LOSA
(LINE OPERATIONS SAFETY AUDIT)

BASIC ERROR MANAGEMENT CONCEPTS

1.1 INTRODUCTION

1.1.1 Historically, the way the aviation industry has investigated the impact of human performance on aviation safety has been through the retrospective analyses of those actions by operational personnel, which led to rare and drastic failures. The conventional investigative approach is for investigators to trace back an event under consideration to a point where they discover particular actions or decisions by operational personnel that did not produce the intended results and, at such point, conclude human error as the cause. The weakness in this approach is that the conclusion is generally formulated with a focus on the outcome, with limited consideration of the processes that led up to it. When analyzing accidents and incidents, investigators already know that the actions or decisions by operational personnel were "bad" or "inappropriate", because the "bad" outcomes are a matter of record. In other words, investigators examining human performance in safety occurrences enjoy the benefit of hindsight. This is, however, a benefit that operational personnel involved in accidents and incidents did not have when they selected what they thought of as "good" or "appropriate" actions or decisions that would lead to "good" outcomes.

1.1.2 It is inherent to traditional approaches to safety to consider that, in aviation, safety comes first. In line with this, decision making in aviation operations is considered to be 100 percent safety-oriented. While highly desirable, this is hardly realistic. Human decision making in operational contexts is a compromise between production and safety goals. The optimum decisions to achieve the actual production demands of the operational task at hand may not always be fully compatible with the optimum decisions to achieve theoretical safety demands. All production systems, and aviation is no exception, generate a migration of behaviors: due to the need for economy and efficiency, people are forced to operate at the limits of the system's safety space. Human decision making in operational contexts lies at the intersection of production and safety and is therefore a compromise. In fact, it might be argued that the trademark of experts is not years of experience and exposure to aviation operations, but rather how effectively they have mastered the necessary skills to manage the compromise between production and safety. Operational errors are not inherent in a person, although this is what conventional safety knowledge would have the aviation industry believe. Operational errors occur as a result of mismanaging or incorrectly assessing task and/or situational factors in a specific context and thus cause a failed compromise between production and safety goals.

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1.1.3. The compromise between production and safety is a complex and delicate balance. Humans are generally very effective in applying the right mechanisms to successfully achieve this balance, hence the extraordinary safety record of aviation. Humans do, however, occasionally mismanage or incorrectly assess task and/or situational factors and fail in balancing the compromise, thus contributing to safety breakdowns. Successful compromises far outnumber failed ones; therefore, in order to understand human performance in context, the industry needs to systematically capture the mechanisms underlying successful compromises when operating at the limits of the system, rather than those that failed. It is suggested that understanding the human contribution to successes and failures in aviation can be better achieved by monitoring normal operations, rather than accidents and incidents. The Line Operations Safety Audit (LOSA) is the vehicle endorsed by ICAO to monitor normal operations.

1.1.4. The *Line Operations Safety Audit Program* describes the process by which all airline flight crewmembers are evaluated on professional standards. This section is designed to provide instructions, guidance, and regulatory requirements for evaluating flight crewmembers during these observations. As professionals, airline flight crewmembers are expected to exhibit the highest degree of airmanship, integrity, professionalism, proficiency, and safety. The flight crewmembers should be a master of the airplane, and demonstrate an ability to operate under complex circumstances throughout the range and scope of his/her duties. Additionally, the flight crewmember bears the final responsibility for the safe conduct of the flight. This standard, more than any other, distinguishes the flight crewmember as a professional. This mastery of complex problems, good judgment, situational awareness, crew resource management, and leadership skills is necessary to ensure that safety is never compromised. *Flight Manual Part* 1, the appropriate *Aircraft Operating Manua*l, and the *Line Operations Safety Audit Program* provide the framework for ensuring standardized flight operations. However, when situations arise that are not specifically addressed by these manuals or FARs, the Flight Crew is expected to exercise professional judgment while maintaining safety of flight as the first priority. The *Line Operations Safety Audit Program* is the responsibility of the Manager of Flight Safety. Written comments and suggestions may be submitted via board mail to the Safety Department. All flight operations are subject to the *Line Operations Safety Audit Program*. The determination of whether a flight crewmember's performance is acceptable is derived from the experience and judgment of the LOSA Observer. The LOSA Observer must evaluate carefully, consistently, and in accordance with the operating procedures outlined in the appropriate *Aircraft Operating Manua*l.

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1.2 BACKGROUND

Reactive strategies

Accident investigation

1.2.1 The tool most often used in aviation to document and understand human performance and define remedial strategies is the investigation of accidents. However, in terms of human performance, accidents yield data that are mostly about actions and decisions that failed to achieve the successful compromise between production and safety discussed earlier in this chapter.

1.2.2 There are limitations to the lessons learned from accidents that might be applied to remedial strategies vis-a-vis human performance. For example, it might be possible to identify generic accident-inducing scenarios such as Controlled Flight Into Terrain (CFIT), Rejected Takeoff (RTO), runway incursions and approach-and-landing accidents. In addition, it might be possible to identify the type and frequency of external manifestations of errors in these generic accident-inducing scenarios or discover specific training deficiencies that are particularly related to identified errors. This, however, provides only a tip-of-the-iceberg perspective. Accident investigation, by definition, concentrates on failures, and in following the rationale advocated by LOSA, it is necessary to better understand the success stories to see if they can be incorporated as part of remedial strategies.

1.2.3 This is not to say that there is no clear role for accident investigation within the safety process. Accident investigation remains the vehicle to uncover unanticipated failures in technology or bizarre events, rare as they may be. Accident investigation also provides a framework. If only normal operations were monitored, defining unsafe behaviors would be a task without a frame of reference. Therefore, properly focused accident investigation can reveal how specific behaviors can combine with specific circumstances to generate unstable and likely catastrophic scenarios. This requires a contemporary approach to the investigation. Should accident investigation be restricted to the retrospective analyses discussed earlier, its contribution in terms of human error would be to increase existing industry databases, but its usefulness in regard to safety would be dubious. In addition, the information could possibly provide the foundations for legal action and the allocation of blame and punishment.

Combined *reactive/proactive* strategies

Incident investigation

1.2.4 A tool that the aviation industry has increasingly used to obtain information on operational human performance is incident reporting. Incidents tell a more complete story about system safety than accidents do because they signal weaknesses within the overall system **before** the system breaks down. In addition, it is accepted that incidents are precursors of accidents and that N-number of incidents of one kind takes place before an accident of the same kind eventually occurs. The basis for this can be traced back almost 30 years to research on accidents from different industries, and there is ample practical evidence that supports this research. There are, nevertheless, limitations of the value of the information on operational human performance obtained from incident reporting.

1.2.5 First, reports of incidents are submitted in the jargon of aviation and, therefore, capture only the external manifestations of errors (for example, “misunderstood a frequency”, “busted an altitude”, and “misinterpreted a clearance”). Furthermore, incidents are reported by the individuals involved, and because of biases, the reported processes or mechanisms underlying errors may or may not reflect reality, this means that incident-reporting systems take human error at face value, and, therefore, analysts are left with two tasks. First, they must examine the reported processes or mechanisms leading up to the errors and establish whether such processes or mechanisms did indeed underlie the manifested errors. Then, based on this relatively weak basis, they must evaluate whether the error management techniques reportedly used by operational personnel did indeed prevent the escalation of errors into a system breakdown.

1.2.6 Second, and most important, incident reporting is vulnerable to what has been called “normalization of deviance”. Over time, operational personnel develop informal and spontaneous group practices and shortcuts to circumvent deficiencies in equipment design, clumsy procedures or policies that are incompatible with the realities of daily operations, all of which complicate operational tasks. These informal practices are the product of the collective expertise and hands-on expertise of a group, and they eventually become normal practices. This does not, however, negate the fact that they are deviations from procedures that are established and sanctioned by the organization, hence the term “normalization of deviance”. In most cases, normalized deviance is effective, at least temporarily. However, it runs counter to the practices upon which system operation is predicated. In this sense, like any shortcut to standard procedures, normalized deviance carries the potential for unanticipated “downsides” that might unexpectedly trigger unsafe situations. However, since they are "normal”, it stands to reason that neither these practices nor their downsides will be recorded in incident reports.

1.2.7 Normalized deviance is further compounded by the fact that even the most willing reporters may not be able to fully appreciate what are indeed reportable events. If operational

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personnel are continuously exposed to substandard managerial practices, poor working conditions, and or flawed equipment, how could they recognize such factors as reportable problems?

1.2.8 Thus, incident reporting cannot completely reveal the human contribution to successes or failures in aviation and how remedial strategies can be improved to enhance human performance. Incident reporting systems are certainly better than accident investigations in understanding system performance, but the real challenge lies in taking the next step understanding the processes underlying human error rather than taking errors at face value. It is essential to move beyond the visible manifestations of error when designing remedial strategies. If the any airline is to be successful in modifying system and individual performance, errors must be considered as symptoms that suggest where to look further. In order to understand the mechanisms underlying errors in operational environments, flaws in system performance captured through incident reporting should be considered as symptoms of mismatches at deeper layers of the system. These mismatches might be deficiencies in training systems, flawed person technology interfaces, poorly designed procedures, corporate pressures, poor safety culture, etc. The value of the data generated by incident reporting systems lies in the early warning about areas of concern, but such data do not capture the concerns themselves.

Training

1.2.9 The observation of training behaviors (during flightcrew simulator training, for example) is another tool that is highly valued by the aviation industry to understand operational human performance. However, the “production” component of operational decision making does not exist under training conditions. While operational behaviors during line operations are a compromise between production and safety objectives, training behaviors are absolutely biased towards safety. In simpler terms, the compromise between production and safety is not a factor in decision making during training. Training behaviors are “by the book”.

1.2.10 Therefore, behaviors under monitored conditions, such as during training or line checks, may provide an approximation to the way operational personnel behave when unmonitored. These observations may contribute to flesh out major operational questions such as significant procedural problems. However, it would be incorrect and perhaps risky to assume that observing personnel during training would provide the key to understanding human error and decision making in unmonitored operational contexts.

Surveys

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1.2.11 Surveys completed by operational personnel can also provide important diagnostic information about daily operations and, therefore, human error. Surveys provide an inexpensive mechanism to obtain significant information regarding many aspects of the organization, including the perceptions and opinions of operational personnel: the relevance of training to line operations, the level of teamwork and cooperation among various employee groups, problem areas or bottlenecks in daily operations, and eventual areas of dissatisfaction. Surveys can also probe the safety culture. For example, do personnel know the proper channels for reporting safety concerns and are they confident that the organization will act on expressed concerns? Finally, surveys can identify areas of dissent or confusion, for example, diversity in beliefs among particular groups from the same organization regarding the appropriate use of procedures or tools. On the minus side, surveys largely reflect perceptions. Surveys can be likened to incident reporting and are therefore subject to the shortcomings inherent to reporting systems in terms of understanding operational human performance and error.

Flight data recording

1.2.12 Digital Flight Data Recorder (DFDR) and Quick Access Recorder (QAR) information from normal flights is also a valuable diagnostic tool. There are, however, some limitations about the data acquired through these systems. DFDR/QAR readouts provide information on the frequency of exceedences and the locations where they occur, but the readouts do not provide information on the human behaviors that were precursors of the events. While DFDR/QAR data track potential systemic problems, pilot reports are still necessary to provide the context within which the problems can be fully diagnosed.

1.2.13 Nevertheless, DFDR/QAR data hold high cost/efficiency ratio potential. Although probably underutilized because of cost considerations as well as cultural and legal reasons, DFDR/QAR data can assist in identifying operational contexts within which migration of behaviors towards the limits of the system takes place.

Proactive strategies

Normal line operations monitoring

1.2.14 The approach proposed in this manual to identify the successful human performance mechanisms that contribute to aviation safety and, therefore, to the design of countermeasures against human error focuses on the monitoring of normal line operations.

1.2.15 Any typical routine flight - a normal process - involves inevitable, yet mostly inconsequential errors (selecting wrong frequencies, dialing wrong altitudes, acknowledging incorrect read-backs, mishandling switches and levers, etc.) Some errors are due to flaws in human performance while others are fostered by systemic shortcomings; most are a combination of both. The majority of these errors have no negative consequences because operational personnel employ successful coping strategies and system defenses act as containment nets. In order to design remedial strategies, the aviation industry must learn about these successful strategies and defenses, rather than continue to focus on failures, as it has historically done.

1.2.16 A medical analogy may be helpful in illustrating the rationale behind LOSA. Human error could be compared to a fever: an indication of an illness but not its cause. It marks the beginning rather than the end of the diagnostic process. Periodic monitoring of routine flights is therefore like periodic physical: proactively checking health status in an attempt to avoid getting sick. Periodic monitoring of routine flights indirectly involves measurement of all aspects of the system, allowing identification of areas of strength and areas of potential risk. On the other hand, incident investigation is like going to the doctor to fix symptoms of problems; possibly serious, possibly not. For example, a broken bone sends a person to the doctor; the doctor sets the bone but may not consider the root cause(s): weak bones, poor diet, high-risk lifestyle, etc. Therefore, setting the bone is no guarantee that the person will not turn up again the following month with another symptom of the same root cause. Lastly, accident investigation is like a postmortem: the examination made after death to determine its cause. The autopsy reveals the nature of a particular pathology but does not provide an indication of the prevalence of the precipitating circumstances. Unfortunately, many accident investigations also look for a primary cause, most often “pilot error”, and fail to examine organizational and system factors that set the stage for the breakdown. Accident investigations are autopsies of the system, conducted after the point of no return of the system’s health has been passed.

1.2.17 There is emerging consensus within the aviation industry about the need to adopt a positive stance and **anticipate,** rather than regret, the negative consequences of human error in system safety. This is a sensible objective. The way to achieve it is by pursuing innovative approaches rather than updating or optimizing methods from the past. After more than 50 years of investigating failures and monitoring accident statistics, the relentless prevalence of human error in aviation safety would seem to indicate a somewhat misplaced emphasis in regard to safety, human performance and human error; unless it is believed that the human condition is beyond hope.

1.3 A CONTEMPORARY APPROACH TO OPERATIONAL HUMAN PERFORMANCE AND ERROR

1.3.1. The implementation of normal operations monitoring requires an adjustment on prevailing views of human error. In the past, safety analyses in aviation have viewed human error as an undesirable and wrongful manifestation of human behavior. More recently, a considerable amount of operationally oriented research, based on cognitive psychology, has provided a very different perspective on operational errors. This research has proven, in practical terms, a fundamental concept of cognitive psychology: error is a normal component of human behavior. Regardless of the quantity and quality of regulations the industry might promulgate, the technology it might design, or the training people might receive, error will continue to be a factor in operational environments because it simply is the downside of human cognition. Error is the inevitable downside of human intelligence; it is the price human beings pay for being able to "think on our feet". Practically speaking, making errors is a conservation mechanism afforded by human cognition to allow humans the flexibility to operate under demanding conditions for prolonged periods without draining their mental "batteries".

1.3.2. There is nothing inherently wrong or troublesome with error itself as a manifestation of human behavior. The trouble with error in aviation is the fact that negative **consequences** may be generated in operational contexts. This is a fundamental point in aviation: if the negative consequences of an error are caught before they produce damage, then the error is inconsequential. In operational contexts, errors that are caught in time do not produce negative consequences and therefore, for practical purposes, do not exist. Countermeasures to error, including training interventions, should not be restricted to avoiding errors, but rather to making them visible and trapping those before they produce negative consequences. This is the essence of error management: human error is unavoidable but manageable.

1.3.3. Error management is at the heart of LOSA and reflects the previous argument. Under LOSA, flaws in human performance and the ubiquity of error are taken for granted and, rather than attempting to improve human performance, the objective becomes to improve the context within which humans perform. LOSA ultimately aims through changes in design, certification, training, procedures, management and investigation – at defining operational contexts, including buffer zones or time delays between the commission of errors and the point in which error consequences become a threat to safety. The buffer zone or time delay allows for recovery from the consequences of errors. The more resistant the buffer or the longer the time delay, the stronger the intrinsic resistance and tolerance of the operational context to the negative consequences of human error. Operational contexts should be designed in such a way that allows front-line operators second chances to recover from the consequences of errors.

1.3.4. In making an analogy with flight instruments, human performance can be considered as falling into three bands: a “green” band”, a “yellow band”, and a “red band”. Within the “green band”, the operational context demands are low. Task and situational factors are compatible with cognitive resources, operational personnel make the fewest errors and, as indicated by the high recovery rate, the operational personnel have ample cognitive resources in reserve to recover from the negative consequences of errors. Task and situational factors put human performance into the “yellow band” when the operational context demands increase and become more complex and, consequently, errors increase in number and the recovery rate decreases. As operational context demands continue to increase and eventually peak, task and situational factors force human performance into the “red band”. In this band, the number of errors sharply jumps and the recovery rate dips to a point at which cognitive control is lost. At this point, cognitive resources are no longer available to cope with the situation at hand; the mental “batteries” are totally depleted.

1.3.5. This classification of human performance into bands is beneficial to organizations to apply the LOSA data. As an example, the term “coffin corner” is used to describe the point in the operational envelope of an aircraft at which the (low) stall speed and the (high) buffet speed are the same and the aircraft exhibits bizarre behavior and eventually goes out of control. Weight-verses-altitude-and-speed capability charts and other tools provide flightcrews with the necessary information to avoid operating aircraft in this condition and, therefore, to stay within a safe operating envelope. LOSA generates the information necessary for organizations to define the “green band” of safe operations in the human performance envelope, thus avoiding taking operational human performance into the “coffin corner” of cognition.

1.4 THE ROLE OF THE ORGANIZATIONAL CULTURE

1.4.1. In order to understand how an organization can effectively implement approaches to error management, it is essential to examine the organization’s daily processes, the kind of corporate culture such processes generate, and the organization’s attitudes toward error and punishment. This will make it possible to assess the effectiveness of the controls that the organization has in place to ensure that its processes foster the “green band” of operational human performance. It is good to remember the following points: humans do not live in a vacuum so their behaviors are affected by many external factors; corporate culture is an organizational mandate that conditions operational personnel decision making; and humans exhibit the kinds of behaviors an organization fosters and which they therefore assume the organization expects of them.

1.4.2. In closing this section, it is important to clearly point out the distinction between errors – which are products of human limitations, and violations – which have a motivational component. While errors should be considered as the inevitable downside of human intelligence and flexibility and the aviation industry must learn to live with it, violations should be considered from a different perspective. Violations are an emerging topic of research, and in due time, the aviation industry might need to change prevailing attitudes towards them. However, for the purposes of this manual, violations should not be condoned.

1.5 CONCLUSION

1.5.1. There is no denying that monitoring normal operations on a routine basis poses major challenges. Significant progress has been achieved in tackling some of these challenges. From a methodological point of view, some of the early problems in defining, classifying and standardizing the data obtained have been solved with this program revision. From an organizational perspective, there is a need to consider using multiple data collection tools, including line observations, surveys, self-reports such as ASAP Reports, and more refined safety incident reporting and Flight Data Analysis systems such as FOQA. Each tool can provide its own unique part of the whole picture and, taken as a whole, provide any airline with a comprehensive look at their actual operations.

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