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LINE OPERATION SAFETY AUDITS (LOSA): DEFINITION AND OPERATING CHARACTERISTICS

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The popularity of the Line Operations Safety Audit (LOSA) as a safety tool that gathers cockpit observations during normal flight operations has steadily increased over the past seven years. However, many people are still unclear about what it is and how it helps improve safety. The purpose of this paper is to help clarify issues surrounding LOSA by providing a brief historical account and outlining the ten operating characteristics that define the LOSA process.

Introduction

The demand for LOSA (Line Operations Safety Audit) continues to grow at a rapid pace in aviation. Unfortunately, misunderstandings abound about its makeup and contribution to airline safety. Drawing from our experience as the original LOSA developers, the purpose of this paper is to help clarify the definition of LOSA through ten operating characteristics that we believe are essential to its long term success.

Perhaps the best place to begin is by recounting the history and evolution of LOSA as a safety tool.

History of LOSA

The precursor to LOSA began in 1994 at the request of Delta Air Lines. After developing a new Crew Resource Management (CRM) course for their line pilots, management questioned whether the concepts taught in training actually transferred to the line. The airline's only perspective of CRM performance at the time came from Line Oriented Flight Training (LOFT) and regular line checks. Many managers agreed these data were good at uncovering proficiency issues but fell short in reflecting actual CRM performance. This prompted a collaborative partnership between Delta and The University of Texas Human Factors Research Project to develop a CRM audit methodology for normal operations.

The biggest concern for developers was whether pilots would feel comfortable enough to normally perform in front of an observer. If pilots believed the audit was another type of evaluative line check, it might elicit fake behavior and defeat the purpose of the project. In an effort to lower pilot suspicions, a letter to the pilot group stressed that observations were not check rides and all data would be sent directly to The University of Texas for analysis.

Within three months, a mixed team of calibrated airline and University observers collected over 450 jump seat observations of regularly scheduled flights. Each observation contained phase of flight narratives and CRM behavioral marker ratings, such as leadership, communication environment, workload management and monitor/ cross-check performance (Helmreich, Butler, Taggart & Wilhelm, 1994).

The audit provided interesting insight on two fronts. First, it provided Delta with an operational baseline of CRM strengths and weaknesses. This allowed the airline to better prioritize areas of improvement for their new CRM training. Second, it provided managers with confidence that the operational report card on CRM performance was valid and necessary to supplement their findings from training data.

In the following two years, other airlines followed Delta's lead, including TWA, US Airways and American Airlines, and conducted their own CRM audits in collaboration with The University of Texas.

The mid to late 1990's marked the proliferation of systems thinking and human error research in the aviation human factors field (e.g., Hollnagel, 1993; Perrow, 1984; Reason, 1990, 1997; Woods, Johannesen, Cook & Sarter, 1994). This period also marked a paradigm shift for The University of Texas Human Factors Research Project. After years of collecting data on CRM-related behaviors, the project added threat and error management performance to its data collection. The premise was that flight crews commit errors and encounter threats such as adverse weather or aircraft malfunctions every day, each having the capacity to contribute to an incident or accident. The real importance of threats and errors is not that they occur in normal operations but how they are managed by flight crew. This shift in thinking fostered the development of the Threat and Error Management Model and the coining of the term *Line Operations Safety Audit* (LOSA) (Helmreich, Klinect Wilhelm & Merritt, 2001).

In collaboration with Continental Airlines, 1996 marked the first threat and error management LOSA. In response to the findings, Continental developed targets for improvements and incorporated major changes throughout the organization. One such change was developing an error management training course for every pilot at the airline.

Using the 1996 LOSA results as a baseline, Continental decided it was time to measure the effectiveness of their organizational changes with a follow-up LOSA. The following is an excerpt from an article by Captain Don Gunther (2002), Manager of Human Factors Training at Continental Airlines about their system performance improvements.

> "The 2000 LOSA, when compared to the results of 1996, showed that the pilots had not only accepted the principle of error management but incorporated them into everyday operations. LOSA 2000 showed a sizeable improvement in the areas of checklist usage, a 70 percent reduction in non-conforming approaches (i.e., those not meeting stabilized approach criteria) and an increase in overall crew performance. It could be said that Continental had taken a turn in the right direction." (p. 12)

Continental Airlines provided the "Proof of Concept" for LOSA that transformed it from a research tool to an industry-ready safety tool. The real value of LOSA lies not just in providing a diagnostic snapshot of organizational performance; it also provides a data-driven mechanism for measuring change.

The Continental LOSA success story was quickly recognized by the International Civil Aviation Organization (ICAO). So much so that LOSA became a central focus of the Flight Safety and Human Factors Program with the long term objective of declaring it as an industry best practice for normal operations monitoring by 2004.

With strong endorsement from the International Civil Aviation Organization (ICAO), including three regional "LOSA Weeks" in Hong Kong, Panama City, and Dubai, and the publication of the LOSA Manual (ICAO, 2002), the demand for LOSA increased dramatically. It was becoming apparent that more time was spent interacting with airlines on LOSA implementation than research. This prompted the start of The LOSA Collaborative (TLC), a private organization set up to serve as the primary implementation arm for LOSA and help preserve research grant funding.

The LOSA Collaborative assists airlines that want to conduct a LOSA, providing support services such as observer training and calibration, data collection software, data analysis, and summary reports. Once the airline-specific needs have been met, and with the airline's agreement, TLC contributes the data, airline de-identified, to The University of Texas Human Factors Research Project for research. This partnership is mutually beneficial. The University of Texas researchers receive observational data at no cost from the LOSA Collaborative and in return, research generates new models, hypotheses and findings for the industry.

The relatively short history of LOSA has been eventful but not well documented, which might account for some of the misunderstandings that exist within the industry. In an attempt to clarify some of those misperceptions, the next section will explain the value of LOSA using a health-based analogy. The LOSA process is then explained in detail with ten fundamental operating characteristics.

LOSA: Getting an Airline's Cholesterol Checked

In the most general of terms, LOSA is similar to getting your cholesterol checked during a routine examination. The test, usually performed as a preventive measure, provides evidence of risk on having a heart attack or other serious health event. The results themselves do not provide a solution but can prompt a person to make healthier lifestyle choices. A person might also choose to do nothing and carry on as normal. Either way, the person learned something and is responsible for change. LOSA is the same. It provides a diagnostic snapshot of safety performance. It uses cockpit observations collected in normal operations to provide a profile of safety strengths and weaknesses. Similarly, the onus is on the airline to respond to the data and make change if necessary, in order to prevent an incident or accident.[1]

LOSA Operating Characteristics

Since 1996, fifteen international and domestic airlines have proactively sought the preventive health

[1] Let's not forget there are some people (and airlines) who do not employ any preventive health measures, preferring to wait for something to happen before going to the doctor. They believe they are healthy until evidence proves them otherwise. The benefit of this approach is no cost and no bad news. The problem with this approach of course is that these people (and airlines) wait until the damage is done, at which time it's often very expensive or too late altogether. The old saying, "an ounce of prevention is worth a pound of cure" seems to apply.

check offered by LOSA (Table 1). Using experiences gained from these projects, we have identified 10 operating characteristics that we believe constitute the essence of a successful LOSA. Each characteristic is of equal importance to its success and without all in place; it is not considered a LOSA. This notion is also supported by ICAO (ICAO, 2002).

Table 1

LOSA Airlines 1996-2003

Alaska Airlines	EVA AIR
Air New Zealand	UNI AIR
Braathens ASA	Frontier Airlines
Cathay Pacific Airways	QANTAS Airways
Continental Airlines	Singapore Airlines
Continental Express	SilkAir
Continental Micronesia	US Airways
Delta Air Lines	

1. Jump seat observations during normal flight operations.

Since LOSA's primary objective is to highlight safety strengths and weaknesses in *normal flight operations*, all observations should occur only on regularly scheduled flights. Line checks, initial operating experience (IOE) or other types of training flights should be off-limits because of the evaluative tone that can exist under these conditions. LOSA observers are there to collect safety data, not evaluate and debrief flight crews. System evaluation - not individual evaluation - is the overarching theme of LOSA. This message must be clear to the pilots and respected by the airline throughout all phases of the project.

2. Anonymous and confidential data collection.

The difference between LOSA success and failure is *pilot trust* in the project. If pilots feel LOSA is a threat to their job or fear that an observation will find its way to management, they might be tempted to "fake good performance" rather than normally performing. This is a real concern for LOSA. The more pilots trust that LOSA will not identify individuals, the more likely observations will reflect the normal operational reality of the airline; hence, it is incumbent on LOSA to create some safeguards.

The second LOSA operating characteristic – anonymous and confidential data collection – is the first pilot safeguard. Observers do not record names, flight numbers, dates or other potentially identifying information on the observation form. Results are always presented at the fleet or airline level; individuals are never identified. Additionally, no one but the observer and the data analysts should know who conducted a particular observation.

3. Voluntary flight crew participation.

Another pilot safeguard is the crew's right to refuse a LOSA observation. This reinforces the message that observations are not check rides. If a crew declines to be observed, observers take another flight with no questions asked. Typically, there are few denials if any. However, a high number of denials should act as a warning sign that pilot trust is low and warrant an immediate suspension of the project.

Our experience has shown that a major source of mistrust is pilot doubt about the purpose of LOSA. This is especially true for a first-time airline. We found that the best method to educate pilots is to publicize LOSA through company memos, media clippings and articles in various corporate publications. The literature should not only come from the operational side of the airline but from the pilots' association as well. A good litmus test to decide whether LOSA communication was effective is to randomly ask pilots in the crew room if they have heard about LOSA and describe its intent before the initiation of the project. It will quickly become clear if there is a need for more education. The more the pilots know about LOSA, the more open they are to allowing observers into their cockpits.

4. Joint management/ pilot association sponsorship.

The final safeguard to strengthen pilot trust is to require a formal agreement between airline management and the pilots' association. The agreement usually states that all LOSA data will be confidential, anonymous and not used to discipline pilots. It should also state that LOSA observations are not check rides and are only collected to learn about existing safety margins. Airline management and union representatives should jointly sign the agreement and every pilot at the airline should receive a copy well before the beginning of the LOSA.

This operating characteristic is so critical in softening pilot suspicion that the LOSA Collaborative has made it a policy to deny service if a signed agreement is not in place. If the airline doesn't have a pilot

association, airlines should garner support from a representative pilot group.

Airlines interested in LOSA must understand that it is not an avenue for airlines to spy on and discipline their pilots. In over 2200 LOSA flights, not one pilot to the knowledge of The LOSA Collaborative has ever been disciplined because of issues observed during a LOSA observation. We believe a big part of this record is directly attributable to the LOSA pilot safeguards highlighted in the previous operating characteristics.

5. Safety-targeted data collection form.

The existing data collection tool for LOSA is the LOSA Observation Form based on the UT Threat and Error Management Model. It is not critical that an airline use this specific form, but we do suggest that whatever instrument is used, it should possess a data framework for collecting systemic factors that affect flight crew performance. This can be any kind of framework, taxonomy or investigation method that would help airlines digest and make better sense of their data. This is a necessity considering the large number of safety data sources collected by an airline.

6. Trusted and trained observers.

As an airline pilot once said, LOSA observers must act like "flies on the wall". The best observers are those who are unobtrusive and non-threatening. At the same time, however, observers must know when it is appropriate to speak up upon seeing a safety concern. The issue is discussed at great length during the observer training until everyone feels comfortable with the process.

The size of a LOSA observation team can vary depending on the scope of the project and size of the organization. The LOSA Collaborative tries to establish an upper limit of no more than 15 observations per observer to prevent observer fatigue. (It is not uncommon for an observer to spend three to four hours writing up a LOSA observation.)

Observer selection is open to check airmen, instructors and safety experts, but the majority should be regular line pilots from within the airline. This composition keeps pilot suspicion to a minimum, which in turn creates more opportunity to see normal crew behavior. The observer team can also include external observers not affiliated with the airline. These experienced and objective observers can serve as an anchor point for the rest of the observation team. The LOSA Collaborative typically uses two or three retired pilot observers. Their experience with LOSA projects at other airlines provides a valuable outsider perspective of operations.

In terms of observer selection, The LOSA Collaborative endorses a joint process between management and the pilots' association. The protocol involves both parties preparing their own list of potential LOSA observers. Persons that appear on both lists are then asked to participate in the project.

After the observer team is selected and everyone agrees with the team's diversity, training in the LOSA methodology can begin. The observer training typically goes for five days. There are two days classroom training in LOSA methodology and use of the data collection instrument, two for initial LOSA observations, and the last day to recalibrate and wrap-up final logistics.

7. Trusted data collection site.

To assure confidentiality, airlines must have a trusted data collection site. If an airline is conducting a LOSA themselves, a jointly appointed management / union representative should serve as the sole data collection point. Another way to build trust in the data collection process is to use a neutral third party removed from the politics and history of the airline. The third party can act as a data repository, securely off-site from the airline.

8. Data cleaning roundtables.

Data-driven programs like LOSA need strict data management procedures and consistency checks to assure quality data. After all the observations are complete and the data have been entered, a joint data cleaning roundtable is convened to review all the recorded threats and errors. In conjunction with the analyst, three to five representatives from various parts of the airline (different fleets, flight ops, safety, or training) look for inaccuracies and coding errors in the raw data. For example, an observer might log a procedural error for a pilot's failure to make a callout for which there are no written procedures. Another example might include someone who codes an error mistakenly, such as labeling a missed ATC call as an incorrect read back. It is the job of the roundtable to handle these types of issues and ensure the correct database entry.

Upon completion of the roundtables, LOSA data should be congruent with the airline's standard operating procedures. Only then does the statistical analysis proceed for the final report.

In sum, the data cleaning roundtables provide a much needed quality check; but more importantly, they instill airline confidence that the data are valid to their operations. This decreases the chance of management discounting the integrity of unfavorable results.

9. Data-derived targets for enhancement.

During the analysis of LOSA data, trends can emerge. Certain errors occur more often, airports or events stand out as problematic or particular standard operating procedures show high rates of intentional noncompliance. These patterns become targets for enhancement for the airline to exert efforts for change. After two to three years, a follow-up LOSA can measure whether the airline's changes improved performance, much like the Continental success story that appeared earlier in this article.

10. Results feedback to line pilots.

On completing a LOSA, airline management and the pilots' association have an obligation to communicate LOSA results back to the line pilots. Pilots will want to see not only the results but also management's plan for improvements. If this is done, experience shows that pilots lower their resistance to LOSA, increasing the likelihood of observing normal performance on follow-up audits.

Airlines should not wait long before presenting LOSA results or line pilots will begin to believe nothing of value came from the project. A summary of the audit, including strategies on how they plan to use the data, is ideal.

Summary

LOSA as it is today is the product of many years' collaboration with airlines, pilots, researchers and many other aviation safety professionals. Based on that experience and the many lessons learned, we believe ten operating characteristics now define the essence of a successful LOSA.

The first characteristic - Jumpseat observations during *normal* flights – represents the over-arching purpose of LOSA is to capture operational reality. To achieve this, two fundamental components are needed – trust in the process and trust in the data.

Trust in the process. Characteristics 2, 3, 4, 6, and 10 specifically address project integrity and ways to build trust in the process. They also represent the pilot safeguards in LOSA:

2. Anonymous and confidential data collection.
3. Voluntary crew participation.
4. Joint management/ union sponsorship.
6. Trusted and trained observers.
10. Results feedback to the line pilots.

Trust in the data. The remaining characteristics - 5, 7, 8, and 9 - address data integrity and quality assurance:

5. Safety-targeted data collection form.
7. Trusted data collection site.
8. Data cleaning roundtables.
9. Data-derived targets for enhancement.

We cannot overstate the most valuable lesson learned over the years: If an airline fails to earn its *pilots' trust,* then LOSA will be nothing more than an elaborate line check, and the airline will have wasted an opportunity to gain a unique perspective of actual practices on the line.

LOSA Reports

An airline's LOSA report is considered a reference document for the LOSA. Typically 60 pages, the report is crammed with charts and details, numbers and percents. The material covers the prevalence and management of threats external and internal to the airline; error prevalence and flight crew management, crew performance strengths and weaknesses, and threat and error-linkages with undesired aircraft states. Fleet comparisons are conducted as well as benchmark comparisons between the airline and other de-identified carriers in the LOSA Archive.

Accompanying the report are the threat and error logs (a list of every threat and error observed during the LOSA) and phase of flight narratives for every observation. To ensure a free flow of critique, airline representatives are blind to observer identity. In other words, it is impossible to identify an observation by its observer.

The LOSA narratives serve several purposes. Recognizing that novice observers may struggle with the coding, the process encourages observers to "write the story of the flight, and let us do the coding later if need be". Event coding can always be retrospectively applied, provided the narrative is thorough. The narratives keep the data fresh, ready to be re-read, re-analyzed, and re-considered as new concerns and issues arise. Regardless the current framework quantitatively, the existence of the

narratives allows endless revisiting of the data.

Cross-referencing allows the interested reader to first identify significant patterns (e.g., an unacceptably high rate of a certain type of threat or undesired aircraft state) and then locate the actual flights on which the event occurred. The quantitative summaries provide the bones of the report; the flight narratives put flesh on those bones by providing the full context in which the events occurred. In this way, the data are extraordinarily rich. One learns how often something happens, how it is typically handled, and the circumstances surrounding successful and unsuccessful management of events.

The Way Ahead

LOSA is strong in data collection, analysis, and reporting. The next step will be to study airline change management strategies and share them with the industry (see Tesmer, 2002). Having an established safety change process ready to address the LOSA findings seems key to maximizing the lessons learned from a LOSA.

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