



Why Learning from All Operations Is Imperative

Jon Holbrook, PhD

NASA

Aviation Safety InfoShare

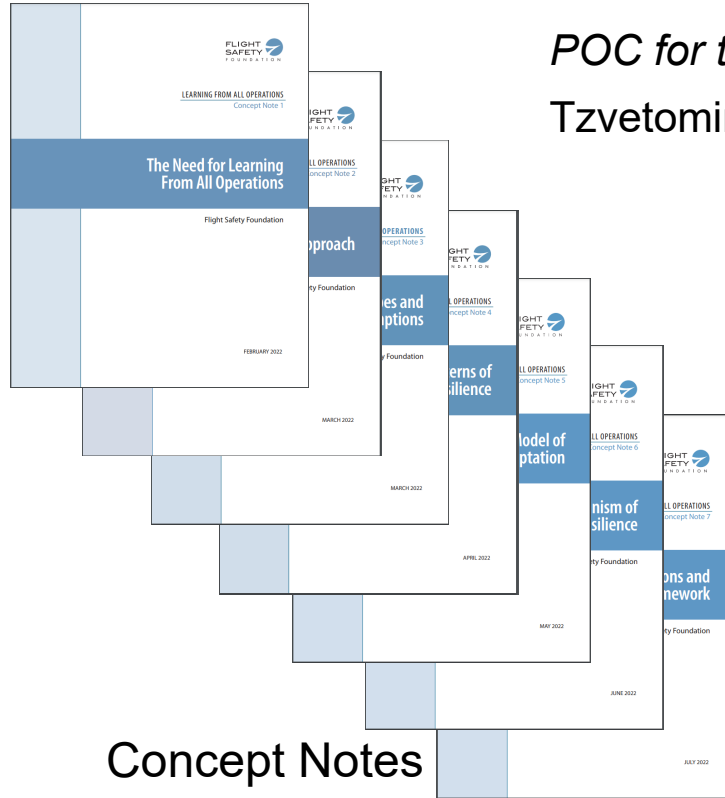
Dallas, TX

December 2023

Learning from All Operations



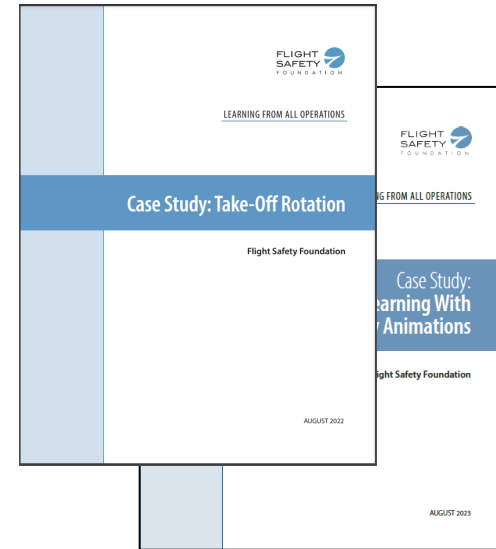
White paper



Concept Notes

POC for the FSF LAO initiative:

Tzvetomir Blajev (blajev@flightsafety.org)



Case Studies

<https://flightsafety.org/toolkits-resources/learning-from-all-operations/>

Why Learning from All Operations Can't Wait



- In today's aerospace industry, *data talks...*
 - ... and it talks a lot about errors and failures!
 - ... and exceedances
 - ... and deviations
 - ... and violations
- Even a “safety event” refers only to a *loss* of safety



To Err is Human...



- Claybrook & Kildare (*Science*, 2018)
 - “... humans are inherently bad at monitoring semi-autonomous systems and are readily distracted.”
 - *Note*: The cited reference (Cunningham & Regan, 2015) doesn’t actually speak to this being “*inherent*”...
- “To fast forward to the safest possible operational state ... network operators will be interested in the path that realizes full machine autonomy as quickly as possible.” (Uber, 2016)
 - *Note*: Accordingly, it’s a *safety imperative* to get those error-prone humans out of the safety loop!

Consequences of Focusing on Human Error



- Designs intended to “protect” the system from “error-prone” humans can design *out* the capability for humans to effectively intervene/adapt, which is a far more common behavior.
- Automation levels are only increasing
 - Until automation designers acknowledge and consider that pilots can intervene to *cause* safety, every increase in automation adds to the risk of
 - Isolating the pilot from the aircraft
 - Limiting the pilot’s adaptive capacity and capability

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	?	20%	?
	Yes	?	80%	?
		?	?	?

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹
- Pilots intervene to manage aircraft malfunctions on 20% of normal flights²

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	80%	20%	?
	Yes	20%	80%	?
		?	?	?

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹
- Pilots intervene to manage aircraft malfunctions on 20% of normal flights²
- World-wide jet data from 2007-2016³
 - 244 million departures
 - 388 accidents

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	80%	20%	?
	Yes	20%	80%	?
		243,999,612	388	244,000,000

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹
- Pilots intervene to manage aircraft malfunctions on 20% of normal flights²
- World-wide jet data from 2007-2016³
 - 244 million departures
 - 388 accidents

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	195,199,690	78	195,199,768
	Yes	48,799,922	310	48,800,232
		243,999,612	388	244,000,000

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error has been implicated in up to 80% of accidents in civil and military aviation¹
- Pilots intervene to manage aircraft malfunctions on 20% of normal flights²
- World-wide jet data from 2007-2016³
 - 244 million departures
 - 388 accidents

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	195,199,690	78	195,199,768
	Yes	48,799,922	310	48,800,232
		243,999,612	388	244,000,000

Frequently Studied (points to 310)

Rarely Recognized (points to 48,799,922)

Learn more: Holbrook, J. (2021). Exploring methods to collect and analyze data on human contributions to aviation safety. In *Proceedings of the 2021 International Symposium on Aviation Psychology*. https://aviation-psychology.org/wp-content/uploads/2021/05/ISAP_2021_Proceedings_FINAL.pdf

Pilots *Produce* Safety Far More Often than They *Reduce* It



- Human error contributes in up to 70% of accidents and malfunctions

$$\frac{48,799,922}{310} = 157,419$$

- Pilots intervene to prevent aircraft malfunctions on flights 2

Pilots intervene to keep flights safe from aircraft malfunctions

- World-wide 2016³

~157,000 times for every time that human error contributes to an accident!

- 244 reported accidents
- 388 fatalities

Frequently Studied

195,199,768

48,800,232

244,000,000

Learn more: Holbrook, J. (2021). Exploring methods to collect and analyze data on human contributions to aviation safety. In *Proceedings of the 2021 International Symposium on Aviation Psychology*. https://aviation-psychology.org/wp-content/uploads/2021/05/ISAP_2021_Proceedings_FINAL.pdf

Key Take-Aways



- When we characterize safety only in terms of errors and failures
 - We ignore the vast majority of human impacts on the system
 - We restrict opportunities to learn
 - Our design decisions and safety policies can be affected
- When we *systematically* restrict opportunities to learn, not only do we learn less and less often, but we can draw misleading conclusions
- We need to “change the conversation” about safety
 - People produce safety far more often than they reduce safety
 - Expand our understanding and definition of what constitutes a “safety event”
 - Demonstrate practical and sound new approaches to data collection and analysis



Thank you!

jon.holbrook@nasa.gov

Airline presentations

American Airlines

Japan Airlines

Southwest Airlines

Delta Air Lines



Why Learning from All Operations Is Imperative

Immanuel Barshi, PhD

NASA

Aviation Safety InfoShare

Dallas, TX

December 2023

Where Do We Start?



- Understanding the big picture
- Demonstrating practical and sound approaches to collecting new data and new ways to examine existing data
 - Specifically, data on how (and the processes by which) humans *contribute* to safety
 - Approaches that can be implemented today
- Changing the narrative that people are the safety problem

Revisiting Our Assumptions on Human Performance



- Human error has been implicated in 70% to 80% of accidents in civil and military aviation (Weigmann & Shappell, 2003)

Actually, 100% of accidents are due to human limitations!

And 100% of successful operations are due to human capabilities!

- Pilots intervene to manage aircraft malfunctions on 20% of normal flights (PARC/CAST, 2013)

Pilots intervene in various ways on 100% of flights!

Revisiting Our Assumptions on Human Performance



$$\frac{48,799,922}{310} = 157,419$$

Pilots intervene to keep flights
safe from aircraft malfunctions
~157,000 times for every time that
human error contributes to an
accident!

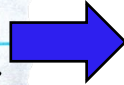
This is a *conservative* estimate!

Revisiting Our Assumptions on Human Performance



$$\frac{48,799,922}{310} = 157,419$$

Pilots intervene to keep flights
safe from aircraft malfunctions
~157,000 times for every time that
human error contributes to an
accident!



$$\frac{\begin{matrix} \text{(All non-accidents)} \\ 243,999,612 \end{matrix}}{\begin{matrix} 388 \\ \text{(All accidents)} \end{matrix}} = 628,865$$

Pilots intervene to keep flights
safe more than **628,000** times for
every time that human error
contributes to an accident!

This is a *conservative* estimate!

This estimate is more indicative
of operational realities!

Approaches that Have Been Implemented



- **American Airlines** – Learning & Improvement Team (LIT)
- **Japan Airlines** – Resilience Operation Monitoring (ROM)
- **Southwest Airlines** – Safety & Learning Advancement Team (SLAT)
- **Delta Air Lines** - Integrating Learning From All Operations into the Components of a Safety Management System

Benefits of Learning from All Operations

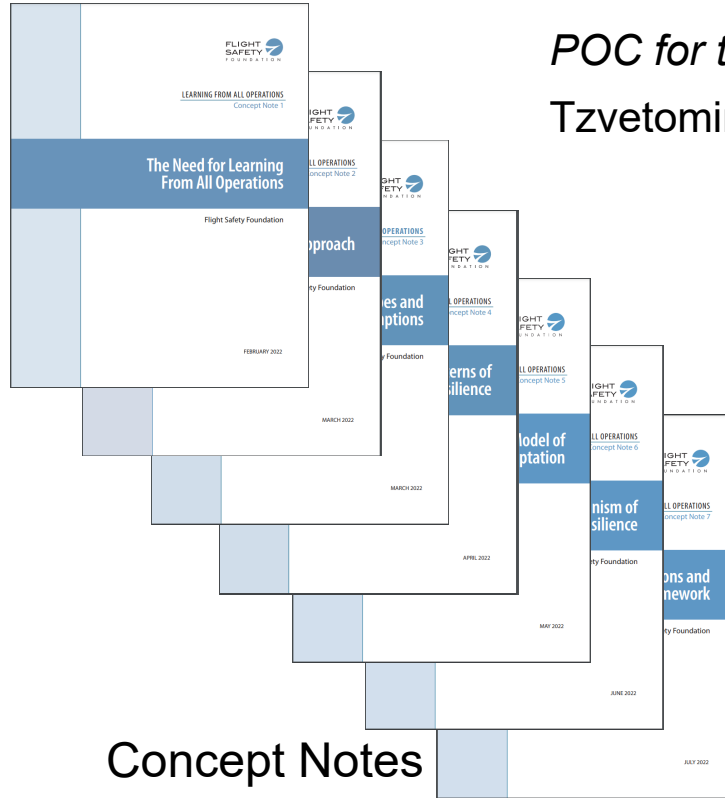


- Safer system designs
- Increased organizational awareness
- More frequent opportunities for operational learning/training
- System safety that is robust to future changes
- Resilience

Learning from All Operations



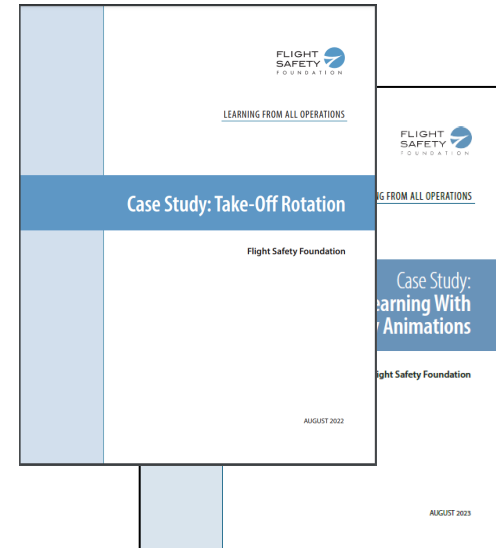
White paper



Concept Notes

POC for the FSF LAO initiative:

Tzvetomir Blajev (blajev@flightsafety.org)



Case Studies

<https://flightsafety.org/toolkits-resources/learning-from-all-operations/>

Key Take-Aways



- Learning from all operations is critical to informing system designs, policies, and procedures that effectively preserve the capability for humans to intervene/adapt to sustain safe operations
- We can “change the conversation” that people are the safety problem by demonstrating practical and sound new approaches to data collection and analysis



Thank you!

immanuel.barshi@nasa.gov

Learning from All Operations – Panel Discussion

- Introduction: Tzvetomir Blajev, Flight Safety Foundation
- Why Learning from All Operations is Imperative: Jon Holbrook, NASA
- Implemented Approaches to Learning from All Operations
 - American Airlines
 - Japan Airlines
 - Southwest Airlines
 - Delta Air Lines
- Why Learning from All Operations is Imperative (Summary): Immanuel Barshi, NASA