Mechanisms in the Chain of Safety

Research and Operational Experiences in Aviation Psychology

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Chapter 11

Safety Reporting System as a Foundation for a Safety Culture[1]

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Introduction

Major organizational accidents such as the destruction of the space shuttle *Challenger* in 1986, the explosion of the Chernobyl's nuclear power plant in 1987, the accident with off-shore platform Piper Alpha in 1988 or the destruction of the space shuttle *Columbia* in 2003, highlighted the relevance of human contributions to organizational safety. Investigations traditionally considered technical and human factors in the development and prevention of these negative events but, in spite of such operational perspective, statistics have revealed the preponderance of human factors in up to 60–70 percent of the situations (e.g., Dekker, 2002).

Applied and academic efforts strived to identify the specific behaviors that could be associated with these negative outcomes in order to prevent them.

A first step in such endeavor was to understand what human error is. Models proposed by Rasmussen (1983, 1990), Reason (1990) and Hollnagel (1998) on human error all seem to highlight a common feature: human error is presented as a category of human behaviors (D'Oliveira, 2006).

The specific behaviors that can be identified vary according to the model considered but, in general, all proposals emphasize malfunctions or deficiencies in human information processing.

Reason's approach to human frailties is probably the most well-known approach with two major categories of behaviors being considered: unintentional errors such as slips, lapses, mistakes and the noncompliance with work rules and procedures (Reason, 1990, 1998).

An additional common facet seems to be present in all models: performance is evaluated at the individual level, that is, organizational safety is associated with inadequate individual behavior.

More recently the relevance of contextual factors such as the immediate social environment and how it may trigger inadequate human action has been analyzed (e.g., Reason, 1998).

1 An initial version of this chapter was first presented by Teresa C. D'Oliveira and Alexandra Franco at the 28th Conference of the European Association for Aviation Psychology, Valencia, Spain, October 27–31, 2008.

Kirwan (1999) considers that there are some situations that work as catalyzers to inadequate human intervention namely the non familiarity with the task, time pressures, and power operator-system interface among others as illustrated in Table 11.1.

Table 11.1 Error producing conditions and human reliability (adapted from Kirwan, 1999)

Error producing condition	Risk factor
1. Unfamiliarity with a situation	× 17
2. Little time to detect and correct errors	× 11
3. Low signal-to-noise ratio (i.e., information deficit)	× 10
4. Poor operator-system interface	× 8
5. Mismatch between the operator's and the designer's model	× 8
6. No means to reverse unintended actions	× 8
7. Information overload	× 6
8. Inadequate risk perception	× 4
9. Poor, ambiguous or inadequate system feedback	× 4
10. Operator's inexperience	× 3
11. Mismatch between educational achievements of the operator and the task requirements	× 2
12. Incentives to use other more dangerous procedures	× 2

Reason (1990) distinguished errors in terms of their consequences. Active errors are those "whose effects are felt immediately" (p. 173) while latent errors regard adverse consequences that could be hidden for a long time in the system and only become visible when combined with other factors. While the active or manifest errors are usually associated with operational work, latent errors are related to activities "removed both in time and space from the direct control interface" (p. 173) such as designers, maintenance, high-level decision makers and managers. In most accidents, operators inherit a system with frailties created by poor design, inappropriate installation, flawed maintenance and bad decision making.

Ramanujam (2003) argues that important organizational disasters have identified organizational procedures and policies, the latent factors or characteristics, as essential precursors of adverse organizational consequences in a variety of settings such as aviation accidents, chemical disasters, nuclear power plant accidents, product recalls in the automobile industry, and losses in financial institutions or deaths from medical errors.

Reason (1998) considers that organizational disasters may be associated with different organizational deficiencies which may be traced to the mission and

strategic options of a company. Various authors claim that some organizational characteristics and procedures (or the lack of them) can be viewed as "an accident in waiting".

D'Oliveira (2006), while reviewing the literature on organizational safety, identified different levels of influence (see Figure 11.1).

Top-level decisions regarding organizational objectives, the dominant values in terms of organizational culture and the way resources are managed can be considered as the most general and macro influences on organizational safety. Decisions at this level may create deficiencies in a variety of practices such as supervision, training, planning and performance monitoring. In many contexts, accident investigation is conducted in order to satisfy legal obligations but is not truly considered an opportunity for organizational learning. These organizational practices can then be translated into unsafe work conditions and processes, which in turn act as catalyzers of inadequate human intervention, that is, errors and noncompliance with rules and work procedures.

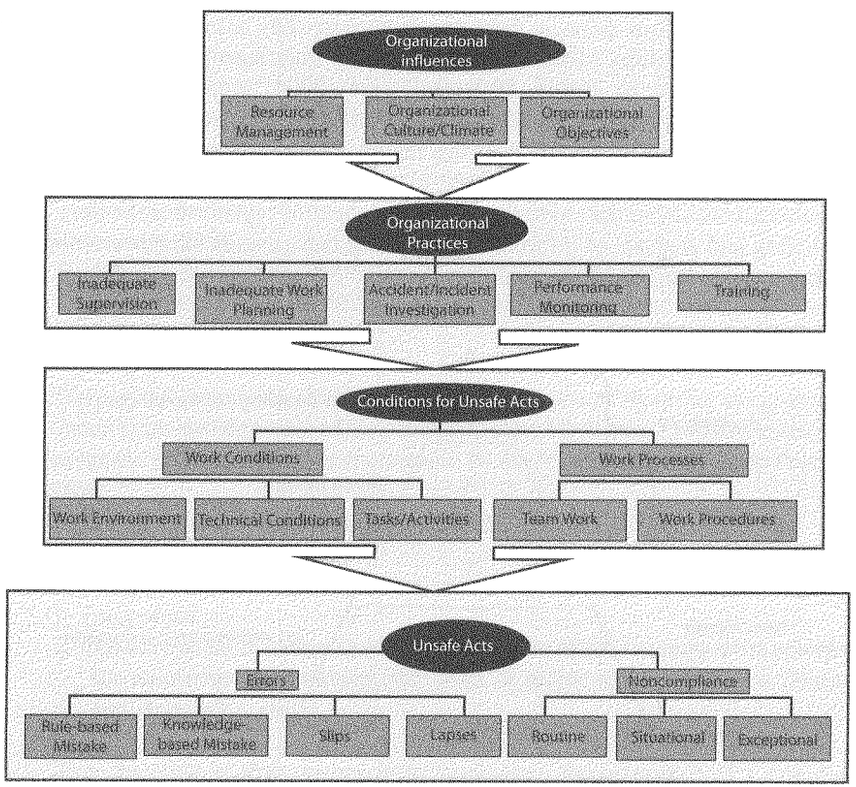

Figure 11.1 Latent catalysers of organizational safety (D'Oliveira, 2006)

The adoption of a system perspective prompted Hollnagel (2004) to identify system conditions that regard the ineffective protection of the organization. Three major latent conditions can be considered: design barriers (e.g., procedures associated with an activity) are missing or are dysfunctional, resources to minimize or neutralize potential threats are insufficient and the highly precarious functioning of the system amplifies any small active failure.

What one has to consider is that current economic conditions can actually trigger these latent conditions and factors. For example, the economic constraints companies are facing and the cost-cutting policies adopted by top management may create the background for organizational practices with consequences deferred in space and time, "an accident in waiting" as previously proposed.

The acknowledgement of safety as a social construction prompted the development of proactive approaches. If most safety elements are embedded in the organization, then one should look for their presence instead of analyzing their consequences. In this regard, Hollnagel (2004) considers that adverse consequences may arise in many forms and degrees of severity and proposed a pyramid of failures and their consequences as illustrated in Figure 11.2.

Events differ not only in their consequences; they also vary in terms of proportion. Regardless of the controversies that may surround the proportion numbers indicated in Figure 11.2, Hollnagel (2004) emphasizes that these events represent symptoms of what needs to be improved and, as such, learning opportunities for the organization. In this regard, information on the most frequent but less costly events may contribute to significant safety improvements and should be considered the starting point of the chain of organizational safety. The gathering and analysis of information regarding these events becomes central to safety management and preventive initiatives.

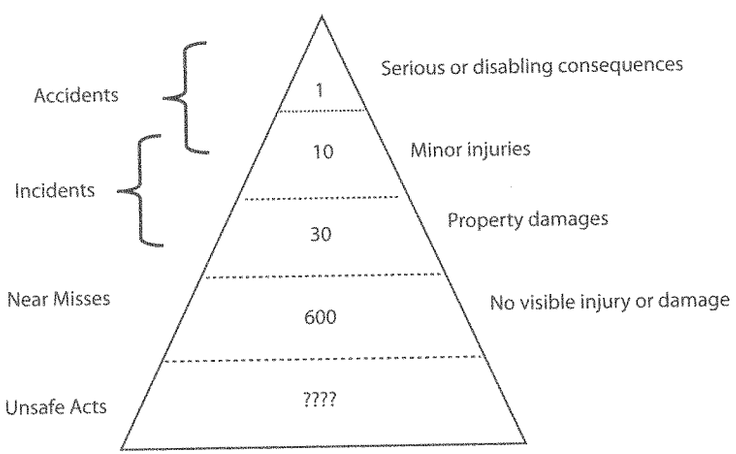

Figure 11.2 The pyramid of failures (adapted from Hollnagel, 2004)

In other words, the use of event reporting programs became central to the development of proactive approaches to aviation safety.

At the same time, a change in approach to organizational safety can be identified: a more traditional reactive perspective to undesirable events has progressively been replaced by a proactive outlook that contemplates a set of elements in an integrated system. Within this framework, latent errors are presented as a recurring theme in theoretical accounts of major accidents and, therefore, should be targeted by preventive initiatives.

The centrality of information for safety management was also highlighted by Reason (1998). According to the author an effective safety culture requires five main pillars:

1. The information element, that is, the organization has an information system where data regarding real and potential adverse events is collected, analyzed and disseminated; the system also considers data from the regular checks.
2. The reporting component where any human element of the system feels the need to participate and provide information regarding their own behavior, the behavior of colleagues or the events that took place.
3. The incentive factor whereby people perceive an atmosphere of trust and feel comfortable in reporting events. This is should not be viewed as synonymous with a blanket amnesty since it would contribute to a lack of credibility of the system.
4. A flexible organizational structure is considered a central feature of a crisis-prepared organization as learning can only take place when the organization accepts change.
5. Finally, organizations must be willing to introduce changes in their regular practices in order to accommodate recommendations from their safety information system.

Harper and Helmreich (2003) consider that the use of reporting programs can be traced to the development of the Aviation Safety Reporting System (ASRS) and more recently, has been further encouraged by the Aviation Safety Action Program (ASAP).

Two major goals were setup for the ASAPs:

1. To gather information regarding safety issues and provide protection to its proponent.
2. To use this information to develop corrective actions to reduce the potential for recurrence of accidents, incidents or safety related problems (Harper and Helmreich, 2003).

The objective of this chapter is to summarize the relevance of a reporting culture in high-reliability industries and, in particular, in the aviation industry. The chapter considers the literature on reporting programs; the safety reporting

program developed at a Portuguese commercial airline, the initial results and suggested interventions.

Method

Participants

Similarly to the ASRS, the airline decided to launch a reporting safety system that included a human factors component. The Human Factors Report was initially launched in June 2006 and was made available to all personnel at the company. Anyone willing to report a safety event was welcome to do so and simply had to fill in the form that was available at the Crew Terminal. Participation was anonymous but volunteers could identify themselves if thought relevant. A total of 214 reports were received between June 2006 and August 2008 and were considered for the analysis.

Instrument

A reporting form was elaborated upon the main recommendations of the literature. A first section of the form considered personal data such as job position, and aircraft involved, activities under way when the event took place such as flight phase and cabin crew activities. A second part of the form regards the Human Factors issues involved in the event. IATA's categories of human factors to be considered in safety events were adopted (IATA, 2006 – Table 11.2). A third part of the form considers the organizational factors involved in the occurrence, the type of event and the characteristics that affected the quality of human performance.

Table 11.2 Human factors categories involved in the event (IATA, 2005)

Intentional non compliance Deliberate and premeditated deviation from operator procedures and/or regulations. Examples include intentional disregard of operational limitations or SOPs.
Proficiency Crew performance failures due to deficient knowledge or skills. This may be exacerbated by lack of experience, knowledge or training. Examples include inappropriate handling of the equipment.
Communication Miscommunication, misinterpretation or failure to communicate pertinent information within the crew or between the flight crew and an external agent. CRM issues typically fall under this category. Examples include failures in monitoring/cross-checking, misunderstanding an instruction.
Procedural Unintentional deviation in the execution of operator procedures and/or regulations. The crew has the necessary knowledge and skills, the intention is correct, but the execution is flawed. It may also include situations where crews forget or omit relevant appropriate action.
Incapacitation/Fatigue Crew member unable to perform duties due to physical or psychological impairment.

Results

An initial analysis of the results suggest that there is a growing interest in the program with an increasing number of participants reporting events in which they were personally involved (29.4 percent in 2006; 45 percent in 2007 and 60.3 percent in 2008). Table 11.3 summarizes data regarding the operator involved, the fleet and phase of the flight when the event in question took place. Events reported involved mainly medium range flights (narrow body fleet) and suggest that the central role in the event shifted from pilots (62.5 percent in 2006) to cabin crew (77.2 percent for both cabin crew and senior cabin crew). As for the flight phase in which the event took place, a pattern of results appears to emerge as in 2006 the majority of occurrences took place outside the flying phase (dispatch, pre-flight, park) and in 2007 and 2008 during the flight itself (during take-off, cruising or descending).

Table 11.3 Main characteristics of the events reported (values in percentages)

Operator involved	**2006**	**2007**	**2008**
Captain	62.5	14.5	15.8
First Officer	0.0	10.1	5.4
Supervisor	0.0	4.3	1.5
Senior Cabin Crew	12.5	17.4	19.8
Cabin Crew	25.0	53.6	57.4
Fleet			
Narrow Body	71.4	76.5	75.9
Wide Body	28.6	23.5	24.1
Flight Phase			
Dispatch	12.5	2.0	2.7
Pre-flight	12.5	2.0	3.6
Pushback	0.0	7.8	4.0
Taxi-out	0.0	3.9	3.6
Take-off	0.0	33.3	5.8
Climb	0.0	5.9	8.5
Cruise	6.3	27.5	17.0
Descent	6.3	9.8	11.2
Holding	0.0	3.9	2.7
Approach	6.3	7.8	5.4
Landing	6.3	3.9	4.9
Taxi-in	0.0	0.0	0.0
Park	25.0	13.7	7.6
Various	25.0	2.0	22.9

Results regarding potential human factors involved in the event (Figure 11.3) suggest that it is possible to identify two major trends in the reports analyzed. Proficiency, communication and intentional noncompliance had a negative evolution from to 2006 to 2008. In contrast, incapacitation/fatigue and procedural issues increased in the period considered. While incapacitation or fatigue refers to the physical or psychological impairment of crew members, procedural regards slips and lapses in the execution of procedures and/or regulations.

In what regards the organizational factors involved in the event, both planning and human resources issues appear to be involved in the occurrences described with the former being responsible for the large majority of reports. This result contrasts with the consistent decreases in reports identifying training, organization and other categories as contributing factors (see Figure 11.4).

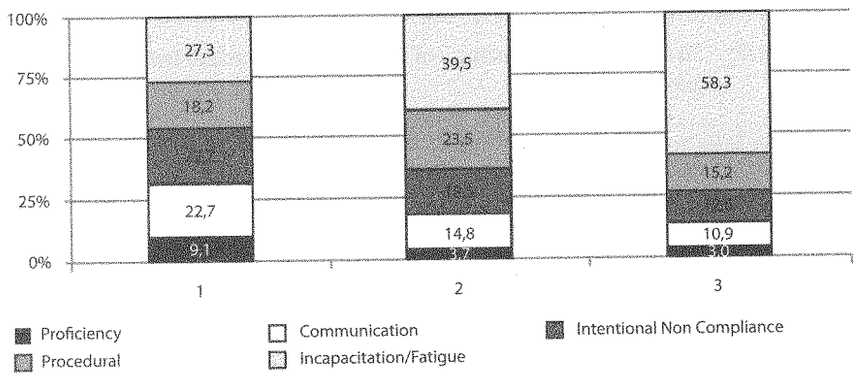

Figure 11.3 Human factors involved in the events reported

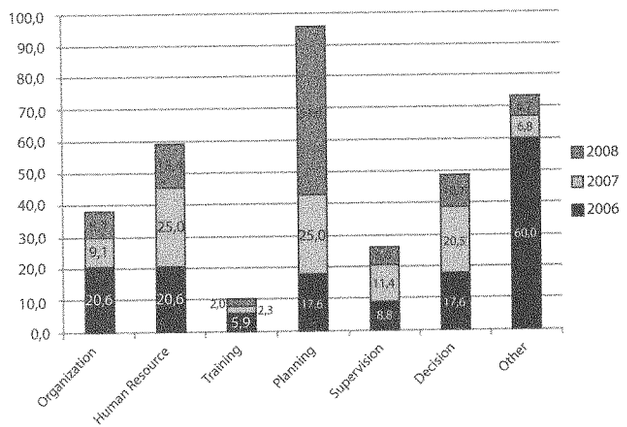

Figure 11.4 Organizational factors involved in the events reported

Discussion

The objective of this chapter is to review the relevance of a reporting culture in high-reliability organizations and, in particular, in the aviation industry. The chapter summarizes the main safety models on human intervention and highlights the relevance of collecting and analyzing data on safety occurrences. The central role of safety reporting programs for the development of an effective safety culture was also considered.

Initial data of a safety reporting program developed at a Portuguese commercial airline were analyzed. Adherence to the program is emphasized by the growing number of reports being submitted.

Results suggest that participants from medium range flights report being involved in more safety events, an involvement that is mainly linked with fatigue or incapacitation of crew members – issues that they associate with planning, human resources and organizational factors. In particular, crew members refer to rostering issues and how their work schedules contribute to higher levels of fatigue, a complaint that reflects current performance concerns in the industry (e.g., D'Oliveira, 2011).

If one is to adopt a more proactive perspective regarding safety then general recommendations should be put forward regarding a minimum number of days off to act as a counter measure for fatigue, a guideline that already exists for the long range flights. Current discussions regarding flight duty times and fatigue risk management systems also reflect these concerns.

The benefits of implementing a safety reporting system appear to be emphasized in this study as results suggested priorities of intervention in what concerns the operators' perspective. The adherence of operators and their genuine participation in such initiatives is not always problem free, especially if a blame culture exists and trust is not central in human interactions. The growing number of safety reports submitted suggests that crew members may view this initiative as a voice mechanism within the airline. It is recommended that main results of the program should be validated by crew members and that the airline communicates the applied interventions that were setup as a consequence. As with any reporting system, if no visible consequences emerge from the data collected and no clear information is conveyed to organizational members, gradual apathy and lack of interest may replace the motivational drive that was identified in implementation of this program. It is up to the airline to respond to this global adherence of operational participants and to avoid it becoming an inconsequential organizational safety ritual.

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Chapter 12
Conclusions: Extending the Chain

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Previously, most references on Human Factors in Aviation have considered such traditional topics as basic psychological processes (i.e., workload, stress, decision making and situation awareness), organizational practices (i.e., personnel selection and training) and technological challenges resulting from growing automation or increased airspace capacity. Improvements in system safety and performance are typical criterion of reference for a variety of interventions.

However, the isolated consideration of each topic fails to capture the dynamic nature of the aviation industry and its operational challenges. "Mechanisms in the chain of safety" was devised with two objectives: to present the most recent research and operational efforts in aviation safety and performance and to illustrate the need for full circle approaches.

In this volume, the adoption of an IPO approach (Inputs-Processes-Outputs) to safety and performance led to the identification of three major topics: inputs, coping and control mechanisms.

Inputs in the aviation industry typically involve personnel selection, the validation of selection batteries and the use of psychological measures that take advantage of recent technological developments. Distinct contributions associated with inputs mechanisms were included in this volume: proposals that take advantage of the use of computerized tasks and suggestions linked with the identification and study of new performance indicators. Potential improvements resulting from technological developments were presented by Oubaid, Zinn and Gundert and by Uyttendaele and de Voogt.

At the center of Oubaid, Zinn and Gundert's proposal are the interpersonal interactions in aviation. Programs and interventions promoting teamwork have been underlined for almost three decades by programs such as CRM—Crew Resource Management in pilots or TRM—Team Resource Management for air traffic controllers, central for basic and recurrent training. Although some form of evaluation of characteristics promoting or associated with team work is included in most selection programs, improvements are needed in the scenarios presented and the evaluations conducted. The authors propose a new computerized tool that allows multi-observations of several applicants that interact face-to-face and through their touch screens. Conventionally, the aviation industry viewed interpersonal competence as trainable but Oubaid, Zinn and Gundert propose that the inclusion of more structured selection systems may benefit training interventions, a proposal that echoes trainability concerns.