AVIATION SAFETY

Personalised Human Factors in the Digital Age

ABSTRACT

Organisational attention to human factors can be an important driver of continuing aviation safety. The rise of the digital age – especially the proliferation of personal digital devices such as smartphones – offers the possibility to transition from the historically group-focused to a new individual-focused approach to aviation human factors. We term this potentially transformative opportunity 'Personalised Human Factors' (PHF). This paper is a call for action to pursue PHF approaches and suggests what we call a Fatigue Risk Management, Assertiveness Facilitation, Safety and Quality Reminders, and Training Dynamisation (FAST) start for this journey.

THE AUTHORS

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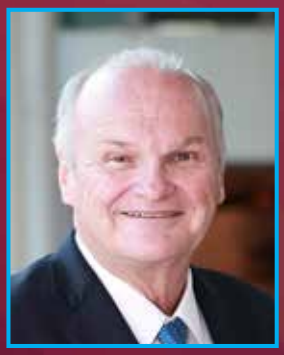

Dr William Johnson (Ph.D. University of Illinois, 1980) is the US Federal Aviation Administration (FAA) Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. Dr Johnson's experience includes over 40 years as a Senior Executive and Scientist in private and public engineering and airline companies before joining the FAA in 2004. He is the top FAA executive responsible for research and development (R&D) and technical programmes related to human performance in maintenance and engineering. He is an Aviation Maintenance Technician and a pilot for over 50 years. Dr Johnson has delivered human factors presentations in over 50 countries.

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INTRODUCTION

Human factors are an important driver of aviation safety in general and safety in aviation maintenance and engineering in particular. Over the past decades, systematic research and industry-regulatory authority cooperation has generated important new human factors insights. During that period, the analytical focus has shifted from human physiology and human-machine interface design to human behaviour and safety management system design. This shift has resulted in a variety of widely used human factors-oriented tools and error investigative procedures. However, in general, human factors programmes remain collectively focused on the analysis of and interventions targeted at groups rather than individual aviation professionals.

The rise of the digital age – especially the proliferation of personal digital devices such as smartphones, tablets, and other wearable devices – offers the possibility to transition from a group-focus to an individual-focus for aviation human factors. We term this potentially transformative development 'Personalised Human Factors' (PHF). This paper is a call for action to pursue PHF approaches and suggests what we call a FAST start for this journey.

AVIATION HUMAN FACTORS: A BRIEF BACKGROUND

The explicit formulation of human factors is still a relatively new concept. Over the past 50 years, major human factors advances have often been triggered as reactionary lessons learned from catastrophic events. These include non-aviation industrial disasters like the partial meltdown of the Three Mile Island nuclear power plant, the Bhopal gas tragedy, the capsizing of the MS Herald of Free Enterprise ferry, and the Exxon Valdez oil spill. Major milestone aviation accidents include the Space Shuttle Challenger explosion, the crash of American Airlines Flight 191 after an engine separated from the aircraft at take-off from Chicago, the explosive decompression of Aloha Airlines Flight 243, and the cockpit window blowout of British Airways Flight 5390.

As a result of these accidents and consequent calls for action in the US and other countries, human factors programmes are now part and parcel of aviation safety management in general and of safety management in aviation maintenance and engineering in particular. Earlier approaches to human factors had focused on issues related to human physiology and on optimal design of human-machine interfaces such as plant control room or cockpit design. These insights remain relevant today as aviation reels from accidents with contributing factors like system design, operating procedures and qualifications of human operators. More recent approaches consider human behaviour and safety management system design with a particular focus on the safety culture within an organisation. These different approaches to human factors have resulted in a variety of ways to understand and apply modern human factors. General models include the Swiss Cheese Model, the Dirty Dozen, and the PEAR Model (all summarised in Johnson, 2016). An exemplary specific tool to explore the role of human factors in an event is Boeing's Maintenance Error Decision Aid process (Rankin & e.a., 2000; Ma & Koschinski, 2018).

These innovative human factors tools have been widely adopted throughout the aviation industry. However, their adoption has been implicitly or explicitly predicated on a one-size-fits-all assumption as aviation businesses have implemented these human factors tools across their operations. There have been calls to adapt human factors approaches to the particular circumstances of different local operating environments via consideration of Four Environmental RISC Factors (Szepan, 2018). However, even if adapted to local operating environments, approaches to implementing human factors programmes remain collectively focused to the extent that they tend to address groups of aviation professionals – for example, aircraft maintenance technicians in the US – rather than individual aviation professionals.

LEVERAGING DIGITAL TECHNOLOGIES

As the industrial age has given way to the digital age, the positive disruption of digital technologies has radically impacted and continues to change the different ways that people live, consume, and interact, societies function, and companies do business. At the heart of the new digital age is the exponential growth of data volumes and ease of data generation and access. This includes the proliferation of smart phones and other smart digital devices. For example, it is estimated that 76 percent of adults in advanced economies and 45% of all adults in emerging economies own a smartphone (Taylor & Silver, 2019).

Given this proliferation of digital technologies, digitisation and digital transformation have become key priorities for almost any business. The capability to access and analyse large amounts of data and the ability to translate these digital capabilities into competitive advantage have become key value drivers. Historically, aviation has been one of the pioneers of leveraging digital capabilities as value drivers. For example, yield management, engine condition monitoring, and aircraft condition monitoring were integral parts of daily commercial and operational reality in aviation long before the term ‘big data’ became fashionable in other industries. Aviation continues to be a digital innovation leader via introduction of – for example – digital twinning and shared data platforms for predictive maintenance.

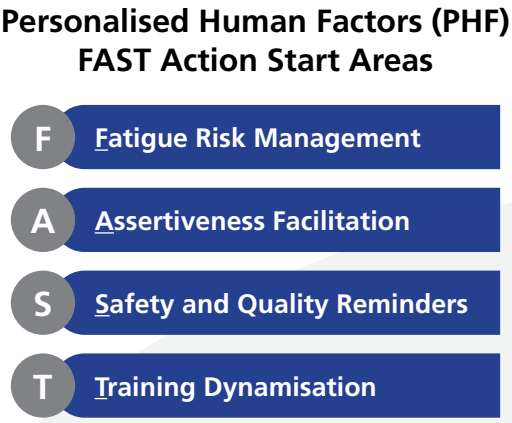
As much as aviation has been a digital innovation leader, especially in the areas of commercial and operational optimisation, digital technologies offer significant leverage for human factors approaches as well. As discussed above, human factors have undergone a significant paradigm shift over the past decades that has focused attention on issues such as human behaviour, safety culture, and safety management systems. However, even these human factors approaches have been implicitly or explicitly based on analysis – and recommended interventions – at the level of a group of aviation professionals. For example, significant progress has been made in terms of fatigue management best practices for groups of aviation professionals such as cockpit crew, cabin crew or aircraft maintenance technicians.

The proliferation of digital technologies and the ubiquity of smart devices such as smartphones – both as a source of individual data and as a means of real-time communications – offers the possibility to enhance safety by moving from a group of aviation professionals to individual aviation professionals as unit of analysis and action. We term this approach ‘Personalised Human Factors’ (PHF).

GETTING A "FAST" START

Digital transformation can be a formidable challenge. In any business, this challenge can be attributed to the plethora and complexity of different digital technologies and the inherent risks of early low-speed stall in any major change management endeavour.

We suggest four exemplary key action areas in the interest of building momentum toward PHF. These action areas are intended to make use of smart phones and other smart digital devices both as sources of individual data and means for personalized custom-tailored communication. We term this approach a FAST start: **F**atigue Risk Management, **A**ssertiveness Facilitation, **S**afety and Quality Reminders, and **T**raining Dynamisation.



Fatigue Risk Management: Despite significant progress in fatigue risk management over the past decades, fatigue as an accident root cause remains a pervasive problem. Worker fatigue continues to feature prominently in the latest NTSB *Most Wanted List*. The National Transportation Safety Board (NTSB) calls for a comprehensive approach to combatting fatigue that includes recurrent training on human factors and actions at the individual level (NTSB, 2019). Traditionally, group-oriented approaches to fatigue prevention have included hours-of-service regulations, minimum rest requirements, and on- and off-duty scheduling policies. Interestingly, recent research suggests that smartphones can have potential value as diagnostic support tools for measuring, for example, Parkinson's Disease symptoms in individual patients (Arora & e.a., 2015). We suggest that research be revitalised to what extent smartphones and other accelerometer-based devices can be leveraged to complement existing (preventive) approaches to real-time fatigue risk management. Wearables can serve as personalised line-of-defence fatigue diagnostic and warning tools. This is especially due to the ability of these devices to assess parameters such as posture, motion, and a multitude of environmental conditions. They can also communicate with personnel time keeping and scheduling systems to affect information relevant to fatigue. Scientific models can determine risk levels and provide immediate warning to the wearer.

Assertiveness Facilitation: Even in the best managed aviation businesses, anonymous or confidential voluntary reporting systems can be important building blocks of the safety management system. Also, in cultural environments that do not encourage public questioning of leadership or senior colleagues, voluntary reporting systems can serve as natural channels for encouraging workforce assertiveness (Szepan, 2018). Often, voluntary reporting systems are still based on somewhat cumbersome e-mail or online submission mechanisms or, at times, even on traditional snail-mail. Considering the ubiquity of smartphones, voluntary reporting could be greatly facilitated by making available smartphone app-based voluntary reporting channels that would allow employees to make submissions from their smartphones and that would allow attachment of pictures taken with the smartphone camera. Obviously, voluntary reporting systems apps would need to be designed in such a way that they would anonymise submissions (i.e. no recording of smartphone serial number, log in details, photo-embedded IDs, etc.). Fortunately, such solutions are ready for service. In keeping with a spirit of continued industry innovation, organisations must step up and capitalise on these digital technologies.

Safety and Quality Reminders: No aviation business is free of errors. Even world class aviation businesses would be well-advised to beware of "Not Happening Here" syndrome (Szepan, 2019). Even minor errors such as left-behind tooling or consumables can have a disproportionate safety and/or reputational impact. Such events can often be prevented by simple safety or quality reminders. For example, a manager of a leading Maintenance, Repair and Overhaul company used to manually send SMS along the lines of "Do not forget to remove aft safety jack prior to lowering aircraft main jacks" to the team leader in charge of jacking down an aircraft at the end of a major base check or landing gear change. Given the proliferation of personal digital devices, it would be relatively easy to turn this sort of manual effort into a systemic software solution that automatically sends personalised custom-tailored safety and quality reminders. For example, when an aircraft maintenance technician tries to close a task card that requires use of a particular tool that she/he had checked out from central tool stores, she/he and her/his team leader would receive an automatic real-time smartphone alert to return such tool. Obviously, many safety reminders are part of well-designed task cards. However, reality suggests that task card content is often overlooked especially if addition of general safety instructions leads to a sense of "content overloading". A direct custom-tailored message to an employee's smartphone received in real-time can be more effective than an easily overlooked reminder on the last page of a long task card.

Training Dynamisation: One of the major training innovations over the past decades has been widespread adoption of Computer-based Training (CBT). As powerful as CBT can be, it does suffer from some disadvantages. For example, poorly designed CBT is often not sufficiently interactive. That affects the transfer from training to the job. Also, similar to traditional training, CBT tends to be subject to 'block scheduling' – for example, scheduling of a full human factors refresher training once a year – which can result in 'learning for the test' rather than for work. In light of the ubiquity of smartphones and other smart digital devices, a 'phased scheduling' approach would lend itself to recurrent training. Instead of completing the annual human factors recurrent training in one go, such training could be broken down into daily increments. An employee would receive a link to a short training increment via her/his smartphone when logging in for work at the beginning of a shift. In addition, certain types of (recurrent) training could be custom-tailored on personal basis. For example, lessons learned from previous

errors regarding, say, landing gear change, could be sent to an employee's smartphone when the employee clocks in. If the employee receives a task card for an unfamiliar task they can receive just-in-time training and enhanced instruction on their digital device. That is just one example of training dynamisation.

CONCLUSION

Historically, human factors approaches have implicitly or explicitly treated groups of aviation professionals as the unit of analysis and action. The proliferation of digital technologies and ubiquity of smart personal devices such as smartphones offers the possibility to zoom in to the level of individual aviation professionals. We term this approach 'Personalised Human Factors' (PHF). PHF are intended to leverage the power of smart phones and other smart digital devices both as sources of individual data and means for personalised custom-tailored communication. We suggest a FAST start in four exemplary action areas to build momentum toward PHF. These FAST start action items are not meant to be an exhaustive, let alone exclusive, PHF agenda. They are intended – quite literally – as start of a journey to better leverage the possibilities of digital innovation in the area of human factors and to complement group-level insights with PHF approaches. We encourage continuation and indeed intensification of existing research and product development efforts in line with PHF approaches. Last but certainly not least, we recommend to stay vigilant with regards to issues of organisational culture and protection of employee privacy as key success factors when leveraging digital technologies in the interest of enhancing safety.

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