Predicting and simulating human errors in using the airborne separation assurance system procedure

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Abstract

ASAS (Airborne Separation Assurance System) is an aircraft system based on airborne surveillance that provides assistance to the flight crew, supporting the separation of their aircraft from other aircraft. This paper describes the process that was used to analyse possible human factors and safety issues affecting an air traffic management (ATM) procedure associated with ASAS. The paper provides some illustrative findings and explains the benefits and difficulties with the method used. A hierarchical task analysis (HTA) and human error analysis (HEA) were undertaken for ASAS separation. These analyses were used to develop eight safety scenarios for a five-day real-time simulation. By simulating hazardous events in real-time simulations, it was possible to observe and discuss with controllers how hazards are detected, and to determine possible means of mitigation.

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Introduction

Contemporary aviation has become a leading industry in terms of safety performance. The International Air Transport Association (2003) has stated that, through safety successes, aviation has been transformed into an ‘ultra-safe system’. Western-built jets experienced an accident rate of 0.68 per million departures in 2003, a decline from 1.19 per million departures ten years earlier. Air traffic management (ATM) is one of the safest components of the aviation system. It may seem sensible to avoid major changes to a system that works so well. However, in light of capacity and complexity increases in European airspace, changes to ATM are inevitable (EUROCONTROL, 2003a). The changes in ATM mean that the very nature of the air traffic controller’s job will alter significantly. Clearly, safety needs to be built into such changes, and it needs to be assessed, and assured. This is underlined by the fact that when accidents do occur, they can be catastrophic, resulting in hundreds of lost lives.

‘Mediterranean Free Flight’ (MFF) is a ‘TEN_t’ (Trans-European Network – transport growth) funded project initiated by ENAV (the Italian Air Traffic Control provider), to study the issues regarding the implementation of the free flight concepts over the Mediterranean area. The main objective of MFF is to provide technical and operational evaluation of integration, interoperability and safe use of communication/navigation/surveillance (CNS)/ATM technologies and applications suitable for future Mediterranean ATM scenario. For example, operational requirements and procedures based on the use of new CNS/ATM technologies that will enable the introduction of free flight operations in Mediterranean area. Part of the project seeks to verify appropriate new operational procedures for ATM staff and crew in free routing and free flight scenarios (such as the delegation of separation responsibility from ATC to aircraft and vice versa).

A key enabler for MFF, ASAS (Airborne Separation Assurance System) is an aircraft system based on airborne surveillance that provides assistance to the flight crew, supporting the separation of their aircraft from other aircraft. The European Aviation Authority/Eurocontrol (2001) ASAS enables the concept of delegating the task of separation assurance of one aircraft from another to the flight deck. The air traffic control officers (ATCOs, or ‘controllers’) would delegate the task to the pilot as a means of potentially alleviating the workload of the controllers by a more efficient distribution of tasks.

The objective of the project described here was to complement traditional safety analysis methods (Operational Hazard Assessment [OHA], e.g. EUROCAE, 2000), by using the results from a human error analysis (HEA) to assess safety during a real-time simulation. The HEA was undertaken using TRACEr-lite (Technique for the Retrospective and Predictive Analysis of Cognitive Errors: Shorrock, 2002a, b, 2003a, b, in press, see also Shorrock and Kirwan, 2002), and the results were used to identify the most important and relevant hazards to be replicated and analysed during a real-time simulation. The process of task analysis, human error analysis, scenario design, and the analysis of hazards is described in the following sections and illustrated in figure 1. The final two sections of this paper will describe the lessons learnt from the simulations.

![Figure 1 Process to assess the hazards in the MFF ASAS Separation procedure](image)

Human error analysis

The objective of the human error analysis (HEA) was to identify potential controller and pilot errors that could occur during an ASAS separation procedure, describe the associated initial consequences and detections means, and suggest measures to prevent, reduce or mitigate the critical errors. Additionally, some of the errors identified would be used in a simulation (described in the section concerning simulating air traffic controller and pilot errors). TRACEr-lite, a HEA
Table 1  Example of human error analysis for part of task step 1.1.1 ‘(Controller) Detect potential for ASAS separation’

<table>
<thead>
<tr>
<th>Task Step</th>
<th>Error Mode</th>
<th>Internal Error</th>
<th>Consequences</th>
<th>Detection Means</th>
<th>RSL</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1 (Controller) Detect potential for ASAS separation*</td>
<td>1. Detect potential for ASAS separation when inappropriate</td>
<td>1. Inappropriate decision/plan</td>
<td>1. Abort ASAS, increased workload; Potential loss of separation</td>
<td>1. Further visual monitoring/check, Planner (other) controller; Flight crew check; MTCO; STCA</td>
<td>1. M-H</td>
<td>Even more problematic when you have a number of ASAS separations at the same time</td>
</tr>
</tbody>
</table>

Plan: Do 1 and 2 in parallel. Then do 3. If 3 = false, then discontinue. If 3 = true, then do 4.
1.1.1.1 Identify reference and designated aircraft
2. Mistake which should be designated aircraft
3. Identify wrong (unintended) a/c
4. Take too long to identify ASAS a/c

<table>
<thead>
<tr>
<th>Task Step</th>
<th>Error Mode</th>
<th>Internal Error</th>
<th>Consequences</th>
<th>Detection Means</th>
<th>RSL</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Create too many pairings</td>
<td>1. Inappropriate decision/plan</td>
<td>1. Monitoring problems due to lack of task involvement, Confusion; Controller may forget about a/c; Sudden increase in controller workload if multiple aircraft abort; Possible loss of separation</td>
<td>1. Further visual monitoring/check, Planner (other) controller</td>
<td>1. M-H, M-H</td>
<td>Is there a limit on number and mix of pairings to reduce complexity? How many pairings indicated on HM? How does the system detect when there are too many pairings? How are pairings indicated on HM? When does controller mark aircraft on HM? If the first a/c has a problem and has to deviate route (e.g. bad weather) then all the other a/c will have a problem. Are all a/c are linked to the first a/c?</td>
<td></td>
</tr>
</tbody>
</table>

2. M-13 | M-2 | M-3 | M-4 | M-4 |
TRACER-lite method

Two analysts applied TRACER-lite to the HTA, where each analyst undertook approximately half of the HTA each. A one page extract from the output of the TRACER-lite analysis is provided in Table 1. The first stage of TRACER-lite set the context of procedure to be analysed using a set of performance shaping factors (PSFs). These are factors that are either internal to the controller or pilot, or relate to the task and operational environment, that affect performance positively or negatively, directly or indirectly, such as traffic and airspace, procedures and documentation, training and experience, workspace design/human machine interface (HMI)/equipment, etc.

The second stage identified the observable manifestations of potential errors, using a set of external error modes (EEMs) relating to timing, sequence, selection and quality of the task step. The EEMs were identified at each lowest-level task in the HTA, then applied to the higher-level tasks. These error types were used to develop safety scenarios in the real-time simulations.

The third stage involved analysing the likely cognitive aspects of the errors predicted using a set of internal error modes (IEMs). In TRACER-lite, these are structured around four 'error domains' (perception, memory, decision making, action) and one 'violation domain'. IEMs describe how the controller's/pilot's performance failed to achieve the desired result (e.g. 'mishear', 'mis-see', 'no detection [visual]' and 'no detection [auditory]'). This part of the analysis was used to develop possible mitigation means. Following this, the likely initial consequences were determined. These consequences, along with the context and type of error, were used to consider how the controller or pilot might detect the errors (e.g. RT (radio transmission) readback, radar monitoring, planned check, other controller, etc.). The analysts also at this point rated the 'recovery success likelihood' (RSL), a 5-point likelihood of recovering the task successfully without adverse consequences. Finally, comments or questions were raised or recommendations were recorded.

The majority of the analysis was performed by two analysts individually. However, each mid-level task in the HTA (i.e. between the high level goals and the individual actions) was also examined and discussed with two controllers and two pilots, to ensure a more holistic analysis. This helps to mitigate the danger of human error analysis becoming too 'microscopic' (focusing on detail) while missing some important issues.

TRACER-lite results

A total of 398 errors were identified in the TRACER-lite analysis, and 383 were rated with regard to their recovery success likelihood (see Table 2). Approximately 17% (n=66) were rated as difficult to detect (i.e. they were categorized as low or low-medium recovery success likelihood).

<table>
<thead>
<tr>
<th>Recovery Success Likelihood</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>12</td>
<td>3%</td>
</tr>
<tr>
<td>Low-Medium</td>
<td>54</td>
<td>14%</td>
</tr>
<tr>
<td>Medium</td>
<td>154</td>
<td>40%</td>
</tr>
<tr>
<td>Medium-High</td>
<td>138</td>
<td>36%</td>
</tr>
<tr>
<td>High</td>
<td>25</td>
<td>7%</td>
</tr>
<tr>
<td>Total</td>
<td>383</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3  A sample of the hazards identified using TRACER-lite and the related recommendations

<table>
<thead>
<tr>
<th>Problem areas identified</th>
<th>Recommendation provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ASAS Separation pairings that can be created</td>
<td>The number and mix of ASAS Separation pairings that may be created, and associated human factors impacts, should be investigated and set in procedures and training.</td>
</tr>
<tr>
<td>Number of procedure checks to be made by controller and flight crew</td>
<td>An ergonomically designed aide-memoir should be designed to help the controller to ensure that all relevant procedural checks are made.</td>
</tr>
<tr>
<td>Number and clarity of manoeuvre symbols, and potential for error in linking aircraft on the PVD</td>
<td>Controllers should have a permanent electronic indication of ASAS equipage, ASAS application status and associated parameters. The impacts on human performance of the symbology used within the TDB should be investigated thoroughly, taking into account other technologies that impact on TDB display. The impact of CDTI (Cockpit Display of Traffic Information) interaction and monitoring on flight crew 'head-down' time should be investigated.</td>
</tr>
<tr>
<td>Flight crew identification of designated aircraft and input of code</td>
<td>The potential for flight crew and controller confusion between different ASAS services should be examined. It should be considered whether separation phraseology should re-emphasise the critical element of the transmission, e.g. 'below'</td>
</tr>
</tbody>
</table>
Errors associated with the three phases of the ASAS separation procedure (initialisation, execution and completion) were identified. The initialisation and completion phases were primarily associated with controller errors, while the execution phase was primarily associated with pilot errors. In screening the predicted errors, a recovery-centred approach was adopted, those errors that were considered difficult or moderately difficult to detect, diagnose or correct were considered further, and 17 key issues to be addressed were identified and their recommendations were derived (see table 3 for a sample). A range of consequences and detection means was highlighted for the errors identified (EUROCONTROL, 2003b for more details of the results).

Simulating air traffic controller and pilot errors

The objective of simulating potential hazards was to further investigate the characteristics of the hazards, and in particular to assess the:

- Causes or contributing factors.
- Hazard credibility.
- Hazard severity, related the severity of the fully developed consequence.
- Detection capability, the ability of the controller to detect and mitigate the hazard reducing the severity of the potential consequences, and
- Mitigation measures and fall-back procedures.

Development of safety scenarios

A scenario describes an operational situation by identifying the actors involved, the operations going on, the tools and procedures employed. In order to create scenarios in a real time simulation setting, specific ‘hazardous’ conditions are inserted into a traffic sample, in order to observe how controllers react to and manage the situation recreated.

Hazardous situations were recreated in scenarios using some of the human errors identified in the human error analysis. It was only possible to simulate a small number of hazards during the simulation, due to the time limits of the simulation. Thus the hazards that were simulated included errors that had ‘low’ or ‘low-medium’ recovery success likelihood ratings (i.e. those errors which were less likely to be detected and recovered from), errors that could be made (deliberately) by the pilot (pseudo-pilots) could be briefed on when and which

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1 Pseudo-pilots are non-pilots trained to simulate the behaviour of pilots. They are stationed in a separate room from the controllers communicate with air traffic controllers over radio-type headsets and respond to controller instructions by using a command set to alter heading, speed, altitude, and other flight commands.

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Predicting and simulating human errors 51

errors to make during the simulation), as well as generic hazards (such as bad weather, airport closure). The following scenarios were simulated (see figure 3 for a more detailed description of Scenario 1):

1. ASAS applied with wrong target (readback incorrect and input incorrect in onboard Cockpit Display of Traffic Information - CDTI).
2. Unexpected movement of surrounding traffic interfering with ASAS configuration
3. ASAS and bad weather. Target requests different level
4. Delegated pilot modifies trajectory too late and contacts controller to report unable ASAS.
5. An aircraft is conflicting with an ASAS in-trail chain of three aircraft.
6. Two conflicts occur at the same time at different points in the same sector.
   Both can be solved by ASAS crossing.
7. Delegated onboard system failure, delegated a/c reports unable ASAS.
8. Sector A forgets to inform sector B over the telephone about an ASAS pair.
9. Sector B does not accept an ASAS pair

The scenarios were defined and refined by simulation and operational experts, and were reviewed by a joint multidisciplinary group (safety experts, human factor experts, simulation experts). Most of the scenarios required fine-tuning during the simulation. The hazards were recreated during the simulation using three methods: 1) manipulation of the traffic samples, 2) collaboration with the pseudo-pilots and, in a few cases; and 3) controllers were asked to make deliberate errors to assess how other controllers would react. In total, there were 11 simulation runs with ASAS. Within each run, between one and three scenarios were simulated. The majority of the nine scenarios were repeated at least once.

Observation and data collection

Observation and data collection were undertaken during the simulation with the help of some supporting tools such as data recording forms and video-recording. Data were also collected and analysed through: 1) meetings between safety observers and human factors experts, 2) analyses of safety reports and questionnaires produced by controllers, 3) brainstorming sessions between controllers and safety observers, and 4) debriefings with controllers involved in the safety scenarios. Three sheets were produced for each simulation exercise. A scenario sheet was developed that described the scenario, the aircraft call signs involved in the event, and the estimated time the event would occur. An observation sheet was designed to help the observers (safety, human factors and operational experts) record events that occurred during the exercise. A debriefing sheet was developed which included questions regarding the scenario and event.
(i.e. development, detection, causes, worst credible consequences and severity, potential developments; frequency; and mitigation).

The hazard conditions and their developments were observed during the real time simulation and analysed by the safety experts in collaboration with the controllers and the human factor and operational experts. In addition, spontaneous occurrences of other safety-relevant events during the simulation were monitored and recorded. Subjective feedback provided by controllers or collected in questionnaires and debriefing sessions was analysed to discover possible additional hazards not yet identified by the safety experts.

**Analysis of scenarios**

The analysis was conducted in three phases. First, the events observed during the simulation were categorised into similar groups that were related to pilot or controller error, equipment failure, procedural or human factors issue. Eleven natural hazard groupings emerged:

1. Delegated aircraft selects a wrong target
2. Unexpected movement of third aircraft interfering with ASAS pair.
3. Delegated does not report ‘clear of traffic’.
4. Technical or communication failure.
5. Unexpected manoeuvre of delegated aircraft.
6. Ambiguous definition of ‘clear of traffic’.
7. Lack of coordination during sector transfer of aircraft under ASAS Separation.
8. ASAS rejection by receiving sector or aborting during initiation.
11. Division of tasks (team work).

**After 10 minutes of simulation**

Controller: ‘DLH456, for ASAS separation target 1234.’

*Simulation assistant tells pseudo-pilot to identify target 5678 instead*

**Controller:** ‘Target identified 3 o’clock, DLH456.’

**Pseudo-pilot:** ‘Target identified 3 o’clock, DLH456.’

**Controller does not detect the wrong position of the target and gives ASAS lateral crossing instruction**

Controller: ‘Pass behind traffic, maintain separation then, report clear of traffic.’

**Pseudo-pilot:** ‘Passing behind traffic, maintaining separation, DLH456.’

STCA alert goes off

**Figure 3** Example of a safety scenario: ‘Wrong target identified’

Second, information about the 11 hazards was compiled separately, regarding detection possibilities, severity levels, causal factors, possible consequences and fallback actions. Third, a discussion of each hazard was conducted to analyse causes, consequences, ease of detection and means of detection, contextual causes, severity, and the proposed mitigation measures. The overall safety activity consisted of a set of safety oriented scenarios, 40 hazardous occurrence debriefing sheets filled in by safety observers, 28 debriefing sessions and one final brainstorming session with all controllers. A sample of the results from the observations and debriefing are provided in table 4 and an example scenario (‘delegated aircraft selects a wrong target’) has been described in more detail in the following section, chosen on the basis of being more simple to describe as well as having the potential for severe consequences.

**Results for scenario ‘wrong target selected’**

In the scenario ‘delegated aircraft selects a wrong target’, the ATCO specifies to the delegated aircraft the SSR (secondary surveillance radar) code of the target aircraft for selection. The delegated aircraft selects a wrong target on their CDTI and reads back the wrong target to the ATCO. This operational failure could be considered one of the most important scenarios examined during the simulation, due to its high credibility and to it being difficult to detect. Some detection and mitigation means are already in place in the existing procedures description, but they are not reliable. Several observations were made during the simulation and debriefings with controllers (see table 5).

Following the simulation and debriefings, six recommendations were proposed to the operational concept and procedures designers, and four recommendations were proposed to those responsible for improvements and architecture regarding the 11 hazards. These recommendations were not ‘safety requirements’, although the objective was to suggest safety-related improvements to the ‘MFF proposed system’ in order to improve the safety of ASAS and achieve a positive safety case. An example of a proposed ‘architectures’ recommendation, relevant to the hazard ‘Wrong target selected’, concerned a system to download (automatically) to the controller some aircraft parameters, e.g. selected target, ASAS status, etc. This would improve safety by ensuring the same situation understanding on-board and on the ground and mitigate possible air-ground misunderstandings and other errors. In particular it could be useful to help the controller detect a wrong ‘target identification’.
<table>
<thead>
<tr>
<th>Label (n)*</th>
<th>Relevance Scenario</th>
<th>Causes / Consequences</th>
<th>Detection</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Delegated aircraft selects a wrong target (n=3)</td>
<td>Inputting SSR code is error-prone due to arbitrary and long number of digits</td>
<td>Pilot must readback ‘clock-position’ for controller to detect error. Detection with clock position may be ambiguous at long distances</td>
<td>Automatic downlink of ‘airborne data’ (e.g. selected target, ASAS ‘status’ of delegated a/c)</td>
</tr>
<tr>
<td>2</td>
<td>Unexpected movement of third aircraft interfering with ASAS pair (n=2)</td>
<td>Situation highlights the diminished flexibility of ASAS configuration. An aircraft is conflicting with an ASAS n-trail chain of 3 aircraft</td>
<td>Detection: situation can be easily detected since it is based on pilot’s report.</td>
<td>Fallback procedure: descending interfering a/c to lower flight level. Automatic downlink to CWP may be a tech solution to mitigate ATCo’s errors, or bad coordination</td>
</tr>
<tr>
<td>3</td>
<td>Delegated a/c did not report clear of traffic and did not resume navigation</td>
<td>Definition of ‘clear of target’ is not enough clear from ATCo’s point of view. ATCo's must rely on pilots’ reports (also with radar coverage)</td>
<td>Situation is not easily detected, since there’s no explicit reminder for ATCo. In non resume navigation condition if a/c is not readily off-track, ATCo may notice it on the routine scan.</td>
<td>Provide automatic monitoring aids based on ASAS envelope to mitigate not resume navigation, provide operational definition of ‘clear of traffic’ for controllers or set automatic reminders to ATCo that prompt them to contact pilot to confirm ‘clear of traffic’</td>
</tr>
<tr>
<td>4</td>
<td>Delegated onboard system failure, delegated a/c reports unable ASAS functioning (n=5)</td>
<td>Consequences: if pilot reports on time, ATCo can easily recover the situation. If tech failure is detected late, situation may become impossible to recover. ATCo’s tasks and duties in the already compromised situation appear as a problematic issue that should be further clarified</td>
<td>Detection: situation is easily detected if pilot reports (critically dependent on this) as it is unlikely that ATCo can notice the problem without pilot’s communication. Detection: situation may also be detected if ATCo is monitoring the two a/c But unless deviation is really noticeable, it is unlikely that ATCo will intervene (or even detect) before pilot reports.</td>
<td>Fallback procedure: descending delegated a/c to lower standard FL (flight level), or to non-standard FL for traffic in opposite direction, or to emergency separation (500 ft). Controllers indicated that they prefer to have a lower FL available when clearing ASAS pair in high traffic area as a fall-back procedure</td>
</tr>
</tbody>
</table>

* n refers to the frequency with which each scenario was observed (which either occurred naturally or was simulated)

### Table 5

<table>
<thead>
<tr>
<th>Observation</th>
<th>Hazard categories</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety findings from 'delegated aircraft selects a wrong target'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Simulating safety scenarios – benefits and limitations

This section details the benefits and limitations for using this method to analyse safety issues. The MFF simulation was evaluated based on the following eight safety activities recommended in the SAFSIM Guidance (EUROCONTROL, 2003b).

1. The role of safety within the experimental process. Safety was explicitly incorporated into the objectives for this simulation, which has not normally been the case in previous simulations. This allowed the simulation team to plan to have sessions dedicated to exploring the safety issues. The simulation was in fact dedicated primarily to safety scenarios, as the simulation was too short (one week) for quantitative analysis of the data.

2. Definition of safety objectives. A small number of safety objectives were devised for the simulation, which enabled more of a focus on safety during simulation. In general, simulation objectives do not include safety. The usage of safety objectives was important to ensure that the simulation team prepared the simulation with safety in mind, and actively searched for safety issues during the simulation. Some of the objectives were general (e.g. to discover possible additional hazards), which encouraged the safety observers to have a broader view. Other objectives were more specific (e.g. to determine the severity of identified hazards), which allowed for some standardisation of the outcomes of the observation. Other specific objectives were added later to the simulation objectives (i.e. the safety scenarios), which could be described in the original objectives, to simulate and observe particular hazards analysed during the safety analysis. This mix of general and specific objectives seemed to allow for a fairly comprehensive analysis of the safety issues.

3. Simulation realism. By introducing ‘safety scenario’ hazards, the realism of the simulation was increased. However, it is important not to include too many hazards within each simulation exercise, otherwise controllers may lose confidence in using the tools, which may in turn lead them to abandon the tools (perhaps thinking that something will inevitably go wrong). One important factor to be considered is the limited realism of the air side. As is typical for ATM simulations, pseudo-pilots were used instead of real pilots. The pseudo-pilot HMI (a computer monitor) was very limited (e.g. no CDTI). Consequently, there was limited realism in terms of pilot behaviour (e.g. acceptance of very large deviations) This may have a small affect on some aspects of data collection, however, controllers were aware of these possible deviations. Ideally, simulations would be carried out with both controllers and real pilots using cockpit simulators, however the practicality and expense of undertaking such a simulation currently outweighs the benefits.

4. Training. Controllers were provided with one week of training, which was probably not sufficient to align the participants working practices (perhaps due in part to the differences in countries in which they worked) and experience using ASAS. Longer training sessions would be required (e.g. an additional week) to achieve this.

5. Simulation Safety Scenario design process. The hazards were taken from the TRACE-lite analysis. The safety scenario method of analysing the safety aspects of a tool only allows a limited number of hazards to be assessed. Other safety assessment methods should be used in combination with simulating safety scenarios, such as using controllers, procedure, human factors and safety experts in a HAZOP (Hazard and Operability study).

6. Safety indicators measured. Some of the safety indicators were difficult to determine during the debriefing sessions. The controllers found it easy to determine whether or not the hazard was credible, whereas the worst probable severity (detected and non-detected) was more difficult to verify, due to the variety of potential consequences that could occur. Controllers were generally able to predict how easily the hazards could be detected and corrected. Controllers also tended to think about hazards in conjunction with other hazards, unlike human error analysis which tends to focus on single errors, although there was not enough time during the debriefing to build a picture of how hazards are linked with each other. Another safety assessment method could be used in this situation (such as fault tree analysis).

7. Data collection methods. Although the information obtained from the safety scenarios was qualitative, it also tapped the experience of the controllers and closely involved them in the safety analysis, asking them to predict how such procedures might operate in the future. This method could be enhanced if more time was given to go back over the incident, the contents of the debriefing sheet, and if ‘replay’ tools were used to help both the observers and controllers recall what happened and why.

8. Analysis strategies. The results from the simulation were based on the analysis by safety and human factors experts of what was observed during the real time simulation and what was discussed during the meetings and debriefings. Quantitative analysis of specific safety hazards was not possible, mainly due to the small frequency of events. However, observations and discussions were supported by forms and tools (such as recording tools or guidelines about what to observe) that facilitated a more formal and standardised approach to the data collection and analysis. Given the described approach to the data collection and analysis, and the aims of the activity, the data collected have no statistical significance but are rather intended to provide information about the hazards, to identify new hazards and other potential mitigation means.
Conclusion

This paper demonstrates how the data from an analyst-led human error analysis can be used in simulations to assess safety issues more thoroughly. The results from the simulated safety scenarios provided information for the update of the MFF safety assessment (the operational hazard assessment). The five objectives of simulating the potential hazards were to assess the: i) causes or contributing factors, ii) hazard credibility, iii) hazard severity, related the severity of the fully developed consequence, iv) detection and recovery capability, and v) mitigation measures and fall-back procedures. The results indicate that it was possible to collect information relating to each of these indicators, although the discussions regarding: ‘hazard credibility’, ‘detection and recovery’ and ‘mitigation measures and fall-back procedures’ were the most beneficial. Discussions regarding the ‘causes and contributing factors’ indicated that there could be many different potential causes. The hazard severities were also difficult to determine as there can be many different consequences, each of which will have a different severity.

It is thought that this analysis will allow for the generalisation of specific scenarios in other, similar situations. Furthermore, the errors that were more difficult to detect or correct/mitigate in the simulation will be used to validate the results of the human error analysis (in particular the recovery success likelihood). This information has been fed-back to the procedural team (to enhance the procedures), the safety team (to enhance the OHA) the design team (to enhance the design specifications) and the simulation team (to improve the simulations in other parts of the project).

In summary, a number of benefits for using this method to analyse safety were identified. i) small scale simulations were found to be a useful way to collect some types of safety information, compared to large-scale simulations which are more restrictive due to the requirements of measured runs; ii) the debriefing sheet provided some standardisation on the types of information collected hence improving the level of data collected, iii) the realism of the simulation was improved by injecting possible adverse scenarios into the runs; iv) rich information was obtained from controllers during the debriefings, where the controllers were open in expressing their opinions of whether a particular hazard was an important safety issue or not and v) the key issues predicted during the human error analysis could be verified during the simulation.

References


EUROCONTROL (2003a) Strategic Safety Research Plan for the EUROCONTROL Experimental Centre, Version 1.0 EUROCONTROL: Brétigny, France

EUROCONTROL (2003b) SAFSIM: Simulation for Safety Insights Final Report; Major Findings and Recommendations. EUROCONTROL: Brétigny, France


Cultural challenges in Australian military aviation: soft issues at the sharp end

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Abstract

In light of the key contribution of human factor issues to aviation safety incidents, it is worth noting that almost 50 fatalities have been incurred in Australian military aviation accidents between 1990 and 2005. All of these losses have occurred in non-combat operations, and almost exclusively within the boundaries of the Australian continent — an operating environment of relatively flat terrain and benign weather conditions. This paper examines the relationship between human factor issues and the safe performance of Australian Defence Force aviation. More specifically, the paper describes the influence that organisational factors within the Australian Defence Force have upon personnel within Australian military aviation.

Introduction

Researchers have long asserted that human factor issues contribute to most aviation accidents and incidents. Indeed, researchers are increasingly asserting that all aviation safety incidents are caused by human factors. While the assertion has had a notable role in bringing human factors to the attention of many aviation and non-aviation personnel, it has become somewhat redundant to the extent that it no longer acts as a catalyst that triggers ideas for new safety initiatives. Yet there are many lingering human factor issues in military aviation that are notable for their potential contribution to aviation safety improvement. For example, previous work by Prince and Salas (1993), Lee (1999), and Soeters and Boer (2000) suggests that

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