

FLIGHT SAFETY FOUNDATION WHITE PAPER

Learning From All Operations: Expanding the Field of Vision to Improve Aviation Safety

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1. A Call to Action: Improving Safety by Learning From All Operations

The time has come for aviation to complement the traditional approaches to learning for safety and recognise the issues that arise from increasingly complex systems and environments. We call for a fundamental shift to learn from all operations and events — not just from those that are unwanted. In an increasingly interconnected and complex aviation system, it is imperative to learn not only from things that rarely go wrong but also from things that go right. Data collection needs to expand from a focus on hazardous events to analysis of routine operational data. While it will continue to be essential to identify hazards and manage risks, organisations should also analyse data that lead to new insights from everyday work across all types of outcomes — insights that enable learning that is more frequent, sensitive and timely. Learning from everyday operational data and events can enhance safety management that is often based on a small subset of performance information, which may introduce avoidable but unrecognised consequences into the aviation system.

This paper is a call to action to managers and executives who are accountable for safety in their organisations. We describe a safety mindset that expands our understanding of what constitutes a safety-relevant event and improves our ability to learn from everyday work. We propose a rethinking of long-held approaches to safety that endeavour to transform organisations focused on *knowing* about safety into organisations focused on *learning* about safety (e.g., Vesel, 2020). We encourage accountable safety professionals to integrate the Learning From All Operations into existing safety programs. To assist in that effort, we offer practical suggestions, specific examples and lessons learned from others who have begun their own pursuit of learning from all operations.

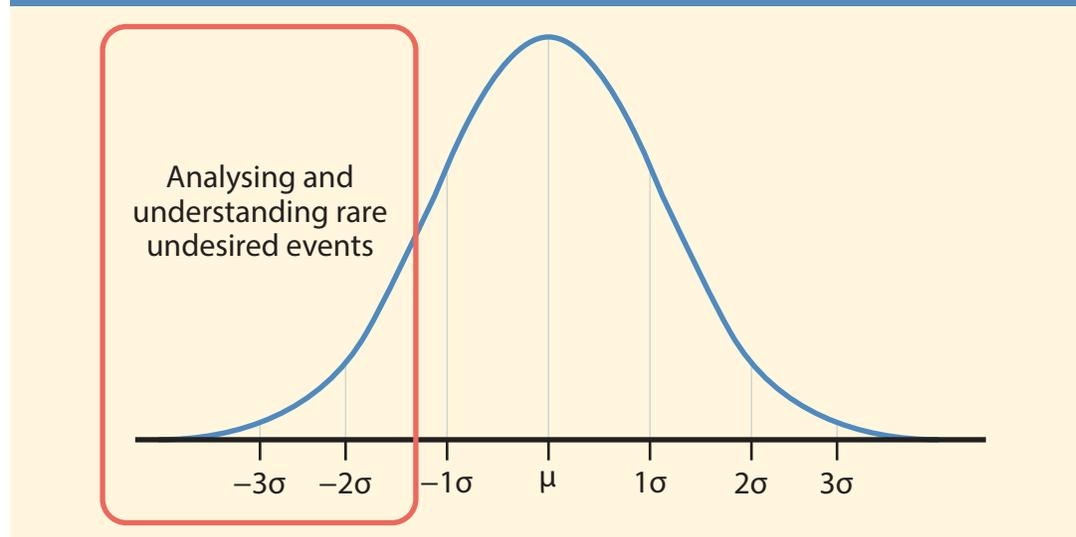
2. Cultivating a Culture of Continuous Learning

Aviation organisations in the 21st century must continuously learn in order to cope with increasing and changing demands and conditions. It is necessary but not sufficient to learn what not to do, to avoid past mistakes and failures. Although this may provide some protection against the recurrence of specific hazardous events, learning only from rare events means that learning only occurs rarely, and learning only from mishaps does not enable an organisation to take advantage of all opportunities.

Most aviation organisations have implemented safety management systems (SMS). The main goals of an SMS are to identify hazards and proactively manage risks to an acceptable level. This

focus on hazards and risks has led to the development of sophisticated processes for data collection, such as safety reporting systems and flight data monitoring. This approach, however, typically focuses on the absence of safety, rather than its presence. Front-line personnel report accidents, incidents and near misses. But these safety reports do provide opportunities to look at what goes right within the context of these much less frequent events. These events, however, are reported because they are exceptional, and thus, by definition, not representative of everyday operations. For example, flight data recorders collect data on everyday aircraft operations, but analysis is typically triggered in most flight data monitoring programmes by infrequent ‘safety exceedances’ or ‘detected invalidations of the safety assumptions’. The analyses of these data sources cover a very small and non-representative sample of total operations, and the learning that occurs, while often valuable, is limited in its applicability and timeliness (Figure 1).

Figure 1. Analysing Rare Events



Changes to routine policies and procedures based solely on data from non-representative performance can introduce new issues to everyday work. Well-intentioned efforts to eliminate or prevent an exceptional hazard may create trade-offs with routine performance. The impact of changes and trends can be difficult and slow to detect when the failures that represent the main opportunities for learning are few and far between. A focus on learning from accidents and incidents to the exclusion of analysing all the other cases in which nothing went wrong, representing the vast majority of operations, may prevent an organization from discovering critical safety solutions. Current approaches are inadequate to meet increasingly complex organisations’ needs for frequent, sensitive and timely learning. A different architecture for learning is needed, one that expands our understanding of what constitutes a safety-relevant event, and thus also expands our opportunities to collect, analyse and act upon safety-critical insights.

3. Integrating Continuous Learning Into Risk Management

In the effort to learn from what has gone wrong, two important truths often are missed.

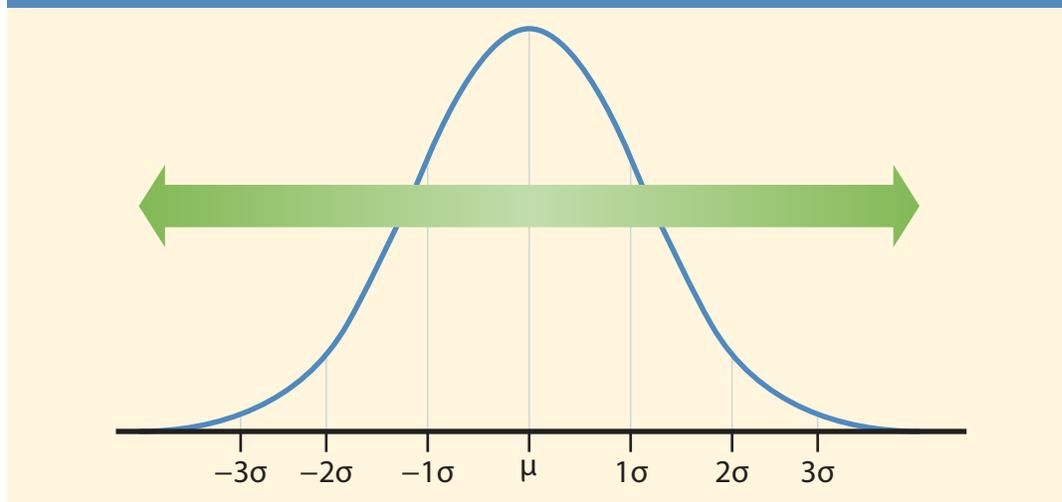
The first truth is that nearly all work activities end well. It is, therefore, imperative to learn from those. Learning only from rare failures means that learning only occurs rarely. Furthermore, it can be expensive and often of limited effectiveness. Safety cannot be ensured only by learning from accidents, from when something has failed. Safety must also include learning from

when work goes well. Therefore, safety studies and safety management should expand their scope to include all operations.

The second truth is that much of the work that precedes both successful and failed outcomes occurs in much the same way. Individuals, teams and organisations routinely adjust their performance to match the current demands, resources and constraints of the system. These adjustments are based on an understanding of the system at that moment in time. That understanding comes from what we learn about the system.

Harnessing the power of the two truths, the Foundation proposes an approach of learning from all operations. This is a scalable approach, allowing large and small organisations to leverage their existing safety programs and data sources. This approach involves review and analysis of activities and processes and extends their scope to learn from all operations. Reporting includes good practices, investigations consider what worked well, and safety monitoring is carried out across the entire performance distribution.

Figure 2. Learning Across the Entire Performance Distribution



The Foundation's Learning from All Operations approach is evolutionary and is rooted in International Civil Aviation Organisation (ICAO) Annex 19, *Safety Management*, and the *ICAO Safety Management Manual* (Doc 9589) provisions for the use of:

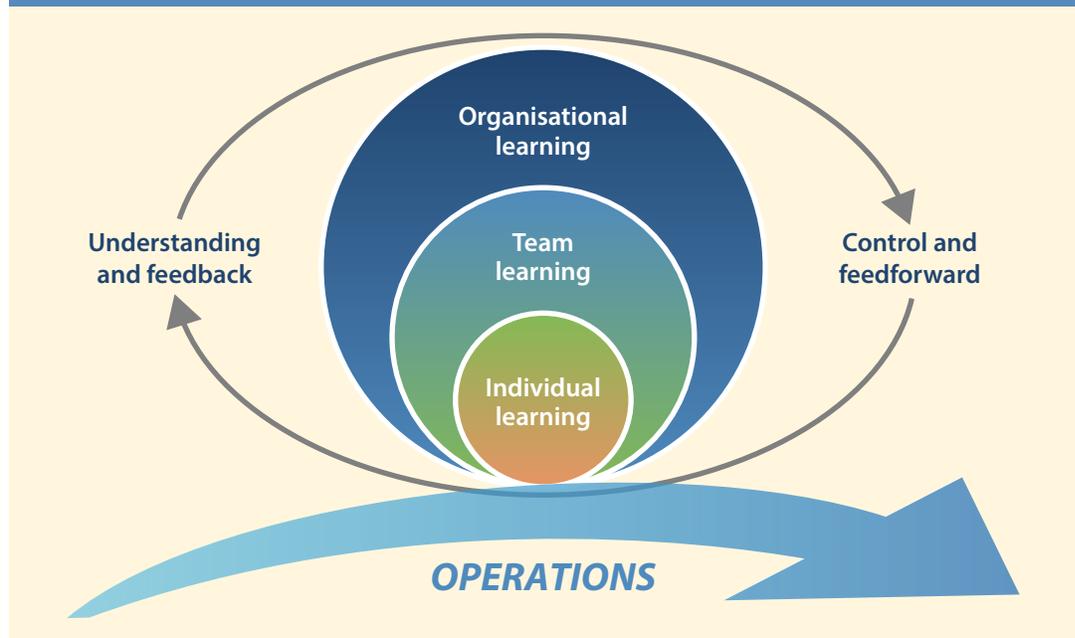
- Proactive safety activities to collect safety information and safety data;
- Proactive methods for hazard identification;
- Predictive safety indicators focussed on processes and activities to improve and maintain safety; and,
- Predictive analysis based upon current operations.

The Learning from All Operations approach emphasizes harnessing the good practices and strengths in an organisation. Learning from all facets of everyday events and operations is key for timely detection of safety issues and reinforcement of strengths.

Learning takes place at individual, team and organisational levels. The results of learning are expressed on the individual level (skills, competence) as well as on team and organisation levels — such as how work is organised, physical environment, instructions, training, processes and standards.

The interdependencies among the three levels of learning are shown in Figure 3 (p. 4).

Figure 3. Holistic Model of Continuous Learning



Individual Learning: On the individual level, personnel learn directly from their work. In fact, individual learning happens virtually all the time — it can be implicit or explicit, occur as a result of success or failure, and follow easy or difficult tasks.

Team Learning: On the team level, learning reflects the experiences of the individuals as well as of the team as a whole. More time and resources are obviously needed, but learning is still closely coupled to the actual work and therefore is specific to the situation. Learning on the team level may, however, also slowly become more formalised and subject to organisational policies and procedures. This changes learning from being direct or personal to something indirect or mediated; the latter requires more time and resources.

Organisational Learning: Learning on the organisational level is typically based on generalised rather than actual experiences. The outcome is usually expressed in terms of the organisation's norms and policies. However, organisations have a key role in facilitating the individual and team learning which are the drivers for organisational learning.

There are interdependencies across all three levels of learning. It is important to understand that at each level, learning takes place in a different manner. Learning from all operations refers not only to expanding our understanding of safety-relevant occurrences, to include those that go well, but also to expanding learning opportunities at the individual, team and organisational levels. The interdependencies across these levels create opportunities for developing insights about how organisations facilitate or hinder individual learning, transfer of learning across levels and overall system performance.

4. Benefits of Learning from All Operations

The purpose of learning from all operations is to understand how work actually is done and how personnel cope with the challenges they typically encounter. Understanding the choices that personnel make when things go well, and why they make those choices, makes it possible to understand why things that usually go well can also occasionally go wrong (Hollnagel, 2009).

There is much to be gained from expanding the scope of learning to all operations. The following are some of the benefits:

- **Learning from everyday work does not have to wait.** While there is much to be learnt from unwanted events such as incidents, learning must wait for something to happen. But unwanted events are not necessary for learning. It is easy to learn about problems and opportunities from the ordinary, if only we pay attention to it. And there is no need to wait, because it happens all the time.
- **Learning from everyday work builds on what is already strong.** By looking at all operations, we can see what works well and why. In any part of an organisation, there are good practices that need to be preserved, reinforced, extended and expanded. To do this, we must highlight them and understand them.
- **Learning from everyday work helps organisations recognise slow changes.** Things often change slowly over time. Without paying attention to everyday work, slow changes may not be recognised before an unexpected — and usually unwanted — event occurs. Learning from all operations helps organisations to see changes to patterns in everyday work.
- **Learning from everyday work helps organisations respond before unwanted events occur.** Small and inexpensive improvements of everyday performance may be more effective than large and expensive responses to infrequent events. Learning should therefore be guided by the activities which happen frequently rather than by the severity of unwanted outcomes.
- **Learning from everyday work helps organisations understand the adaptations personnel make to keep the system operating.** Rather than looking at initiating events in isolation and trying to find and propose probable causes, it is recognised from the beginning that the same event most likely will have happened before and that it usually will have gone well. It is important to understand how that happened, since it makes it easier to understand why it did not work now.
- **Learning from everyday work can involve everyone.** A focus on everyday work can — and should — involve those who do it, support it and are affected by it. While learning from everyday work may be unfamiliar, much can be done with existing resources and capabilities.

5. Implementing Learning from All Operations Can Leverage Existing Resources and Processes

Learning from all operations does not require a wholesale replacement of processes, practices and tools. But it does require the willingness to expand one's perspective or mindset — as a complement to what is already in place. Accountable managers and executives should promote language and behaviours that reinforce and support evolution toward Learning from All Operations in their organisations. If an organisation wants to change conversations about safety, the language used to talk about safety and the language used to talk about operational goals must be aligned. Under the broader view of learning from all operations to improve safety, this language needs to focus on the presence of safety and on describing what actually happens in a constructive and non-judgmental manner.

The basis for learning should not be limited to that which goes wrong, to failures and accidents, but should encompass everyday performance. In contrast to characterising unwanted events or failures, there are few ways of describing what goes well. Yet if we are to learn from all that happens, we must be able to describe it in sufficient detail: not just by expanding terminology, but also by being careful with terms that convey negative connotations. When describing events and performance, organizations should use *descriptive* language, which seeks to provide an account of work in a way that is as neutral and objective as possible, vs. *normative* or evaluative language, which seeks to compare against a standard or overlay judgement.

6. Learning from All Operations Methods and Practices

Expanding the scope of what constitutes safety-relevant events will require organisational resources to study and learn from those events. However, most aviation organisations are already well positioned to collect, analyse, manage and disseminate safety data and insights. These existing processes can be leveraged in manageable ways by organisations to expand those insights and translate them into action, through policies, procedures, training, equipment design and system design.

Below are examples of methods to support the Learning from All Operations concept. These methods build upon or complement approaches that are already used to collect and analyse safety data:

6.1. Observations of work

Studying how work takes place is an important basic method for understanding everyday work. Observations can have a single or broad focus, use a variety of recording technologies, or be continuous or selective. The focus should be on work as a whole, rather than limited to specific unwanted outcomes or negative elements of work. For example, in a line operations safety audit (LOSA) program, methodical observations of work are conducted. The next section describes how American Airlines extended this method. For examples of observations by air navigation service providers (ANSPs) refer to the UK NATS Day-to-Day Safety Observation and Spanish provider ENAIRE's normal operations monitoring.

6.2. Event investigation

Event investigations conventionally focus on what went wrong, but the same methods can also be applied to what goes well. Even in the context of adverse event investigations, questions can be asked about what went right during the event, how things usually go well, and why things sometimes go exceptionally well. In expanding the event investigation into a learning from all operations process, modifications to the organisation's classification schemes and taxonomies are likely to be needed. The examples that follow explain how EUROCONTROL modified and neutralised its incident taxonomy to be descriptive rather than normative and how Cathay Pacific Airways gradually began introducing a new language around the management of safety.

6.3. Surveys and audits

Surveys and audits traditionally focus on problems and on negative aspects of group-based values, beliefs, attitudes and behaviour. But they can easily be applied with a focus on strengths and everyday work practices. Refer to the example of German ANSP DFS as an example of how to transform the conformity audits into local safety surveys.

6.4. Expanded Use of System Data

Data analysis, and specifically digital surveillance data, flight data analysis and flight operations quality assurance, have been historically focused on 'exceedance events'. These data sources can be expanded to support learning across the performance distributions. Refer to the example of how Lufthansa is using distributions of everyday operational data to address specific operational safety issues. Digital data can also be used to support individual learning. See in our examples how Ryanair and All Nippon Airways implemented replay capability, available soon after the completion of the flight, to enhance the effectiveness of crew debriefing and to facilitate self-learning. Another example of expanded use of system data is the weak signals approach used by DFS, Danish ANSP Naviair and EUROCONTROL for computer-assisted text analysis.

7. Vignettes — Illustrations

The change from a conventional safety approach to look beyond adverse events is already taking place in many aviation organisations — and in other industries as well. The following examples are intended to provide suggestions about how it can be done in practice.

7.1. Normal operations monitoring: ENAIRE (Spain)

During the past six years, ENAIRE has implemented new processes and policies for normal operations monitoring (NOM) of what happens every day: the actions of front-line operators, the factors influencing them and the reasons behind their actions. The approach involves over-the-shoulder observations to understand the operational reality and the complexity of factors that may not be revealed in investigations. Observations are complemented by talking with the observed individuals to gain a better understanding of work-as-done. Work practices that are usually taken for granted are identified and discussed, thus creating an opportunity for analysis and improvement using the expertise of the staff.

NOM started after it was decided to apply this set of techniques to an air traffic services (ATS) unit with safety concerns. The idea emerged within the Safety Division after a review of the previous safety plans that had had little effect on the safety record. Initially, the project was limited so it did not require a large investment: just one person during one week of observations, plus the time necessary to analyse data and develop a report. The learnt lessons after the observation led to a set of actions that had a positive impact on the number of occurrences. In addition, an unexpected byproduct was a positive impact on the safety culture of the ATS unit, not only with the air traffic control officers (ATCOs) involved in the observations, but also with the implication of the unit managers towards safety. The approach has become a flexible and valuable tool, especially where a perceived safety issue is just a concern, a weird feeling or so unspecific that is difficult to verbalise. The approach helps ENAIRE to understand operations and complex problems that require a systemic understanding. The organisation also has found that the simple presence of safety observers within the units has broken the invisible divide between safety experts and front-line operators (de la Flor, 2020). As general advice for implementing a similar program, ENAIRE suggests not being too ambitious, increasing observational activities little by little, approaching observations from a ‘blank mind’ mindset, and preparing for the unexpected when observing.

7.2. From auditing to understanding: DFS (Germany)

In recent years, DFS has learnt that pure conformity audits are problematic; responses tend to reflect the ‘right answer’. Classical audits were found to provide insufficient insight into the reality of front-line operators’ work. In response, DFS developed a ‘local safety survey’ (LSS) approach, involving workshops with operational and non-operational staff, as well as management, to get a picture of the actual situation, daily routines, and why rules and norms may not always fit. The objective was to transform the role of an auditor, who addresses deviations with findings, into a surveyor, who seeks to understand work-as-done, including why — in some cases — rules are interpreted differently. This enables survey teams to get an unfiltered and behind-the-scenes insight, which proves useful in all the different discussions concerning procedure design or change implementation. DFS has conducted LSSs at tower, centre, systems and infrastructure, and aeronautical information service units. This was acknowledged by those who brought up the issues, as they were the ones affected. Topics of conversation (problematic situations, opportunities and contextual examples) are recorded in a database and used for further evaluation (Gontar and Kurth, 2020).

7.3. Neutralising incident taxonomies to reflect all operations: EUROCONTROL

The EUROCONTROL toolkit for air traffic management (ATM) occurrence investigations known as TOKAI is a web-based application that enables users to report, investigate and take corrective actions following occurrences. This incorporates a taxonomy including words for activities (such as ‘supervision’, ‘preflight briefing’, ‘operator flight planning’); infrastructure, technical systems and artefacts (e.g., signage, glide path, procedures); and conditions (e.g., ‘experience’, turbulence’, ‘medical emergency’). Many terms in the taxonomy previously included negative adjectives such as ‘poor’, ‘inadequate’ and ‘incomplete’. These modifiers restricted the utility of the taxonomy to unwanted events, and therefore restricted learning to what had gone wrong. A simple change was made to expand learning from operations without abandoning the taxonomy altogether, by removing the negative modifiers, so that the terms could be used more generally to learn from what happens more generally. The taxonomy (and associated learning cards) is now used to help facilitate discussions, observations and analysis. There are currently more than 60 ANSPs (10 of which are located outside Europe) using TOKAI. (EUROCONTROL 2020; Patriarca et al., 2018).

7.4. Learning and Improvement Team (LIT): American Airlines

Since 2018, American Airlines (AA) has been striving to implement Safety-II in flight operations. With the support of senior leadership, the Learning and Improvement Team (LIT) was created and tasked with this responsibility. LIT members were initially recruited from the ranks of the AA LOSA observer corps due to their experience in flight deck observation and data collection using a traditional LOSA framework.

During initial discussions, it was agreed that LIT would develop its own language and model for data collection in order to provide initial direction and a vector for development efforts. LIT’s language comprises the four resilience potentials (Hollnagel, 2017) that are specified in terms of a subset of proficiencies. The language is rooted deeply in Safety-II and accounts for aspects unique to AA and the modern airline cockpit environment. The proficiencies are observable performance indicators that can be captured during flight deck observations. This data collection allows flight operations and individual pilots to learn from everyday operations. LIT continues to collect flight observations (over 100 captured) on regularly scheduled flights. Data collected have been analysed and used to improve the flying operation, including providing content for a new captain leadership development course.

Another set of data collection includes facilitated discussions with line pilots. Known internally as Shop Talk, these informal discussions between a LIT member and line pilot occur in a one-on-one setting, and provide a forum for pilots to share experiences and learning. The format serves as an opportunity for AA to learn about the challenges facing front-line pilots and how they address them. AA sees tremendous opportunity and value in this data stream.

LIT members published a paper titled “Trailblazers into Safety-II: American Airlines Learning and Improvement Team (LIT)” documenting initial progress and challenges faced during the journey. A second white paper is expected soon and will further explore data analysis and understanding. The learning has been a challenging and rewarding adventure that is only beginning to show its promise.

7.5. Changing language and the investigation process: Cathay Pacific Airways (Hong Kong)

In 2019, Cathay Pacific gradually began introducing a new language around the management of safety. The aim was to increase management curiosity about operational work and thus enhance organisational learning. Each month, a five-minute article was shared with the agenda packs of all the operational safety action groups and the safety review committee. Topics included local rationality, work-as-imagined and work-as-done, the efficiency thoroughness trade-off (ETTO), complicated and complex systems, and resilience. These articles were followed by 10-minute

presentations within each meeting to discuss the month's topic and the role it could play in enhancing airline safety. Understanding why things usually go well and occasionally go wrong can help explain why it made sense to someone to do what they did in their work, acknowledging that no one intends to have an incident. Cathay found that introducing a new language led to a change in how managers thought about safety and operational work, resulting in greater curiosity and less judgment about human performance after an unwanted event.

Alongside this evolution of safety language, Cathay's Flight Operations team introduced the operational learning review (OLR) in collaboration with the corporate safety team to replace the traditional investigation process. It is aligned with the principles of systems thinking and a view of safety as being the presence of wanted outcomes rather than the absence of unwanted outcomes. The OLR is designed to enhance learning from all operations, but most often it is used to follow up on an air safety report (ASR). The process seeks to learn what happened in an objective, judgment-free manner, regardless of the outcome and its severity. The OLR establishes the local rationale of the pilots involved from their perspective, (that is, why their actions made sense to them at the time). This requires a strong focus on contextual and system factors, and how these influenced what happened and the decision-making of those involved. The process also encourages managers to identify positive pilot performance in every event.

7.6. Application of Safety II concepts: Lufthansa

In 2005, an Airbus A340-300 of a major European airline overran the runway at Toronto. This raised the question of whether a similar event could happen to Lufthansa, since the operation occurred in comparable operational environments. Thus, the event was the starting point of a major in-depth flight data analysis. This was the first time in this airline where an analysis has been conducted with a different perspective on safety.

Besides the classical approach of focussing on exceedance events, which reflect the high-risk occurrences of the operation, a new methodology was introduced which incorporated the operation as a whole in the so-called campaigns. Instead of solely an identification of outliers, these types of analyses focused on the distributions of flight data and their specific characteristics.

The main purpose of those campaigns was to learn from the majority of flights, which typically result in a safe outcome, in order to improve those flights which seemed rather unsafe. By focussing on the distributions of the everyday operational data, a clearer picture of the overall operation could be achieved.

The concept of these campaigns led to further improvements in different aspects of aviation safety within the airline, such as safer landing technique (with regard to landing overrun protection as well as prevention of hard landing and tail strike), improved traffic-alert and collision avoidance (TCAS) handling, better handling of turbulence encounters and more efficient takeoff rotation with regard to safety.

Moreover, during the COVID-19 pandemic, the number of high-risk events was significantly reduced due to the overall reduction in traffic. This made it difficult to monitor safety performance trends, especially for events which had occurred less frequently even before the pandemic. By using distributions of measurements rather than exceedance events, safety trends can be detected more easily by observing shifts of these distributions. These distributions represent the overall operation, and a shift of the distributions can act as a precursor for certain risks.

7.7. Flight data replay via electronic flight bag mobile apps: Ryanair and All Nippon Airways

Since the incorporation of commercial airline flight data monitoring (FDM) programs, pilots normally have had the opportunity to review animated flight replays when the SMS required a debrief or the operating pilots themselves requested a review of a specific flight which they operated. When provided, the flight data replay was conducted under supervision of an approved FDM facilitator, and often days, if not weeks, after the duty.

Through the innovative combination of approved technologies and confidentiality protocols, operators now can relocate historical FDM replays from office desktops directly onto the pilots' company-issued electronic flight bag (EFB) in a manner that is compliant with regulations and confidential. The flight replay capability, available soon after the completion of the flight, greatly enhances the effectiveness of crew debriefing, self-critique and facilitated training through a timely, tailored and confidential feedback loop. When enabled, each pilot can access his/her own flights and the process is fully automated, protected by the European Union General Data Protection Regulation, and does not require human interaction to provide the replay file. The data are secure in that only the operating pilot(s) can request access to review their flight profiles and the time window in which pilots can access their flight replay can be customized in accordance with company, industrial and regulatory stakeholder requirements. For the airline, EFB FDM replay technologies can be easily and efficiently incorporated because no additional installation is needed, provided that the aircraft's quick access recorder data transmission system operates via an automatic, wireless process.

All airlines seek to provide positive, progressive learning opportunities over the pilot's career. Companies providing EFB flight replay aim to achieve common goals: improve the effectiveness and efficiency of training, strengthen pilot performance, harmonize skill levels across the pilot community, and, ultimately, improve flight safety. The immediate, objective and factual replay provides pilots with a better understanding of their own performance from the perspective of both pilot flying and pilot monitoring. The ability to review the flight in a dynamic, near real-time, self-facilitated manner, versus the traditional static means of delivery, creates a data/technological-driven opportunity to enhance not only pilot performance, compliance and safety, but also that of the airlines themselves.

All Nippon Airways and Ryanair already incorporate EFB flight replay systems into their programs and consider the capability as beneficial and a natural progression to existing safety, operational and training processes. Soon after introducing EFB flight replay capability into the airline, Ryanair noted positive feedback from its pilots, who welcomed the innovative means and opportunities for feedback, self-assessment, knowledge transfer and reinforcement of standard operating procedures and shared mental models.

Figure 4. Example of an EFB-Based Flight Replay Display



Already, EFB-based flight replay has demonstrated a positive impact on airline training, operations and safety by innovatively enhancing the feedback loop, improving performance and reducing exposure to key operational risks areas through Safety-I (what went wrong) and Safety-II (what went right) concepts. The application and success of this technology thus far illustrates the benefit of industrial collaboration and the importance of understanding, pursuing and implementing improved methods which provide improved synergies, resiliency and safety to the aviation system.

7.8. Day-to-Day Safety Observation (D2D): UK NATS

Circa 2005, NATS developed and began using Day-to-Day Safety Observations (D2D). This methodology uses a subjective observational technique to understand the frequency with which ‘good’ behaviours are seen within the operational environment. The observable criteria are derived from techniques developed to mitigate top human error causal factors, capturing information on the positive behaviours that are used by operational staff to keep the operation safe. This includes a range of behaviours, such as visual scanning, which is described below.

Amongst the myriad of non-technical behaviours utilised by controllers, visual scanning has long been of interest to human performance and safety specialists. In the air traffic control (ATC) environment, poor visual scanning is thought to be an aggravating factor in a variety of errors. Visually, it can lead to controllers’ not seeing or mis-seeing an element of the visual scene, such as a conflict, or misidentifying an aircraft. There are several reasons why this may occur, including tunnelling of the visual field, expectation and distractions. It can also be exacerbated by the controller being over- or under-loaded. Poor scanning is also thought to affect judgment, planning and decision making; these actions are dependent on the quality of information that is assimilated in the perception stage. In the dynamic world of ATC, missing a critical piece of visual information can have serious consequences leading to operational error.

The NATS D2D programme recognises ‘good’ visual scanning techniques as a strong mitigation against certain perception errors. Utilising this early, indicative data, NATS designed and developed a series of activities, which formed the basis of new training packages for controllers and trainees and helped in the design and implementation of new systems. As a result of this work, we saw an increase in the presence of positive scanning behaviours. Furthermore, we have seen areas where D2D and incident data are correlated, so improvements in day-to-day performance would also reduce incident rates.

Having now been utilised for over 10 years in NATS, several safety improvement activities at aerodrome, approach and en-route units have been carried out as a result of the findings from the D2D safety observation programme. Examples include visual scanning experiments (as described), development of handover checklists, updates to procedures, telephone discipline, training activities, defensive controlling simulations and hear back/readback exercises for use in training. The findings also are being used to inform the development of future changes to both technology and airspace. Using a more proactive approach to ‘designing in’ safety performance enabled a 70 percent reduction from 2007-2010 in our safety risk index, which is a weighted average of all significant incidents.

Programme developments have allowed the extension of D2D safety observations into the flight deck of one of the United Kingdom’s major airline carriers, adjacent units and ground handling staff. Numerous recommendations have resulted from these observations relating to training, procedure changes and equipment enhancements.

Focussing on observing the presence of good behaviours allows us to build a picture of where emerging risks in the system may be. This significantly increases the data available to enhance safety performance and provides a focus for managers on how to better support frontline safety performance.

7.9. 'Weak signals' detection through text analysis: DFS, NAVIAIR and EUROCONTROL

DFS, Naviair and EUROCONTROL, supported by academia, are pioneering a way to monitor 'weak signals' to support ATM organisations in developing their capability of anticipating disruptions and changes, as well as connecting pieces of information and turning data into knowledge. The weak signals approach is a complementary concept for learning that includes information that is not monitored via safety indicators or processed through reactive safety management processes like safety investigations.

A weak signal is seen as a seemingly random or disconnected piece of information that at first appears to be background noise but can be recognized as part of a significant pattern by viewing it through a different frame or connecting it with other pieces of information. The weak signals comprise the many small events that lie below the threshold of reporting or severity, but also the observable performance patterns — the habits, the routines and the common trade-offs — that most of the time lead to the expected outcomes but which every now and then lead to unexpected and unwanted results.

Currently, the weak signals process is performed through structured interviews followed by computer-assisted text clustering, pattern and semantic similarities analysis and results interpretation by an interdisciplinary team. Tacit knowledge of operational personnel about work-as-done is elicited and subsequently compared to the explicit organizational knowledge (rules, procedures and taught-in-training practices) about work-as imagined. Differential analysis is one of the approaches used to compare observed patterns for different ATC units.

As an example, the word 'neighbouring' was identified to be much more prominent for one specific ATC sector and the word 'radar' was only, and very prominently, detected for one of the ATC sectors. The subsequent, deeper analysis identified previously undetected variability of the radar performance and coordination efficiency between two ATC sectors.

The resources needed involve the time to perform interviews by the local unit's safety representatives (10 to 20 interviews for one run of the process — the more interviews the better) and the text mining software and skills. Each interview tries to capture the story of the day, week and season and is usually a relaxed conversation for about 30 minutes about how the work goes. The approach is recommended to ANSPs and any other aviation organisations to enhance their flow of business intelligence and complement the analysis of strong signals.

8. Measuring the Effectiveness of Learning from All Operations

Risks and threats have traditionally been attributed to the failure of individual system components, whether human or technological. But it is necessary to think of systems as dynamic configurations of functions that are only ever partly under control due to compensating changes, rather than as components in a well-described configuration. Accidents, as events that inescapably attract our attention, therefore represent snapshots of situations in which control for a moment has been lost amid a constellation of interactions and interdependencies, rather than simple component failures. Conversely, the steady functioning where all goes well is conventionally seen as a non-event, as a situation in which 'nothing' happened. Yet safety management should serve to ensure this steady functioning by focussing on management *for* safety rather than on management *of* safety.

The purpose of an SMS is to ensure that the services continuously meet or exceed safety requirements. To effectively achieve this purpose, those who oversee, support and are affected by the SMS should have a shared understanding of what constitutes a safety-relevant occurrence. Today's safety requirements mean that as much as possible goes well, rather than that as little as possible fails. In a future SMS, learning should be a natural part of how an organization is managed and the focus should include that which happens every day and not just be a response to unwanted events.

A natural starting point would be to examine activities that take place often, to look for typical patterns of performance and try to understand how they have come about. This approach to learning can be illustrated as follows:

- Document and analyse how operations are performed, particularly repetitive work; identify performance outcomes, particularly positive outcomes.
- How has this way of performing operations developed? How have personnel come to do it in this way?
- Are there organizational operating norms and procedures? Are they documented?
- What are the benefits of the way the operations are performed and what are the potential weaknesses?
- What can be done to strengthen benefits and prepare for the weaknesses?
- What else is done in the same or a similar way?

Striving to ensure things go well is a proactive rather than a defensive approach to safety, and it is clearly not limited to safety issues. It is a natural consequence of adopting the systemic perspective that managing safety must be considered within the larger context of learning opportunities in total operations. Learning from everyday operations can with equal motivation be applied to productivity, quality and reliability. From a systemic perspective, they can only be managed well if their mutual dependencies are understood and recognised in practice.

9. Next Steps

In this paper, the Foundation has described a safety mindset that expands our understanding of what constitutes a safety-relevant occurrence and improves our ability to learn from everyday work in the aviation system. We call upon managers and executives who are accountable for safety in their organisations to build upon the ideas, lessons and examples presented and apply them within their organisations.

The Foundation will be working to evolve the Learning from All Operations concept and methods by engaging with practitioners and researchers. We will carry out a three-pronged campaign to promote the global practices of the Learning from All Operations concept and methods as follows:

- Establish a dedicated global community and network for exchange of Learning from All Operations ideas and best practices and promote Learning from All Operations implementation by including Learning from All Operations workshops and symposiums;
- Support Learning from All Operations knowledge generation through dedicated studies and based on the aggregation of exchanged ideas and best practices; and,
- Facilitate Learning from All Operations knowledge organisation, accessibility and promotion, including via publications, toolkits and training.

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