A TREND ANALYSIS OF HUMAN FACTORS ISSUES IN UK MILITARY AVIATION

Sarah Weedon, Victoria Cutler, and Saskia Revell
Royal Air Force Centre of Aviation Medicine
Bedfordshire, UK

Human factors issues in UK military aviation are identified and mitigated through a combination of proactive support and reactive investigations, both of which employ qualitative data collection and analysis methods. Each piece of work to identify human factors issues is performed on a standalone basis, but a regular review is undertaken to identify common trends. In the most recent review of trends, thematic analysis was used within the framework of the Accident Route Matrix to determine the most prevalent and qualitatively important human factors issues. The thematic analysis identified a wide range of human factors issues, including resource availability, training, documentation, and fatigue. By applying a qualitative approach throughout the data collection and analysis, it was possible to develop a rich understanding of each trend.

A combination of proactive support (examining normal flying operations) and reactive investigations (analysing air accidents) are used to identify and mitigate Human Factors (HF) issues in UK military aviation.

Proactive support is provided through the conduct of Operational Events Analysis (OEA, Revell, Harris, and Cutler, 2014). The OEA is a proactive and preventative approach, which examines typical military aviation operations and uses that information to identify HF issues which are influencing the work of the unit. OEA involves an HF specialist attending a unit for a period of time, typically between five and ten days. During that visit the specialist will conduct semi-structured interviews with a cross section of personnel on their experience of working on the unit. The specialist will also observe work on the unit such as flight planning, debriefing, engineering tasks, and team meetings. The information gathered during the visit is then analysed qualitatively to identify HF issues which could influence flight safety and specify the role those issues may play in an accident.

UK military air accidents are investigated by a Service Inquiry (SI) panel. Each SI panel is supported by a number of advisors, including an HF specialist. The HF specialist supports the panel in the collection of HF evidence and throughout the analysis phase. The HF specialist also determines where HF issues could have contributed to the accident. The HF specialist then prepares a report for the SI panel which characterises each relevant HF issue and their role leading up to, during and immediately post-accident (Harris, 2011).

The proactive support and reactive investigations use a common framework to analyse HF issues, which is known as the Accident Route Matrix (ARM). The ARM was developed by Harris (2016), by adapting the Human Factors Analysis Classification System (Wiegmann and Shappell, 2003) into an investigation matrix. As shown in Figure 1, the ARM allows HF issues to be presented by both the type of issue (on the y-axis) and time of effect (on the x-axis). The ARM also identifies the links between the HF issues and demonstrates how each HF issue is connected to its role in an (actual or potential) accident sequence (shown by the boxes hazard entry, recovery, escape, and survival).

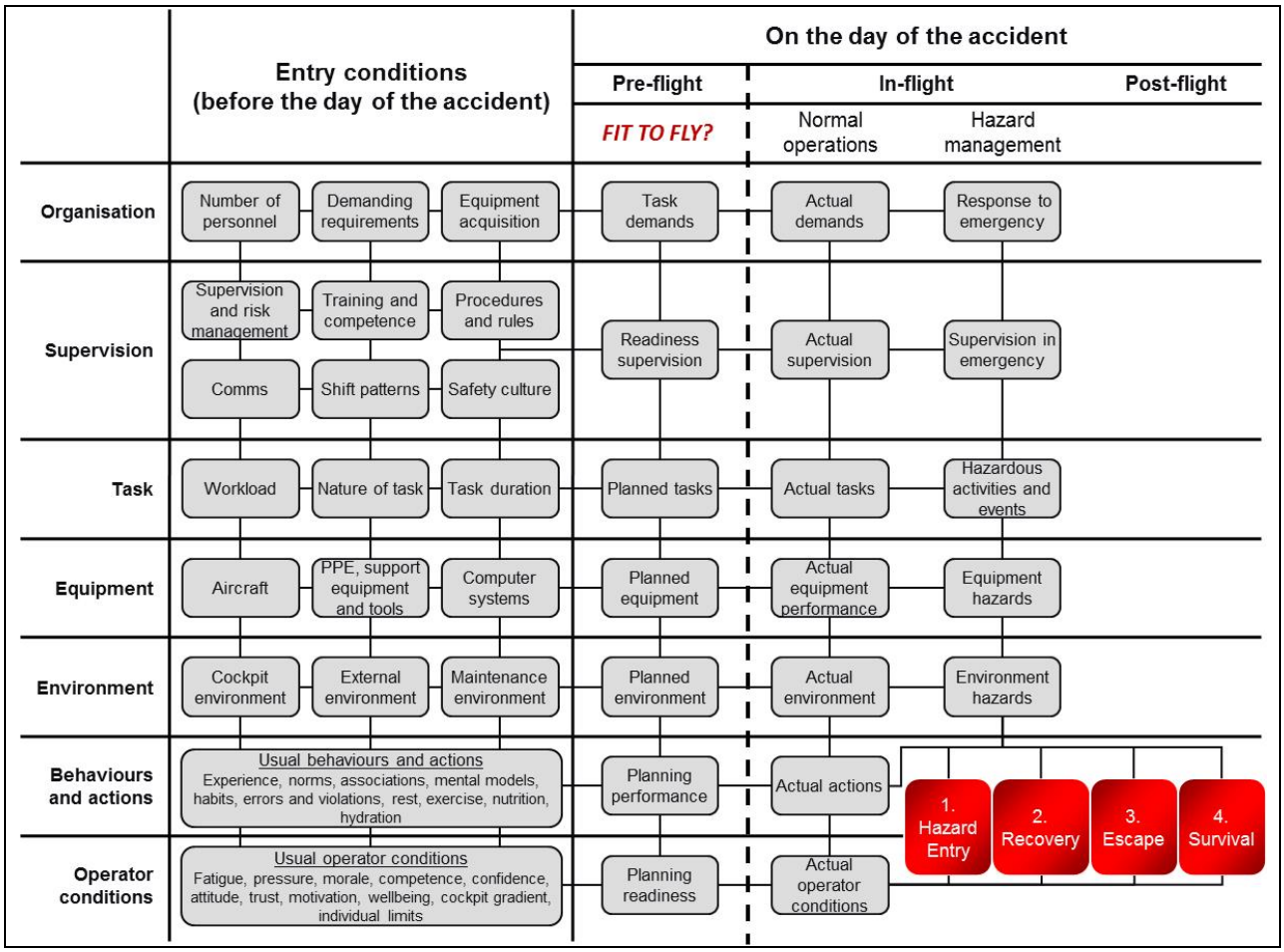

Figure 1. Accident Route Matrix.

The ARM is a fundamentally qualitative approach, as it is driven by the content and meaning of the information gathered. The benefit of such a qualitative approach in accident investigation is that the investigator can remain flexible during evidence collection and adapt to the nature of evidence available regarding the accident. The use of qualitative information reflects the richest available information about the accident, and so maximises the scope to understand why the accident happened. In applying the same process, used to investigate an accident, in the OEA immediately communicates the value of the OEA approach and means the OEA has good face validity. Applying a qualitative approach in a proactive safety investigation also offers benefits in terms of the depth of understanding of the HF issues and the links between those issues. Such an understanding assists in communicating the findings, demonstrating the credibility of the work, and in developing recommendations to address the issues identified.

Aviation safety incidents often share root causes and so analysing accidents and normal operations using the same framework (the ARM) enables common issues to be identified. However, each accident investigation and OEA is carried out on a standalone basis to ensure the HF input is appropriately tailored to the context. This enables targeted recommendations to be provided to the unit to improve safety but raises the risk that common issues and opportunities to address issues at the organisational level could be missed. Accordingly, a periodic trend analysis is undertaken with the aim of identifying the most critical trends.

Method

Data collection

Scope. Twenty reports were identified to act as the data set for the trend analysis. The data set comprised all the reports produced by the Aviation Psychology Team at the Royal Air Force Centre of Aviation Medicine (RAF CAM) between March 2013 and May 2015 inclusive. The type of reports included in this data set are shown in Table 1, the "other" reports refer to parachuting and Air Traffic Control (ATC).

Table 1.
Reports included in the trend analysis.

	Accident or incident investigation	Operational Events Analysis (OEA)	**Total**
Fixed-wing	2	4	**6**
Rotary-wing	4	7	**11**
Remotely Piloted Air System	0	1	**1**
Other	1	1	**2**
Total	**7**	**13**	**20**

The reports all shared the common qualitative investigative and data analysis procedure, as summarised in the introduction. The reports each presented the results of that analysis in the form of a series of descriptions of HF issues. Each description included the nature of the issue and, where possible, the causes of that issue and its impact on safety.

Analysis

Once the data set had been collated, a thematic analysis was carried out to "identify, analyse and report the patterns within the data" (Braun and Clarke, 2006). Thematic analysis was chosen as patterns within the data could be identified and reviewed in an iterative manner until the most prevalent themes emerged. As such, the process was driven by the qualitative information contained in the reports, but it also allowed a framework (the ARM) to be applied to the findings.

Data familiarisation and generating initial codes. Initially the reports were reviewed fully. Once fully immersed in the report contents, the HF issues were identified from the reports and collated so that very similar issues are grouped into a theme. A theme was defined as the highest level description of the issue and allowed for grouping later. Where similar but different issues were identified they were given a high level theme, but that theme was divided into sub-themes. The sub-theme provided more detail on the nature of the HF issue. For instance, a theme may be at the level of "number of personnel", which could be associated with sub-themes of "not enough supervisors" and "not enough instructors". During the analysis the titles of the themes and sub-themes were refined to reflect the whole body of information in the reports.

Categorisation of themes. Once all of the issues had been considered and the themes and sub-themes were drafted, they were compared against the ARM and categorised into one of the seven HF categories used in the ARM: organisation, supervision, task, equipment, environment, behaviours and actions, and operator conditions.

Reviewing themes and categorisation. After the ARM categorisation was completed, a full review was performed of the themes, sub-themes, and ARM categories. This comparison was undertaken

by a different HF specialist, providing both an independent check of the initial identification of themes and a check of the suitability of the themes and sub-themes.

Defining trends. The ARM was then scrutinised in terms of the prevalence of each theme and sub-theme across the reports and its importance to flight safety. From this process, a number of themes and sub-themes were drawn out from the analysis to form the trends. A description of each trend was then prepared which was derived from the relevant descriptions in the twenty reports which comprised the data set.

Results

A total of thirty-one HF trends were identified from the thematic analysis and presented using the framework of the ARM, as shown in Figure 1.

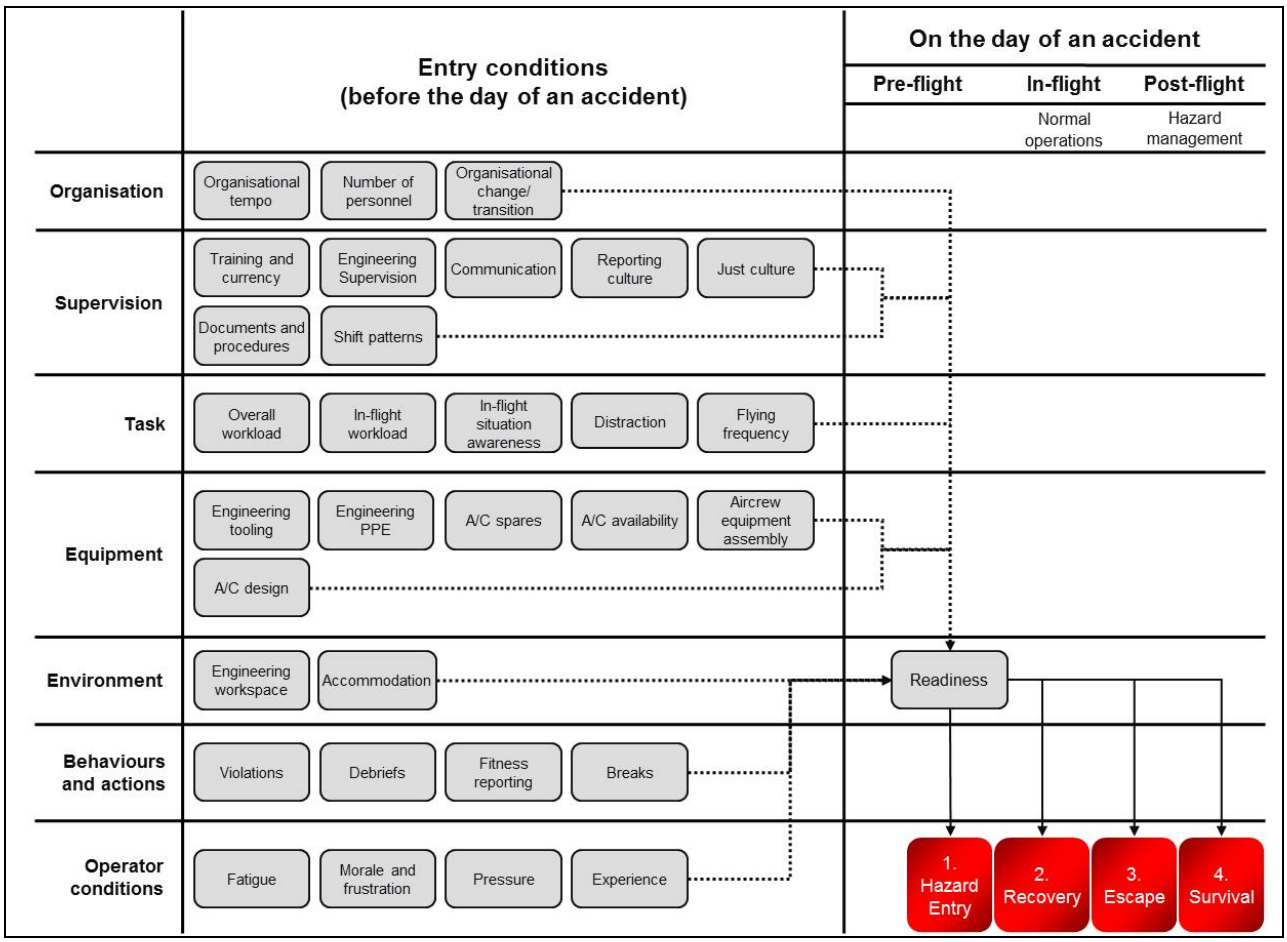

Figure 1. Accident Route Matrix presenting the 31 trends that were identified from the thematic analysis.

Descriptions were prepared for all thirty-one trends. The descriptions comprised a narrative of the issue, an actual example from the evidence, its causes, and the anticipated consequences of that issue for flight safety risk.

Amongst the thirty-one trends it was noted that there were a small number of critical trends which both prevalent and qualitatively important, and these were highlighted for particular focus and mitigation:

1. **Number of personnel**. Areas were highlighted where there were limited personnel in specific roles or with specific qualifications.

2. **Training and currency**. In all cases, training was provided to personnel to enable them to perform effectively in their role. However, some limitations were found in the content of training and in the opportunities to practice skills once trained.

3. **Documents and procedures**. A common issue in aviation is the high volume of rules, procedures and regulations. This issue was identified as a trend in the analysis, as it increased the risk of information being forgotten and so contributing to a procedural violation. There were also issues identified with the content of documentation – such as errors within the documents, unclear information, or information spread across multiple documents.

4. **Overall workload**. Rather than an issue with on-task workload, the critical trend was that personnel had a large number of tasks to perform during their working day which was challenging to achieve in the time available.

5. **In-flight Situation Awareness (SA)**. Difficulties in developing and maintaining SA in-flight were identified across a number of accident investigations. In OEA, limitations were identified with the cockpit equipment which could reduce SA in-flight.

6. **Distraction**. Two types of distraction were noted: In-flight distraction, most commonly linked to equipment discomfort, and general distraction, linked to uncertainty and frequent task changes.

7. **Fatigue and pressure**. There were very few reports of overt pressure being imposed in personnel, but personnel were highly motivated to achieve their tasks which, when combined with issues such as lack of personnel and high workload, was acting to impose a perceived pressure which could also contribute to a risk of fatigue.

8. **Experience**. Declining experience levels was identified as a critical trend, sometimes linked to new platforms where experience was naturally low, but also linked to limited opportunities to practice skills after training.

Discussion

Using qualitative analysis allows a large amount of contextual data, collected in various forms, to be examined in such a way that the feelings, values and perceptions underlying and influencing behaviours can be recognised. The language and imagery used by personnel can be captured to further understand the issues and factors being described in a way that statistical analysis cannot. Using thematic analysis allows for the identification of patterns and meanings across the data. Themes are developed from within the data and supported with assertions from grounded theory.

In the current study, combining the use of the ARM framework alongside thematic analysis has identified the HF issues which are critical trends for UK military aviation units. The analysis generated a wide range of HF issues which were then examined and explored before identifying the most critical eight. Each trend was identified based on qualitative data collection and analysis, which enabled an in-

depth understanding of each issue to be developed, beyond what could have been achieved with a purely quantitative approach.

The nature of the qualitative approach used ensured that the results were evidence based, which was particularly important when presenting the findings to senior stakeholders to provide confidence in the conclusions. The nature of the analysis then allowed a detailed and descriptive set of results to be produced which could be easily and clearly explained to non-aviation psychologists. This clarity is vital in enabling action to be taken to address the issues identified and to guide decision making regarding the operational risks in military aviation.

The results of the trend analysis have been presented to senior personnel within the UK military to further aid their understanding of HF risks. Recommendations have been developed to address each of the eight critical trends at the organisational level, and to develop the use of OEA to support continual improvement in aviation safety.

Acknowledgements

The authors acknowledge the contribution of the relevant military units for which the original reports used in this paper were written.

References

Braun, V. and Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2), 77-101.

Harris, S. (2011). Human factors investigation methodology. *Paper presented at the 16th International Symposium on Aviation Psychology.* Dayton, OH.

Harris, S. (2016) Errors and accidents. In *Ernsting's Aviation and Space Medicine* (707-722). Boca Raton, CA: Taylor and Francis Group.

Revell, S.D., Harris, S.L. and Cutler, V.J. (2014). A preventative approach to identifying and addressing flight safety human factors issues. *Paper presented at the 31st Conference of the European Association of Aviation Psychology*. Valetta, Malta.

Wiegmann, D.A. and Shappell, S.A. (2003). *A Human Error Approach to Aviation Accident Analysis.* Ashgate: Aldershot, UK.