FLIGHT SAFETY FOUNDATION

LEARNING FROM ALL OPERATIONS

Concept Note 1

The Need for Learning From All Operations

Flight Safety Foundation

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FLIGHT SAFETY FOUNDATION

1. Introduction

1.1 Background

Flight Safety Foundation is an independent, nonprofit, international organisation exclusively chartered to provide impartial research, education, advocacy, and communications in the field of aviation safety. Founded in 1947, the Foundation brings together aviation professionals from all sectors to help solve safety problems facing the industry. With membership throughout the world, the Foundation brings an international perspective to aviation issues for its members, the media and the traveling public.

The Foundation is in a unique position to identify global safety issues, set priorities and serve as a catalyst to address these concerns through data collection and information sharing, training, safety standards, best practices and toolkits. The Foundation strives to bridge proprietary, cultural and political differences in the common cause of advancing global aviation.

In July 2021, Flight Safety Foundation published a white paper "Learning From All Operations: Expanding the Field of Vision to Improve Aviation Safety." The white paper explains the rationale for, and the benefits to be derived from, learning from all operations, and offers practical examples and lessons learned from airlines and air navigation service providers (ANSPs) that have implemented Learning From All Operations concepts.

1.2 Purpose of the concept notes series

The Foundation acknowledges that 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 (Flight Safety Foundation, 2021). Data collection needs to expand from a focus on hazardous events to analysis of routine operational data.

However, in order to facilitate learning from all operations there is a need for a conceptual framework that incorporates taxonomies and concepts based on the existing risk and hazard terminology but expanded to include resilience and adaptation, best suited for use for both abnormal and normal operations. The suggested framework should be suitable for understanding of work-as-done and for collecting and analysing diverse sources of data on the real-world resilient behaviour of operators.

This concept note is the first in a series of concept notes that define the Learning From all Operations conceptual framework. The note will be followed by concept notes that cover the following subjects:

- Systems approach for Learning From All Operations.
- Operations limits assumption and safety envelope.
- Manifestations of resilience.
- Foundation's three forces model of system adaptation.
- Mechanisms of operational resilience.
- Learning dimensions.

2. The Need for Expanding the Learning Beyond Failure

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 on its presence (Flight Safety Foundation, 2021). There are at least five different reasons that necessitate extending the safety learning beyond learning from hazards and risk and towards Learning From All Operations:

- The need to have representative and timely learning.
- The need to see failures in the correct perspective.
- The need to expand learning beyond explicit knowledge.
- The need to counterbalance negativity bias.
- The need to learn from processes as well as from outcomes.

2.1 The need to have representative and timely learning

Commercial aviation has an exceptional safety record. And the better we are in reducing the rate of accidents and serious incidents the less we will have to learn from if our learning comes predominantly from undesired events. In a way, we are becoming victims of our success.

While there is much to be learnt from unwanted events such as incidents, learning must wait for something to happen. Learning only from rare events means that learning only occurs rarely (Flight Safety Foundation, 2021). We can resolve this impediment to learning in three different ways:

- We can learn richly from low frequency events by treating unique events (incidents, accidents or hazards) as detailed stories rather than single data points (March, 1991). A single event can raise different interpretations if seen from the perspective of different expertise, cultural background or through another type of diverse lens. Aggregating across these different interpretations is one way of learning from low frequency events. Another way is by seeing every unique historical event as a collection of micro events. In this sense, the learning potential of any historical event is in seeing the interconnections of the micro events. Finally, sometimes even statistically insignificant events can bring valid information challenging some of our safety assumptions — for example we may discover previously unknown and unaccounted for patterns, hazardous scenarios or causal and contributory factors.

- We can start pooling and learning from larger sets contributed by many operators, aviation segments and geographical regions. Industry programs like the Aviation Safety Information Analysis and Sharing (ASIAS) system in the United States, Data4Safety (D4S) (U.S. Department of Transportation, 2021) in Europe and the International Air Transport Association's (IATA) Flight Data eXchange (FDX) are examples of successful learning from larger scales through pooling and analysis of information from multiple actors. Typically, the larger scale of these programs is complimented by lower, local-level positioning like benchmarking at a regional, airport level, benchmarking against other operators with similar/same aircraft types or through trend analysis for evolutions in time.
- We can enlarge the learning to involve more than just failures or undesired outcomes. Unwanted events are not necessary for learning (Flight Safety Foundation, 2021). 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. If you don't pay attention to everyday work, slow changes may not be recognised before an unexpected — and usually unwanted — event occurs. And often slow and fast changes do not happen without preceding, weak signals that can be scanned for and diagnosed early. Learning from all operations helps organisations to see changes to patterns in everyday work and can help us understand our resilience and vulnerabilities. Moreover, knowing well the entire spectrum of operations can help us be proactive and predictive by mentally extending the present to some possible hypothetical scenarios.

Learning From All Operations promotes all three approaches for enlarging our learning that are described above. And the name says it — it is about learning from all operations, not only from failure and not only from success. It is about learning as an individual as well as from the experience and knowledge of others.

Supporting timely learning is especially important for systems where tasks or functions are automated. People are intrinsically adaptive and when they perform a task or a function they naturally adapt to the changing context. When tasks are automated, system adaptations to change are still needed but the humans may not always be in the loop to successfully provide those adaptations. Because of that there is a need for the systems to monitor the evolution of the environment and the change of the context, for example through leading indicators, and to detect early the need for adapting the system operations.

Learning helps systems to anticipate and manage pressures that can be expected, and it can also help systems to build capacity and address vulnerabilities for events that cannot be expected. Learning from localised adaptations and resilience processes that were successful in managing surprise helps to cope with the unexpected events.

2.2 The need to see failures in the correct perspective

The importance of something is only possible to judge when it is seen in perspective. To have perspective we will need to learn about the entire spectrum of 'things' and to learn continuously in time. This means to consider realised events, or events that happen, as drawn from a distribution of possible events. In this way a true understanding requires attention to the whole distribution of possible events, including those that did not occur. This is what we call Learning From All Operations.

Let us, for example, look at incidents over a defined time period for two ATC sectors — sector BLUE and sector RED. Over the specified period, sector BLUE had 30% of its incidents during level flight and 70 percent during climb or descent. Sector RED, however, had only 50 percent of its incidents during level flight and the other 50% during climb or descent. The question facing the ATC centre management is what to prioritise. Which of the two sectors, BLUE or RED, has a bigger problem with aircraft in vertical movements?

Very often when this question is presented to audiences during workshops the predominant answer is that sector BLUE should be the priority for the risk of aircraft in vertical movement. This answer does not account for the overall frequency of a phenomenon in each sector — also referred to as the 'base rate'. Imagine that, for ATC sector BLUE, traffic is in level flights for 30 percent of the flight time and in climb or descent for 70 percent of the flight time. For sector RED, the traffic is in level flight for 90 percent of the flight time, and in climb or descent for 10 percent of the flight time.

What do these traffic distributions tell us? It appears that for sector BLUE 70 percent of the flight time 'produces' exactly 70 percent of the incidents while for sector RED only 10 percent of the flight time 'produces' 50 percent of the incidents. Maybe our priority in terms of vertical movement risk should be sector RED. These base rates of the frequency of flight time spent in level flight and in climb or descent for each sector provide the perspective necessary to interpret data about the frequencies of incidents.

Base rates are an important component of many safety management decisions, and, by definition, come from monitoring and learning from all operations.

2.3 The need to expand learning beyond explicit knowledge

SMS relies predominantly on information based on the explicit knowledge of individuals. Explicit knowledge is knowledge that we know that we know. We can easily explain what we know in case we are asked. Within an SMS the explicit knowledge comes from the submitted safety reports, from the hazard and risk analyses and from automated data monitoring processes like flight data monitoring/flight operations quality assurance exceedance events analysis.

Yet, individual knowledge includes more than the explicit knowledge that we can easily articulate, write down, and share (Klein, 2009), (Kahneman & Klein, 2011). Individual knowledge also includes implicit and tacit knowledge. A large part of the expertise of professionals is outside their explicit knowledge — it is sometimes even an intuitive form of knowledge or something that we do not know that we know (Kahneman, 2003), (Klein, 2009).

It is important for an SMS to capture as much as possible from the safety knowledge of individuals. Relying only on explicit knowledge is not simply less efficient — it can be dangerous to base safety management only on knowledge that individuals can easily report. First, critical details that affect system performance may not be obvious to the reporter. Second, many factors that affect human performance are simply not open to conscious inspection, therefore our introspections about how we perform can be wrong without realising it. Thus, while explicit knowledge represents one important source of information about what happens, it is inherently incomplete and can be inaccurate. The Learning From All Operations framework promotes capturing all types of individual knowledge and cross-learning at team and organisational levels — including through monitoring, observation and identification of weak signals.

Moreover, if we want to automate a certain task that is currently performed by people it will be safety critical to base our operational requirements and technical specifications not only on what people tell us they do (Holbrook at al., 2019). Instead, we will need to compliment the people's account of their work with careful observations and data collection covering the entire spectrum of the task performance distribution.

Understanding the ways in which people contribute to safety can facilitate system design that balances the interactions between people, technology and procedures. Without this understanding, the full benefits of automated or autonomous systems will not be realised.

2.4 The need to counterbalance our negativity bias

People have a propensity to react more strongly to negative outcomes than to positive outcomes (Kahneman, 2011). This may be an evolutionarily adaptive strategy whereby organisms that were better attuned to bad things were more likely to survive threats, or simply that the evolutionary

survival benefits of positive events were outweighed by the survival decrements of negative events (Lazarus, 2021). This asymmetry may make us likely to pay more attention to how work fails compared to how work succeeds. Bad impressions that we form from the processes of incident investigation, hazard identification and risk analysis are quicker to form and are more persistent than the good impressions formed from successful hazard prevention, recovery or mitigation. By nature, we are biased to process more thoroughly the information associated with the risk than the information about resilience. The conceptualisation of negativity is more elaborate and complex than that of positivity. When we assign importance only to negative events, then positive events become invisible — the tragedy that is averted is a non-event.

To counteract the effect of this intuitive bias in the way we manage aviation safety we need a deliberate action to look into the positive outcomes.

2.5 The need to learn from processes as well as from outcomes

The sources of success and failure are sometimes very similar — under demands and resources pressures systems adapt to fulfil their objectives (Hollnagel, 2014). Individuals, teams, and organisations routinely adjust their performance to match current demands, resources, and constraints of the system. These adjustments are based on an understanding of the system at that moment in time, and that understanding comes from what we learn about the system (March, 2010).

In this way good process sometimes leads to bad outcome, and also bad process can have a good outcome. This means that a good outcome can have both good and bad process as precursors. We need to consider not only bad outcome but good ones, we need to learn from all types of processes and not trigger our learning based only on the negative outcome.

In fact, some actual adaptations can, in hindsight, be associated with successful or unsuccessful 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.

Additionally, learning from everyday work builds on processes that are already strong (Flight Safety Foundation, 2021). 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.

3. Continuous Learning at Three Levels

In the previous section we argue about the need for Learning From All Operations. Here, the Foundation proposes an approach to Learning From All Operations that is scalable, enabling large and small organisations to synergise with their existing safety programs (Flight Safety Foundation, 2021). This approach calls for a review of the activities and processes and extends their scope to learn from all operations. Reporting could include good practices, investigations could look into what worked well, and safety monitoring could be done across the entire performance distribution.

The purpose of learning from all operations is to understand how work is actually 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.

The Learning From All Operations approach emphasises 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 (Flight Safety Foundation, 2021). The results of learning are expressed on the individual level (skills, competence) as well as on team and organisational 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 1.

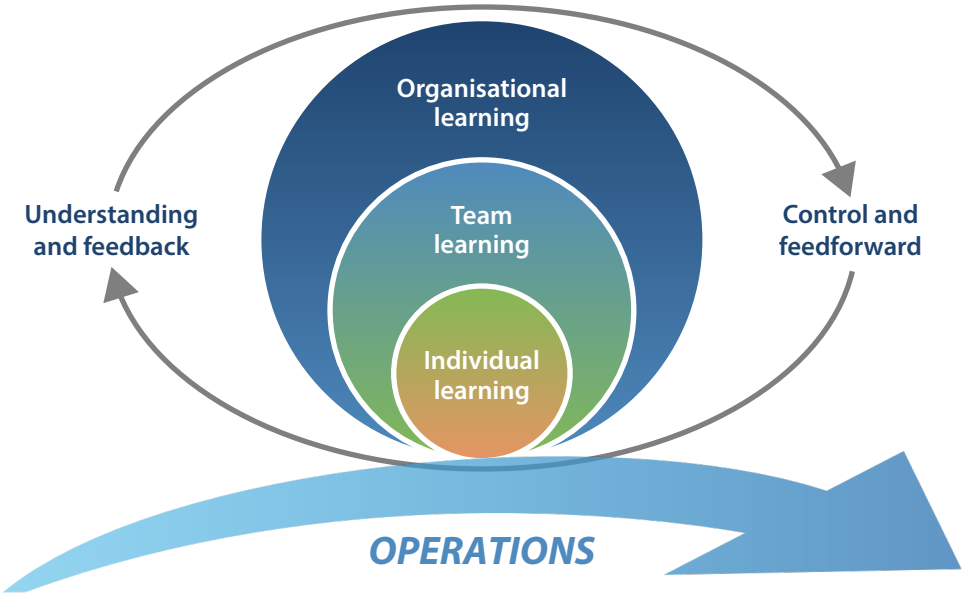

Figure 1

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 learning across levels and overall system performance.

There are challenges for Learning From All Operations posed by the independencies of the three levels of learning and challenges brought by the need to bridge the concepts based on the existing risk and hazard terminology but expanded to include resilience and adaptation. These challenges are addressed by adopting a systems approach. The next concept note from this series defines the systems approach perspective used for Learning From All Operations.

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References

Flight Safety Foundation. (2010, October 27). Using "Positive" Human Factors Data (OGHFA BN). Retrieved from SKYbrary.aero: https://skybrary.aero/articles/using-%E2%80%9Cpositive%E2%80%9D-human-factors-data-oghfa-bn.

Flight Safety Foundation. (2021, July). Learning From All Operations: Expanding the Field of Vision to Improve Aviation Safety. Retrieved from https://flightsafety.org/toolkits-resources/special-reports/.

Holbrook J. B., Stewart, M. J., Smith, B. E., Prinzel, L, J., Matthews, B. L., Avrekh, I., Cardoza, C. T., Ammann, O. C., Adduru, V., & Null, C. H. (2019). Human performance contributions to safety in commercial aviation. NASA/TM-2019-220417. Retrieved from: https://ntrs.nasa.gov/api/citations/20190033462/downloads/20190033462.pdf.

Hollnagel, E. (2014). Safety-I and Safety-II: The Past and Future of Safety Management. England: Ashgate. doi:https://doi.org/10.1201/9781315607511.

International Civil Aviation Organization (ICAO). (2016, July). Annex 13 to the Convention on International Civil Aviation: Aircraft Accident and Incident Investigation. 11th. Montreal, Canada: ICAO.

International Civil Aviation Organization (ICAO). (2016, July). Annex 19 to the Convention on International Civil Aviation: Safety Management. Second. Montreal, Canada.

International Civil Aviation Organization (ICAO). (2018). Doc 9859: Safety Management Manual. Fourth Edition 2018. Montreal, Canada.

Kahneman, D. (2003, December). Maps of Bounded Rationality: Psychology for Behavioral Economics. The American Economic Review, 93(5), pp.1449–1475.

Kahneman, D., & Klein, G. (2009, September). Conditions for Intuitive Expertise: A Failure to Disagree. American Psychologist, 64(6), pp. 515–526. doi: https://doi.org/10.1037/a0016755.

Kahneman, D. (2011). Thinking, Fast and Slow. Farrar, Straus and Giroux.

Klein, G. (2009). Streetlights and Shadows: Searching for the Keys to Adaptive Decision Making. Cambridge, MA: The MIT Press.

Lazarus, J. (2021). Negativity bias: An evolutionary hypothesis and an empirical programme. *Learning and Motivation* (75). Doi: https://doi.org/10.1016/j.lmot.2021.101731.

March, J. G., Sproull, L. S., & Tamuz, M. (1991). Learning from Samples of One or Fewer. Organization Science, 2(1) Special Issue: Organizational Learning: Papers in Honor of (and by) James G. March), pp.1–13. Retrieved from http://www.jstor.org/stable/2634936

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. Organizational Science, 2(1) Special Issue: Organizational Learning: Papers in Honor of (and by) James G. March), pp.71–87.

March, J. G. (2010). The Ambiguities of Experience. New York: Cornell University Press.

McCarthy, P. (2020). The Application of Safety II in Commercial Aviation — The Operational Learning Review (OLR). In: Harris D., Li WC. (eds) Engineering Psychology and Cognitive Ergonomics. Cognition and Design. HCII 2020. Lecture Notes in Computer Science. 12187, pp. 368–383. Switzerland, AG: Springer,Cham. Doi: https://doi.org/10.1007/978-3-030-49183-3_29

Taleb, N. N. (2007). The black swan: The impact of the highly improbable. New York: Random House.

U.S. Department of Transportation. Office of Inspector General. (2021). FAA Has Made Progress in Implementing ASIAS, but Work Remains To Better Predict, Prioritize, and Communicate Safety Risks.