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

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

<table>
<thead>
<tr>
<th>Overview of automation surprise in high-profile accidents</th>
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<tbody>
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<td><img src="image.png" alt="image" /></td>
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</tbody>
</table>

*) 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.