Patterns of threat and error management in regional airlines

PATRICK S. MURRAY, PAUL R. BATES
Griffith University Aerospace Safety Centre, Brisbane

Abstract
It is generally accepted that approximately 70% of airline accidents involve crew error. Traditionally, formal accident and incident investigations have been the main sources of providing an understanding of crew performance. However, these reports are necessarily reactive in nature and lack of data, due to the relatively small number of accidents, limits the use of such reports as a predictor of events and crew performance.

The International Civil Aviation Organisation (ICAO) has stated that proactive safety interventions can be developed by effective monitoring of crew behaviour in normal operations and has endorsed the Line Operations Safety Audit (LOSA) methodology developed by the University of Texas and the LOSA Collaborative as a recommended practice through publication of ICAO Document 9803 (ICAO 2002). A LOSA database (the LOSA Archive) has been established, using rigid protocols to collect data to the Threat and Error Management (TEM) framework, mapping crew performance over 10,000 flights from 40 airlines (Klinec, Murray, Merritt, & Helmreich, 2003).

Data from the International Air Transport Association shows that accident rates are significantly higher in regional airlines operating turbo-prop aircraft than in jet carriers (IATA 2009, 2008, 2007, 2006). However, regional airline operations have historically been under-represented in safety research. This research project uses LOSA methodology to study TEM performance in regional airlines and compares this with LOSA Archive data for major carriers.

The project is still at an early stage but findings to date indicate significant differences in patterns of TEM performance amongst regional airline crews. These will be discussed during the presentation of this paper at the 2010 Australian Aviation Psychology Association Symposium. The research is intended to inform training and regulatory interventions in order to improve safety in regional airline operations.

Introduction
Whilst accident causal factors vary, it has been generally accepted in the airline industry for nearly three decades that more than 70% of accidents involve flight crew error. Similarly it is generally accepted that, for every accident, it is probable that there have been multiple examples of similar circumstances that did not result in an accident but may have been a "near miss". Due to inadequacies in incident reporting requirements and low rates of self-reporting, it is probable that many of these events go unreported and are not investigated. Aircraft accidents are, fortuitously, extremely rare and therefore accident investigations, although useful in uncovering systemic deficiencies, due to sheer lack of data are limited in their ability to proactively predict behaviours and events that may cause future accidents. However, if normal operations are monitored effectively, it is possible to diagnose crew behaviours and possibly develop proactive safety interventions (ICAO, 2002). The majority of normal operations research to date has concentrated on major carriers flying jet aircraft. However airlines that fly turboprop aircraft, serving regional and rural centres, form a significant part of the aviation landscape in Australia, New Zealand and the South Eastern Asia Pacific region and accidents and serious incidents occur more frequently in the regional turboprop airlines sector of the industry than in the larger carriers using jet aircraft (ICAO 2009).
Discussion

ICAO data shows that the accident rate in regional airlines flying turboprop aircraft is consistently higher than in jet carriers. Figure 1 shows the 2008 accident rate in Western built turboprop aircraft as being three times greater per million flight sectors and over seven times greater per million flight hours than in Western—built jet aircraft. (IATA 2009, 2008, 2007, 2006).

Figure 1
Accident rates - IATA Safety Report (IATA, 2009)

<table>
<thead>
<tr>
<th>Hull losses</th>
<th>Western built aircraft</th>
<th>Eastern built aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per million hours</td>
<td>Jet 0.81</td>
<td>Turboprop 2.43</td>
</tr>
<tr>
<td>Per million sectors</td>
<td>Jet 0.41</td>
<td>Turboprop 2.89</td>
</tr>
</tbody>
</table>

The figures for Eastern built aircraft show even more alarming differences involving an accident rate of twenty four times greater in sectors flown and almost thirty two fold greater based on hours flown, when compared to a baseline of Western built jets. However, whilst the number of Eastern built aircraft in use worldwide increased by 10% in 2007, they still only comprise approx 24% of the world turbo—prop fleet and fly less than 10% of the total hours of that fleet (IATA, 2008). However, Eastern built aircraft are currently all but non—existent in the geographical area of immediate interest and therefore do not specifically form a focus for this project.

Interestingly, as the rate and number of accidents has increased over the past 3 years, the number of fatal accidents has not increased in proportion, only increasing slightly, and the number of fatalities has decreased significantly as shown in the raw data in Figure 2. These data on fatalities illustrate the need for discerning carefully between the various definitions of “safety”.

Figure 2
Accident raw data - IATA Safety Report (IATA, 2009)

<table>
<thead>
<tr>
<th>Hull losses</th>
<th>Jet</th>
<th>Turboprop</th>
<th>Fatal Accidents</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>66</td>
<td>46</td>
<td>23</td>
<td>502</td>
</tr>
<tr>
<td>2007</td>
<td>57</td>
<td>43</td>
<td>20</td>
<td>692</td>
</tr>
<tr>
<td>2006</td>
<td>46</td>
<td>31</td>
<td>20</td>
<td>855</td>
</tr>
</tbody>
</table>

The much higher rate of accidents in regional turboprop aircraft, when taken at face value, may intuitively indicate some simple unique commonality within this type of operation that renders it intrinsically more dangerous. Interestingly a broad environmental scan of accident databases indicates little difference in accident causation between fleet types. Furthermore, the commonly accepted figure that around 70% of all airline accidents involve crew—related human factors or errors holds good across all fleet types and therefore this area of human performance would appear to be the area of research that may yield the most immediate benefit.

Threat and Error Management

The framework of the Threat and Error Management (TEM) model is shown in Figure 3 and is adapted from ICAO Doc. 9803 (2002). It portrays operational activity as a series of ongoing threats and errors that flight crews must manage in order to maintain adequate safety margins. Threats are external events or
errors by other parties, outside the influence of the flight crew, that increase the operational complexity of a flight and require management by the crew in order to maintain safety margins (Kline et al, 2003). Complex, challenging and distracting operating environments increase crew workload and increase the likelihood of error.

Crew errors can vary from minor slips and lapses, to more severe errors of omission or commission with outcomes that adversely affect safety. Regardless of cause or severity, the outcome of an error depends on whether the crew detects and manages the error before it leads to an unsafe outcome. The foundation of TEM lies in understanding the contexts in which errors are committed and the detection and management of those errors, rather than solely focusing on error commission.

**Figure 3**  
**Threat and Error Management Model (Adapted from ICAO Doc 9803, 2002)**

It should be noted that not all errors are produced by threats. Experience has shown that only approximately 50% of errors are directly linked to a threat and that the remaining 50% of spontaneous errors are a direct example of the frailty of human performance. This underscores the essential need for robust procedures and discipline in their execution, both to minimize occurrence and to detect and manage errors prior to them becoming consequential.

**Research Overview**
The author through membership of the LOSA Collaborative is aware that, anecdotally, only a very small number of individual regional airlines have undertaken exercises in reviewing their normal operations. In the cases of those that have, the data gained have been kept confidential within the airline and as such, there is no documented observational research into patterns of threat or human error in this particular segment of the industry.

*Murray and Bates, Patterns of TEM in regional airlines 2009*  
220
The research comprises:

- A study by observation and survey of regional aircraft operations to establish patterns of threats and errors and the effectiveness of their management by flight crews.
- A comparison of the results with benchmark data from the LOSA Archive to examine for differences.

The output of the project will be a report on the collated data from all participating airlines and an analysis comparing patterns of TEM performance between the regional airlines and the major carriers in the LOSA Archive. Differences may provide the basis for training, operational or regulatory interventions within regional airlines. In addition to the main research outputs each participating airline will receive:

- A comprehensive report analysing the patterns of TEM in that airline
- De-identified raw data and reports from all flights
- Benchmarking of detailed TEM patterns against the LOSA archive

Participating airlines will therefore, individually, have available an objective analysis of crew performance during normal line operations.

The results of the benchmarking exercise will inform further research to develop appropriate intervention strategies to address any issues that become apparent. The areas may include (but are not limited to) training, operational procedures and techniques and regulatory effectiveness.

Conclusion
This project is has been established as a result of the significantly higher rate of accidents in regional airlines flying turbo – prop aircraft, when compared to major carriers flying jet aircraft. The research will specifically investigate patterns of Threat and Error Management during normal operations by regional airline crews and compare these with results from major carriers. The results will inform and assist the development of training, operational and regulatory interventions with the aim of reducing accident rates amongst the regional airline sector of industry. The project builds upon work that has previously been conducted in the major airline sector.

At the time of writing the observation phase is in progress and planned to be completed by the end of the second quarter of 2010. Some initial results will be presented at the ninth International Symposium of the Australian Aviation Psychology Association in April 2010. It is anticipated that full results will be available by the end of 2010.

The research uses established LOSA methodology developed by the University of Texas and the LOSA Collaborative (Kline et al, 2003). This methodology is in the public domain and endorsed and published by ICAO in ICAO Document 9803 as a recommended practice for normal operations monitoring (ICAO, 2002).

References:

