An Analysis of the Role of Safety Nets in the National Airspace System

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Overview

• Introduction
• Accidents and Incidents
• Safety Nets
• Positive Taxonomy
• Event Sequence Diagrams (ESDs)
• Aviation Safety Reporting System (ASRS)
• Airspace Operations Centric ESD
• Aircraft Operations Centric ESD
• Summary
Introduction

• Motivation
  – Provide insight into safety nets providing resilient recovery from off-nominal conditions ensuring flight safety proactively

• National Aeronautics and Space Administration (NASA)
  – Aeronautics Research Mission Directorate’s (ARMD) Thrust 1 and 5\(^1\)
    • Safe, efficient growth in global operations
    • Real-time system-wide safety assurance

• Next Generation Air Transportation System (NextGen)

• Reduction in accidents over time

Introduction

- ASRS Database 2015 (5971 Reports)
- Safety Nets
  - Positive
  - Taxonomy

445 Incident Reports

12 Individual ESDs
Accidents and Incidents

Evans, J. K. (2014). Frequency of Specific Categories of Aviation Accidents and Incidents During 2001-2010. NASA/CR - 2014-218184 (Updated results to include 1986-2014)
Accidents and Incidents

Number of Incident Reports from the ASRS, 2006-2015
Safety Nets

• Reason’s Swiss Cheese Model

• Safety Net Role

• Safety Nets
  – Hard Safety Nets
  – Soft Safety Nets

• Hard Safety Net Database
  – Ground Based Technologies
  – Airborne Based Technologies
  – Aircraft Operations Based Technologies
  – Airspace Operations Based Technologies
  – Flight Phase
  – Aviation Occurrence Category

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Positive Taxonomy

• Commercial Aviation Safety Team (CAST)/ International Civil Aviation Organization (ICAO) Common Taxonomy Team (CICTT)

• Positive Taxonomy Document
  – Decisions
  – External Interventions
  – Soft Safety Nets

• Reactive vs. Proactive Prevention

CAST/ICAO Common Taxonomy Team, (2013, April). *Positive Taxonomy, Definition and Usage Notes* [Version 1.2]
Event Sequence Diagrams (ESDs)

- Event Sequence Diagrams visually represent an accident/incident scenario

- Include initiating events followed by several pivotal events and their end results
  - Initiating Events: deviation from normal operations and active failures/triggering events
  - Pivotal Events: event with possible intervention, other causal pathways

- Aggregated ESDs within this study provide the complete list of initiating events (e.g. Human Factors, Weather, ATC, etc.) leading up to a pivotal event (e.g. CFIT conflict) and the subsequent pivotal events (noticing the conflict and performing evasive maneuvers)
Event Sequence Diagrams (ESDs)

Generic Event Sequence Diagram (ESD)
• Search Criteria in the ASRS
  – Year Restriction
  – Positive Taxonomy
  – Safety Nets

• Reports in 2015
  – 5971

• Reports using both positive taxonomy and/or safety nets in 2015
  – 445

• ESD Representation Limitations

• ESD Representation Categories
  – Airspace Operations Centric
  – Aircraft Operations Centric
Airspace Operations Centric ESD

Generalized Airspace Operations Centric ESD
Enhanced Ground Proximity Warning System (EGPWS) ESD

Weather (Gusts, clouds, rain) -> 10
Procedural -> 15
Environment (Non weather) -> 9
Human Factors -> 39
ATC (Poor CRM) -> 4
Aircraft Anomaly (Instrument) -> 4
Mode Confusion -> 3

CFIT Conflict -> 7
Flight Crew Notices -> 81
Flight Crew Saves -> 1
Rejected Takeoff

ATC Notices -> 2
ATC Saves -> 23
Go-Around

EGPWS Notices -> 82
EGPWS Saves -> 79
Evasive Maneuver
Enhanced Ground Proximity Warning System (EGPWS) ESD
Aircraft Operations Centric ESD

Generalized Aircraft Operations Centric ESD

- Instrumentation Failure
- Engine Failure
- Landing Gear Failure
- Control Surface Failure
- Human Factors
- Pressurization Failure
- Fluid Error

Warning System Notices
Crew Notices
Perform Quick Reference Handbook Tasks

Problem Fixed?
Yes
Continue to Destination
No
Rejected Takeoff
Go-Around
Divert to Nearby Airport
Land at Takeoff Airport
Land at Destination
Aircraft Operations Centric ESD

Airbus Electronic Centralized Aircraft Monitoring System (ECAM) ESD
Aircraft Operations Centric ESD

Airbus Electronic Centralized Aircraft Monitoring System (ECAM) ESD

1. Go-Around
2. Land at Takeoff Airport
3. Rejected Takeoff
4. Continue to Destination
5. Land at Destination
6. Divert to Nearby Airport
7. Continue to Destination
Summary

• Use of the ASRS, Positive Taxonomy, and Safety Nets for a proactive analysis of the role safety nets play in the NAS

• Airspace and Aircraft Operations Centric ESDs

• Identify gaps in safety in the NAS

• Future Work
  – Increase range of years
  – Develop more safety net specific ESDs
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References


Questions?

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