. PREDICT AI retrieves the routes flown by any given airspace user and makes suggestions for better routings taking due account of their business needs as interpreted from historical data. The model can run on any city pair and on any aircraft operator on the network. As a result, the Network Manager Operations Centre (NMOC) benefits from more reliable route predictions, thus increasing network predictability and stability, which in turn facilitates the adjustment of capacity to demand.

Additionally, given that only around 5% of NOTAMs are relevant to network operations, the NOTAM list AI module will identify, extract, and display the most relevant NOTAMs at the top of the list, allowing NMOC Operators to deal with them quickly, freeing up their time for higher value tasks.

PREDICT AI and NOTAM list are now fully developed, are aligned with the EASA guidance on AI certification and thus ready for integration in NM systems.

On the airport side, the D-1 AI-based predictive model will provide new enhanced predictions of airport regulations using information available prior to the day on which they should apply (hence "D-1"). These are then integrated into NMOC's morning briefings on the day of operations. D-1 AI uses information from airport events in NM's "airport corner" and from NOTAMs, as well as weather and traffic forecasts to estimate the likelihood of a regulation being required at any of the network's busiest airports. It already predicts the hours when regulations are more likely - with 84% accuracy.

(9) http://www.atmseminar.org/seminarContent/seminar14/papers/ATM_Seminar_2021_paper_14.pdf
 (10) <https://www.eurocontrol.int/event/ai-cyber-and-cyber-ai>



Moreover, it addresses concerns about “AI explainability”⁽¹¹⁾ by providing the rationale behind the prediction, be it atmospheric phenomena, industrial action, works in progress at the airport, over demand, etc.

This information is shared with the rest of the functions in the NMOC. The purpose of the prediction is NOT to take any un-coordinated action but to proactively contact the airport for considering in a collaborative way the best options.

Although it was initially planned to serve as a decision support tool for the NMOC Airport Function, D-1 AI will also be shared with our stakeholders, to foresee the impact that other airports’ daily situations have

at their own airports. Its deployment on EUROCONTROL’s cloud is expected at the end of 2022, which will accelerate its operational uptake.

Finally, the mature AI-based application COAST⁽¹²⁾ allows ANSPs to optimise the calibration of their Final Approach Separation Delivery tools for safe and efficient Time-Based Separation (TBS) operations, using machine learning models trained on historical local airport traffic and MET data. COAST is a decision-support tool that helps air traffic controllers to organise the spacing and separation of traffic. COAST, therefore, is probably our first human-AI collaboration application and the only ATM use case supporting the EUROCAE standard for AI in aviation.

EUROCONTROL is moving forward quickly with this wide range of AI applications that are already bringing operational benefits to the European Network. These are just the first steps and, together with our FLY AI partners, we look forward to moving faster to help European aviation recover in a sustainable and scalable way. ■

(11) AI models currently used, essentially deep neural networks, are of such complexity that it is practically impossible for their creator to understand their inner workings. Explainable artificial intelligence is a set of processes and methods that allows human users to comprehend and trust the results and output created by machine learning algorithms.

(12) <https://www.eurocontrol.int/publication/eurocontrol-coast-calibration-optimised-approach-spacing-tool-use-machine-learning>

Paul Bosman has been with EUROCONTROL since 1992, working in many different technical and managerial positions in various locations (R&D centre – France, seconded to Airbus, Brussels headquarters). Currently, he is the head of the Network Manager / Infrastructure Division, planning, deploying and monitoring European infrastructure digitising the SES European Sky through activities such as CNS, information management and overall resilience (cyber, interference...).

He chairs the European Aviation/ATM – AI High-Level Group, which has delivered – amongst others – the FLY AI report.



Smart Digital Tower – transforming air traffic control operations in Singapore

Kuah Kong Beng

*Director of Special Projects,
Civil Aviation Authority of Singapore*

▶ Introduction

The provision of aerodrome air traffic services remotely without a physical tower may seem novel to some but in fact it has been a reality for several years now. The first digital tower was approved for operations at Örnköldsvik Airport in Sweden in April 2015.

While remote towers have been implemented for smaller airports, there were none for high intensity airports back in 2014. The Civil Aviation Authority of Singapore (CAAS) embarked on a research study to evaluate a digital tower concept for high intensity runway operations at Changi Airport. The research found that there was scope to develop a digital tower solution for Changi Airport which could reap numerous operational benefits. The development of such a prototype started in early 2018 with NATS (Services) Ltd and Seairidge Technologies.

▶ Smart Digital Tower prototype

The Smart Digital Tower prototype at Changi Airport provides real-time surveillance of Changi Airport's aerodrome operations through more than 100 fixed-position cameras and pan-tilt-zoom (PTZ) cameras installed across multiple locations at the airport. The flexible and multiple camera placements around the airport allow visual surveillance of the aerodrome areas that are located far away or blocked by buildings when viewed from the physical control tower,

“ The Smart Digital Tower prototype at Changi Airport provides real-time surveillance of Changi Airport's aerodrome operations through more than 100 fixed-position cameras and pan-tilt-zoom (PTZ) cameras installed across multiple locations at the airport. ”

and increase visibility during conditions such as hazy, low light or night conditions. The PTZ cameras, with the ability to deliver up to 30x optical zoom, mirror the function of binoculars in conventional control towers.

The Smart Digital Tower prototype operations room has three controller working positions (CWPs) and a video wall made up of large monitors that provide a common situational awareness for the air traffic controllers at their respective CWPs.

▶ Digitalisation

Air traffic controllers rely on the out-the-window (OTW) view in conventional towers to provide aerodrome air traffic services. The digitalisation of this view in a digital tower environment, commonly known as a video wall, is a paradigm shift for air traffic management. The video wall allows the air traffic controllers to select and integrate critical data such as aircraft call signs and other essential flight information to be overlaid on the screens. Consequentially, these data overlays will reduce the “heads down” time on multiple air traffic control (ATC) displays and allow for easy flight identification and enhanced situational awareness, thereby improving safety as a result.

More importantly, digitalisation of the OTW view also allows the provision of aerodrome air traffic services from a remote location. This mode of operation has already been deployed in Germany; the international airport at Saarbrücken has been remotely controlled from a Remote Tower Centre in Leipzig more than 400km away. Integration of two or more control tower operations at different locations into a single integrated facility is a possibility. Now, it is a function of getting the appropriate infrastructure in place. When implemented successfully, it is expected to enhance the coordination between multiple control towers, reduce the complexity of operations and improve overall safety and efficiency.

Separately, CAAS is also exploring using speech recognition tech-



Smart Digital Tower – video wall with a runway view

nology to create a “digital assistant” to automate processes and streamline operations. The aim is to replace manual inputs, laborious data entry and issuing of common commands via speech recognition technology. For example, an air traffic controller will be able to use voice commands to provide clearances for flight altitudes and assigned headings, which will then be transcribed and entered automatically into the air traffic management (ATM) systems. Automatic transcription of conversations between pilots and air traffic controllers not only allows for more expeditious post operations incident review but also provides ample data for greater insights into ATM operations. If the development of the “Digital Assistant” proves to be successful, CAAS may integrate this feature into the digital tower environment to augment air traffic controllers’ operations.

▶ Video analytics applications

As one of the busiest airports in the world under pre-COVID-19 traffic, air traffic controllers in Changi Airport operate at a high-paced environment with approximately 380 000 annual movements. Usage of video analytics and decision support tools will help to alleviate the workload of the air traffic controllers. One potential application that can be incorporated into the digital tower environment is the detection of moving objects in the airfield. This can be achieved via video processing of the images obtained from the numerous cameras

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deployed across the aerodrome. These alerts on the video wall can help to enhance the situational awareness of air traffic controllers and improve runway safety. On a similar note, PTZ cameras can also be programmed to do a patterned sweep in the aerodrome to scan for objects of interests or specifically selected by air traffic controllers to track a particular aircraft, vehicle or even humans in the aerodrome. These features can help to reduce cognitive workload for the air traffic controllers and thus allow them to focus their mental resources on other tasks at hand.

Another video analytics application we can potentially leverage on is in the indication of runway clearances. Currently, air traffic controllers rely on visual means to determine whether an aircraft has vacated the runway prior to allowing another arriving aircraft to land, or clearing a departing aircraft for take-off. During inclement weather or periods of low visibility, this could be challenging for air traffic controllers to operate at their usual

intensity. As a safety measure, air traffic controllers will have to ensure there is appropriate separation, and more communications with the pilots are also expected due to the low visibility conditions.

To address the above challenges, CAAS is studying the feasibility of using camera surveillance sensor technology and artificial intelligence to provide indication to air traffic controllers when the tail of the aircraft is clear of the runway. This digital advisory tool will be especially useful during periods of low visibility to advise air traffic controllers on the runway clearance status so that they can make quicker and more informed decisions on whether to land or depart the next aircraft. If the development of this feature is successful, it is expected to improve overall safety in the following aspects.

Firstly, there will be reduction in workload for both air traffic controllers and pilots in terms of radiotelephony (RTF) exchanges during periods of low visibility. Timely issuance of landing/take-off clear-

Smart Digital Tower – transforming air traffic control operations in Singapore



Smart Digital Tower – evaluation of the prototype by air traffic controllers

ance is key for safe and smooth operations, especially in a high intensity airport. With this feature, there will be no need for the air traffic controller to request the pilot to report when they are clear of the runway. Similarly, the pilot will not need to report to ATC when the aircraft vacates the runway. This will result in better use of airtime, which includes lower probability of RTF congestion and timelier issuance of clearances to pilots.

Secondly, it is envisaged that the information provided by this tool may reduce the time required for an air traffic controller to form a decision on whether to clear the next arrival to land. Thus, it is expected that there will be a lower risk and probability of an arriving aircraft having to carry out missed approaches during periods of low visibility due to late issuance of clearances. Increase in aircraft movements and traffic can be possible without compromising safety and can potentially lead to greater operational efficiency.

► Future plans

Technologies advancement and digitalisation are increasing at a rapid pace. The changes are seen to be disrupting existing business operations and redefining the new normal in our society. While COVID-19 has decimated air travel, it is a window of opportunity for air navigation service providers (ANSPs) like CAAS to invest in research and development (R&D) projects that will enhance air traffic management. The low air traffic demand presents good opportunities to trial new technologies and allows ANSPs to deploy air traffic controllers for R&D projects – as providing these resources for R&D projects is often a challenge to most ANSPs when airports are operating at pre-COVID-19 levels.

For CAAS, the Smart Digital Tower prototype is a living lab where relevant technological innovations will be incorporated and tested to continuously improve and fine-tune the digital tower system. The living lab allows us to determine the suitability and robustness of the new innovations before commissioning the technology in an operational environment.

CAAS had conducted evaluation on the Smart Digital Tower prototype and the data showed that the overall concept of a digital tower was acceptable for operations. With the advanced features and tools, air traffic controllers were able to provide safe, orderly, expeditious and effective air traffic control at Changi Airport, albeit at low traffic conditions due to COVID-19. The key areas of evaluation include operational safety, efficiency and capacity, performance and limitations, air traffic controllers' acceptance of the new concept of operations, as well as an assessment of human-machine and human-human interactions.

Singapore has embarked on a journey toward being a smart nation since the initiative was announced in 2014⁽¹⁾. CAAS is similarly on board this journey of adopting smart technologies as it is important for us to stay relevant in today's fast-changing world. CAAS will be building upon our past successes with the living lab and continuing our journey of leveraging on artificial intelligence. We will be evaluating the steps required to progress from a prototype system to the next stage whereby we can deploy digital tower technologies in an operational environment. This includes various activities such as developing the relevant safety case, training plans as well as deployment strategies.

With the advancements in technology over the years, it is timely for one to evaluate the latest technology that could potentially enhance safety and operational efficiency, as well as provide better service levels. Where possible, CAAS will be harnessing smart technologies that will give us the competitive advantage to stay ahead as a leading ANSP in the digital era. ■

(1) <https://www.smartnation.gov.sg/whats-new/speeches/smart-nation-launch>

Kuah Kong Beng has served as the director of Special Projects at CAAS since 2016, in which he oversees the Smart Digital Tower programme. He also advises on air traffic management (ATM) operational issues and safety, as well as ATM research and development projects.

Having joined CAAS in 1972 as an air traffic controller, Kong Beng brings with him a wealth of experience in air traffic control and management that makes him a renowned expert in his field. He also actively contributes to making new ATM solutions a reality for the region.

Fostering artificial intelligence in ATM

Tanja Grobotek

Director Europe Affairs,
CANSO (Civil Air Navigation Services Organisation)



We are without doubt living in turbulent times. The COVID-19 pandemic and its conrescence at large are probably one of the biggest challenges the aviation industry has ever faced. It is equally clear that we should not allow COVID-19 to stop innovation in aviation, or progress on building our future digital skies.

We are now entering a new, exciting era for aviation in which the speed of change and rate of innovation will be faster than they have been for decades.

In order to support and foster innovation, it is essential to engage with all stakeholders in the aviation value chain and reduce the time to deployment of new and emerging technologies, which are essential to achieve safer, more efficient and more scalable air traffic management, as well as to accommodate increasingly diverse airspace users and boost the sustainability of aviation.

There are several new and emerging technologies that can have a huge impact on air traffic management (ATM) – and artificial intelligence (AI) is clearly one of those.

The availability of enormous quantities of data coupled with the growth of highly effective and efficient computing power has the potential to enable the widespread use of AI in ATM and related fields. AI is an exciting prospect and offers opportunities to increase the efficiency of services provided by air navigation service providers (ANSPs) through a variety of new tools and systems.

In April 2021, CANSO published the white paper, *Emerging technologies for future skies: Artificial intelligence*, which explores the main enablers and challenges of AI in ATM. It also includes an exam-

ination of a number of use cases where machine learning (ML) has been successfully implemented in ATM and identifies the key elements that will be important for AI-based technologies to gain the trust of ANSPs and air traffic controllers (ATCOs). AI use has kept spreading rapidly in the ATM industry; however, I feel we have barely started to scratch the surface of the opportunities and limitations of AI within aviation. The essential question is not whether – or if – these AI-based applications will be used, but when they will be in operation.

► Enablers

New technologies come with some associated risk, and as aviation is a safety critical domain, there is a need to examine the use cases and capabilities of AI carefully. In order to see successful applications of AI in ATM, several enablers are necessary:

- **Trust needs to be built for the use of this new technology.**

The aim of Explainable AI (XAI) is to “describe the purpose, rationale and decision-making process of the AI tool in a way that can be understood by the average person”. It is essential that ATCOs know why an algorithm has provided a particular answer and how that answer compares with the manual completion of a task. This will require ongoing training and monitoring.

“ There are several new and emerging technologies that can have a huge impact on air traffic management – and artificial intelligence is clearly one of those. ”

- **Safety assurance.**

Safety approaches that rely on existing software are based on the assumption that the software is fully explainable. However, it is not always true for machine learning, as almost every popular ML method contains a “black box” part, hardly constraining the explainability. This represents a new paradigm for software assurance, where we go from certifiable algorithms to certifiable data sets and training programmes. So even the most robust ML algorithm’s performance is highly dependent on the training data set. It might not be a problem in the case of applications with low safety effect

Fostering artificial intelligence in ATM

but can be a strong constraint in the development of safety critical applications.

- **Certification of these technologies will be crucial.**

EUROCAE (WG-114) and SAE (G-34) are guiding the relevant authorities to agree industry standards on aeronautical systems using AI. These are now in place, making possible certification that the industry can trust.

- **Cyber security and ethics will also be very important.**

ANSPs can benefit from employing AI systems to improve both the efficiency and safety aspects of air traffic control. It is unlikely machines will replace humans in such a safety critical domain for the foreseeable future. But they can be deployed to enhance situational awareness and provide decision support to increase safety and efficiency by enabling human experts to focus on more complex decisions.

► Human-machine collaboration

We foresee a fluid cooperation framework between humans and AI to minimise operational risks and improve the overall performance of the ATM system. Experience gained during the successful implementation of automation in the cockpit or in the unmanned traffic management world can be used in designing automation in ATM systems.

In a human-machine collaboration paradigm, the human roles are developed and implemented in a way that fosters trust and confidence by the human in the automation functions. The AI is not used as a simple tool but it is used to complement and augment human capabilities.

The objective is that human experts can focus in areas where additional operational perspective is needed, while the machine can automate large and repetitive tasks that it can handle more accurately in a scalable fashion.

It is key that trust in the Joint Human-Machine System is improved by upskilling human

“ In a human-machine collaboration paradigm, the human roles are developed and implemented in a way that fosters trust and confidence by the human in the automation functions. ”

operators, to better understand the new data-based algorithms paradigm and adjust their expectations to the existing limits.

In the current AI/machine learning applications, the role of the human does not change significantly. However, the introduction of AI-based models will support higher levels of automation, more advanced decision-making tasks and there is little doubt that it will impact the way work is performed in the future.

The roles and responsibilities of human actors in the functional system will change and evolve. There could be new actors – Joint Human-Machine Systems – working with different look-ahead time horizons, airspace scopes and operational performance indicators from the ones that exist today.

One key message is that **keeping the human in the loop** is essential in a synergic human-machine collaboration, and contributes to the resilience of the functional system.

For example, air traffic controllers should always be able to override some procedures in a given context while still maintaining an acceptable level of safety.

It is even more important because applications increasing the level of automation to support ATCOs to handle traffic with higher complexity, might decrease situa-

tional awareness. Proper assessment of this issue is important to make the ATCO self-confident in their new role. Explainability and proper safety assurance of AI is a key factor to build trust, and support human-machine collaboration.

► Fields of application

Some of the areas where AI has been successfully implemented in ATM, in particular related to air traffic control (ATC), tower, air traffic flow management (ATFM), and ground operations, and where its use shows the potential to deliver real benefits, are the following:

CONFLICT RESOLUTION ADVISORY

AI can provide tools to help ATCOs resolve (especially) mid-term conflicts, once these are detected. Indeed, ML algorithms can provide optimal solutions as a sequence of actions solving the conflict and satisfying a certain number of intended qualities: for example, ensuring preferred safety distance, having a minimal number of commands, reducing fuel consumption or delay, and others. These methods can learn from ATCO experience and also explore billions of possible solutions and choose the best from among them.

OPTIMAL SECTORISATION

In the dynamic airspace management domain, ML/AI techniques can introduce a significant improvement. The basic idea is to train a machine with traffic data and sector configuration and let it learn how to re-shape sectors boundaries in order to better accommodate the traffic.

DEMAND PREDICTION

ML/AI algorithms can be applied to improve the accuracy and predictability of traffic demand by adding to the current calculation methods the complementary stochastic information deriving from historical data intelligent processing aimed to provide hidden patterns between flight plans and actual flown trajectories. This kind of AI-augmented demand enables the improvement and the efficiency of the entire demand and capacity balance (DCB) process.

“The roles and responsibilities of human actors in the functional system will change and evolve.”

REMOTE TOWERS

AI-based pattern recognition can be used to combine multiple video tracks of one detected object (separate tracks on wings, body, etc.). The entire shape of an aircraft or vehicle can be recognised from different viewing angles (e.g. back profile, side profile, front profile). It can also be used to detect standing aircraft or vehicles on the runway or holding point, stands or parking position, and continue tracking if such objects start moving. Or in a close-up view (pan-tilt-zoom or static hot-spot cameras), to recognise when no landing gear is down, or special situations (e.g. smoke or engine fire) and to alert the controller. It can also be used to filter output data of conventional video tracker and remove false bounding triggered by cloud movements.

UNMANNED TRAFFIC MANAGEMENT

Unmanned aerial vehicles (UAVs) with high levels of automation and advanced features will require AI to drive the development of new unmanned traffic management (UTM)/U-space services and address the ATM integration challenge. AI will support ATM actors and increase safety from flight planning to operations by providing new solutions for conflict detection, traffic advisory and resolution, and cyber security. The

change in both UTM and ATM will entail increased levels of automation and applying AI/machine learning to the strategic, pre-tactical and tactical aspects to enable the transition from airspace-based to trajectory-based operations.

DIGITAL ATCO & DIGITAL TWIN

Powerful machine learning techniques can provide digital assistance to ATCOs in many ways:

- by a natural human-machine dialogue, enabled by automatic speech, natural language processing (NLP) and intent recognition. Thus, ATCO orders as well as pilot voice can be directly transcribed into the system, to increase ATCO efficiency and globally the safety of the dialogue;
- by increasing situation awareness, through an increased precision of data surveillance;
- by learning from previous ATCO actions and providing decision-aid for increased efficiency, AI will complement ATCOs enabling them to enhance their capabilities, reducing their cognitive involvement in repetitive tasks and allowing them to focus on highly value-added tasks.

Conclusions

The development of AI has come a long way in recent years. The availability of enormous quantities of data allied to the growth of highly effective and efficient computing power has enabled the use of AI in ATM and related fields, as has been explored in this article. The use of machine learning and deep learning systems is exciting and offers opportunities to increase the safety and efficiency of services provided by ANSPs through a variety of different tools and systems. The expanded use of AI in ATM has the potential to bring significant benefits, including: improving safety by understanding anomalous traffic patterns; improving capacity by supporting decision-making and understanding changes in flows; and finally, bringing environmental benefits by optimising flight plans.

CANSO is committed to working with the research community, States, industry and other stakeholders to ensure Europe's airspace is fit for purpose now, and in the future. ■

“CANSO is committed to working with the research community, States, industry and other stakeholders to ensure Europe's airspace is fit for purpose now, and in the future.”

Tanja Grobotek joined CANSO in 2018 and is responsible for CANSO's activities and objectives in Europe. Tanja previously worked at IATA as the regional director safety and flight operations (SFO) – Africa and Middle East, where she was responsible for providing strategic direction, guidance and leadership for IATA's safety, flight operations and infrastructure activities and initiatives. From August 2013 to February 2014, Tanja was also ad interim vice president Africa. Tanja has significant experience of working with governments and international air transport institutions across Europe, Middle East and Africa. Before joining IATA, she was a flow control specialist with South African air navigation service provider, ATNS, where she established the Central Airspace Management Unit (CAMU). She started her aviation career in the airline maintenance planning division of Croatia Airlines. Tanja holds an executive master's in business administration in aviation management from Geneva University and a Bachelor of Science degree in air transport engineering from the Transport Science University in Croatia.



Artificial intelligence and the next generation of airport air traffic management

Andy Taylor

Chief Solutions Officer, Digital Towers, NATS

Not long before the pandemic – if you can remember such a time – I attended a EUROCONTROL artificial intelligence (AI) summit in Brussels at which people from across the industry gathered (again, remember that?) to attempt to cut through the hype and look at real, practical ways in which this disruptive technology could help transform how the aviation industry works.

Fast forward two years and our world has been transformed in a way that none of us could ever have anticipated. You'd think that with parts of the industry still clinging to survival, talk of investing in new and what's often perceived to be a risky technology, would be further away than ever.

But, of all the transformational technologies surrounding our industry, to my mind artificial intelligence, especially when coupled with our ever-maturing application of digital tower concepts, remains the best placed to support the wider recovery in terms of improving efficiency, safety and resilience. Those are issues that still matter today and will matter even more tomorrow.

One figure at that event that really resonated with me was the fact that less than 10% of the data produced by the industry in Europe is actually used. That's a massive, untapped resource and long term a much more open approach to how data is stored and shared will be needed in order to unleash its latent value.

It's the ethos of harnessing the power of operational data that has been the cornerstone of Searidge Technologies' work for the past few years. Searidge began considering the ATM applications of AI by building on the technical expertise developed using machine learning and neural networks to enhance tracking and detection capability in image processing.

Neural networks work by analysing data sets in order to "train" and create an understanding of what normal operations look like. Once a period of training has taken place, the next stage is for outlier or marginal data to be highlighted in what is referred to as "anomaly detection". This ability to detect operational events which are outside normal parameters is a key differentiator between machine learning and the traditional system development and coding, meaning the time between development and operational deployment can be shortened from years to months.

Working together with Searidge, our focus is on using AI and machine learning to identify ways of supporting controller decision-making in order to improve efficiency, resilience and performance. This might be by using it to simultaneously monitor multiple areas of interest across an airport – like runway exit points for example – something that humans simply aren't physically capable of doing.

This ability can then be used to reduce the impact of external factors, such as weather, by creating a more predictable operation in terms of aircraft spacing and runway throughput. This focus doesn't reduce the importance of people in the process, but rather looks at how to support the optimisation of human performance.

To give a practical example, before the pandemic, we started a



Heathrow digital tower lab



Heathrow digital tower lab landscape

project looking at whether we could apply a combination of AI and digital tower camera technology to help cut airport weather-related delays.

We installed 18 ultra-high-definition 4K cameras on the tower at Heathrow and additional 4K cameras at exit points on the airport's northern runway. The images from those cameras were then fed live into Searidge's AI platform, known as AIMEE.

When trained on enough data, AIMEE can identify the exact moment when an aircraft has safely left the runway and to then notify the air traffic controllers. Our intent was to prove that when a tower like Heathrow's disappears into low cloud despite the taxiway and runways remaining clear – known as "VIS 2 conditions" – AIMEE could inform the controllers that the runway was free for the next arrival, something that would help recoup the landing capacity that is lost in these circumstances.

Not only would this reduce delays for the airlines and their passengers, but it would also ensure safety is maintained and reduce the monitoring workload on the controllers. This would free them up to make other key decisions, whether that's in support of capacity growth, resilience, safety or efficiency.

During our trials, AIMEE continually monitored arrivals on Runway

27R/09L, identifying over 40 000 arrivals in all. Data analysis has proved hugely exciting, showing AIMEE performed extremely well, including being able to identify aircraft in poor weather conditions and in darkness, when the 4K cameras were shown to perform better than the human eye.

So successful were the initial trials that we hope to be able to extend the work to include more varied weather conditions, giving further opportunities to refine the model and test whether the solution would work in full CAT II/III low visibility conditions. If AIMEE performs as well as expected, it will prove an enormous benefit given the impact Low Visibility Procedures (LVPs) have on operations at airports around the world.

To give another example, automated voice clearances are something that the industry has dabbled with in the past, but the technical hurdles have always seemed insurmountable. Not only must a system be able to issue the clearance safely and correctly, but it would also need to be able to understand the pilot's response and act appropriately.

Again, here machine learning and artificial intelligence could provide the key. Using AIMEE, we have been experimenting as part of a non-operational trial, by training the system to successfully monitor

incoming radio traffic and respond by giving aircraft route clearances and transponder codes, including being able to interpret and respond to the "read back" from the pilot over the radio.

It's that ability to interpret ambiguity, which might include the use of non-standard phraseology or accented English (something humans are so good at), that has always been the real technical hurdle to the idea taking off, but the unique nature of AI and machine learning means the results of our non-operational trials have been very encouraging.

AIMEE was asked to interpret the pilot request, check the details against the existing flight strip system and then respond to the pilot with the appropriate clearance or request for clarification. Obviously, this is a long way off being ready to deploy, but our analysis shows that with the provision of enough training data, AIMEE performed very well when monitoring real pilot RT transmissions.

If the work continues towards achieving something that is one day operationally deployable, it could be possible to automate some of the more routine tasks controllers undertake, helping reduce their workload and again, leave them free to concentrate on the things where their skills and training are best employed.

Artificial intelligence and the next generation of airport air traffic management

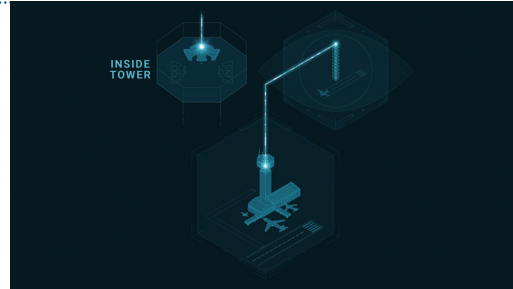
These are two radical applications, and while they are not ready for operational deployment, to me it is the combination of the digital tower technology and artificial intelligence that is the real potential game changer in terms of airport performance.

One thing that was very clear is that despite the pandemic, we remain in an era of accelerating change, with pressure to increase the rate at which new systems can be introduced safely. Technology is going to play a huge part in the future of ATM, with AI machine learning and

digital tower applications freeing people of routine tasks and allowing them to concentrate on decision-making and performance. ■

Find out more at
www.nats.aero/digital-towers

Most digital towers around the world today have been put up to replicate the view of the airfield and relocate the controllers. That's an application that suits some smaller airports, but it's not going to be how we really unlock the full operational and business benefits. We've been on a mission to rethink how digital towers can be deployed in order to tackle specific challenges, and have distilled that thinking into five operational concepts, or what we call "models". All are built on the same software platform, making them compatible with the kinds of future AI-enabled applications like those I have outlined.



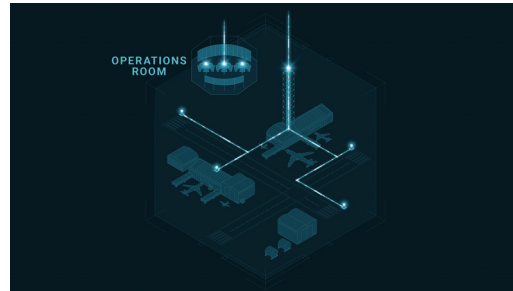
MODEL 1 Digital Tower in Tower

A tower within a tower for operating a small airfield remotely from inside the tower of another "parent" airport.



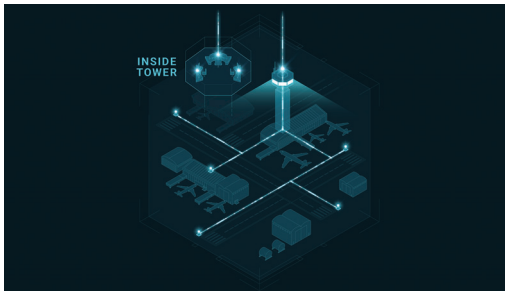
MODEL 2 Remote Digital Tower

A fully digital control tower for a single runway airport, which can be either on or off-site.



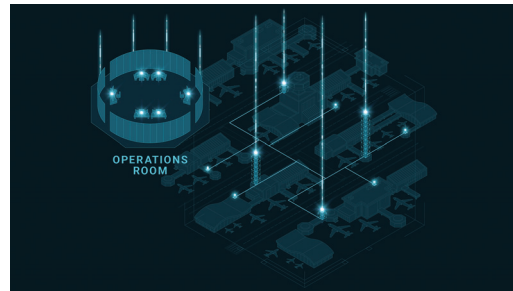
MODEL 3 Remote Digital Tower+

A fully digital tower for more complex, mid-sized airports, which can be operated within the airport or from another site.



MODEL 4 Hybrid Digital Tower

A hybrid digitised tower, ideal for upgrading an existing physical tower at a larger airport.



MODEL 5 Hub Digital Tower

A fully digital tower, perfect for replacing a physical tower at a major, multi-runway, multi-terminal airport, or for creating an equally capable contingency.

With nearly 30 years of experience in the air traffic management industry, **Andy Taylor** has led, developed and delivered innovative ATC solutions for global customers to increase airport capacity and operational performance. As chief solutions officer, Andy works across both NATS and Searidge Technologies. He is responsible for the joint development of the partnership's digital tower capabilities and delivery models.

Andy is currently leading the NATS/Searidge deployment of the world's largest digital tower programme at Singapore's Changi Airport, together with establishing a network of digital tower laboratories.

Schiphol as a tech company



Floris Hoogenboom
Head of Artificial Intelligence



Sebastiaan Grasdijk
Lead Data Scientist



Bas Cloin
Lead Data Scientist



Martijn Schouten
Product Manager

Schiphol is quickly becoming Europe’s leading digital airport. In managing an airport that size, predictability and insights play a key role. From optimising our passenger experience, minimising our environmental footprint to just running our day-to-day operations. To achieve this, Schiphol is building a solid data foundation that feeds many of its cloud-based artificial intelligence (AI) capabilities.

Data and AI are a foundational part of transforming from a traditional airport into a tech company. This involves transforming the way we store and process data, but even more importantly how we act on the insights we develop. Schiphol is moving from using AI as a tool to develop insight, towards using AI as a decision-support tool. Ultimately, our goal is to put AI first in a lot of our processes, striving towards total airport management and even autonomy. In this article, we will take you through a few of the use cases Schiphol is working on and explain how these fit into a larger vision of AI as a transformational power in how Schiphol is run.

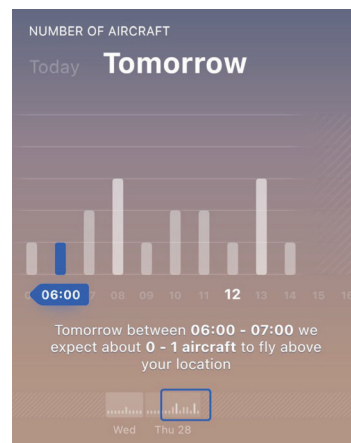
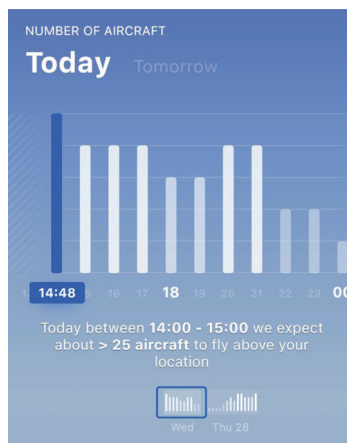
▶ Notify

Schiphol Airport, the oldest airport worldwide still at its original founding place, is situated in a part of the Netherlands crowded with businesses but also with residents. Although we try to minimise nuisance for residents, people living close to flight paths experience aircraft noise every day. To keep

residents informed on the number of flights they can expect overhead, we developed a mobile application called Notify. This app shows the predicted number of flights per hour in the next 24 hours based on the user’s location. This allows residents to factor in the expected nuisance while planning their activities.

The reason why an app like Notify is especially interesting for an airport like Schiphol has to do with the runway configuration. Due to its location on flat terrain near the

coast, Schiphol’s runway system is designed to deal with many different weather conditions. This means that the number of flights on a certain route may differ depending on a lot of complex factors. To predict this number of flights, a machine learning model is trained on a year of historic data. During training, the model learns the complex dependency of the number of flights on multiple factors, including weather information (e.g. wind direction and speed), the flight schedule and generic seasonal effects.



Screenshots of predictions in Notify app

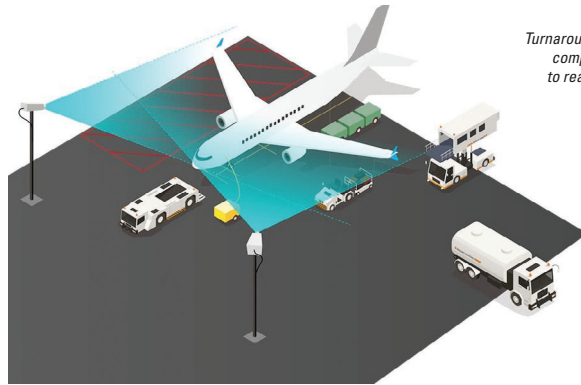
Schiphol as a tech company

► Security planning

Having a safe and pleasant trip is a key aspect of our passenger experience. For this, a smooth flow through all of our processes is important. Research has shown that the security check is one of the most stressful pieces of our passenger journey. Combined with the fact that security is one of an airport's largest operational expenses, this means that optimising this process is critical. Furthermore, it is important to strike a correct balance between operational expenses on the one hand, and passenger satisfaction on the other. A large factor deciding the "smoothness" of the security process is the number of personnel at the filters and how many lanes they have opened per filter.

To give relevant insights into the number of lanes and the staff required, predictive modelling is used that gives a suggested lane schedule as a basis. However, our planners remain at the wheel, being able to easily adjust the proposed schedules and retrieve updated insights. This can be information such as the number of personnel required, but they are then also able to see the expected impact on important metrics such as occupancy norms or waiting times. This process allows the security planners to give an expected assessment of the number of personnel required, allowing the external security parties ample time to plan their personnel. This collaboration between predictive algorithms and human insight is something we frame as augmented decision-making and is part of a larger vision on AI.

Next to being an important component by itself, it is also a building block for creating insight into the whole passenger process at Schiphol. Schiphol is in some ways a closed system with clearly defined entry and exit points. This means most, if not all, important variables for the processes can be defined and measured. Knowing what flows into this closed system is something that this digital copy of our security process helps with,



Turnaround Insights by applying computer vision techniques to real-time camera streams

in order to help understand the impact of changes to the planning or passenger inflow.

► Turnaround Insights

The turnaround process is important in making sure aircraft leave Schiphol on time. It has been shown that a significant portion of the total delay is caused by events happening during the turnaround. At the same time, the organisational structure of Schiphol is such that this process is one that Schiphol has little insight into. Because of this, the Turnaround Insights project was started. The goal of this project is to provide end-to-end insight on what is happening around the aircraft during the turnaround. For example, at which point in time did the aircraft actually arrive and what was the exact timestamp it was in block. Or similarly, when did fuelling start and end. The timestamps produced by Turnaround Insights offer an important peek into what otherwise would be a black box process.

The data created by the Turnaround Insights project has two important usages. Firstly, these data allow for analysis and process improvements. By analysing what happened during delayed turnarounds and identifying patterns, processes can be improved. Secondly, real-time processing of this data feed makes it possible to alert and signal e.g. ground handling staff, if certain tasks are at risk of causing delay. Taking this concept even further, the information we obtain is being considered as an input for our predictive block times models.

Turnaround Insights works by applying computer vision techniques to real-time camera streams from the apron. This is convenient because these camera images are obtained from a generic interface and that means that it is possible to track the turnaround process regardless of system integrations between handler, airline and airport.

► Predicted block times

All airport processes are essentially tied to the arrival and departure of aircraft. Gate designation, runway assignment, planning for handlers, buses, security and others, all depend on aircraft block times. Although on-time performance is one of the most important performance indicators for Schiphol and we take great care in getting all flights out according to schedule, departures and arrivals can still occur off schedule. To allow better process coordination, we developed a model that predicts block times for all flights up to 36 hours in advance. Information used by the model includes previous delays on multiple levels such as gate, pier, flight number and airline, weather predictions and handler information.

These predicted block times allow us to improve the coordination of processes and enable us to anticipate on upcoming delays and other changes that impact our operations. Moreover, it allows us to inform our passengers in an early stage about possible changes regarding their flight.

► Augmented decision-making

AI is by definition a transformational discipline. It is not about facilitating the current way of doing business but rather about improving it or changing it. This is an important realisation, especially when you look at AI applied in airport operations. Providing insight into what is going to happen or is happening, as is being done with the predicted block times and Turnaround Insights projects above, is just a foundational step. To really create value out of AI in aviation, it is important to determine how to act on these new insights.

To make this more concrete, we like to think of AI using the concept of augmented decision-making. Hereby the models described above form the foundational insight into what is going to happen, but rather than just showing these, we try to translate these insights into actionable advice. For example, a combination of our live Turnaround Insights and predicted block times might predict a gate scheduling conflict, but rather than just flagging this conflict, it is our

vision that our algorithms should deliver actionable solution paths for resolving it. This by itself creates a first step towards airport autonomy.

To achieve this first step of augmented decision-making, we are working on bringing together multiple streams of information to come up with a single, consolidated picture of the airport and such that we can evaluate the effect of interventions on all process points. A nice example of this is a tool called Iris, which we are developing as our version of the AOP. Iris brings together, for example, the block time predictions, the security filter predictions and the gate planning to create this integral overview described above. A digital twin of the airport containing these processes and their interactions is needed. Switching a flight from one gate to another won't only influence that gate but will also trigger many second order effects, like a change in the needed lanes at a security filter. With Iris, users are given insight into where bottlenecks will occur and the tool provides them with possible paths of solution, for example by moving flights or adding capacity at certain process points.

These are the first steps Schiphol is taking into this concept, but they come with a clear path towards autonomy in mind. Of course, the road towards really reaching full autonomy in a safe manner is long but the path via a collaboration between human and AI in the form of augmented decision-making is clear and will keep playing an important role in this domain for the time to come.

► Scaling and commercialising

We strive to maximise the impact of the AI solutions mentioned above, both within and outside our organisation. That's why we recently started a commercialisation initiative, which enables other airports and industry players to benefit from the developments we make by adopting our solutions. We engage technology and service providers to do so in the most efficient and effective way. Notify is the first product that is market-ready and can be implemented by other airports within the coming months. If you are interested, feel free to reach out to mieke.struik@schiphol.nl. ■

As head of AI, **Floris Hoogenboom** is responsible for all AI initiatives that happen around the airport, both together with partners as well as for the in-house AI development teams. His mission is to apply the transformational power of AI throughout all airport processes.

Sebastiaan Grasdijk is a lead data scientist within Schiphol's core AI team. Currently, he is working on creating the predictive backbone for the airport operations plan. He is involved with a broad range of innovative projects, from specific airport processes to overall process interactions.

Bas Cloin is a lead data scientist within Schiphol's core AI team. For the past 18 months he has worked on a variety of data science projects, among which are Notify and Predicted block times. Although he loves to dig into technical details, his main focus is maximising business impact through alignment of the team's efforts with the overall AI strategy.

Martijn Schouten is product manager within the data and analytics domain of Schiphol and recently accepted a new challenge to improve and accelerate the collaboration between the business and data and analytics departments by installing embedded data teams. In these teams, all kind of data-related products are being shipped to the business: from business intelligence dashboards, data (quality) analyses, predictive models to end-end solutions like the security plan tool.

Airlines' data sharing and artificial intelligence adoption



Jean Ruiz Carpio

Head of Aviation Data, Financial, Settlement and Distribution Services, IATA

Jeroen Mulder

Technology Innovation Project Manager, Air France KLM Group – CIO Office

▶ Building a data-driven culture

Airlines are set to become data-driven organisations. The adoption of artificial intelligence (AI) in the airline business is only expected to grow significantly in coming years. Access by airlines to new data types in larger amounts, supported by digital technology, brings the opportunity to design more customer-centric processes, achieve operational excellence and reach their environmental goals.

With unrestricted access and control of their data, airlines will be able to maximise value creation. Enabled with open data ecosystems and trust frameworks, they will use advanced analytics to incorporate new data sources into their processes.

▶ Sharing is caring: airline industry data exchange programmes

Airlines operate in a complex environment and rely on multidimensional data to fulfil their services. Data and analytics are used to better coordinate all dimensions of their business.

Airlines have (long ago) recognised the value of accessing larger data sets beyond their own. Together with IATA, they established industry data exchange programmes that could deliver the much-needed global insights. **Direct Data Solutions (DDS)**⁽¹⁾ for planning and market intelligence, in partnership with Airlines Reporting Corporation (ARC); and the **Global Aviation Data Management program (GADM)**⁽²⁾

for improving global safety levels, are two good examples of airlines' collaborative approach. Through the years, data exchange programmes have expanded to different areas of the business.

Airlines have developed exchange programmes based on principles of **trust and transparency**. Working together, they have built a best practice on sharing data, supported by three pillars:

Data governance:

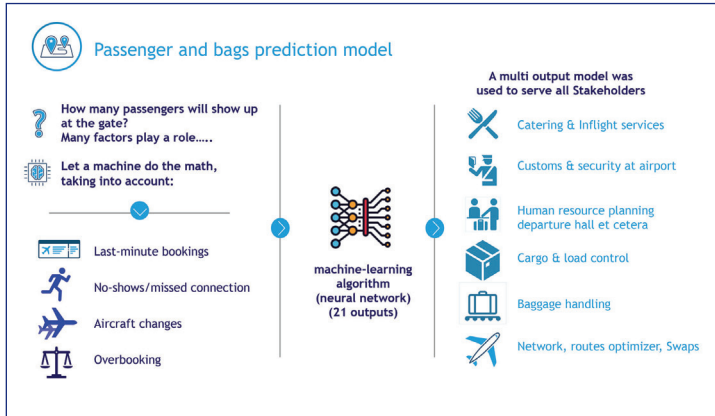
With clear rules for a fair exchange. Airlines crafted the concept of Give-to-Get, where any airline can participate in the programmes and access available data, provided it also shares its own company information. Data formats and taxonomy follow accepted standards while each participant is asked to fulfil mandatory data requirements. Without a significant sample of airlines, there is no real value in the exchange; therefore industry programmes set critical mass goals, to achieve industry representation to derive averages and aggregations. Anonymisation and confidentiality principles are established where required.

IATA Data Exchange Programs Working with airlines on **Trust & Transparency**

Data Governance	Data Management	Collaborative approach
Give to Get G2G Global Standards Entrant requirements Critical mass Data access	Airline Compliance Data engineering Data security Data Quality Distribution Rules	Airline Advisory Group System providers & data suppliers Stakeholders User Groups

(1) <https://www.iata.org/en/services/statistics/intelligence/direct-data-solutions/>

(2) <https://www.iata.org/en/services/statistics/gadm/>



Data management:

To ensure that the data is reliable, the industry agrees on definitions, as they are key for harmonised and reliable data sets. Data quality key performance indicators (KPIs) are established to cover for data accuracy and timeliness.

A collaborative approach:

Programmes are equipped with airline sounding boards, discussing the strategic aspects of the data exchange, and driving the enhancements to keep the constantly evolving data fit for purpose.

This approach resonates with airlines worldwide, with hundreds of them actively participating. The IATA legal team is actively involved in regulatory compliance of all activities. As a result, IATA can provide airlines with relevant industry data that follows industry standards, and is compliant with applicable regulations.

This best practice for data exchange is now a building block towards airlines becoming data-driven organisations. The original concept of data exchange described above, powered with new technology such as cloud infrastructure, open data ecosystems and advanced analytics, brings opportunities for more sophisticated exchange and value creation.

Adoption of AI

Individual airlines are fast advancing on experimentation of AI/ML (machine learning) methodologies in multiple areas to increase cus-

tomercentricity and achieve operational efficiencies, some of which have a direct positive impact on environmental performance: demand behaviour, customer digital experience, network and fleet planning, operational safety and security, predictive maintenance, ground operations optimisation, and decarbonisation are some of the user cases explored.

A key component to enable AI adoption is access to data, beyond transactional, from new data sources captured along customer journeys. To facilitate this, IATA brings together airlines and industry players to adopt a collaborative data-sharing approach among partners and stakeholders in the value chain and accelerate industry digital transformation goals.

Using AI/ML for improved food waste reduction at KLM⁽³⁾

In combination with larger data sets, AI rapidly improves and replaces traditional operations research techniques. For example, to reduce food waste, airlines have been looking at implementing optimisation practices such as meal selection at time of check-in, enabling frequent flier services to include customer food and drink preferences, and personalising meals and toiletries on board. With AI, airlines can track better what passengers want to consume on

board and improve waste sorting.

To reduce the number of unnecessary meals taken on board, KLM improved its passenger forecasting system, not only for the day of departure itself but also for predefined moments before departure. In this way, KLM could better cater for the expected number of meals. The existing passenger forecast model was based on traditional forecasting techniques. An AI-based model incorporating and combining several data sources like schedule data and flight data, proved to increase accuracy and be more reactive.

The improved passenger forecasts resulted in an improved service for customers. Less unnecessary meals are taken on board thereby reducing the food waste by up to 50% for their European flights, and reducing the fuel needed because of the associated weight reduction.

As a next step, the passenger forecast model has been extended with an enlarged data set to model predictions affecting different operational teams. It includes information on last-minute bookings, about passengers that did not show up or missed their connections, and on schedule and aircraft changes. The extended model uses many data sources and can predict AT-gate, the passenger and baggage volumes, and flight delays. In-flight catering, customs and security, baggage handling and other stakeholders are currently using these predictions to improve their operational excellence.

Looking ahead – with passenger numbers remaining dynamic up to the point of departure, in combination with better passenger number predictions and a closer collaboration between the catering company and airline – the airline can better match meals to consumers on board. Matching of meal supply to passenger demand is a priority for a more sustainable catering model. Volume of data, and consolidation of different data sources are important factors. In this context, data can be extended

(3) IATA 2021 Digital and Data Think Tank White Paper

Airlines' data sharing and artificial intelligence adoption

by capturing an individual's food preferences at different traveller journey points (Frequent Flier Programmes (FFP), booking, check-in) to improve the accuracy of the forecast. Improved food and water loading will also minimise excess weight on the aircraft providing marginal fuel savings.

▶ Developing industry AI capabilities

The success of AI adoption lies in its scalability, i.e. through open ecosystems data, and AI can be shared at large scale, in both a trusted and sustainable way.

Developing AI/ML algorithms on the "small" scope of an individual airline might have only limited benefits. On the other hand, once in use, and applied on big data volumes, these AI/ML algorithms can reach exponentially larger impact than expected.

Individual airlines using their own - limited - data scope to develop AI will achieve some benefits, but relatively (exponentially) small compared to big data volumes. To maximise the value of these algorithms, data volumes should be increased, for example by combin-

ing data sets at an industry level or by combining different types of data sets.

To maximise the potential benefits of AI, airlines need to experiment with AI on big data volumes. This requires access to new data sources and AI exchange ecosystems that are open to all airlines and can be trusted by them. However, to prevent an exponential increase of the processing of data and AI algorithms, these ecosystems should focus on their energy consumption and apply new technology and best practices to become more sustainable.

Of equal importance, a dedicated community of experts sharing knowledge about the data (quality) and the algorithms is needed to support and animate this ecosystem and share best practices: for example, an AI community for sharing best practices on the environmental and sustainability area, where AI is an enabler.

Airlines, in collaboration with IATA, are working towards enabling open data ecosystems and trust frameworks, to allow industry data and AI exchange, and designed to provide an industry platform for airline collaboration at scale, respecting antitrust regulations and

security and privacy policies of the different stakeholders. With sufficient data and proofed AI/ML applications across different areas of the business, airlines can fast track implementation of operational optimisation programmes, e.g. monitor and measure operational KPIs to track progress against industry environmental goals.

The IATA Digital Transformation team leads multiple industry programmes to support airlines on their digital transformation journey and their transition away from legacy. Our main priorities include enabling customer centricity with modern digital identity management, developing an open data ecosystem based on Open APIs, and stimulating innovation in the industry. ■

For more information, visit:

<https://www.iata.org/en/programs/innovation/>

Jean Ruiz Carpio is an aviation data and analytics professional with 21 years of experience. A former industrial engineer, she holds an MBA in aviation and an MBA in international business. Jean joined the International Air Transport Association (IATA) in 2000. During her extensive career in data, Jean has led multiple airline working groups focused on data acquisition and data sharing matters – Direct Data Solutions (DDS), Ticket Tax Box Service (TTBS), World Air Transport Statistics (WATS), New Distribution Capabilities (NDC) insights, Airline Cost Management Program (ACMG) among others. Jean has a broad understanding of airlines' use of industry data to support their operations and business decision-making. Recently, she joined the IATA Digital Transformation team (2021). In her role of head of aviation data, her focus is on industry engagement, data connectivity and AI initiatives.

Jeroen Mulder works for the Air France KLM Group CIO Office as technology innovation project manager. He has a background in mathematics, a PhD in algebraic geometry, and more than 20 years of experience as operations research analyst and data scientist. He has extensive experience in setting up simulation, optimisation, and statistical models for various divisions, like Operations Control Centre, Hub Control Centre, Engineering and Maintenance, and Revenue Management at Air France KLM.

Jeroen worked and lived in Paris for five years as part of the French Operations Research team responsible for developing the forecasting and optimisation models in the joint Revenue Management system of Air France KLM. In his current role, his focus is on supporting the airline to become more sustainable by applying AI. From this role, he has been organising webinars and hackathons as part of his "AI for Aviation Sustainability" initiative.

Air France pursues continuous innovation and invests in Big Data solution to improve flight efficiency

Laurent Lafontan

*Flight Operations Technical Development Vice-President,
Air France*



Reducing Air France's CO₂ emissions goes hand-in-hand with reducing fuel use. One of the cornerstones of the airline's environmental policy is therefore to reduce fuel consumption.

Air France is continuously investing in new equipment; a modern fleet not only provides greater comfort to passengers, but also helps to achieve significant fuel savings and to meet the airline's sustainable development commitments by reducing CO₂ emissions and noise levels.

One area where Air France is making a difference is in the promotion and use of sustainable aviation fuels (SAF) – an important factor in emissions reduction. Both Air France and KLM – who have been pioneers in the use of SAF – have policies in place that encourage and support their development and use.

Last – but not least – improving flight operations and implementing weight reduction measures on board, optimising flight routes and using up-to-date weather information all contribute to the reduction of fuel consumption. At Air France, there have been fuel plans in operation since 2009. The first actions to improve fuel consumption were



A350 with SAF

implemented between 2012 and 2014. It was decided to generate a new fuel plan in 2017, which resulted in a reduction of CO₂ emissions by 60 000 tons per year.

Subject to the strict rules of flight safety, every possible fuel saving measure is identified and implemented at Air France. Through its actions, the Air France fuel plan

reduces consumption by more than 4% currently on a yearly basis. All Air France departments are involved in the fuel plan, and the aim is to reduce fuel consumption by improving the operations processes, by making partnerships and innovating in the supply chain, and by mobilising staff and the industry.

We can take the example of the innovation partnership that Air France has built with Safety Line – a 100% SITA company – and its OptiFlight solution. Most airlines are familiar with Excel sheet fuel dashboards that offer descriptive analytics; but importantly, compared to those solutions that only analyse best practices, OptiFlight takes fuel efficiency two steps further by using predictive analytics with machine learning performance models that allow users to predict fuel consumption in different scenarios, and to prescribe recommendations directly to pilots to enable them to select the best scenario for each flight. That is achieved by bringing data science

Air France pursues continuous innovation and invests in Big Data solution to improve flight efficiency

into the cockpit, leveraging historical flight data towards developing flight-specific pilot recommendations. Historical data is used to build machine learning performance models for each tail number and that is then combined with the operational flight plan data and the 4D weather forecast of the day. Next, a “what-if” engine is run, considering tens of thousands of different scenarios to identify the best scenario and send that, by the simplest way, to the pilot.

In spite of these difficult times, both Air France and Safety Line are committed to reducing aviation’s environmental footprint and that is why they are co-innovating to improve fuel efficiency. Air France is an innovation partner with Safety Line; this means that together the two are exploring further innovation opportunities, such as OptiClimb – an app for flight optimisation in the climb, OptiLevel – to optimise flight levels during the cruise, and OptiDescent – which helps pilots anticipate the most likely approach plan.

The first module available to Air France pilots is OptiDirect. This



A350 cockpit

allows pilots to do what they have always done when requesting directs from the ATC to save time and fuel – but to do it better. Previously, they didn’t have the right information to be able to determine which direct they should take, or how much saving they would achieve thanks to that choice. They didn’t really have these answers and that is why airlines use OptiDirect to implement shortcuts based on historical tracks flown with an indication of fuel and time savings.

Air France is currently organising an experiment with the OptiClimb module. Thanks to customised speed changes at different altitudes, climb out offers a systematic savings opportunity.

Air France is also developing with Safety Line the OptiDescent module, which aims to improve even more flight efficiency by helping pilots better anticipate on Distance to Go based on machine learning of historical approach patterns.

The post-crisis world will not be the same. The fundamentals of AF-KLM strategy, including commitment to sustainability, remain and will accelerate. Innovation will be one of the elements of this reconstruction. ■



Laurent Lafontan has been the flight operations technical development VP since 2018. He is in charge of the technical support and strategical domains flight standards and policies, aircraft connectivity, EFB, flight optimisation, pilot and dispatcher’s digital tools, communication/navigation/surveillance, ATM.

As part of the ATM domain, he is also responsible for Air France’s SESAR projects and is a member of the SESAR Deployment Manager’s board representing the airlines grouping A4.

He started his career in 2000 as a flight quality engineer for Airbus. In 2002, he joined Air France as a cadet pilot and became a first officer on the A320 in 2004. After four years, his experience led him to fly the B777.

In 2019, he returned to the A320 as a captain. In parallel to his flight activities, since 2005 he has built an extensive knowledge of the flight operations domains, occupying numerous positions dealing with strategy, innovation, change management, safety, and quality management. In 2013, he was appointed as flight safety deputy VP (ten years of experience in flight safety), in 2015 as innovation and strategy VP. He holds a French aeronautics engineer diploma (ISAE Sup Aéro) and is a graduate of the HEC Paris Joint Senior Management Programme.

Next Generation Intelligent Cockpit – Single-pilot operations’ potential to increase flight safety

Dirk Kügler

*Director of the Institute of Flight Guidance,
German Aerospace Center*



Christian Niermann

*Researcher and Project Manager –
Pilot Assistance department,
German Aerospace Center*



For some, aviation with single-pilot operations will soon be the new standard and could be the means of achieving safe and efficient flight operations in the future with all the compelling changes. Others, however, are highly sceptical of such concepts and their consequences. Regardless, many aviation companies are researching these concepts.

In summer 2020, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) launched the Next Generation Intelligent Cockpit (NICO) project to research future single-pilot operations, which refers to flights with only one pilot in the cockpit. Unlike other projects, the NICO project aims to neutrally evaluate the possibilities and boundaries of single-pilot operations for airline-class aircraft. While the project is independent of aircraft manufacturers, avionics companies or interest groups, it nevertheless consults experts from all domains, and its results are regularly reviewed by external independent experts. NICO also considers flights as a whole instead of examining individual flight phases. The NICO project’s goal is a holistic evaluation of the challenges in commercial aviation from the planning and preparation of a flight through the flight

execution and final debriefing at the destination airport.

In addition to evaluating single-pilot operations, the NICO project aims to develop two core technologies and investigate their support potential for future generations of cockpits. The first technology is a virtual co-pilot, which functions as an assistance system to support the crew inside the cockpit. The second development is the concept and implementation of a remote co-pilot. The remote co-pilot is intended to support the flight crew from the ground in low-workload situations as well as during high-load phases. For example, the remote co-pilot will have an extended information field for emergency situations to enable it to assist with planning and decision-making. Both technologies will be expanded in the future with artificial intelligence so that necessary

“...the NICO project aims to neutrally evaluate the possibilities and boundaries of single-pilot operations for airline-class aircraft.”

decisions of the pilot can be based on the largest possible database and react correctly to unforeseen events. In the short term, the research results also contribute towards the reduced workload and increased safety of ongoing multi-pilot operations.

Next Generation Intelligent Cockpit Single-pilot operations' potential to increase flight safety



Besides these technologies, future systems and procedures within the context of single-pilot operations will have a major impact on current handling methods in the cockpit and on the ground. The NiCo project is therefore also examining the resulting effects on pilots and remote co-pilots. The potential changes arising from single-pilot operations cannot be neglected. Both physiological and psychological effects are being examined in the project. This change in the responsibilities will change the requirement profile for future pilots. While at present a strong focus exists on teamwork, communication skills and the ability to work under pressure, the next generation of cockpits in the air or ground support may require new and extended skills.

► Single-pilot operations: opportunity or dead end?

The term “single-pilot operation” has been familiar for some time, particularly in commercial and military aviation. Single-pilot operations place exceptional demands on the pilots. Factors such as increased workloads, higher traffic densities, the integration of other traffic participants into the airspace

or an increasing danger resulting from weather phenomena necessitate more extensive pilot support and a more intensive networking of the aircraft with its surroundings.

Faced with these obvious challenges, the NiCo project conducted multiple pilot workshops during the end of 2020 with 19 professional pilots from civil and military aviation. Five pilots were already flying as single pilots at the time of the workshops. The major difficulties for single-pilot operations in a commercial airliner were identified and assessed. Thirteen key categories of challenges posed by current aircraft if flown with only one crew member were identified. These categories ranged from shared situational understanding to decision-making in marginal weather, and handling the aircraft on the ground. The workshops also identified the advantages of supporting single-pilot operations via a virtual or remote co-pilot. The pilots in the workshop stated that the acquisition and processing of important information as well as the general information situation in the cockpit should be improved through new systems and active support from the ground. Despite the existing possibilities, such as satellite phones or support from the pilot's airline, there is still significant potential for improvement in

this area. All the experts agreed that extensive support from the ground would not only lead to better situational awareness of the current flight phase and possible alternatives but would also improve decision-making on all sides and result in safer flights.

Through concepts such as virtual and remote co-pilots, this necessary enhanced support could be realised. Additional coordinated assistance functions could reduce the strain on pilots by significantly increasing their performance and, as a result and in combination with automation, the safety of the flight. Another challenge is error management, which currently places the highest demands on the crew in multi-pilot operations. In future single-pilot operations, it is essential to ensure that system errors continue to be processed quickly and safely and that the best possible decisions are taken to avoid endangering flight safety at any time.

Beside internal causes, such as possible aircraft system errors, pilots must also consider the external hazard factors for a planned flight when making decisions. This consideration begins with the current and future weather conditions (e.g. thunderstorms, wake vortices or icing) and extends to difficult terrain and high air traffic density as well as demanding take-off and landing conditions. In a further finding from the expert workshop, the NiCo project considers risks that can arise subliminally and that have received little attention in aviation research to date. These risks include flights in challenging regions of the world in combination with minimal support from air traffic control, communication problems and errors due to language barriers, limited airport alternatives due to political situations and passengers or cargo with special status.

At the conclusion of the workshops, a senior captain of a major German airline stated that, “The future is already here; it is now time to make sense of it instead of resisting change. This is the only way to achieve safe and efficient flight operations in the future with all its compelling changes.”

“ The future is already here; it is now time to make sense of it instead of resisting change. This is the only way to achieve safe and efficient flight operations in the future with all its compelling changes. ”

▶ Artificial intelligence as a virtual co-pilot

The NICo project is developing a virtual co-pilot to support and relieve human pilots. Besides rule-based guidance, the virtual co-pilot will also be based on artificial intelligence. One primary research goal is a new intuitive interface between the crew and the virtual co-pilot. The current task is to create a human and virtual co-pilot team. According to the pilots interviewed, this is only possible if the artificial intelligence's behaviour and decisions are understandable, logical and comprehensible to the human pilot.

The transparency of the decisions and recommendations is particularly important when the virtual co-pilot focuses on automating functions for error management and defusing emergency situations, especially for errors that lead to cascading subsequent errors. By the end of the project, the error analysis and diagnosis capabilities with the intelligent functions of the virtual co-pilot will form the basis for improved human-machine interactions, which can also be applied to error events in current multi-pilot operations. At present in such an event, pilots are flooded with a high number of error messages. There is no quick way to ascertain what the core issue is. Pilots need information about the extent to which the aircraft remains airworthy or, in case of serious doubt, the necessary steps to restore this state. Therefore, in the NICo project, a consolidated system fault diagnosis is conducted, and the indication of failures focuses on the remaining capabilities of the aircraft.

▶ Remote co-pilot ground support as a transitional solution

The possible use of a remote co-pilot should not be seen in isolation but rather as a complement to the crew in the air. In contrast to the virtual co-pilot, the human support will remain on the ground. This approach, which at first sight appears to be a minor step towards providing comprehensive support for a single-pilot, can quickly become a major leap towards safer and more efficient air traffic. By removing the limitations of current aircraft design and certified cockpit technology, it is not only possible to access more up-to-date and comprehensive information on the ground, but it is also possible to contact specialists for specific problems or challenges. Since development is increasingly moving towards digital aircraft design, and simulations can depict an aircraft almost completely, it is also possible to examine the effects of creative troubleshooting by testing what-if probing simulations on the ground before they are presented to the air crew as an optimum and fully tested solution. Artificial intelligence can be a significant advantage when finding and checking possible solutions to determine their impact on the system as a whole. Thus, it will be possible at the end of the project by using artificial intelligence, not only to test solutions in a brute force manner but also to select the most likely best solution for the current problem at the outset. Furthermore, it is feasible to conduct trend analyses that can signal a possible danger before a problem occurs. The NICo project will develop a risk analysis for flights that can identify flight

segments that require special attention from all involved. This awareness will lead to a better understanding of the situation in the cockpit and enable the effective planning of rest periods and efficient organisation of the necessary availability of specialists on the ground.

The pilot workshops quickly revealed that the introduction of a remote co-pilot, at first considered to be a small step, has great potential. Selected functions that have been identified as being particularly important and helpful for remote-pilot operations are currently being implemented as prototypes. These functions are not only being developed for single-pilot operations in the long term but should also reduce the workload in current multi-crew cockpits. The use of a remote co-pilot requires a rethinking of the classic cockpit layout as well as a consideration of the necessary control station for the ground operator.

The NICo project concepts foresee that on a larger scale, a remote co-pilot would be responsible for providing support to numerous aircraft. Questions regarding the ideal design of the remote co-pilot centre, the transfer of aircraft between remote co-pilots, and emergency procedures are currently being addressed and will be taken to the prototype stage during the project.

Next Generation Intelligent Cockpit Single-pilot operations' potential to increase flight safety

► Outlook: from simulated flight campaigns to real flight trials

As the next step, the NICO team will fly the presented concepts with professional pilots in a full motion simulator as part of a large pilot study. The focus will be on crew communication strategies in the event of a challenging technical error on the aircraft. Troubleshooting in the cockpit will be particularly observed. During the study, the crews will fly an airliner both classically in a multi-crew and in single-pilot operations with the support of a remote co-pilot.

The findings of this study will contribute directly to the continuing work of the project and will guide further developments on all systems. Additional studies are planned for each following year. The final products will be demonstrated in a real flight with the DLR research aircraft ISTAR, which is a modified Falcon 2000LX, in 2024. ■

Follow the project at:
<https://nico.dlr.de/>



DLR aircraft ISTAR Falcon 2000LX

Dirk Kügler has been the director of the Institute of Flight Guidance at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) in Braunschweig since 2008. He is also a full professor (W3) for air traffic management (ATM) at the Technische Universität in Braunschweig, Germany.

His personal area of interest is the future design and automation of the ATM system (on ground and on board) as well as CNS technology. He also focuses on airborne collision avoidance and future surveillance technologies as well as navigation applications.

Dirk Kügler received a doctorate degree (Dr-Ing) in electrical engineering, communication, data and high-frequency engineering from Technische Universität in Braunschweig, Germany. Dirk Kügler is a member of the SESAR Joint Undertaking Administrative Board and a fellow (FRIN) to the Royal Institute of Navigation (RIN).

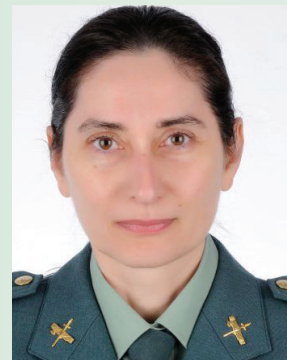
Christian Niermann has worked at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) in Braunschweig since 2014. He is a researcher and project manager in the Pilot Assistance department. As project manager, he oversees the Next Generation Intelligent Cockpit project. In his research, he investigates future multimodal assistance systems for use in the cockpit and can thus directly contribute his experience through his pilot licence.

Christian Niermann holds a bachelor's degree in international media informatics from the Berlin University of Applied Sciences and a master's degree in human factors with a focus on aviation psychology from the Technische Universität in Berlin, Germany.

ECAC Behaviour Detection Study Group

Interview with Carmen Feijoo

First Corporal of the Spanish Guardia Civil at the Fiscal and Airport Unit of the Command, and chair of the ECAC Behaviour Detection Study Group



The Behaviour Detection Study Group (BDSG) develops guidance material and best practices on behaviour detection (BD) in aviation security for the benefit of all ECAC Member States, as well as supporting those States wishing to establish their own BD programme. Carmen Feijoo, who has been chairing the study group since February 2018, answers a few questions for ECAC News on some of the latest issues the group has been dealing with.

1. What is the BDSG?

The BDSG brings together all those ECAC Member States that have already developed programmes of this nature. It is currently made up of participants from nine ECAC Member States, plus the United States and New Zealand as guests (observers).

One of the characteristics of the group is the confluence of people with different expert knowledge and backgrounds, such as scientific (psychology, criminology, etc.), operational (from State forces and airport managers) and regulatory (personnel from civil aviation authorities). This convergence is enriching and allows three perspectives to be brought together.

2. What are the BDSG's objectives?

The group was created a decade ago, with the following objectives:

- to develop guidance material and best practices on BD in the field of aviation security;
- to support Member States wishing to establish their own BD programme;
- to exchange information on the implementation of BD programmes, research and development initiatives, best practices, etc.; and
- to collaborate in international fora.

3. What are the BDSG's most important achievements as it marks its 10th anniversary?

As the largest forum of States with programmes of this nature, the BDSG remains in a unique position to optimise BD approaches and advise competent authorities on innovative developments in this field with potential application to the aviation security environment. In addition, the BDSG serves as a platform for scientific cooperation between experts.

Through collaboration, the BDSG has developed common guidance material and tools aimed at influencing international dialogue on BD techniques, and

enhancing existing national capabilities as well as the quality of BD programmes.

The ECAC Behaviour Detection Model Programme (BDMP) and relevant research and development initiatives carried out by BDSG members and observers continue to contribute to a more successful implementation of these techniques at airports around the world. The BDSG has developed guidance material on the use of BD that offers numerous deployment options in a range of environments including landside, airside and security checkpoints. In addition, BD could be adapted for different purposes, such as enhancing patrol and surveillance operations, improving security culture and reducing insider risk vulnerabilities.

4. What are the advantages of using BD applied to civil aviation?

BD can be deployed anywhere in the airport (e.g. central screening areas, check-in counters, boarding gates, etc.) and could therefore be considered as a suitable tool to enhance security in public areas. In fact, ICAO Doc 8973 considers that passenger waiting times provide the ideal opportunity to apply unpredictable measures such as BD.

Further advantages of this technique are its potential for improvement and flexibility, allowing it to be combined with other strategies aimed at deterring those who may pose a threat to civil aviation, and in turn raising awareness and engagement of both employees and airport users.

The primary objective of implementing a national BD programme at airports is to reduce the risk of terrorist attack by detecting, deterring and/or disrupting suspicious activities that may pose a threat to civil aviation.

In addition, BD is aimed at detecting, deterring and stopping other criminal activities within an airport (e.g. smuggling of people, drugs, money, theft, etc.). The



As soon as passengers enter the airport, behaviour detection officers carry out their work.

benefit of this wider application would be twofold: first, terrorist groups often engage in criminal activities to finance their operations, and second, these groups often have links to criminal organisations.

Tougher measures against criminal activity could therefore result in a reduction or greater discouragement of terrorist activity in the airport environment.

5. What topics is the group currently focusing on?

The task force is currently completing its 2021 work programme and planning for 2022. The activities carried out during the year include reviewing and improving the mentoring package and procedure, the study on the possible implementation of an online training methodology for BD, best practices for deploying countermeasures, and as an important topic, the research on the use of artificial intelligence within BD.

Also, on this last issue, a conference on the use of artificial intelligence in BD within the civil aviation context is being organised by ECAC with an important contribution from the BDSG. It will be held by video-conference on 13 December 2021.

6. What challenges do you see arising in the near future?

As included in our recent strategy paper and implementation plan for 2021-2025, the group acknowledged some of the ongoing legal challenges within the EU in respect of, inter alia, discrimination, bias, and invasion of privacy. Although it was agreed that these should not, in themselves, curtail continued research in respect of BD, consideration of the current legal positions would need to be taken into account before embarking upon any project/initiative.

In addition to this, the BDSG understands the severe impact of COVID-19 on the aviation sector and has acknowledged that it will probably be some time before the industry makes a complete recovery. Due to this, it is important to consider how to support stakeholders in providing the same levels of security with fewer resources.

Finally, the BDSG members are looking forward to developing more effective links with other ECAC working groups to improve the sharing of knowledge and best practice. ■

Carmen Feijoo is a law enforcement officer with 32 years of experience working as Guardia Civil. She is also an AVSEC trainer certified by the Civil Aviation Authority in Spain (AESA), has a five-year university degree in clinical psychology, a master's degree in forensic psychology and a PhD in psychology. Carmen has experience as a negotiator in crisis situations. She is head of the Behaviour Detection Group at Madrid Airport and responsible for the ICARO project (Identification of Anomalous Behaviour and Operative Response).

▶ ECAC Presidential visit to Montreal

Montreal, 27-29 October 2021

During his first visit to ICAO headquarters as ECAC President, Alessio Quaranta, together with ECAC Executive Secretary Patricia Reverdy, met with several Council members from all regions and enjoyed discussions on the lessons learnt from the ICAO High-level Conference on COVID-19, the priorities for the next ICAO Assembly in 2022 and cooperation between the



ECAC President and Executive Secretary (3rd and 2nd from left) with ICAO Council representatives from Australia, Japan, Malaysia, Republic of Korea and Singapore

regions. The parties held valuable exchanges of views on their respective priorities (innovation, safety and security and environment among others), including with industry representatives such as ACI World and ICAIA.

This visit was also an opportunity for fruitful discussions with the President of the ICAO Council and the ICAO Secretary General.



ECAC President and Executive Secretary (3rd and 4th from right) with ICAO Council members from Latin and South America in Montreal

▶ European inputs to ICAO High-level Conference on COVID-19

12-22 October 2021

European experts in the safety, facilitation, economic and security domains participated in the online ICAO High-level Conference on COVID-19 (HLCC 2021) under the theme of *“One Vision for Aviation Recovery, Resilience and Sustainability beyond the Global Pandemic”*. The experts have been preparing their inputs to the two conference streams through their participation in European coordination group meetings in their specific domains.

At the high-level conference, a good result was achieved on a ministerial declaration from the conference, based on a range of interventions on matters of key importance, such as the role of vaccination in enabling the removal of travel restrictions, and the need for sustainable recovery in the broadest sense, encompassing economic resilience and environmental considerations, in particular climate change given coming political decisions on this subject.

In the facilitation stream, the European working paper on strengthening the resilience of aviation by improving its crisis management framework, was widely supported. Other European priorities, such as the interoperability of digital health certificates, adherence to ICAO CART recommendations, assistance to aircraft accident victims and their families, and accessibility for passengers with disability, were discussed and supported.



As some papers were of particular relevance to the European coordination group on economic matters, the co-chairs and several members of the group participated in the daily coordination meetings of the European coordination group on facilitation, as well as in the conference itself.

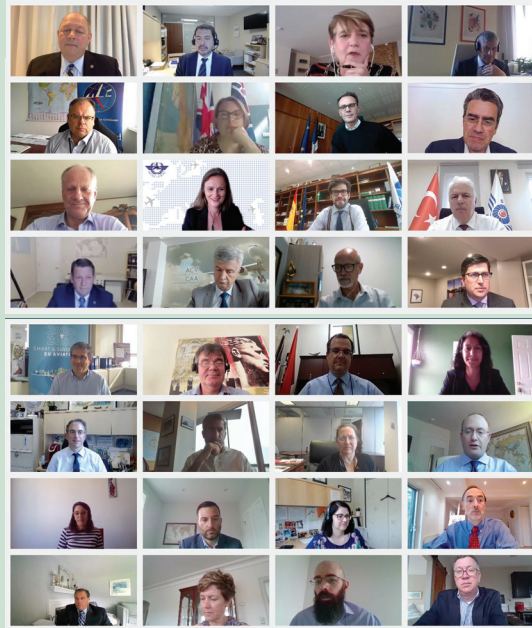
Europe presented three papers under the safety stream: remote oversight as a supplementary means to perform oversight; enhancing GASP to support innovation and increasing consistency with other global plans; and strengthening the resilience of aviation through the improvement of its crisis management framework, all of which were widely supported.

The European coordination groups on aviation security and aviation cyber security matters also provided advice on working papers with content relating to their own areas. These were taken on board and conveyed during the conference.

▶ United States' authorities and ECAC Coordinating Committee discuss strategic cooperation

3-4 June 2021

The ECAC Coordinating Committee's meeting with senior US officials made progress on a wide range of issues of strategic cooperation. Among the matters discussed on which common ground was explored and cooperation proposed were responses to the COVID-19 crisis, objectives for a long-term aviation goal for climate change and other environmental objectives, current and future aviation security technologies, priorities for ICAO and responses to the incident affecting Ryanair flight 4978 over Belarus. The meeting began with remarks from FAA Administrator Steve Dickson, who emphasised the importance of the transatlantic relationship, gave a brief update on key FAA programmes and highlighted his vision for the agency.



▶ ECAC Triennial Session elects new president and approves work programme and budget for next three years

12 July 2021

Directors General of ECAC Member States gathered online with high-level representatives from a number of ICAO Member States, regional and international organisations, and industry partners, including ICAO, the European Commission, EUROCONTROL, EASA, ACI EUROPE, A4E, CANSO and IATA, for ECAC's 39th Plenary (Triennial) Session.

Opening the Session, which for the first time ever was not held in Strasbourg, ECAC President Ingrid Cherfils commented on ECAC's commitment to supporting its Member States since the start of the COVID-19 crisis. She underlined how more than ever, coordination and harmonisation of measures had been at the heart of European action to ensure a fully coordinated approach for the restart and recovery of the sector and mutual recognition of measures, regionally and globally.

The Session featured opening remarks from ICAO Council President, Salvatore Sciacchitano, ICAO Secretary General-designate, Juan Carlos Salazar, and European Commission Director General for Mobility and Transport, Henrik Hololei.

Delegates heard reports from the Focal Points on ECAC's activities during the triennium 2019-2021 in the fields of safety and accident investigation, unmanned aircraft systems, security, facilitation, environment, economic and legal matters, as well as from the JAA TO, and the Session adopted the ECAC work programme and budget for the next triennium (2022-2024).

Alessio Quaranta (DGCA Italy) was elected as the new president of ECAC. Damien Cazé (DGCA France), Johann Friedrich Colman (DGCA Germany) and Raúl Medina Caballero (DGCA Spain) were appointed as vice-presidents. The Triennial Session also elected all other members of the Coordinating Committee. Full membership of the Committee is available on the ECAC website.

Recalling the importance of cooperation with regional and international partners, Ms Cherfils invited representatives of ACAO (Arab Civil Aviation Organization), AFCAC (African Civil Aviation Commission), LACAC (Latin American Civil Aviation Commission) and WAEMU (West African Economic and Monetary Union), as well as from Kazakhstan, Singapore, the United Arab Emirates and the United States, to offer statements on their cooperation with ECAC.

This year's Session marked the end of Ms Cherfils' second three-year mandate as president of the organisation. ECAC took this opportunity to thank her warmly for her active involvement in ECAC's activities over the years, for her excellent coordination, and constant determination to foster a culture of transparency and collective responsibility in order to promote safe, efficient, and sustainable civil aviation in the European region and internationally. We wish her every success in her new endeavours, and look forward to continuing and enhancing our activities with new president, Alessio Quaranta.

The documents and presentations from the Session are available on the ECAC website: <https://www.ecac-ceac.org/events-and-meetings/past-events/ecac-39>

► New ECAC appointments

13 July 2021

Following the election of a new Coordinating Committee at the ECAC Triennial Session on 12 July, ECAC's Coordinating Committee members gathered online for their 191st meeting. The following Focal Points were appointed from among its membership:

- External relations: ECAC President, Alessio Quaranta (DGCA Italy)
- Safety: Luís Ribeiro (DGCA Portugal*)
- Facilitation and Security: Raúl Medina Caballero (DGCA Spain – lead for facilitation) and Gunnar Ljungberg (DGCA Sweden – lead for security)
- Environmental matters: Rannia Leontaridi (DGCA United Kingdom)
- Economic matters: Damien Cazé (DGCA France)
- Unmanned Aircraft Systems: Elisabeth Landrichter (DGCA Austria)
- Pan-European matters: Kemal Yüksek (DGCA Turkey).

ECAC Focal Points
(as of July 2021)

 Alessio Quaranta DGCA Italy ECAC President Focal Point for External Relations	 Damien Cazé DGCA France ECAC Vice-President Focal Point for Economic matters
 Raúl Medina Caballero DGCA Spain ECAC Vice-President Focal Point for Facilitation and Security (lead for facilitation)	 Elisabeth Landrichter DGCA Austria Focal Point for Unmanned Aircraft Systems (UAS)
 Luís Ribeiro DGCA Portugal Focal Point for Safety	 Gunnar Ljungberg DGCA Sweden Focal Point for Facilitation and Security (lead for security)
 Kemal Yüksek DGCA Turkey Focal Point for pan-European matters	 Rannia Leontaridi DGCA United Kingdom Focal Point for Environment

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* Luís Ribeiro has since stepped down from his role as DGCA Portugal and as Focal Point for Safety

► Outcomes of 70th Special meeting of Directors General

Tirana/virtual, 26 -28 August 2021

Air transport developments in Albania, recent EU developments – in particular on the Slovenian Presidency of the Council of the European Union in the second half of 2021 – and developments in ICAO, including the main outcomes of the 223rd Council Session deliberations and European priorities and ambitions for the ICAO High-level Conference on COVID-19 (12-22 October 2021) were on the table for discussion at the 70th Special meeting of Directors General of Civil Aviation (DGCA/70(SP)).

The meeting was held over three days in Tirana in a hybrid format, with 57 Member State representatives joining the meeting on-site and 40 online, offering many Directors General the opportunity to meet in person for the first time in well over a year.

This was the first DGCA meeting chaired by Alessio Quaranta in his capacity as ECAC President. He was joined by ICAO Secretary General Juan Carlos Salazar and Albanian Minister of Infrastructure and Energy, Belinda Balluku, who both addressed the meeting.

Ahead of next year's 41st session of the ICAO Assembly, the meeting discussed the elections to the ICAO Council and the high-level strategic ambitions for the Assembly. Directors General identified environment, COVID follow-up including crisis response and health safety, cyber security, and innovation as European strategic priorities for the Assembly.

EASA, EUROCONTROL and the ECAC Secretariat shared information on recent developments in safety, ATM and environment matters. ECAC Executive Secretary, Patricia Reverdy, and Deputy Executive Secretary, Mark Rodmell, provided updates on recent ECAC Secretariat activities, including the implementation of the CASE II Project, and forthcoming events such as ECAC Forum/14.

An innovative feature of the meeting was a high-level briefing on the long-term aspirational goal for international aviation (LTAG), delivered by César Velarde, ECAC Climate Change and Capacity-Building Specialist. Directors General welcomed the initiative and asked the ECAC Secretariat to prepare similar briefings on other subjects at future meetings.



► Coordinating Committee discusses business ahead of DGCA meeting in December

4 November 2021

The ECAC Coordinating Committee reviewed the business of ECAC based on recommendations from the ECAC Medium-Term Objectives Task Force, and discussed other essential business ahead of the December DGCA meeting (DGCA/157). Topics included preparations for the 41st ICAO Assembly, including the question of elections to the ICAO Council. The report of implementation of the work programme and the

ECAC risk register were respectively acknowledged and endorsed ahead of the DGCA meeting, and the Committee dealt with other business relating to financial priorities, the work of coordination groups and other matters. Mirjana Čizmarov (DGCA Serbia) was appointed to the JAA TO Foundation Board; and Bertrand de Lacombe (France) was appointed as the new EMTO chair, with thanks recorded to the outgoing chair, Urs Haldimann (Switzerland).

► First joint ACAO/CASE II Project workshop on security culture in civil aviation

CASE in brief

6-8 September 2021

The first workshop of the CASE II Project jointly organised with the Arab Civil Aviation Organization (ACAO) focused on security culture in civil aviation. Approximately 60 experts attended this virtual event from 13 ACAO Member States. The wide range of presentations delivered to participants by experts from across the globe highlighted the breadth of issues related to promoting positive security culture in civil aviation: human factors, policy implementation and cyber security were amongst the subjects covered, and

experiences were shared by practitioners representing both airports and airlines. The workshop also benefited from a contribution by ICAO offering guidance on the support available as part of the ICAO Year of Security Culture (YOSC). The final day was dedicated to a breakout session, providing an opportunity for participants to assess a case study and answer questions designed to prompt discussions of various aspects of security culture. For the latest CASE II information, you are invited to visit their dedicated website at <https://www.case-project.org/> and follow them on Twitter using Twitter handle @CASE_II_Project.

► CASE II pilot activity on landside security vulnerability assessment in Morocco

Rabat, 27-29 September 2021

In the last week of September, the CASE II Project delivered a new activity in relation to landside security vulnerability assessment. The event's significance lay in the fact it was the first in-country activity to be coordinated and delivered by the CASE II Project in the wake of travel restrictions applied as a result of the global COVID-19 pandemic.

This pilot activity provided an introduction to the topic of landside security and was intended to examine the scope of related assessments so that participants develop the perspective required to undertake an effective review of landside security measures and potential vulnerabilities. Classroom activities were reinforced with a visit to Rabat-Salé Airport where the relevance of training topics could be associated with the physical airport environment. Participants came from a range of Moroccan State authorities, each of which were involved in the national level aviation

security risk committee. The activity was met with an enthusiastic and positive response from those involved and benefited from the kind support of the Arab Civil Aviation Organization through logistical support and the provision of classroom facilities.



► NEWS FROM THE ECAC SECRETARIAT

ECAC welcomes new staff members

BOHDAN KOVERDYNSKÝ joined the ECAC Secretariat on 1 November as an aviation security expert. Bohdan has 17 years of aviation security experience, working both for government agencies and operators. For the last five years he was responsible for the security operations of the Czech Republic air navigation services, covering the areas of aviation, cyber, physical security, personal data protection and emergency management. He is happy to bring back his experience to ECAC, where he started to gain it at the beginning of his aviation career.



TRIIN VENDIK joined the ECAC Secretariat on 1 November as CEP Assistant. Prior to joining ECAC, Triin worked in a bank in Estonia as a senior records management specialist where she was responsible for all the bank's administrative documents. Triin looks forward to bringing her previous experience of organising documentation and information-related data and ensuring it is easily accessible to support the CEP in the best way possible.



ALEKSANDAR YANKOV joined the CASE II Project team on 1 November, keen to participate in ECAC's activities in Partner States. His professional development has spanned various stages, but invariably directly related to aviation security. A former commercial airline pilot, he also has over 25 years of hands-on experience in development and application of national regulations and international standards. From 1995 until joining the CASE II Project, he was head of the security department at the Bulgarian CAA, manager of an aviation training, consulting and security services centre, as well as an independent trainer and a freelance consultant. Since 2013, Alexander has also been an ICAO international aviation security instructor.





► Events to come

DECEMBER

- 3/ 1st meeting of the EAEG Sustainable Aviation Fuels Task Force (SAFTG/1)
- 8/ 6th Familiarisation webinar on basic knowledge on aviation and the environment (ENV-FAMWEB/6)
- 9/ 46th meeting of the European Aviation and Environment Working Group – Expanded (EAEG/46-Expanded)
- 13/ ECAC Conference on the Use of Artificial Intelligence in Behaviour Detection
- 14/ 14th ECAC Forum of Directors General (ECAC-FORUM/14), Paris
- 15/ 157th meeting of Directors General of Civil Aviation (DGCA/157), Paris
- 15/ 40th ECAC Plenary Session (ECAC/40), Paris

JANUARY

- 11-12/ 54th meeting of the Guidance Material Task Force (GMTF/54), Paris
- 13/ 42th meeting of the Legal Task Force (LEGTF/42)

FEBRUARY

- 2/ 7th Familiarisation webinar on basic knowledge on aviation and the environment (ENV-FAMWEB/7)
- 2-3/ 52nd meeting of the Common Evaluation Process (CEP) Management Group (CEP-MG/52)
- 22/ 64th meeting of the ECAC Medium-Term Objectives Task Force (EMTO/64), Paris

MARCH

- 1/ 69th meeting of the Facilitation Sub-Group on Persons with Reduced Mobility (FAL-PRM/69)
- 2/ 53rd meeting of the Facilitation Sub-Group on Immigration (FAL-IMMIGRAT-SG/53)
- 2/ 8th Familiarisation webinar on basic knowledge on aviation and the environment (ENV-FAMWEB/8)
- 8/ 43rd meeting of the Legal Task Force (LEGTF/43)
- 10-11/ 49th meeting of the Training Task Force (TrTF/49)
- 24/ 194th meeting of the Coordinating Committee (CC/194), Paris
- 30/ 13th meeting of the Economic Working Group (ECO/13), Paris

News from the JAA Training Organisation (JAA TO)



ASSOCIATED BODY OF ECAC

► Editorial

Paula V. de Almeida, JAA TO Director

Dear readers of ECAC News,

The COVID-19 pandemic has severely impacted our air transport system and challenged the social aspect of our global aviation community. Business meetings, collaboration and synergies had to be rethought. Yet the progress in artificial intelligence (AI) seems unfazed, even accelerated, by the non-appearance of human interaction.

Aviation has always been at the forefront of innovation, the most disruptive being AI. These fast movements in cutting-edge technology, such as autonomous devices, machine learning (ML) and deep learning (DL), create opportunities to transform air mobility systems by enabling new business models and mobility services. Aviation stakeholders embrace innovation and start research, policymaking and software/hardware production to bring efficiency, sustainability and safety to our air transport system. The fast-moving tech stakeholders and policymakers need to foster strong cooperation to integrate AI in the existing aviation architecture.

While AI will have an impact on the conduct of aviation operations, our training and learning development at JAA TO is very much in the hands of human control. Many internal processes have been automated and digitalised during COVID, but the heart of our operations remains a human affair – the JAA TO training experience is a social happening.

Proof of concept can be seen this quarter. Since JAA TO reopened its headquarters in September, trainees, instructors and staff have been enjoying the



much-anticipated classroom training energies in the corona-proof facility. Welcoming the executive director of CAA Albania for training, the ICAO TIC-2 course was the kick-off for an engaged registration period - classroom and virtual - bringing together the global aviation community and enabling professionals to excel in their jobs. With an adjusted schedule for the remainder of 2021, and newly introduced courses (*Aviation Security Management, FSTD Evaluation for Operators*), JAA TO is supporting the sector in building back better and restarting operations.

A new spirit and leadership also for JAA TO's Foundation Board: it was an honour to welcome newly appointed director, Jaco Stremmer (Director General, CAA Netherlands) to the training centre in Schiphol-Rijk for a meeting with JAA TO's director, Paula Almeida on 29 September. We look forward to having the full board present in the near future - a warm welcome is guaranteed. A recent interview with the current Foundation Board's directors is available on JAA TO's website.

By innovating its portfolio, expanding operations with a growing team and providing high-quality classroom/virtual training solutions, JAA TO is looking to successfully guide organisations through this training year and establish fruitful relationships for the sustainable and safe future of our sector.

► Hermes Air Transport – new JAA TO position paper

Continued collaboration, cooperation and consistency across the aviation industry will be the key to rebuilding global air services capacity and keeping passengers safe, and this sector sustainable.

Hermes – Air Transport Organisation, a not-for-profit organisation providing a worldwide networking and bridging platform for key stakeholders of the air transport sector, invited JAA TO to submit a position paper for its annual Recommendations series. Under the title “Resilience and efficiency through leadership and

cooperation”, JAA TO contributed to the conversation with its second position paper for Hermes, proposing a “future risk” research body that supports contingency planning and provides evidence-based solutions to potential industry problems in the future. The goal will be to have repertoires of prototypical solutions capable of being rapidly scaled up in the event of a crisis. Leadership must be exercised through an agency that has global reach, executive powers and access to meaningful sanctions.

▶ ICAO training – JAA TO director co-instructs prospective training managers

JAA TO's restart of classroom training was a success! Fourteen aviation professionals participated in the *International Civil Aviation Organization (ICAO) TRAINAIR PLUS - Training Instructor Course (TIC 2)* in September. JAA TO director, Paula Almeida, Master of Education (Med), co-instructed this course as an ICAO-qualified TIC-2 instructor. Edlira Kraja, Executive Director of the Civil Aviation Authority of Albania, is the first director to complete a JAA TO TIC-2 training, seeking to expand resources on training and facilitation: *"Albania is a remarkable country with regard to [the] fast recovery of the industry from the pandemic."* The TIC-2 training enables all trainees to methodically conduct training courses in accordance with ICAO's instructor competencies and develop the required training strategies for course delivery and



capacity building. As Ms Kraja comments: *"The knowledge and skills gained today can be used to develop our own in-house training modules taught in basic courses customised for our specific organisations or industry."*

▶ Interview: creating a robust security culture

In adoption of Resolution 40-11 at the 40th Session of the ICAO Assembly, the development of tools to enhance security awareness and security culture continues.

In this regard, JAA TO – in liaison with *dyami.services* – developed a five-day *Aviation Security Management* training for security managers to understand their role and responsibilities in establishing and maintaining security policy and internal quality control programmes to effectively secure an organisation's assets against outside threats. Robust security management helps to mitigate security risks to the organisation and the aviation system as a whole.

JAA TO interviews security and crisis management expert, Eric Schouten, to talk about the importance of intelligence network building and leadership-driven security culture. According to Mr Schouten, the omnipresence of COVID-related news in the media and security debate causes other imminent threats to be side-lined. *"We are not in a safe environment and people tend to look away. It will be the big thing for the next couple of years to refocus on the other threats and initiate a change of mind for proper contingency planning."*

To establish strong security culture in organisations, awareness-building and leadership-driven change are most important. The training develops the mindset to draft the right policy papers and determine how to work with those threats in the risk management model. *"Organisational security should not be a rule-driven necessity, but rather a preventive measure to protect people, the organisation, its assets, and its reputation"* says Mr Schouten. Read the full interview here.



If you want to learn how to identify and apply a multi-agency threat and risk management process within the aviation sector, including the management of change, check JAA TO's *Aviation Security Management* training.

More information on JAA TO UAS training via our website: www.jaato.com

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