Aviation safety concerns for the future

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Area of change (AoC)

AoC is a change that could potentially influence aviation safety

Examples:

- Increasing operations of military and civilian unmanned aerial systems in shared military, civilian, and special use airspace
- Proliferation of voluntarily-submitted safety information
- Changes in aviation fuel composition
- Reliance on automation supporting a complex air transportation system

Current AoC list: http://www.nlr-atsi.nl/fast/aoc

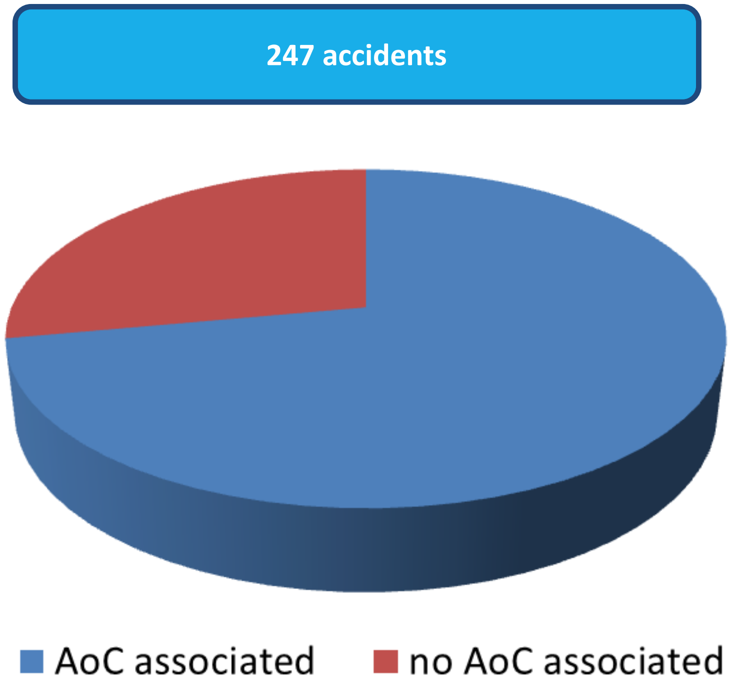
Verification of AoC relevance – association of AoCs with accidents

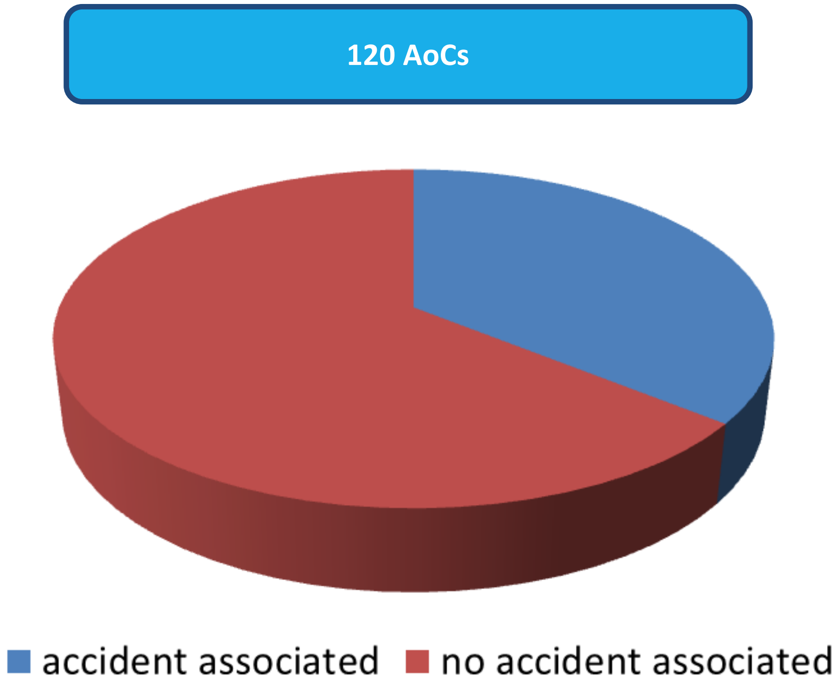
Accident inclusion criteria

- 247 fatal accidents
- Time frame 2004-2014
- Commercial operations
- Fixed wing aircraft
- Maximum Take-Off Mass larger than 5,700 kg

Information source: https://aviation-safety.net/database

Results


247 accidents
AoC associated
no AoC associated


120 AoCs
accident associated
no accident associated

Most frequently assigned AoCs

Area of change (2004) vs Total accident set (N=247)	Accident count	% of total set
Socio-economic and political crises affecting aviation (AoC-265)	48	19,4
Operation of low-cost airlines (AoC-125)	44	17,8
Smaller organisations and owners operating aging aircraft (AoC-252)	42	17,0
Reliance on automation supporting a complex air transportation system (AoC-013)	40	16,2
Increasing operations of cargo aircraft (AoC-114)	39	15,8
Increasing reliance on procedural solutions for operational safety (AoC-282)	19	7,7
Operational tempo and economic considerations affecting flight crew alertness (AoC-205)	16	6,5
Accelerated transition of pilots from simple to complex aircraft (AoC-122)	10	4,0
Decreasing availability of qualified maintenance staff at stations other than home base of operations (AoC-256)	8	3,2

Key lessons from this analysis

- AoC "Reliance on automation supporting a complex air transportation system" was a major factor in 10 years of world-wide accidents (confirmed study hypothesis)
- There were also other intriguing findings:
  - 4.1 In service inertia - 22,000 737 & A320 in service by 2025
    - Knowledge maybe fading, also moderates/constrains automation evolution
    - Also true for ATC & Air Ground Space syst. incl. SESAR and US Next Gen
  - 4.2 The prosperity factor – strength of economy = dominant factor
    - Explains differences of accidents accross geographical regions
    - Need to work Regional issues, addressing human factors will not work
  - 4.3 Cosmic cycles – organizations don't have a memory
    - Critical know-how & know why fading with time, especially problem when
    - Safety relies on procedural solutions, e.g. ground ice, stall training (as part of UPRT), etc

Key lessons from this analysis

- Other intriguing findings (continued):
  - 4.4 Next Generation of Pilots – how to keep "hands on" currency
    - Due to future advances in flight deck automation
    - Stress & fatigue will increase rapidly when flight crew does not understand what flight deck automation is asking the aircraft to do
    - **Note:** from 190 pilot survey with 10,000 hrs mean experience (2003)
  - 4.5 Safety Oversight – not as simple as it appears
    - Analysis of 42 accidents involving small low cost airlines – at least half had one or more prior accidents (USA & EU)
    - Knowledge of the past essential for Performance based safety oversight
  - 4.6 Miscellaneous – Cargo aircraft & Maintenance expertise
    - 2001 NLR study suggests 2,5 x per million accident rate in USA: 5x airplane
    - Decreasing availability of qualified maintenance at out stations

Reliance on automation supporting a complex air transportation system

- ***Flight Crew-automation Interactions Issues****

Overview of automation surprise in high-profile accidents					
	Colgan Air Q400 Feb 12, 2009 (NTSB, 2010)	**Turkish Airlines B737-800 Feb 25, 2009 (DSB, 2010)**	**Air France A330 June 1, 2009 (BEA, 2012)**	**Asiana B777 July 6, 2013 (NTSB, 2014)**	**Air Asia A320 Dec 28, 2014 (KNKT, 2015)**
Automation surprise	Crew surprised by stickpusher operation and responded inappropriately.	Crew unaware that auto-thrust reduction was triggered by faulty radio altimeter.	Aircraft response to control input when in alternate law at high altitude not understood by crew.	Crew failed to recognise that selection of the autopilot mode cancelled the auto-thrust speed protection.	Crew failed to recognise that pulling the circuit breakers in-flight keeps the aircraft in alternate law.

*) Theme II from FAST 2004 report resulting in 21 recommendations (from 286 identified hazards).

Reliance on automation supporting a complex air transportation system

- Unclear whether revised training - e.g., upset recovery training-, new procedures or design changes can prevent the occurrence of such cases in the future,
  - human decision making in unusual situations not understood (Lamme, 2010).
- FAST position
  - research into human behavior and decision making in normal and off-nominal conditions will help to reduce these types of accidents.
  - Such knowledge is relevant for improving flight training and flight deck design.

Technological Watch items

- TWI's were formulated as "companions" of each hazard statement*.
  - Describe technology drivers that may enable these futures to come about.
  - Include "social science" considerations and business/affordability perspectives.
- Back in 2004, FAST's described several exemplar TWI's under "Other Technologies, One of them suggested:
  - "Monitor development of "eSafety" systems for road and air transport".
- Today, **self driving cars** are in test (Google) & deployed (Tesla) and "eSafety" an issue. Hence, TWI's for (some of) the major associated issues may be:
  - Emergence of viable business models and markets (e.g. for insurance & product liability)
  - Rapid advances in artificial intelligence incl. self learning systems enabling detection and avoidance of unusual objects on the road,.

*) Each Area of Change description lists one or more hazards, see http://www.nlr-atsi.nl/fast/aoc/

Conclusion

- Changes catalogued many years previous were directly implicated in the majority of fatal aviation accidents over the past ten years.
- AoCs provide a view into the contributing contextual factors of accidents.
- AoCs help safety analysts adopting a prospective mind-set; that is, discovering future hazards arising from changes inside or outside the aviation system.
- Technological Watch items can be an important tool to see whether predicted futures are becoming reality
- Monitoring for the emergence of new AoCs can point toward proactive mitigation strategies.
- Essential strategy getting the message across:
  - Concerted effort “to prepare” the recipient of the prognostic message(s)
  - Continued processing of signaled problems in a follow on team.