

Human Factors in Aviation Safety

13-14 November 2017, Hilton London Gatwick Airport

Presenters' abstracts

Monday 13 November 2017

Session 1: How do we improve human performance in aviation systems?

09:40 **Keynote: Health - the forgotten human factor in aviation?**
Sian Blanchard
EasyJet

The airline is pursuing an integrated approach to health and human performance to support our people at all stages throughout their working career and to develop initiatives to ensure optimal health and operational performance.

Accidents such as Germanwings 9525 have drawn attention to the psychological wellbeing of aircrew and have raised fundamental questions about an area that may not have received adequate oversight by safety management systems. Recognising the contribution of individual wellbeing to safety represents a coherent next step in the increasing sophistication of our safety management system which has been through stages of asset management, crew resource management, fatigue risk management, human factors and now health and human performance.

This integrated approach responds to: operational experience and meets senior management expectations; provides a vehicle for us to satisfy regulations and go further to achieve wider business objectives; and, aligns with a growing recognition in society about the importance of honest discussion of personal difficulties and provision of timely interventions in fostering resilient individuals and organisations.

10:10 **Introducing the Aviation Academy Safety Culture Prerequisites Tool**
Selma Piric
Amsterdam University of Applied Sciences Aviation Academy

Throughout the past three decades, much has been written about what fosters a positive safety culture within organisations. Following a literature review, the Aviation Academy of the Amsterdam University of Applied Sciences identified a list of 37 prerequisites for safety culture development and has proposed a respective framework. Preliminary studies in the Aviation Academy indicated that the topics assessed through existing safety culture measurement tools do not reflect all prerequisites for safety culture. In addition, current safety culture assessment tools target to the measurement of the subjective perceptions of the workforce without examining the parameters affecting safety culture, thus they cannot be used to provide the organizations with guidance on the action points for improving their safety culture.

To accommodate the need for a practical guidance to companies, and as part of a four-year research into Aviation Safety Metrics, the Aviation Academy has developed the AVAC-SCP too which aims to shed light on the planning and implementation aspects for developing a safety culture. The tool has been reviewed by knowledge experts and companies as a means to meet various criteria referred in literature with regard to metrics. More pilot studies and reviews have been scheduled before the conference in order to improve the tool further.

Also, the researchers will couple the AVAC-SCP tool with a well-established safety culture assessment tool in order, on one hand, to enable organizations to cover both dimensions of safety culture (i.e. plans and their effects), and, on the other hand, to demonstrate how the results from a safety culture measurement can be linked to the AVAC-SCP in order to derive action points. Moreover, a scoring method will be included in the AVAC-SCP in order to examine statistical associations with safety culture measurement results and safety outcomes of organizations. The concept, layout and other characteristics of the latest version of the AVAC-SCP will be presented and discussed with the participants of the conference.

10:30 **How does managing a formation of multiple unmanned vehicles impact operator performance?**
Jaina Mistry and Fiona Cayzer
BAE Systems (Operations) Ltd

Current Unmanned Air Systems (UAS) operations involve several operators/pilots supporting one Unmanned Air Vehicle (UAV). Future UAS operations are driving requirements for one operator supporting more than one UAV as a formation of vehicles to achieve mission goals. Additionally, there is a requirement for the UAV to operate covertly, which will mean the UAVs must go offline and stop communicating with the Ground Control Station (GCS) and the Operator. This highlights the need for increasing levels of automation/autonomy and the role of the operator evolving from direct control to that of a supervisory/commander role with the potential for moving towards a Human Autonomy Teaming relationship.

Subject matter experts took part in a week long assessment investigating the impact of remote multi vehicle operations on human performance. They were required to operate a formation of vehicles in a range of scenarios of varying durations and content. Performance data were collected including workload, situation awareness, trust, error and usability of the displays provided.

The results provided some expected and unexpected insights into what impact remote operation of multiple vehicles had on the operator's performance. In general workload and SA were good despite periods of no communications, errors were few and far between and trust in the system grew over the course of the assessment week with operators modifying their opinions on a number of key aspects of the assessments.

The presentation will provide details of the assessments and the outcomes and will discuss what this means for the design of such systems.

11:35 **Can the use of angle of attack systems help to mitigate Loss of Control In Flight (LOC-I) events?**
Michael Bromfield, Thomas Milward and Ben Everett
Coventry University

In-flight loss of control (LOC-I) is the number one fatal accident category in all sectors of aviation and all types of aircraft. In fixed-wing aircraft, the most common type of LOC-I event is likely to involve an upset/unusual attitude leading to a stall and LOC-I. The stall occurs when the critical angle of attack (AoA) is exceeded and this is independent of airspeed. Airspeed is used as a surrogate to manage the 'margin to stall' but this is not reliable as 'stall speed' may vary with the aircraft mass and balance, bank angle, normal acceleration and configuration etc.. The Federal Aviation Administration (FAA) actively promote the use of AoA in the cockpit as a mitigation for LOC-I but there is a lack of objective data to support this assertion. This research study evaluated the effects of AoA systems on performance and workload for student and low experience pilots (n= 20, Mean Total Hours = 46) whilst flying simulated normal and emergency procedures in the circuit (or pattern) in a Cirrus SR20. For the repeated-measures, within subjects study pilots flew 4 different scenarios in a pseudo-randomised sequence with and without a simulated commercially available AoA display in the cockpit. Pilot performance was assessed using RMSE

airspeed/AoA and un-weighted NASA- TLX workload assessment. Preliminary results suggest that whilst using an AoA system, pilot performance improved and occurrences of LOC-I were reduced, however this was accompanied by small but significant increase in workload. The results have implications for the operational use of current AoA devices and future AoA design.

11:55 **Human performance data collection – lessons learned and future challenges**
Anna Collard-Scruby and C. Jaeger
NATS

At the aviation safety conference in 2016, NATS presented the initial findings from a biometric measurement trial which aimed to gather human performance data in live air traffic operations at two NATS centres. We specifically wanted to look at the workload and fatigue behaviours of air traffic controllers with a more objective collection method than the ubiquitous self-reported questionnaire. This was a successful activity, and we were able to share some of the preliminary results at the 2016 conference. We hope to present a brief update to these results at the 2017 conference.

Additionally this work has now moved forward, and we hope to share some of the lessons NATS have learned, identify how to progress the use of biometrics in live operations and discuss the future challenges for applying this kind of measurement in Aviation. We think that Human Factors teams are well placed and well qualified to provide significant benefit to the on-going development of this work within the Aviation industry (and others!), and we offer some suggestions for how we might position ourselves to provide the most significant benefit from biometrics, along with some suggestions for skills we may need to develop to achieve this goal.

The potential benefits of collecting real time human performance data includes:

- Operations can be managed more effectively, increasing operational performance, reducing performance variability and safety events.
- Controllers gain greater knowledge and understanding of their psychophysiological responses during live operations which can be used to develop effective personal training plans to achieve the desired level of performance.
- An understanding of a good physiological profile can be used during recruitment process to recruit candidates most likely to be successful.
- The data can be utilised to inform Strategic Change programmes to enhance deliverables and ensure that change is delivered effectively and seamlessly into the organisation, with greater user acceptance.

We also hope to be able to share further research work in collaboration with one of the kit suppliers, which is currently in-process.

14:00 **Predicting human performance aspects of human error in Fast Jet cockpits**
Will Tutton, Nathan Smith and Don Harris
Defence Science and Technology Laboratory
Coventry University

Human factors regulations and standards do not provide adequate guidance on what are the most effective (valid and reliable) methods for use in design and certification of military Fast Jet aircraft cockpits (Godwin, 2015). This paper describes an assessment of the accuracy of using two Human Error Identification (HEI) methods, which have been validated for use on civilian flight decks, on Fast Jet aircraft cockpits. The two HEIs are the Human Error Template (HET) and Human Error In Systems Tool (HEIST). HET and HEIST analysis of an Air to Air Refuelling task was performed independently by three human factors analysts on FJ Aircraft X's cockpit. The results of the analyses were compared with actual errors collected through structured interviews with

experienced AAR pilots using signal detection methodology. The results showed that both HEI methods were significantly less accurate at identifying design induced errors in FJ aircraft than identified in civilian aircraft studies (e.g. Stanton et al. 2009). Reliability data showed that the inter-rater reliability for HET was good, and HEIST was moderate, indicating that the error framework for the methods was the principal reason for poor accuracy. Consistency issues with the methods stemmed from the majority of reported FJ pilot errors coming from manual control problems, which did not fit well with the two method error frameworks, as civilian aircraft have fewer manual controls. Of the two methods, HET was the more reliable; regarded as the most usable by the analysts; and has a greater utility for design and certification of Fast Jet cockpits. Improving the error framework to be more relevant to military Fast Jet cockpits will be essential to gain a more systematic understanding of human errors in Fast Jet cockpits. This study provides some evidence for needing to improve HEI Methods in this domain, and puts increased reliance on first generation methods such as HAZOP that are used in Fast Jet human error assessment currently.

14:20 **Helicopter pilot perception of air traffic controller responsibility**
Dan Martin
Coventry University

In this article, we describe an analysis of helicopter pilot perception of air traffic controller responsibility in several types of airspace, performing different tasks. Controllers and pilots must work together using a shared understanding to ensure safe and efficient flight. Structured interviews and subjective ratings of controller responsibility with thirty helicopter pilots indicate that there is variation in pilot understanding of controller responsibility when compared to the formal regulations governing airspace. This variation could impact on flight-safety. Significant differences in the perception of controller responsibility from the regulations were found for the task of aircraft separation in two specific types of airspace. Analysis of the pattern of response suggests that task type rather than the overarching variable of airspace type may be the key defining factor. Results are explained using the concept of shared mental models developed between the pilot and the controller. We suggest that further activities designed to bridge the pilot-controller gap are required to ensure a mutual understanding of tasks, continuing to support safe and efficient operations.

14:40 **Human performance - international regulatory update**
Kathryn Jones
CAA

Performance based oversight of aviation safety regulations requires a greater understanding of their impact on human performance (HP). The focus needs to be towards understanding the actual performance of the human in the operating context. This requires a safety management system approach that goes beyond the procedures and actively seeks to understand the impact of the organisation and the environment on the individual.

Regulators have to understand and monitor the performance of the Human Factors (HF) and HP requirements beyond the completion of HF training. ICAO Standards and Recommended Practices (SARPS) make frequent reference to consideration of “Human Factors”, “Human Performance”, “Human Factor knowledge”, and “Human Performance principles”. This multiple and inconsistent terminology has been recognised as a barrier to understanding. In order to support and develop understanding of the requirements and what they should deliver, ICAO has established a Human Performance Task Force (HPTF). The group’s aim is to develop a Human Performance manual that will describe the relationship between the terms HF and HP, as well as identifying and describing HP principles.

In parallel, EASA has recognised the cross functional nature of HF and the risks that are generated within and across domains. They have established a collaborative working approach with their stakeholders to identify aviation safety risks. This includes a cross functional HF Collaborative Analysis Group (HF CAG).

This presentation will provide an update on the work of the ICAO HPTF. It will include an overview of the group, the problem as identified, expected outputs and progress to date. It will also provide a briefing on the work of the EASA HF CAG and the way that EASA is approaching HF risks with European regulation.

Session 2: Is adaptive automation still a useful concept?

15:45 **Keynote: Is adaptive automation still on the horizon?**

Kathy Abbott
Federal Aviation Administration

Abstract to follow.

16:15 **Autonomous systems: designing pilots out of the loop or back into the loop?**

Fiona Cayzer and Annette Ek
BAE Systems (Operations) Ltd

It is widely accepted that there is a continuum from manual operations, through automated operations to now autonomous operations by exploring computational intelligence and system learning to adapt to unanticipated and changing environments. Unfortunately there also seems to be a conception of an associated continuum from pilot-in-the-loop, pilot-on-the-loop to pilot-out-of-the-loop. This is a misconception which will be illustrated in the presentation.

Up until now the role of the human in automated systems has mainly been as a supervisor over the automation. The alternative role emerging with more capable systems is one of humans and autonomy acting as team mates who collaborate on the performance of tasks. To make a real difference and avoid repeating what happened in the early days of automation –the role of the human in autonomous aviation systems needs to be considered from the start. Essentially the role of the pilot is evolving back into the loop (not out-of-the-loop). The flow of information is changing to a two-way communication and it is no longer about monitoring and intervening when things go wrong. It is about engaging the pilot in the most efficient manner and utilising the strengths of both the human and the more intelligent machine to achieve the optimum overall system performance.

So how do we design the pilot back into the loop? The presentation will discuss the need for human autonomy teaming strategies, going beyond specifying levels of automation, alongside creating human machine interfaces that will facilitate shared situation awareness to achieve efficient human autonomy interaction. The presentation will provide top level guidance whilst recognising that there is an urgent need for more detailed design guidance.

16:35 **The STRESS project**
Stefano Bonelli

During the first six months, the project generated future scenarios that will be the reference for the future work. STRESS started from the analysis of the current expectations of ATM stakeholders towards automation. European research agenda is working to introduce higher levels of automation in air traffic control. In the future, a new generation of highly automated supporting technologies will be developed. They are expected to autonomously (or partially autonomously) manage tasks that are currently carried out by human operators and/or to support humans in making decisions that the operators will hardly be in a position to question. This new scenario will inherently change the role of the technology, its interactions with the operators and the capability of the operators to judge the quality of the information provided. This, in turn, will imply the need to consider the new systemic risks and mitigations that can be associated with technological and/or organisational failures. It will also imply the need for a radical revision of the competences required to perform tasks – as well as of how tasks, roles and responsibilities are allocated among the operators (both in the front-end and in the back-end) and between operators and machines. To address all these implications the project selected as a theoretical framework for automation definition and classification the research carried out by different authors such as Sheridan, Parasuraman and Bainbridge.

Based on this expected future scenario, STRESS choose some Human Factors aspects that will be particularly relevant in the future:

Stress

Attention

Mental Workload

Type of cognitive control on tasks

These have been recognized to be the most impacted Human Factors issues.

For this reason, they will be investigated through neurophysiological measurement tools.

In particular, the project designed 4 indexes able to assess these factors using electroencephalography (EEG), eye-tracker and skin-conductance-response measurement tools.

To check that these indexes are really able to measure these factors in an operational environment (traffic control center), they will be tested in an ad-hoc validation experiment.

16:55 **A cockpit designer's perspective on adaptive automation**
Sylvain Hourlier
Thales Avionics

Adaptive automation has been “a good idea” for 40 years now. Yet it’s hardly used so far. Automation changing in accordance to internal rules are widely distributed and eventually fail to be understandable whenever their inner change can’t be grasped by the operator supposedly “in charge”. Many example exist especially in the aeronautical industry.

The Asiana Airline crash (SFO July 2013) is only one example. Automation complexity (AP & Auto throttle) was reported by NTSB as one contributing factor.

The thing is the system didn’t publicize enough to the pilot what it was doing and the pilot never conveyed his intention in a way understandable by the system. The effect is a typical quid pro quo with eventually a dramatic “surprise” effect at the end.

Surprise is the problem. Either the system changes and brutally throws the pilot in front of a new situation (in complete rupture with their train of actions) or the system changes surreptitiously and the catastrophe will happen later on when nothing goes as planned by the pilot. So AI could be the

answer? When the system is based on AI all will be better. A personally witnessed UCAV experiments based on AI gives incentive that it isn't so sure.

So what is it that we want from adaptive agents? What is so cool about them? If you take the example of an assistant surgeon, you have your answer, we want that kind of adaptation. They facilitate the surgeon work without any (verbal) exchanges (not resource demanding to control). They know what to do and when to help. They can interpret any sign from the surgeon as a directive for help. They completely share the same references. They know so well the implicit that collective work seems like the work of a single entity.

Alas that is the description of a human being. So definitely what we seek in an adaptive automation (and the adjective should have given it away) is a quality reserved to the living. Adaptation is a characteristic of the living. We have misplaced assumptions of humanity on a technology without giving it the potential for it: proper communication.

It's called articulation work (most studied in CSCW L. Bannon, K. Schmidt) and it's been around 30 years at least. It's the key to enable effective cooperation between agents. DARPA has just realized it and is launching (2017) a massive research project so as to use AI to digitize the interaction level between an agent and an operator. Modeling with AI what makes a proper cooperation between agents could be the answer...All in all, I might revise my views on adaptive automation (but the bicentennial man is yet to come).

Tuesday 14 November 2017

Session 3: Are we managing fatigue in aviation?

09:30 **Keynote: Is Fatigue Risk Management Science working?**
Douglas Mellor
FRMSc

Fatigue Risk Management Systems (FRMS) in aviation has been promoted as a method of managing aircrew fatigue for some considerable time. ICAO has assisted in this endeavour by publishing their first ever guidance on the subject in 2012, co-authored by IATA and IFALPA. In some parts of the world, regulations have been put in place as a measure to assist airlines to focus on the fatigue hazard.

But, is FRMS working?

This presentation will explore the indicators that may tell if the rewards of introducing an FRMS are being achieved and indeed, if any of the stakeholders are enjoying a benefit.

10:00 **Pilot fatigue: an unmanageable condition, without extreme concessions**
Andy Taylor
TaylAir Aviation and Education Services

The flight time limitations of a pilot are complex in their detail, but EASA's increase in 2016 from a maximum 900 to 1000 hours caused concern amongst many, including BALPA, whose members cite fatigue as the biggest safety concern in modern aviation. Their data is compelling and logic dictates that pilots working longer hours will increase their susceptibility to fatigue. The ICAO definition of a fatigue management system is one that is driven by data and based on scientific principles and knowledge, incorporating operational experience. The persistent discussion on fatigue centres around duty and flying time, but the other side of the coin is often forgotten.

Managing fatigue isn't just about working hours, it is also about the off-duty time of a pilot. Today's industry offers little in terms of job security with zero or low hour contracts being offered to new recruits by some airlines; a stressful notion for anyone, especially considering the vast financial burden of training many of these people will bear. These recruits will also arrive after months, or even years of long hours, hard work and stress from their training and job application process, thus some start their career already suffering from or on the verge of fatigue. Add this to tight schedules, short turnaround times and little flexibility in the system to tolerate poor punctuality (or worse). Modern living carries its own stressors, some good, some bad, but the latter are on the increase and the recent forays into mental health awareness and management for the general public, as well as pilots, demonstrates this. Unless training is amended to be more forgiving, unless the industry relaxes scheduling and places less emphasis on punctuality, unless global aviation accepts that pilots are human and thus will always be affected by long hours, multiple sectors and/or crossing of time zones, unless stress management is fully incorporated into company fatigue management programmes, then fatigue will never be managed fully and will remain as a safety issue. This paper will address these concerns by reviewing past literature, past campaigns and initiatives, and considering the opinions of pilots and the public, to show that whilst industry is talking a lot about fatigue and safety, the concessions mentioned are unlikely to be undertaken and thus industry must accept fatigue as a systemic problem that will never be overcome; as long as we have human-centred operations, we will have human-centred problems.

10:20 **Are we managing fatigue in aviation: a practical examination of Fatigue Risk Management**
Sarah Booth
Clockwork Research

Aviation regulators, for example in Europe, Australia, and the USA, have introduced new flight and duty limitations (FDTL) for flight and cabin crew, along with the requirement for operators to demonstrate that they are effectively managing their fatigue risks. As with other areas of aviation safety, the management of risks is moving into performance-based regulation – simple compliance with prescriptive FDTL is no longer considered sufficient to manage fatigue risks.

While there are manuals and guidance materials for operators – for example the International Civil Aviation Organization (ICAO) Fatigue Management Guide for Airline Operators (Second Edition, 2015) – fatigue risk management can still prove to be a challenge. This presentation outlines four different fatigue risk management projects undertaken by Clockwork Research during 2016-2017. In all of these projects, the operator's aim was two-fold: to better manage fatigue risk and also to gain specific operational advantages, such as approval to operate outside a specific section of the national prescriptive FDTLs. The four operators are distributed across the world, and represent four very different areas of the aviation industry – a short-medium haul operator; a long-haul commercial and cargo operator; a Helicopter Emergency Medical Services (HEMS) provider; and a float-plane operator.

This presentation focuses on how the fatigue risk management system approach is used in aviation. This is achieved through examining these four case studies, which highlight differing degrees of sophistication with safety management, the impact of the different operational and regulatory environments, and the unique fatigue hazard profiles presented by the operation. The presentation will also discuss the role of consultants as fatigue management facilitators, rather than the 'fatigue police'.

The presentation concludes with identifying global differences in the management of fatigue in aviation, and examining existing and future challenges to ensuring that aviation fatigue is

managed.

Session 4: Where are the human performance limits in remote operations?

11:25 **Keynote: The future of remote towers**

Per Ahl
SAAB

Saab and LFV was first in the world to get an operational approved Remote Tower system, already in 2015. Now three airports are operated from the same Remote Tower Centre and more than 15000 operational hrs can be logged. Before going live numerous Human Factor validations and test was conducted since the start 2006. Per Ahl will present some of the experiences and findings through the years, as well give an outlook of possibilities which are around the corner.

11:55 **The certification processes of human-computer interaction for multiple remote tower operations**

Desmond Whitty
Irish Aviation Authority

The Irish aviation authority successfully provided remote air traffic services to two low to medium-density aerodromes from a remote location, simultaneously, thus winning the Single European Sky Award of Performance- Cost Efficiency. The main purpose of remote towers is to provide air traffic services from a remote location in a safe and expeditious manner. The study was conducted during the large scale demonstration (LSD) at Dublin airport where the Remote Tower Centre (RTC) is located. The LSD required 50 trials and involved 500 aircraft movements to demonstrate the provision of aerodrome control service (air movements control/surface movements control) and alerting service for both Cork and Shannon aerodromes from Dublin RTC simultaneously.

The study utilised a phased approach for the large scale demonstration (LSD) which gradually introduced scenarios with clear objectives in three defined batches. After each batch of trials a report was produced recommending advancement to the next batch of trials. The report detailed unexpected behaviours and results which informed conclusions and recommendations feeding forward to subsequent batch of trials. Following NSA assessment of documented argument and evidence, approval to advance to the next “batch” would be authorised.

The study utilised several research tools including the application of eye tracking device to assess controller’s monitoring skills, attentional distribution, situational awareness and focus of attention, additionally NASA-TLX was applied to assess ATCO’s perceived workload and performance. Further a Hierarchical Task Analysis (HTA) for Human Error Template (HET) was conducted for specific scenarios to identify potential human error in the multiple remote tower operation. Three scenarios were presented Scenario 1: Simultaneously Landing on EINN and EICK, scenario 2: Simultaneously Landing on EINN and departure at EICK and Scenario 3: Simultaneously Landing on EINN, departure and circuit item at EICK. Further, a Human Computer Interaction analysis was conducted to assess ATCO interaction with the electronic flight strips (EFS) system, out the window (OTW) view, Radar Data Display (RDP) and Information Data Display (IDP).

Generally, it was found that the design of the Pan Tilt Zoom (PTZ) function and the menu of OTW should be revised for enhancement of human-centred design, as these sometimes proved difficult to operate smoothly or be viewed clearly by ATCOs during emergent situations. Moreover, improved functionality can reduce ATCO workload and heads down time by providing a target lock function therefore assisting ATCOs in tracking objects in the air and on the ground. In addition, the touch input device of EFS for hand writing on strips should be revised for easier usage by ATCOs. Although, interaction with the EFS and PTZ increased heads down time however it is believed that this potentially

will decrease with increased usage and exposure to the system.

There is a trend of increasing mental demand (46 vs 86), physical demand (20 vs 53), temporal demand (43 vs 85), effort (34 vs 78), and frustration (21 vs 61) for departing and arrival plus a trainer on circuit simultaneously between local tower and multiple remote tower operations. Furthermore, the performance has no significant differences (87 vs 82) by multiple remote tower operations compared to local tower operations (figure 1). There is a significant difference on the ATCO's perceived workload on mental demand, physical demand, temporal demand, effort and frustration, the multiple remote tower operations induced higher perceived workload than the local tower operations in order to maintain the same level of performance. It is quite straight forward that we expected one ATCO doing 2 ATCOs' work by using the new technology. Prior to operational deployment, any identified issues with the multiple remote towers solution, can be resolved by means of additional training, certification and interface design enhancements.

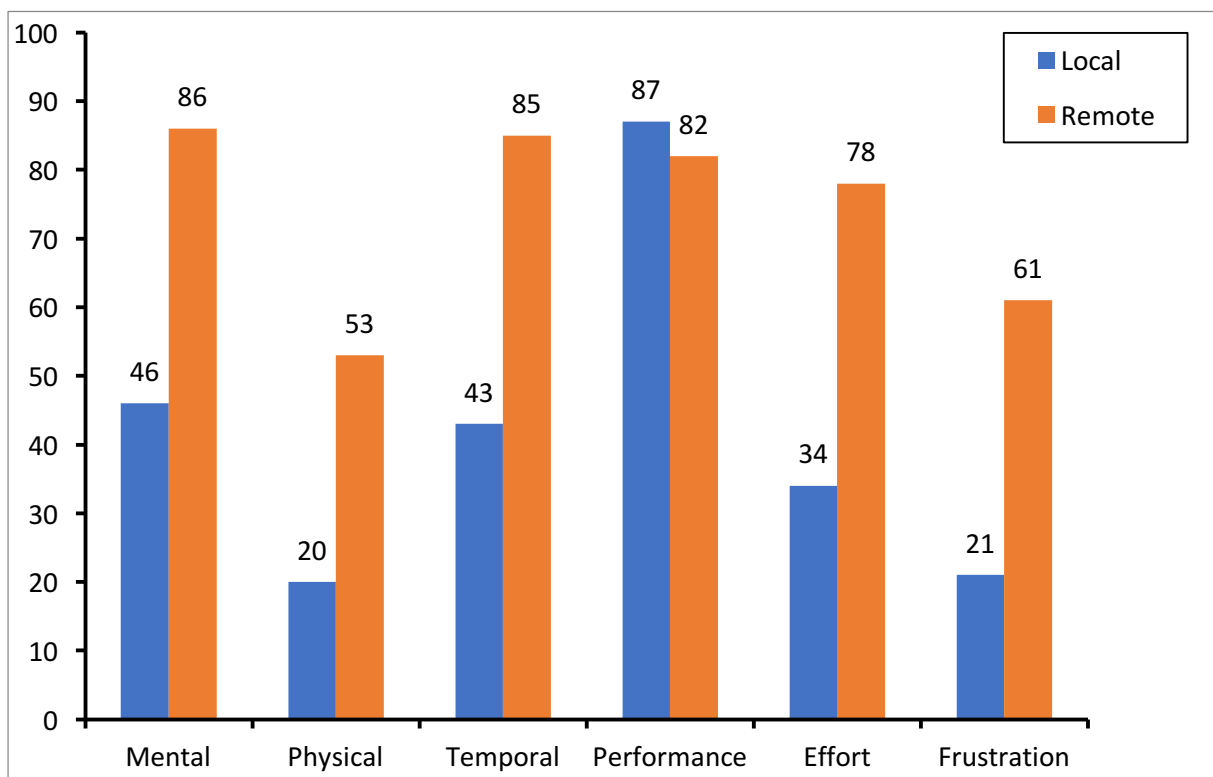


Figure 1: ATCO's perceived workload related to two B-737 departing and arrival from CORK in sequence compared to multiple remote tower operations of departure from R-35 CORK and arrival R-24 Shannon plus a trainer circuit on CORK simultaneously by NASA-TLX

12:15 **How real does reality have to be in remote towers?**

Jocelyn Clark

NATS

There is considerable research and guidance available to the discerning HF practitioner on the optimal design of a remote tower; in particular how to ensure that the experience is as real as possible for controllers. However, there are a number of challenges surrounding the concept of "reality" which need to be considered and resolved to ensure that the transition from airport to remote based towers is managed effectively.

What Sort of Challenges?

Whilst the debate about how to define reality is one of the oldest in existence, it is generally agreed that there are several different reality types that an individual can experience. Furthermore, the reality judgements which people make will influence their decisions about what needs to happen next. Therefore, understanding the key factors people use to work out what is and isn't real and how these differ in the remote operating environment is critical.

Building on from this is a need to understand the degree of reality experienced and its associated implications for sustained and optimal human performance. The question "can reality be TOO real in a remote tower environment?" needs to be asked and answered. Luckily there is already some research, such as the "uncanny valley hypothesis", which has done this and suggests that the relationship is far more complex than you may anticipate.

What Does This Presentation Provide?

This presentation provides:

An insight into the research that has been carried out on reality judgements, decision making and human performance and how these can be applied to digital towers;

Food for thought regarding the types of questions, data and advice that HF practitioners should add to their "tool kit", and

A forum to discuss future research requirements to explore this concept in more detail within the specific environment of remote tower operations.

Session 5: Have maintenance human factors fallen off our agenda?

14:00 **Keynote: The Airbus A320 family fan cowl door safety modification: a human factors scenario analysis**

Kyriakos I Kourousis¹, Anna V Chatzi², Ioannis Giannopoulos³

¹**School of Engineering, University of Limerick, Limerick, Ireland**

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Several Airbus A320 family engine fan cowl door losses have occurred in the past due to uninspected unlocked situations that have occurred in service¹. This issue is known to the industry for almost 18 years, however it has not been addressed adequately by the aircraft manufacturer and the various operators and regulating authorities. Airbus, in an attempt to address the issue permanently, proceeded in redesigning the FCD locking arrangement and control philosophy, which were subsequently adopted by the European Aviation Safety Agency, in 2015 and 2016, as Airworthiness Directives. However, as part of the EASA consultation process, a number of major operators (United Airlines, American Airlines, All Nippon Airways, Air Canada) have expressed reservations on the effectiveness of the Airbus redesign, on the basis of human factors issues, potential financial impact on operations and implementation cost. This brief paper intends to examine and discuss in a systematic way the possible operational and safety implications that the fan cowl doors modification can have in aircraft maintenance practice. It identifies issues in relation to this modification, introduced by Airbus and the European Aviation Safety Agency, which may prove problematic from the point of view of safety effectiveness and disruption of operations. An array of error-prone scenarios are presented and analysed under the prism of human factors in a non-exhaustive qualitative scenario analysis. Furthermore, a number of accident prevention solutions are proposed for each of the scenario examined, in view of the acceptance and implementation of this modification by operators.

14:30 **Big 5 personality traits and safety in maintenance engineers**

Paul Dickens

Core Aviation Psychology

Over the years there have been many studies of the typical personality characteristics of pilots. Recently these have generally focussed on the so-called “Big Five” personality factors – extraversion, neuroticism, agreeableness, conscientiousness and open-mindedness – as there is much research into the validity of these factors in predicting pilot performance, particularly in training. Other research has shown a clear correlation between low individual scores on two factors – agreeableness and conscientiousness and an increased tendency to be involved in unsafe incidents across a number of safety-critical professions.

There is little or no research into the personality characteristics of maintenance engineers, however, which is surprising given the correlations shown between safety incidents and personality. Psychometric testing of engineers during the recruitment process remains rare, although is common practice for other safety critical roles in aviation.

This paper will report on the typical personality characteristics of a sample of over 100 B1 and B2 licensed engineers working for a North Sea helicopter operator using a valid and reliable measure of the Big Five personality factors, and relate this to other variables such as engineering expertise and knowledge. Implications for safety and performance will be discussed, and relationships with the forthcoming EASA ruling about the psychometric testing of aircrew.

The presenter has many years’ experience consulting as a psychologist to operators and aviation manufacturers, and is a regular presenter at national and international conferences.

14:50 **Individual latent error detection in UK naval aircraft maintenance**

Justin Seward and Neville Stanton

Southampton University

Navy Command

Undetected error in safety critical contexts generates a latent condition that can contribute to a future safety failure. The detection of latent errors post-task completion is observed in naval air engineers using a diary to record work-related latent error detection (LED) events. A systems view is combined with multi-process theories to explore sociotechnical factors associated with LED. Perception of cues in different environments facilitates successful LED, for which the deliberate review of past tasks within two hours of the error occurring and whilst remaining in the same or similar sociotechnical environment to that which the error occurred appears most effective. Identified ergonomic interventions offer potential mitigation for latent errors; particularly in simple everyday habitual tasks. It is thought safety critical organisations should look to engineer further resilience through the application of LED techniques that engage with system cues across the entire sociotechnical environment, rather than relying on consistent human performance.

15:10 **Maintenance observation programme: gaining deeper insight**

Andy Evans

Aerossurance

The Flight Safety Foundation has produced a set of safety performance requirements for offshore helicopter operations (BARSOHO: Basic Aviation Risk Standards Offshore Helicopter Operations). This includes the concept of Line Operations Safety Audits (LOSA) during flights. LOSA is widely used in the airline community but has only just started to be used by the helicopter community. Despite the title, this is not an audit in the conventional sense but a campaign of de-identified

observations of flight crew that when collectively analysed gives insight into routine flight operations.

However, due to their mechanical complexity helicopter maintenance includes a far greater number of critical maintenance tasks than that of fixed wing aircraft maintenance. In 2016 the Foundation developed a further BARSOHO safety performance requirement for a Maintenance Observation Programme to give similar insight to how maintenance is performed.

MOP uses trained independent observers to collect data during routine maintenance, on a de-identified, non-punitive basis. It gives insight to how maintenance personnel manage threats and detect (or not) errors.

We will describe how this requirement evolved and discuss some of the previous attempts to produce some of the LOSA benefits in the maintenance world and the pitfalls.

This paper will explain how MOP is not a form of quality audit, compliance monitoring or supervision, but complements traditional oversight to provide deeper context and insight into organisational factors, the effectiveness of training and procedures and the strategies that personnel use to routinely ensure success that would not otherwise be evident. We discuss different ways that the objectives of MPO can be successfully achieved.

Posters

Aviation maintenance human factors – let's get creative (and disruptive)

Sam Lee

Integra Aerospace

Background

Human factors within the maintenance environment has become, for the most part, a tick in the box exercise for most organisations. Although Safety and Compliance departments relish the idea of having tailor made, memorable and engaging human factors training, mostly it ends up being a class presentation at best and generic off the shelf training at worst.

Having worked with a number of aviation maintenance organisations, small and medium sized, it has become apparent that there is a desire to increase safety and error preventative behaviour – but at what cost? Often budget sizes limit innovation and a creative approach to breaking out of the 'normal' way of delivering human factors.

Talk Overview

In this talk I lay the foundation and ground work for challenging delegates to think beyond the usual way of delivering human factors within the maintenance environment, regardless of their organisations size, and consider how we can better engage our teams using blended training design, activity based discussion, and cutting edge video based scenarios – such as recent occurrence reported incidents.

Human factors training that truly changes behaviour and challenges attitudes needs to go beyond the minimum regulatory frequency of once every two years and become a common theme that is talked about frequently.

This can be achieved by increasing exposure to human factor topics, within an organization, by running roadshows, poster campaigns, short HF animations on displays, developing a continuation programme that is split into 4, or 6 monthly segments, etc.

I will endeavor to promote a creative and innovative theme to the talk and subsequent discussion and demonstrate how this can be achieved.

Socio-technical systems design within organisational cultures: addressing growing complexity in the 21st century

Monica Quercioli and Paola Amaldi

University of Hertfordshire

The widespread use of techno-centric approaches in today's world reflects a growing acceptance that they meet technical requirements, increase efficiency (Eason, 2001) and improve economic performance. Yet despite their popularity as economic drivers, these approaches often neglect the complex relationships within human-technology interactions that can increase opacity, complexity and unforeseen risk (Baxter, 2011). As an alternative approach, socio-technical designs seek to address human-technology interactions (Baxter, 2011). However, this approach typically focuses on human-technology interaction rather than social interactions (Hollnagel, 1998) and the organisational cultures shaping the experiences of those working at the "sharp end" of operations (Antonsen, 2009). A more thorough understanding of these social interactions, unconscious biases and organisational power dynamics (Norman, 1993; Goguen, 1999) could shed light on how to enhance human communication, cooperation and interaction.

The perspectives of blunt-end and sharp-end stakeholders (regulators, air traffic controllers, engineers and

pilots, human factors experts) were analysed using findings from a 2014 automation workshop and a subsequent series of Civil Aviation Authority (CAA) meetings over an 18-month period. Stakeholders sought to identify concerns about automation at different echelons of the organisations. Power dynamics within organisational hierarchies can prompt senior/mid-level managers (either consciously and unconsciously) to dominate their subordinates, who willingly comply in the belief that this is in their best interests (Lukes, 1974; 2005). In doing so, the opportunity for sharp end operator input to assist crucial feedback is therefore reduced, as is the opportunity to create organisational learning (Senge 2009).

Using Grounded Theory (GT), themes were generated and illustrated to indicate possible relationships, associations and inter-connections. The resulting hypothesis stated that current work practices in the CAA, National Air Traffic Service (NATS) and broader aerospace community would benefit not only from focusing on enhancing human communication, cooperation and interaction, but also by raising awareness about deeper cultural issues, such as power dynamics, unconscious and organisational biases that lie beneath the surface of day-to-day operations.

The management of safety nets and their interdependencies

Paola Amaldi and Sara Khalil

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Automation challenges patterns of co-ordination/co-operation if the interactions between tools, procedures, tasks and agents are not understood during early phases of design or adaptation of legacy system. The present work examines the human system performance in the case of the management of the onboard air traffic collision and avoidance system aka ACAS.

Human Factors specialists support the design of interactions among distributed agents. The role of HF research is to identify principles that make these interactions fit for purpose at the individual, organisational, social and societal level. Recent development in Cognitive System Engineering (CSE) (Feltovich, Bradshaw, Clancey, & Johnson, 2007) have summarised the debate in human automation interaction by representing it through a bi-dimensional matrix, i.e., self-sufficiency refers to the degree of autonomy from the human input and self-directness refers to the degree of its autonomy from the human control. The coactive design approach emphasises a third dimension called 'interdependence' whose main attributes are: predictable, directable, feedback, transparency and provide assistance ((Johnson, Bradshaw et al., 2010).

Our Study. Through a mixed method analysis of 1636 Incident Reports from pilots and 1876 from ATCOs, ACAS-team members performance patterns were identified. Given Bradshaw et al framework of coactive design, how does ACAS-team members interaction score on the dimensions constituting the interdependence matrix?

The items requested by the Incident Report template included: whether there was any traffic information given by ATC before or after triggering off of the alarm and an appraisal of the evasive maneuver. There was a window ("Remarks") to use narratives to explain the circumstances that lead to the triggering off of ACAS.

Concerning interdependence, ACAS scored low in terms of its predictability, detectability, transparency, and knowledge of intent of the other agents including higher-level goals or other aspects of the task environment. Moreover its self-directedness was low. Given the current patterns of ACAS-team members performance, a shifting away from managing ACAS as a compelling (coercive?) alarm to an attention alerting device (coactive?) is suggested.

Enhancing pilot training through the use of computer based de-briefing tools

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Pilot training has traditionally been based on a combination of theory and instruction, delivered by ground and/or flight instructors. Prior to every training flight, trainee pilots are briefed about the purpose of the flight, in terms of development of skills, technique and/or maneuverers. Following the flight, instructors provide a de-brief which centres on providing feedback to the pilot. It is the latter briefing that is the focus of the current research. Advancements in technology now allow pilots to extract key information about their flight, in terms of track, altitude, heading, and roll to name a few. This information can be used to self de-brief. Hence, the aim of the present research was to assess if a commercially available web-based (and i-Pad) software application, capable of recording and displaying 3-D flight data in combination with graphical presentation of flight parameters such as altitude, groundspeed and heading could facilitate improved flight performance. Eleven trainee pilots with 64 mean flight hours performed three circuits in a fixed-base trainer designed to replicate a Cirrus SR20 aircraft in light 5kts cross-wind conditions. Participants were randomly divided in two groups: control group (no de-briefing) and experimental group (assisted de-briefing). Both groups conducted a circuit familiarisation flight, followed by two full circuits. The control group received no de-briefing after the first full circuit. The experimental group received assisted de-briefing using the web-based tool. The results revealed that the de-briefing group demonstrated improved ability to maintain altitude, speed and climb rates within generally accepted flying tolerances for private pilots. Pilots in the de-briefing group showed a 62.5% improvement for mean flight parameters in contrast to pilots in the control group who improved by 18.8% (i.e., learning effect). The results illustrate the benefits of using a de-briefing tool that displays flight performance information for trainee pilots.

Improving human performance in pressured situations

Rhian Williams-Skingley

NATS

Human performance lies at the heart of everything we do. In NATS, we incorporate and implement current human factors thinking into our design, development and assurance of new technologies, airspace and training. Working across both centres and airports, we have sought new ways to bring safety performance to the forefront of people's minds. Looking to the sporting world, we have combined and explored the principles that underpin Matthew Syed's "Black Box Thinking" book with the theory of "System 1/System 2 thinking" as explained in the works of renowned psychologist Daniel Kahnemann, notable for his work on the psychology of judgment and decision-making. This is being used as a vehicle for operational staff to discuss techniques for dealing with difficult and pressured situations.

As we move toward greater levels of automation, the NATS Human Factors team seeks to provide new and innovative ways in which to support operational ATC staff both from a technical and non-technical perspective. The aim of our work is to equip operational staff with the tools and techniques to enable them to recognise and react appropriately when the technology, the airspace or the traffic complexity requires. It seeks to counter biases in people's fast and automatic thinking (Daniel Kahnemann refers to this as our system one thinking) which make them seek only information which confirms their beliefs (called confirmation bias) with slow, considered and questioning thinking (system two and falsification).

Maintenance process and practice monitoring - taking human factors to the shopfloor

James Hayton

Baines Simmons Ltd

Regular human factors and error management training in maintenance has been in place for a number of

years now and despite initial enthusiasm and some initial gains there is a perception that the improvements it offers have stagnated. The work carried out in this study was aimed at moving the focus of prescriptive HF training from the classroom to the real-time workplace. Baines Simmons were approached by a leading helicopter operator in the UK to implement a maintenance LOSA (Line Operations Safety Audit) programme. However, on consultation it was decided that the collection and analysis of statistical trends, the basis of a normal LOSA programme, had several weaknesses. The 'LOSA-light' programme developed was named 'Maintenance Process and Practice Monitoring' (MPPM) and centred on a schedule of peer-to-peer observations, in which trained observers monitored peers conducting their daily work. The observers were tasked with looking for environmental issues (e.g. poor lighting, ineffective or poorly positioned staging, etc), deviations from procedures, alternative interpretations of procedures, stress, fatigue, system weaknesses, system improvements, cultural issues, etc. Where this programme differed from most LOSA programmes was that the observers offered feedback at the end of the observation period so that the observed worker could learn quickly from their errors, etc. However at the same time trending data and system improvements were also collated centrally so that individual learning could be broadened to organisational learning. Our client has been so impressed with the improvements made that they have quickly rolled the programme out across their global operation. Furthermore, and despite our initial fears, the programme has been enthusiastically received at all levels of the organisation not just by management.

Angle of attack displays in the cockpit – are they fit for purpose?
Samuel Everett, Michael A. Bromfield, Steve Scott, Alex Stedmon
Coventry University

On June 1, 2009, an Airbus A330-200 crashed into the Atlantic Ocean during a flight from Rio de Janeiro to Paris with the loss of 228 lives due to a 'Loss of Control In Flight' (LOC-I) incident. Following the surprise event of the autopilot disconnecting, the critical angle of attack was exceeded, leading to a stall, resulting in the LOC-I situation. Traditionally, commercial aircraft are fitted with stall warning systems and these may include audible warnings (aural cues), stick-shakers and stick-pushers (haptic cues). However, few commercial aircraft are fitted with a visual display of AoA to manage proximity to stall. Following the accident, the Bureau d'Enquetes et d'Analyses (BEA) recommended that Angle of Attack (AOA) be displayed on the flight deck to help mitigate LOC-I events by increasing pilot situation awareness (SA) and assisting in recovery. In contrast, in the General Aviation (GA) sector, where LOC-I accidents also dominate fatal accident statistics, there has been a recent proliferation of commercially available AoA displays - this growth being attributed to the relaxation of restrictions by the Federal Aviation Administration (FAA) with regard to the installation of AOA systems in GA aircraft. This said, there are no published design standards or certification requirements for such displays. This study, which forms part of a larger project in Human Centred Design (HCD) of AOA presentation in relation to LOC-I, has reviewed multiple presentation methods and designs in their aviation context using human factor principles to try and answer the question: are they fit for purpose? This presentation will set out key findings and discuss their relevance to developing standardised LOC-I support on the flight deck.

Maintenance human factors issues in UK military aviation
Sarah Weedon
Royal Air Force

Maintenance human factors issues in UK military aviation are identified through a combination of reactive investigations (where an engineering issue contributed to an accident or incident) and proactive review of engineering operations. By looking across the human factors investigations conducted for serious aviation accidents and the proactive reviews it was possible to highlight the human factors risks and issues which were found across military aviation engineering and maintenance.

Some of the human factors risks specific to the maintenance environment were those associated with procedures and documentation, tooling and equipment, and the working areas. Maintenance human factors risks and issues have been compared against those identified across broader defence aviation (including flying operations, air traffic control, and parachuting) and a number of the human factors issues

associated with the engineering cadre were common to broader defence aviation.

Identifying human factors issues creates the opportunity to provide interventions that will benefit the maintenance team, improve safety and reduce the risk of error. For example, ensuring sufficient rest breaks are taken throughout the day, including a lunch break, to reduce the risk of fatigue and ensure adequate nutrition is obtained. The finding that similar human factors issues affect both engineers and other aviation personnel provides a base from which to make organisational level interventions that will benefit the broader team. For example, to review the number of personnel in relation to task demands, working patterns and requirements, and then making adjustments as appropriate.

Maintenance human factors may have fallen off the research agenda in recent years, but the UK military has maintained a strong focus on human factors aspects of engineering tasks by recognising and taking action to identify, mitigate and address issues and continuing to improve flight safety.

Development of human reliability assessment methodology for military aircraft

Isabel Holtby and Will Tutton

Defence Science and Technology Laboratory

Military aircraft are complex systems and a human error in operating a system could contribute to an increased risk to life. Military Regulatory Publications (MRPs) mandate that potential risks to life induced by system failure are modelled, often using fault trees. This is to enable the person responsible for the aircraft (duty holder) to understand the risks inherent in its use, so they can either mitigate or accept them, or restrict operations with the aircraft.

Pilot error is more difficult to model, is not explicitly required under the MRPs and is therefore often not accurately represented in the safety case. Dstl Human and Social Sciences Group conducted an assessment to identify design-induced pilot errors that could lead to risk to life incidents on a particular military aircraft. Modelling of pilot error is adequately performed within the civilian aviation environment, however military aircraft perform a wider range of more complex tasks; therefore a different Human Reliability Assessment (HRA) methodology was required.

This poster presents the approach taken to develop an HRA methodology specific to a military aircraft. To identify the appropriate HRA approach, requirements were identified through: a literature review of other HRA requirements; stakeholder interviews to identify specific requirements; and review of relevant project literature within which the HRA will become a part. It was identified that the HRA methodology should be mapped onto Kirwan's HRA Process model (1994). This model requires several methods, including human error identification and human error quantification. Each method was chosen using a rigorous down-selection process, which will be further described in the poster.

The HRA methodology outputs a Human Error Probability (HEP) for pilot design-induced errors within the cockpit, and identifies mitigations to the identified errors. HEP of pilot error can then be included in the aircraft system safety case, resulting in a more accurate assessment of risk.

Use of touchscreens in a vibration environment

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Turbulence induced aircraft vibration is a key environmental characteristic that has potential to severely impact usability of touchscreens in the cockpit. Previous research is limited to static touchscreen testing, hence the use of touchscreens whilst undergoing motion is currently under-reported. Therefore, studies were undertaken under vibration conditions to investigate: (1) whether touch interaction (simple tap and gestures) could be performed with an acceptably low interaction error rate, (2) whether display positioning and hand anchor points could minimise arm fatigue and discomfort, (3) whether, under turbulence conditions, the use of force sensing can distinguish between erroneous and intentional interactions and (4) whether there are functional differences between a 15" infra-red (IR) touchscreen and the prototype 17.3" flight deck PCT display unit with touch pressure sensing.

Twenty-four participants undertook multi-direction tapping tasks (MDTT, as described in ISO 9241) with and without force sensing and gesture tasks: pan/move and increase/decrease functions under four vibration

conditions (control, light chop, light turbulence, and moderate turbulence), in three touchscreen positions: centre, side and overhead. Tests were conducted in a randomised order, on a 6-axis motion simulator at the University of Southampton. Recorded measures included error rate, time, accuracy and self-rated questionnaires for usability, workload and hand/body comfort. In an early pilot study, for MDTT under vibration conditions, the error rate increased significantly for circular button diameters below 3 cm and time for successful press doubled, when compared to the control condition. For functional gesture tasks, whilst the time to move a slider to the desired setting region remained similar for all vibration conditions, under vibration conditions, it took longer to position the slider accurately onto the setting compared to the control. The full results will be presented at the conference and discussed in relation to implications for future technologies on the flight deck.

Illuminating good-practice coping approaches to dealing with fatigue in aviation; the human side of pilot fatigue

Nick Carpenter

Flight crew cumulative fatigue has long been studied (Caldwell *et al.*, 2008) but has recently been given increased attention in aircraft accident investigation (Colgan Air, 2009). In this study, conducted for an MSc in Occupational Psychology, eleven commercial pilots were interviewed individually to explore their fatigue coping methods. A thematic analysis identified three themes enabling participants to improve their performance; strategically planning rest before duties, tactically adjusting behaviour to maintain alertness on duty and not complying with some company procedures to ensure alertness at critical times.

Procedures are assumed to be the glue that hold aviation together. Yet sometimes, crews cannot do their work in the manner laid out by procedures. With the cohort interviewed, fatigue management at a corporate level needs to be augmented as the work-as-imagined procedures fall short of the requirements of pilots' work-as-done reality. It can be argued that not complying with procedures strengthens safety by ensuring that crews are alert when their skill is most likely to be called upon. Consideration of how to integrate 'enabling non-compliance' into safe operations by improving crews' resilience may be one method of optimising crew performance.

Pilot fatigue management: where to focus more?

Jeffrey Nederend and Nektarios Karanikas

Amsterdam University of Applied Sciences

Pilot fatigue has been identified as a determinative factor in various safety events, leading to the introduction of Fatigue Risk Management regulations and standards worldwide. The scope of this study was to examine whether event and pilot characteristics recorded in safety investigation reports were associated with fatigue when the latter was stated as a contributing/causal factor. The sample consisted of 296 reports published by various investigation authorities and referred to safety events occurred between 1990 and 2014. The researchers conducted frequency analyses and Chi-square / Fisher Exact tests as a means to examine possible associations. Flight crew fatigue was found as a cause in 8.8% of the reports and was more frequently present in occurrences during evening and night operations, take-off, climbing, approach and landing phases, and Control Flight into Terrain and Runway Excursion eventualities. No significant differences were found regarding the year of occurrence, aircraft age, weight and type (jet, propeller, rotary), flight type (Commercial Air Transport and other), operation type (passenger and non-passenger) and event severity. Regarding the pilot characteristics, the more the hours on duty the higher the frequency of events where fatigue was recognised as a factor. However, no association was detected between the frequency of fatigue related events and pilots' age, hours of experience in the respective aircraft type and in total, and sleeping and resting hours before reporting for duty. The results suggest that specific event and pilot related parameters might play an increasingly influential role in fatigue development and its effects during adverse situations, thus indicating a need to steer the attention of the aviation industry accordingly.

Listening and learning

Andy Evans

Aerossurance

Organisations need to be confident that they are hearing all the human performance concerns and observations of their workforce. They also need the assurance that their decisions and learning are being actioned. The RAeS Human Factors Group: Engineering (HFG:E) set out find out a way to check if organisations are truly listening and learning.

This presentation will discuss that project. It will explain why the group choose not to develop an audit checklist, a questionnaire or a common data taxonomy. It will then discuss the advantages of a structured approach to encourage self-reflection by senior managers.

This reflective approach looked at three areas:

1. Identifying the Warning Signs and Opportunities
2. Analysing the Significance of Warning Signs and Suggestions
3. Taking Action: Learning, Improving and Leadership

The presentation will also discuss issues such as:

- How can we build a stronger open dialogue on safety and human performance?
 - How can we learn more as safety gets better and major accidents become rarer?
 - What do senior managers need to do?
-