Safety Management

Predictive Hazard Identification

Captain Patrick Garrigan
Ulaanbaatar, Mongolia
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Accident / Serious Incident Cycle

Accident
Or
Serious Incident

Monitoring

Investigation

Safety Enhancement
Implementation

Contributing Factor
Analysis
Precursor Event Cycle

- Hazard Identification
- Risk Assessment
- Mitigations
- Monitoring
Precursor Event Cycle

- Decline in Precursor Event
- Hazard Identification
- Risk Assessment
- Mitigations
- Monitoring
Predictive Hazard Identification

- **Normal operations monitoring.**
  - Belief that safety management is best accomplished by aggressively seeking information from a variety of sources, which may predict emerging safety risks.
  - *Flight Operations Quality Assurance (FOQA) or Flight Data Analysis (FDA)*
  - Maintenance reliability program
  - Engine condition monitoring
Predictive Hazard Identification:
Flight Operations Quality Assurance (FOQA)
Also known as Flight Data Analysis– FDA or Flight Data Monitoring

- ICAO Annex 6 standard
  - 3.3.6 An operator of an aeroplane of a maximum certificated take-off mass in excess of 27,000 kg shall establish and maintain a **flight data analysis** program as part of its safety management system.

  - 3.3.7 A **flight data analysis program shall be non-punitive** and contain adequate safeguards to protect the source(s) of the data

- Trend and aggregate, not individual
- Not for punishment purposes, but to identify
- Capture, analyze and visualize
- Enhance overall efficiency
- Enhance maintenance effectiveness
- Increase flight safety – Data driven
In 1998, the Flight Safety Foundation’s comprehensive document on Flight Data Monitoring adopted the name Flight Operations Quality Assurance (FOQA) to avoid sensitivities associated with “monitoring.”

Outside the USA, most CAAs require an FDA system to be in place.

Both systems can identify individual events and both include statistical analyses:

- FOQA program, statistical trend information is used as the primary source of information and analysts can drill down into the monitored flights for more detail.

- FDM program, analysts examine the safety events from individual flights before rolling these up into a statistical summary.
FOQA – De-identified Data

FAA Order 8400.10:

“Data from which any identifying elements that could be used to associate them with a particular flight, date, or flight crew have been removed. Operator data which is provided to the FAA may be further de-identified by removal of identifying elements that could be used to identify the operator.”
Flight Crew Liaison Officer (FCLO)

Data that could identify flight crewmembers are removed from the electronic record as part of the initial event extraction process. However, FDA programs typically include a crew liaison officer who is normally provided with a secure means of determining crew identity to enable follow-up inquiry and feedback with a particular flight crew concerning a particular FDA event. The crew liaison officer should be someone who has the confidence of crewmembers and managers for their integrity and good judgment. This person provides the link between fleet or training managers and the flight crew involved, in circumstances highlighted by FDA.

COSCAP-NA Advisory Circular 006
“The FMT member who is primarily responsible for the security of identified data. The FCLO or gatekeeper, who is normally appointed by the pilot association, has limited ability to link FOQA data to an individual flight crewmember. If further information is needed to understand the reasons why an event occurred, the gatekeeper is the only individual who may contact a crewmember to elicit further information.”
Purpose of Flight Data Analysis (FDA)

- Why not use flight data to evaluate individual pilot performance?
  - The true problem is never solved
  - Safety data programs are no place to catch bad pilots – training dept., line check, check rides are best used to identify those pilots

- What are the sources of crew errors?
  - Think back to the Just Culture discussion – Behaviors?
  - Think back to types of errors and accidents:
    - Organizational accidents (system)?
    - Knowledge based errors (multiple)
    - Rule based errors (misapplication of good rule or application of a bad rule)
    - Execution errors (slips, lapses)
The Aggregate

▪ Power of “aggregation” is *trend* analysis

– Definition of Aggregate = formed by the conjunction or collection of particulars into a whole mass or sum; total;

– How wide is a problem in your operation – crew, fleet or airline?
– How geographically broad is the issue? Does the issue exist at one airport or many airports?
Flight Data Analysis - Process

Flight Data → deidentification → FDA Analyst → FOQA Gatekeeper → FDA Monitoring Team → Safety Information Users

FDA Monitoring Team:
• Fleet instructors
• Pilot group reps
• FDA Manager

Safety Information Users:
• Training
• Management
• Maintenance
• Safety Office
## Undesired Aircraft States and Parameters

<table>
<thead>
<tr>
<th>Undesired State</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Affects a/c controllability</td>
<td>jammed controls, &gt;90% control input</td>
</tr>
<tr>
<td>Deviation from ATC clearance</td>
<td>&gt;0.5nm cruise, &gt;0.2nm terminal</td>
</tr>
<tr>
<td>Fire</td>
<td>fire/smoke warning, crew detection</td>
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<td>Loss of separation</td>
<td>&lt;500 ft vertical, &lt;X ft lateral</td>
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<td>Ground proximity</td>
<td>TAWS 2.18 threshold</td>
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<tr>
<td>Loss of navigation capability</td>
<td>crew detection, (eg dual FMS failure)</td>
</tr>
<tr>
<td>Passenger inflight injury</td>
<td>crew detection</td>
</tr>
<tr>
<td>High speed RTO</td>
<td>&gt;100 KIAS (V1?)</td>
</tr>
<tr>
<td>Runway excursion</td>
<td>off runway (&gt;50kt@1000ft remaining?)</td>
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<tr>
<td>Runway incursion</td>
<td>crew detection</td>
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<td>Fuel starvation/leakage</td>
<td>low fuel caution, crew detection</td>
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<tr>
<td>Stall warning</td>
<td>0,1, &gt;2 sec</td>
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<tr>
<td>Unusual attitude</td>
<td>&gt;30 pitch, &gt;45 roll</td>
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<tr>
<td>Misconfigured a/c (T/O warning, pressurization, etc)</td>
<td>flaps/trim not set, cabin altitude &gt;10k ft</td>
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<tr>
<td>Unstabilized approach</td>
<td>flaps (not set by 1000ft), speed (&lt;Vref-5, &gt;Vref+20), gllideslope (&gt;1 dot)</td>
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<tr>
<td>Loss of/unreliable air data</td>
<td>pilot detection, flagged data?</td>
</tr>
<tr>
<td>Abnormal runway contact</td>
<td>(tailstrike, excessive flare (&gt;10? sec, 50ft to T/D), throttle not at idle at T/D, hard landing (&gt;8fps @ 5 ft?)</td>
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Fatalities by CAST/ICAO (CICTT) Aviation Occurrence Categories
Fatal Accidents – Worldwide Commercial Jet Fleet
Undesired Aircraft States and Parameters

- TAWS alerts (CFIT)

- Loss of Control In Flight (LOC-I)
  - Stall/over-speed (energy state awareness)
  - Bank angle (attitude awareness)

- Runway excursion (RE)
  - High speed RTO
  - Unstabilized approach or flare
Unstable Approach example
Unstable Approach example
Unstabilized Approach Content and Definition Example

In This Workbook

An analysis of Unstable Approaches from January 2008 to December 2010 by:
1) Airport
2) Runway
3) Arrival Procedures
4) Fleet Group and Fleet Type
5) Flight Date and Go-Around
6) Criteria Exceedances by Fleet Type
7) Go-Arounds after Criteria Exceedances
8) Unstable Approach by HAT

Definition of an Unstable Approach (UA)

Measured in three severity levels: 1000 to 500 feet Height Above Touchdown (HAT), 500 to 50 feet HAT, and Egregious

Exceeds 3 criteria listed and defined on the right, with different thresholds for Egregious versus 1000 to 500 ft HAT and 500 to 50 ft HAT

The average unstable approach rates are:

<table>
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<th>Category</th>
<th>Event Rate per 10,000</th>
</tr>
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<tbody>
<tr>
<td>Egregious</td>
<td>43</td>
</tr>
<tr>
<td>500 to 500 ft</td>
<td>63</td>
</tr>
<tr>
<td>800 to 600 ft</td>
<td>2</td>
</tr>
</tbody>
</table>

Unstable Approach Criteria - Severity Levels 1000 to 500 ft HAT and 500 to 50 ft HAT:

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<tr>
<th>Category</th>
<th>Criteria</th>
<th>Threshold</th>
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<tr>
<td>ILS</td>
<td>1. Above Glideslope</td>
<td>&gt; 1 dot high for 5 sec</td>
</tr>
<tr>
<td></td>
<td>2. Below Glideslope</td>
<td>&gt; 1 dot low for 5 sec</td>
</tr>
<tr>
<td></td>
<td>3. Localizer Deviation</td>
<td>&gt; 2 dot left/right for 5 sec</td>
</tr>
<tr>
<td>Airspeed</td>
<td>4. High Speed</td>
<td>(Vref + 35 kts) for 3 sec, 500 to 200 ft HAT</td>
</tr>
<tr>
<td></td>
<td>5. Low Speed</td>
<td>&lt; Vref - 3 kts for 3 sec, 500 to 50 ft HAT</td>
</tr>
<tr>
<td>ROD</td>
<td>6. High Descent Rate</td>
<td>&gt; 1500 ft/min for 3 sec, 500 to 50 ft HAT</td>
</tr>
<tr>
<td>Thrust</td>
<td>7. Low Thrust Descent</td>
<td>Below Approach Power Limit (Fleet Constant) for 5 sec, 500 to 50 ft HAT</td>
</tr>
<tr>
<td>Config</td>
<td>8. Late Flap Extension</td>
<td>Any flap movement, below 300 ft HAT</td>
</tr>
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<td></td>
<td>9. Late Gear Extension</td>
<td>Any gear movement, below 1000 ft HAT</td>
</tr>
<tr>
<td>GPWS</td>
<td>10. GPWS Alert</td>
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Unstable Approach Criteria - Severity Level Egregious:

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<td>2. Below Glideslope</td>
<td>&gt; 2 dot low for 5 sec, 500 to 200 ft HAT</td>
</tr>
<tr>
<td></td>
<td>3. Localizer Deviation</td>
<td>&gt; 3.5 dot left/right for 5 sec, 500 to 200 ft HAT</td>
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<td>Airspeed</td>
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For the Entire Workbook:

Choose an Event
- Above Glideslope
- Below Glideslope
- Fast Approach (CAS - Vref)
- GPWS ALERT
- High Rate of Descent
- Late Flap Extension
- Late Gear Extension
- Localizer Deviation
- Low Thrust Descent (Kt)
- Slow Approach (CAS - Vref)
- Speed Brakes used During Final Approach
- Unstable Approach (HAT Method)
- Unstable Approach Exceeding 3 Criteria
- Unstable Pitch
- Unstable Roll
- Unstable Yaw

Select a Severity
- 1000 to 500 ft HAT
- 500 to 50 ft HAT
- Egregious

Select a Minimum Flight Count per Airport (default 1,000): 1,000
FDA Outputs

- **Education**
  - Flight Crew Bulletins
  - Corporate Safety Reports (weekly, monthly, quarterly, ad hoc)
  - Current Event Posters
  - Presentations and Animations (Special Airport, training aids)
  - Flight crew training (hot topics, trends, SPOT, CQ etc)
  - Jeppesen Airport Alerts

- **Procedure Modification**
  - Create visual approach procedures to reduce unstable approaches
  - CDA approach procedures and arrival modifications

- **Enhanced Surveillance**
  - Systemic issues that rise above acceptable benchmark norms.
Use of predictive information by US Commercial Aviation Safety Team (CAST)


- Data was used to prioritize air carrier fatal accident risk.

- Safety Enhancement Initiative (SEIs) and Detailed Implementation Plans (DIPs) were developed to reduce the fatal accident risk.

- Predictive data (flight data and air traffic radar data) are used to determine the effectiveness of the SEIs and DIPs.
Use of predictive information by US Commercial Aviation Safety Team

- Predictive data can then be aggregated to form a comprehensive trend for SEI effectiveness monitoring.

Approx 8 Million FOQA Flights
Predictive Hazard Identification - Summary

- Aggregate data, not individual data
- System monitoring, not individual correction
- Early detection of adverse safety trends
- Benchmarking / data sharing opportunities

- AC 120-82 (FAA document) for reference
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