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Digitalization, AI in Aviation and the Human Factor

Presented by JAA TO

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

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Introduction

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

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

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

Digitalisation

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

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

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

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

Data-driven Management

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

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

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

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

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

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

Implications for Regulation and Oversight

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

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

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

Conclusion

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

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

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