Lima FDA Seminar
Presented by Paul DUBOIS
AIRBUS - Airline SMS & FDA Assistance

PROCESSING
PROCESSING - INTRODUCTION

FLIGHT ANALYSIS PROGRAM

011010100011
RAW data

FAP

Altitude, Speed, Pitch angle & Event...

FDA tool
This module aims at describing the way binary data, extracted from the A/C avionic network, are treated in order to generate relevant safety information.
Be aware
Parameters extracted from avionic buses have not been designed for FDA uses.

Consequence
Sizeable amount of work is needed in order to generate information of a high quality level.
FLIGHT ANALYSIS PROGRAM - FAP

PARAMETERS

EVENT DESIGN

FDA TOOL - AIRFASE
The decoding program, used for actual exploitable values recovery, must be refined and validated by expert engineers and pilots for operational legibility.
FRAME Definition

=> Number of Word Per Second from 64 to 2048 WPS

=> Number of acquired parameters between 250 and 3000

=> Sampling rate From 1/64 Hertz to 8 Hertz

For one aircraft type you can have several different frames and so it will need several different FAP.
FLEET OPERATIONAL LIMITS

- A/C Type
- Key Values
  - Geometry / Engines / Weights Limitations
- Events threshold definition
PROCESSING

FLIGHT ANALYSIS PROGRAM - FAP

PARAMETERS

EVENT DESIGN

FDA TOOL - AIRFASE
PROCESSING - PARAMETERS

SENSOR → Analogic Numeric Converter → A/C Computer

A/C Computer

FDIMU

A/C Systems

FDIMU: Flight Data Interface and Management Unit

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They must be **derived** to become exploitable into the FDA tool.

This derivation allows:

- Automatic wrong parameter filtering
The derivation also allows:

⇒ new parameter development

*example: vertical speed derived from altitude*
Parameters can be derived rather simply

**Boolean Example**

0 = FALSE

1 = TRUE

Derived Parameter = Acquired Parameter
Parameters can be more complex

**Binary Example**

Some can be read quite straightforward:

![Image of gauges showing parameters]

**Derived Parameter**

\[ \text{Acquired Parameter} \times \text{Coefficient} + \text{Offset} \]
Parameters can be more complex

Some others are even more complex:

Configuration Example

- Slats angle values
- Flaps angle values
- Algorithm Range, offset, 0 position value
- Slats position
- Flaps position
- Airbus Slats/Flaps CFG
PROCESSING

FLIGHT ANALYSIS PROGRAM - FAP
PARAMETERS

EVENT DESIGN

FDA TOOL - AIRFASE
Purpose of an FDA tool

Identify **Non-Desired** flight conditions

This is a situation where an aircraft goes **beyond its expected operational envelope**

Such an occurrence is called an **EVENT**
Acquired Parameters

Derived Parameters

Filtered + Created parameters

Events

Specific conditions met during the flight needed to be reported

Readable Safety Data

PROCESSING – EVENT DESIGN
DOC 10000
Manual on Flight Data Analysis Programmes (FDAP)

Chapter 2 Description para 2.3 Processing Data

- Exceedance detection
- Routine measurements
- Incident investigation
- Continuing airworthiness
- Integrated safety analysis.
Exceedance detection

« such as deviations from flight manual limits or SOPs… A set of core events/parameters establishes the main areas of interest to an operator »

« Exceedance data provides factual information which complement crew and engineering reports »

« Operators may also modify the standard set of core events to account for unique situations they regularly experience or for the SOPs they use ». 
The **Flight Phase** information is one of the most central parameter of the system. The **Flight Phases** split the data stream according recognized operational flight phases.
What are the associated hazards?

**Low energy after lift off**
- 1100 - Pitch High at Takeoff
- 1101 - Pitch Rate High at Takeoff
- 1915 - Overweight Takeoff
- 1934 - Takeoff Configuration Warning
- 2020 - Over Rotation at Takeoff

**Windshear**
- 1500 - Vertical Acceleration High at Takeoff
- 1903 - Windshear Warning

**Being out of protected trajectory**
- 1990 - GPS Primary Lost
PROCESSING – EVENT DESIGN

Operator A/C Operation Policy → Expected Operational Envelope → EVENT programming → FDA tool Abilities
EVENT programming is based on two basic attributes of flight parameters: **magnitude** and **duration**:

- **Low severity**
- **Medium severity**
- **High severity**

<table>
<thead>
<tr>
<th>Level</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LOW</td>
<td>A small deviation from the Standard Flight Profile, which would not be serious individually, but which can indicate an unsatisfactory safety situation if occurring in specific areas in statistically significant numbers.</td>
</tr>
<tr>
<td>2</td>
<td>MEDIUM</td>
<td>A significant deviation from the Standard Flight Profile that may indicate a more serious situation, especially if occurring regularly in particular circumstances.</td>
</tr>
<tr>
<td>3</td>
<td>HIGH</td>
<td>A large deviation from the Standard Flight Profile that may have flight safety implications and which should be investigated as an individual event.</td>
</tr>
</tbody>
</table>
2 types of Event

Single Event:

- Measures an exceeding deviation
- Triggers a severity level

Combined event:

- Combination of single events that highlight typical hazard
- Triggers a severity level
SINGLE EVENT

Ex: **Yellow event**: Glideslope high between 1000ft and 500ft
A parameter can be used for several event definitions with different thresholds.

**15xx - Vertical Acceleration**

The Deviation Definition 1500 monitors the vertical acceleration during the rotation phase.
The Deviation Definition 1501 monitors the vertical acceleration during the flight except the rotation and landing portions sections of the flight.
The Deviation Definition 1504 monitors the vertical acceleration at touch down.
### 1500 - Vertical Acceleration High at Takeoff

<table>
<thead>
<tr>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.35 G</td>
<td>1.4 G</td>
<td>1.45 G</td>
</tr>
</tbody>
</table>

### 1501 - Vertical Acceleration High in Flight

<table>
<thead>
<tr>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 G ; 0.6 G</td>
<td>1.6 G ; 0.4 G</td>
<td>1.8 G ; 0.2 G</td>
</tr>
</tbody>
</table>

### 1504 - Vertical Acceleration High at Touchdown

<table>
<thead>
<tr>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 G</td>
<td>1.6 G</td>
<td>1.75 G</td>
</tr>
</tbody>
</table>
1504 - Vertical Acceleration High at Touchdown

This event detects High G landings by monitoring Touchdowns exceeding a Vertical Acceleration of 1.5G.

A severe High G landing might indicate, but not always, a hard landing as per the maintenance definition.
The first vertical acceleration delta from which a maintenance action could be requested is 0.75G (A330).

This is why the 1.75G vertical acceleration value has been chosen.
The event development and algorithms of computation need, as far as possible, to be simple and operationally meaningful.

Events are assessed via comparison, simulation and/or flight tests.
No Event raised when remaining inside the zone

1919 - Level Bust

+ 150 ft

- 150 ft
Event raised when entering and escaping the zone

1919 - Level Bust

Event
No Event raised in case of Go Around

1919 - Level Bust

New Monitoring Window

Go-Around
2) Combined event:

Several single events can be associated to unveil an undesirable situation.
Combined events are rated with the **sum of the severity** of the relevant single events, but ALSO by **analyzing the trend** of the **severity** of the events.

Yellow = Recovery

Red = Degradation
PROCESSING

FLIGHT ANALYSIS PROGRAM - FAP

PARAMETERS

EVENT DESIGN

FDA TOOL - AIRFASE
Flight Access Module
Airport Visualization
List & Trace Module

[Image of a software interface showing various data fields and graphs related to processing and trace module]
Stats & Trends Module

Ratio of Top 10 Events

- Tail Speed High in Turn (031)
- Reversers Abusive Use (1619)
- Rate of Descent High in Approach (3000 ft - 10000 ft) (1402)
- Speed High in Climb (below 10000 ft) (1032)
- Level Eust (1919)
- Braking Delayed at Landing (1029)
- Short Flare Distance (1917)
- Height High at Threshold (1913)
- Speed Low at Touchdown (1023)
- Short Flare Time (1919)

EVENT NAME EVENT CODE

<table>
<thead>
<tr>
<th>Low ratio</th>
<th>Low count</th>
<th>Medium ratio</th>
<th>Medium count</th>
<th>High ratio</th>
<th>High count</th>
<th>Number of Flights</th>
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<td>0.0555</td>
<td>29</td>
<td>0.043</td>
<td>24</td>
<td>471</td>
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<td>0.0555</td>
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RNP Monitoring Module*
The FDA tool is very powerful.

It will tell you

**WHAT** happened,

but not **WHY** it happened…
The FDA tool has some limitations.

It is partially:

- Blind
- Deaf
- Dumb

It needs human expertise for the analysis of the data.
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