Unique Reporting Form: Flight Crew Auditing of Everyday Performance in an Airline Safety Management System

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Abstract. This paper presents the proposed prototype for a Unique report form, which will constitute the basis for all operational and safety related reports completed by Flight Crew. This reporting form provides an opportunity for operational personnel to audit their own company's processes and procedures and has been developed in collaboration with a major Spanish Airline as part of the Human Integration into the Lifecycle of Aviation Systems (HILAS) project. This research involved extensive fieldwork, including process workshops, task analysis and collaborative prototyping of new concepts. Traditionally airlines use performance monitoring tools to evaluate human performance and by implication their organizational/system safety. Feedback from these tools is used to direct improvements (re-design procedures, enhance training etc.). The Line Operation Safety Audit (LOSA) methodology constitutes the current state of the art in terms of performance monitoring. Building on this concept, end user requirements elicited were the main focus for the design of this reporting form.

Keywords: Human Factors, performance monitoring, threat & error management, task support, safety management systems.

1 The Unique Reporting Form within the Context of a Safety Management Systems Framework

Until recently, airline approaches to safety have reflected a reactive model (e.g. complying with regulatory requirements and prescribing measures to prevent the recurrence of undesirable events). Current models follow a more proactive safety management approach. According to the international civil aviation organization (ICAO), this is characterized by a number of factors [1] including:

- The application of scientifically-based risk management methods
- Senior management's commitment to the management of safety
- A non-punitive environment to foster effective incident and hazard reporting

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- Systems to collect and analyze safety-related data arising from normal operations
- Sharing lessons learned and best practices through active exchange of information

From ICAO's perspective, this is supported by the development of appropriate safety management systems (SMS), defining the required organizational structures, accountabilities, policies and procedures [1]. In this regard, most airlines have developed (or are in the process of developing) safety management systems in accordance with regulatory guidance. Currently, airlines use a range of paper and technology based tools to monitor and evaluate human performance (and by implication organizational/system safety). Feedback from these tools is used to direct system safety improvements (e.g. process/procedures re-design, enhanced training etc.). Traditionally, these tools have divided into two types: those that focus on gathering human performance information; using either self report or observer based methodologies (e.g. Air Safety Reports, Line-Checks and Line Operations Flight Training) and those that focus on gathering aircraft performance information (e.g. Flight Operations Quality Assurance). Crucially, these tools fail to provide a real-time picture of routine operations supporting predictive risk management [2]. The use of many discrete tools presents additional information management challenges. Much valuable data is gathered about the operation. Yet this data is gathered, analyzed and stored in different formats, making it difficult to obtain an overall integrated safety/risk picture. Although useful from a data gathering perspective, these tools fall short of providing adequate data integration and analysis support. To this end, airlines are interested in developing tools which provide a real-time and continuous picture of the operation. Furthermore, many airlines are focusing on improving knowledge integration both internally (e.g. within airline) and externally (e.g. with authorities, other airlines etc). Arguably, little or no attention has been paid to the development of tools which embed crew reporting in the Flight Crew task, and link directly to airline safety/risk monitoring and process improvement activities).

The HILAS project is part of the Sixth Framework Programme for aeronautics and space research, sponsored by the European Commission. Its overall objective is to develop a model of good practice for the integration of human factors across the life-cycle of aviation systems [3]. The flight operations strand is aimed at developing a new methodology for monitoring and evaluating overall system performance to support improved information sharing, performance management and operational risk management. Its current research suggests that the first step is to gather the right information from operational personnel. Potentially, allowing operational personnel to 'audit' their own companies processes and procedures, may provide safety and risk personnel in an airline, with the necessary feedback to determine the safety/risk status of the operation. Furthermore, such an approach may motivate operational personnel to report both routinely and above and beyond what is required by regulatory bodies.

2 Performance Monitoring of Flight Crew

Airlines use performance monitoring tools to evaluate human performance and by implication their organizational/system safety. Feedback from these tools is used to direct improvements (re-design procedures, enhance training etc.). The Line Operation Safety Audit (LOSA) methodology constitutes the current state of the art in terms of performance monitoring. LOSA evaluations have been successfully undertaken by many airlines to assess routine flight operations. The purpose of LOSA is to identify threats to safety, minimize the risks that such threats may generate and implement measures to manage human error in operational context [4]. In a LOSA evaluation, trained observers watch real-life operations and provide feedback about Flight Crew threat and management skills. Observers (a) document external threats, (b) record flight crew errors in terms of their type, management response, and outcome (e.g. aircraft states), and (c) rate the crew on several Crew Resource Management behavioural markers [5]. Evaluations are conducted under strict non-jeopardy conditions - crews are not at risk for observed actions. Helmreich's Threat and Error Management (TEM) model [6] provides the theoretical basis for LOSA evaluations. The LOSA model distinguishes (a) threats: both external threats (including latent threats) and internal threats (crew performance), (b) error types, (c) error responses/countermeasures and (d) error outcomes (in terms of aircraft states)[5]. Critically, LOSA has highlighted the fact that error and violation are normal occurrences in operational systems and must be managed. The LOSA framework and methodology has many benefits which should be considered in the design of a future tool. This includes (a) the evaluation of non technical and technical skills (albeit these are separated in LOSA), (b) the attempt to link technical performance (procedures, aircraft handling), non technical performance (CRM, TEM behaviours) and aircraft states, (c) the observation of real operational practice and (d) non jeopardy evaluation (de-identified, confidential, non-disciplinary data collection) -which fosters a sense of trust between operational personnel and management.

3 Empirical Research: A Brief Excursus on the Methodology

The fieldwork for this research was carried out with five airlines using participants from across the three flight operations sub-processes: flight-planning, active flight operations and change/safety/quality process. Table 1 presents a summary of the steps undertaken during the fieldwork.

4 Development of the Unique Report

Input from flight crew led to the further development of the LOSA concept and the following end-user requirements were elicited:

Requirement 1: Establish a reporting framework linked to the journey log of each flight that would allow the pilots to report on threats and errors encountered and managed during each flight.

Requirement 2: Enable an improved logical reconstruction of occurrences and their links to flight phases and potential (crew) corrective actions.

Requirement 3: Provide an established channel for reporting threats and occurrences in parallel to LOSA. In this sense, the structure of the reporting form should give a clear focus on the actual accounts of the main facts constituent to the event, introducing an "ad hoc" space for the crew to express their analysis at the end. The analysis can be directed towards the elements of the operation performance upon which the company has leverage.

Requirement 4: Develop an intelligent flight plan in order to provide feedback on performance management concepts.

The report is embedded in the Extended Journey Log that the flight crew compiles at the end of each flight, and is contained in an electronic flight bag (EFB). The data collected through the report will allow safety personnel to derive a reliable picture of the main threats and hazards faced in everyday operations, along with the TEM strategies used by crew. Reporting data can be used to generate a picture of the threats associated with a specific flight, and the associated TEM guidance. The unique report should not only provide crucial quantitative data for the safety management process, but also provides the flight crew with a tool which is easily accessible (some reports may be saved and completed later in the crew room, hotel room or at home), more efficient (only one report is required for completion as supplementary reports are pre-populated with data from the unique report) and therefore promotes an integrated data format for reporting and storing data which is related to the overall systems process.

Table 1. Summary of fieldwork

	Research Type
1	Process derivation workshops were conducted with the airlines, to map the active flight operations process and understand Flight Crew task performance within the context of this process.
2	A detailed task analysis was undertaken with Flight Crew from two partner airlines. This research was directed at understanding the nature of Flight Crew task performance (and associated information requirements) and identifying how this might be facilitated by the design of improved situation assessment and reporting tools.
3	Seven jump-seat observations and de-brief interviews, with one pilot from each airline
4	Two detailed task analysis case studies involving one pilot from each airline
5	Semi-structured interviews with twelve pilots
6	Twelve semi-structured interviews with other operational personnel (e.g. Dispatch, Cabin Crew and Maintenance) from two airlines. The purpose of these interviews was to identify other roles which feed information to Flight Crew and correspondingly, Flight Crew information outputs to these roles.
7	Ten interviews were conducted with Flight-planning Personnel and Quality/Safety personnel from both airlines. This research investigated dependencies between active flight operation and flight-planning and safety/quality processes.
8	A more in depth task analysis exploring certain critical activities (e.g. flight-planning and briefing, reporting etc), was then conducted with Flight Crew from one partner airline. This resulted in the identification of three high level Flight Crew scenarios and associated tool concepts.
9	Subsequently collaborative prototyping activities were conducted with Flight Crew from a Spanish Airline, using participatory design methodologies, [7]. This research focused on modelling low fidelity prototypes of the Graphical User Interfaces with the airline designated working group.

5 Section A: Event Structure

Pilots are asked to classify the event as either a single event or a chain of events. This logical distinction is necessary in order to correctly reconstruct the occurrence sequence. If the occurrence is a chain of events; all sections of the report structure will be completed cyclically until the chain is complete.

6 Section B: When Did It Happen?

Pilots are asked to select the process phase in which the event occurred

- It was observed by revising a sample of reports that a substantial majority of the narrative accounts start by stating when in the process phase a certain event happened.
- The pilots involved in the brainstorming sessions stated that they do not like to classify occurrences before starting an actual account of the event.
- The classification of the event can become confusing since it can be assigned according to main actors involved, main causes or consequences.
- Currently most of the accident or incident reporting forms force the users to classify events at the beginning, which often leads to a misclassification and a misuse of the information

Linking threats and errors to information contained in a process map of the Flight (see Fig.1). Operations can help in building up a systemic repository of information. This generates a living picture of the threats and hazards most recurrent in every process phase that could, in turn be used as a foundation of a safety management system based upon a systemic view of risk. This section utilises the Operational Process Model of Flight Operations, which was previously developed through field research.

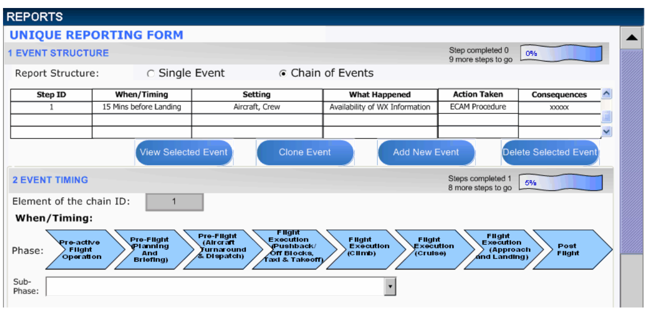

Fig. 1. Event structure and timing

7 Section C: “What happened” – Setting the Scene

This section allows the pilots an opportunity to list all the actors who were involved in the event, and to provide further information about them as linked to each process phase identified.

a. Users are presented with a list of all Actors and be able to select one or more actors involved by using check boxes
b. A narrative section enables users to describe what happened during the event by using a combination of selected Threats, Human Errors (based on the LOSA classification) and Delay Codes (company specific), and free text.

c. The threats and issues list will be linked to the process phases previously selected and can also be screened according to the actors selected.
d. If the event reported is classified as part of a chain of events, threats, highlighted threats (or added in previous phases, and outcome of previous phases) are listed as possible threats of subsequent flight phases that the user can select.
e. The users can input a qualitative assessment of the perceived criticality of each threat. Five levels of gravity can be reported: Catastrophic, Hazardous, Major, Minor, Negligible (see Fig.2). This data assists in rating the importance of each threat on the basis of historical data. This facilitates a review of how many high/critical threats are successfully managed on a daily basis.

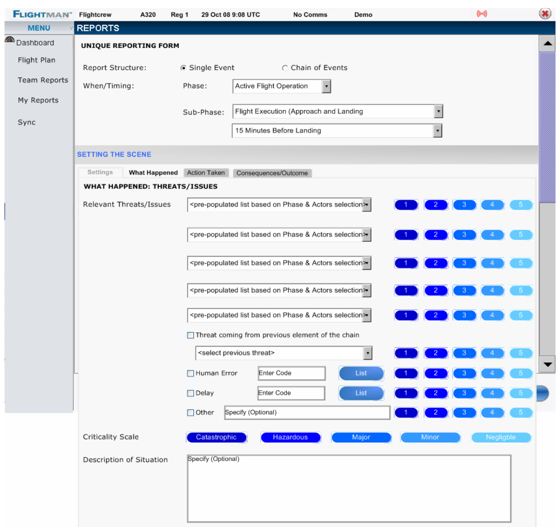

Fig. 2. "What happened: threats and issues"

8 Section D: Actions Taken

In this section, users are asked to describe actions taken. It also highlights features of TEM. Actions that prevent undesired outcomes within a chain of events may turn into a worse outcome at the end of the chain of events are symptomatic of effective Threats and Error Management.

- For each event the user can input one or more action
- For each action it is possible to select the threats in response to actions taken and the main actor should be selected from the actors list
- If the actor is a member of the crew the actions taken can be selected from:
- Action according to ECAM Procedures ((ECAM: Electronic Centralised Aircraft Monitor is a system that monitors aircraft functions and communicates them to the pilots. It also produces messages detailing failures and lists suggested procedures to correct the problem)

- Non-ECAM procedures (Normal, Abnormal, Emergency):
- Action taken in accordance with company procedures
- Action taken in accordance to Authority Regulation
- None of the above (“I’m not sure”)
- No action taken

A narrative section enables users to describe what action(s) they took by using a combination of key words and free-text. An example is reported in Fig. 3.

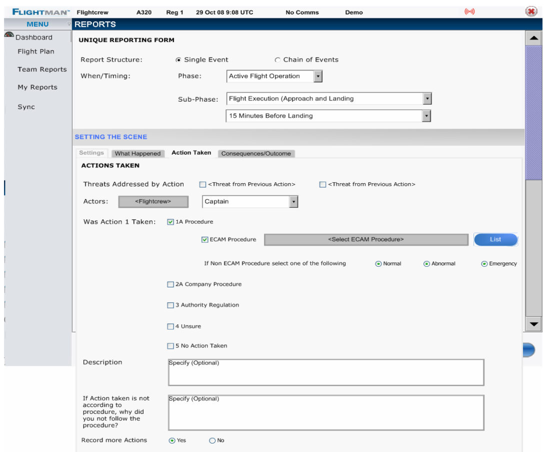

Fig. 3. Actions Taken

9 Section E: Consequences/ Outcome

Users are asked to indicate the consequences and outcomes for every element of a chain for both safety and operational issues. They are presented with pre-defined lists and are asked to select relevant issues. The lists are taken from the ECCAIRS classification scheme [8] of potential events and are linked directly to all phases selected at the beginning of the report. Should further levels of classification of the outcome be required, a pop- up box will appear with a short list from which pilots can choose the relevant item.

- More than one item can be selected (as events can have numerous consequences)
- The outcome of one stage of a flight can be selected as a threat for subsequent flight phases in the report.

10 Final Outcome

Pilots are asked to describe the final outcomes of events for both safety and operational issues. The final outcomes can be selected from the same ECCAIRS event classification scheme for each flight phase. Delays are also possible outcomes. Users can provide an estimate of the gravity of the outcome. The gravity can be associated to a single item or can be an overall property. Part of the screenshot for this section is reported in Fig. 4.

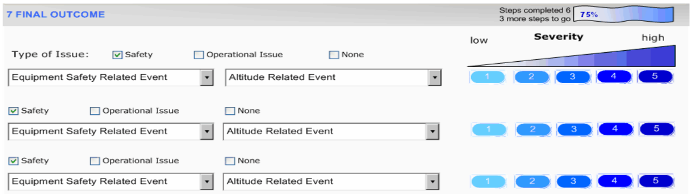

Fig. 4. Final Outcome

11 Section F: Analysis

This section of the report is optional. It provides pilots with an opportunity to report and rate factors which affected an event (see Fig.5). All previous sections appear in a summary format for ease of reference. Users are asked to evaluate contributory factors in terms of: (a) Blockers (contributory factors which have a negative impact on the performance) (b) Facilitators (contributory factors which have a positive impact on the performance). The importance of each contributory factor can be rated (1 = least important and 4 = most important). Users can enter information about possible consequences for an event. This provides input on TEM actions that had a positive impact on the chain of events, or that, near misses should be analysed further. Pilots can save this section of the report for review and submission at a later date.

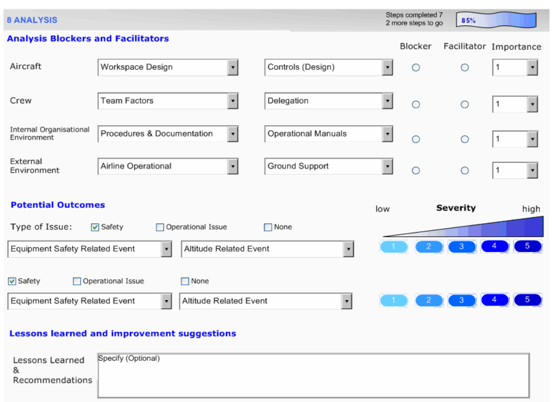

Fig. 5. Analysis of the event

12 Envisaged Use of the Data: Some Examples

The performance management concept is based on the relationship between flight crew task activities in the cockpit (e.g. flight-planning/briefing, ongoing TEM, reporting),

Table 2. Summary of envisaged use of data collected through the UNIQUE REPORT

#	Report Feature	Related Use of data
1	At the beginning of the report – users select whether they are reporting on a single event or a chain of events –	*Strategic Safety Management*: This data can be used to provide information in relation to process dependencies for each high severity reported Threat or Issue, highlighting the need of specific safety barriers and the placement of them where they might be more effective.
		Organizational Learning: Further reports on specific event chains that result in unacceptable aircraft states can be used for training purposes.
2	Users are not required to classify the nature of the event (e.g. event types) or error types.	*Legal Requirements:* Event and error classifications can be flexible in respect to the different accident classification schemes. The ECCAIRS classification was taken as a benchmark.
		Organizational Learning: The data can be queried according to the specific needs of the company, choosing freely between threats categories, routes, actors involved, and contributory factors examined.
3	Users are required to state single events or the elements of the chain of events according to the process phases they refer to.	*Strategic Safety management:* The Data collected about threats, errors, delays etc. through the form is linked to a map of the relevant airline processes. This feature can building up a living picture of the threats and hazards most recurrent in every process phase.
		Organizational Learning: The process map can be periodically updated taking into account the suggestions coming form the report users whenever they needed to add a processes not well depicted in the map
4	The report captures information about contributory factors (e.g. fatigue, poor situation assessment, information availability and so forth). and their estimated relevance in respect to the final outcome.	*Tactical Safety Management:* The indication about the relevance of contributory factors can be used to structure an index for decisions regarding the allocation of resources to the possible corrective actions. The process however also required an estimation of the expected impact of the corrective action (in terms of prevention of Loss associated with the related Risk Factor) and its foreseeable costs.
		Strategic Safety Management: Feedback on the follow up activities and how they took into consideration the notes provided about contributory factors can be made available to the reporters. This is recognised as a factor stimulating a proactive attitude of the front line staff.
5	The report captures information about the application of Standard Operating Procedures	*Tactical/strategic Safety Management:* Reports can be filtered according to SOP usage and problems. Threats and route can be associated to a frequency in the issue highlighted in respect to the use of Procedures.
		Organizational Learning: Update SOPs considering suggestions made by crew (via reports).
6	The UNIQUE REPORT allow the association of threats to specific routes and flight phases	*Tactical/strategic Safety Management:* Use reports information, along with information from other data sources, to determine risk ratings for specific types of flights/flight route/operations etc.
		Organizational Learning: Revise the reports pertaining threats that have been successfully managed, and rank in terms of effectiveness of actions reported.
		Task support: Provide the list of threats that pertain to specific routes in the intelligent flight plan. Provide additional information available on how threats have been successfully managed in the past.

supporting, operational and organizational processes on the ground. Reporting data can be integrated with a range of safety and operational data, and analyzed by Safety/Risk personnel. For example, flight-planning can receive information about problems/ threats to be managed in flight-planning activities. Flight crew can receive a threat/risk picture for their specific flight. Current performance management processes within airlines often neglect operational feedback. Within HILAS, it has been stressed that feedback to operational processes is a central part of a best practice in performance management activities which cannot be conceived in isolation from other safety management processes and functions. For example, the provision of TEM information to Flight Crew (e.g. task support) links to broader risk management activities (e.g. reports data analyzed as part of reactive safety management and ongoing proactive strategic safety management activities). Therefore the provision of reports feedback and safety case studies relates to broader organizational learning processes. Specifically, the critical organizational areas considered for the possible usage of data were the following:

(a) Task Support which involves supporting the safe, competent, effective and timely execution of individual and collaborative work tasks/activities in relation to the achievement of the operational goal. (b) *Tactical Risk Management* which is performed through routine processes such as reporting, investigation, assessment, analysis, recommendations, implementation, monitoring. (c) *Strategic Risk Management* which performed through involving strategic policy decisions for the organization and systemic assessment of events, monitoring trends against boundaries, analyzing and prioritizing systemic risks, policy decisions, organizational change. (d) *Organizational Learning* which entails knowledge-acquisition, information distribution, information interpretation, and organizational memory [9]. Table 2 provides a summary of the main high-level functionalities linked to this reporting data as suggested by flight crew as part of the evaluation of this reporting form.

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